Final Evaluation

Machaze Emergency Water Project

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(translated from the original Portuguese)

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EXECUTIVE SUMMARY

ANNEXES

ABBREVIATIONS

ACNUR-UNHCR	UNITED NATIONS HIGH COMMISSIONER FOR REFUGEES
CARE	CARE INTERNATIONAL IN MOZAMBIQUE
CNP	NATIONAL PLANNING COMMISSION
DNA	NATIONAL WATER DIRECTORATE
DNA/SdG	NATIONAL WATER DIRECTORATE/GEO-HYDROLOGY SECTION
DPOPH	PROVINCIAL DIRECTORATE OF PUBLIC WORKS AND HOUSING
EPAR	PROVINCIAL RURAL WATER WORKSHOP
GTZ	GERMAN AGENCY FOR TECHNICAL COOPERATION
OMS-WHO	WORLD HEALTH ORGANIZATION
PEC	DEPARTMENT OF EDUCATION AND COMMUNITY PARTICIPATION (OF NATIONAL RURAL WATER PROGRAM)
PRONAR	NATIONAL RURAL WATER PROGRAM
USAID	UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
VLOM	VILLAGE LEVEL OPERATION AND MAINTENANCE

EXECUTIVE SUMMARY

The Machaze emergency water project has been implemented by CARE from May 1994 to November 1995. The main objectives of the project included:

- to construct 50 deep boreholes, equipped with handpumps;
- to conduct a study of a cost recovery system, and to implement a pilot cost recovery system in 5 communities;
- to train 10 local mechanics in installation, operation and maintenance and basic repairs of handpumps;
- to train community water point caretakers for each water point in handpump operation, basic maintenance and repairs and proper practises of water use;
- to provide sanitary education to the beneficiaries of the water points.

Initially 35 boreholes were planned under the USAID Grant. UNHCR provided financing for an additional 15 boreholes, due to the larger-than-planned number of repatriations to the district.

The project activities aimed to have the following impacts:

- a decrease in the ratio of users to water points northern Machaze, from 9,750 to 2,000;
- the existence of a reliable water source within 7 km for 90% of the beneficiaries.

A final evaluation of the project was executed in October 1995 to assess the outputs of the project and the project's final impact.

Construction of water points

It was found that at the time of the evaluation 51 new boreholes had been constructed, while 4 existing boreholes had been rehabilitated. Hence the number of producing boreholes exceeded the revised project objective.

Of the 55 drilled or rehabilitated boreholes, 27 were equipped with a functioning pump (including 25 handpumps) at the time of the evaluation. 11 installed pumps were not functioning while 17 boreholes were not yet equipped with any pump. The non-functioning pumps included 3 AFRIDEV and 7 VOLANTA handpumps, and one motorpump. Almost all of the pumps that have not yet been installed are VOLANTA pumps. Repair and installation of the 18 VOLANTA pumps has been seriously delayed due to the necessity of ordering new unions from Europe to replace the misdesigned old ones. It is recommended to continue to try to apply alternatives for the VOLANTA pumps.

Cost recovery system in 5 communities

In 53 of the 56 water points that are managed by the communities a collection of funds for maintenance and repairs had been established. The average amount of collected money was MTS 509,804.00 per water point. This value is believed to cover the repair and maintenance costs for an AFRIDEV pump during 1 year. As the VOLANTA is not a VLOM pump, the community contributions will not ensure that pump's sustainability.

During the evaluation it was found that a proper management system with respect to the collection and control of funds had not been studied. An adequate training of the responsible persons is recommended. It is feared that a poor functioning cost recovery

system could lead to a negative attitude of the population in the future towards such a system.

10 local mechanics

During the evaluation it was found that 6 mechanics had received an on-the-job training in installation and repair of AFRIDEV and VOLANTA handpumps.

This training is considered not to be sufficient for all required maintenance and repair activities, especially those required for the VOLANTA pumps. It is recommended to establish a clear structure at district and administrative post level, in order to organize and co-ordinate the activities of the mechanics. The water point caretakers may need assistance in repair and maintenance of the AFRIDEV pumps. The mechanics are also considered to be needed for repair and maintenance of VOLANTA pumps and motorpumps.

Water point caretakers

43 groups of water point caretakers are responsible for 53 of the 56 water points that are managed by the communities. Each group of caretakers received training in proper handpump operation, basic maintenance and repairs of handpumps, and proper practises of water use. A total of 251 caretakers, of which 21% women, have been trained by water technicians of the project and by animators.

With respect to their capacity to repair and maintain AFRIDEV pumps it is considered that only the caretakers trained in 1994 (responsible for 11 water points with AFRIDEV pumps) have sufficient experience. Caretakers for Afridevs mounted recently in 1995 are receiving the same training as the 1994 groups; however they have not yet had experience in repairing breakdowns independently. It is considered that the caretakers are not able to perform maintenance and major repairs on VOLANTA pumps.

During the evaluation the water point caretakers proved to be able to maintain hygienic conditions around the water points and to educate the water user's with respect to safe collection and transport of water.

Sanitary education

35% of the users of the water points (especially women) attended at least one talk by the animators in sanitary education. The animators had received a proper training by the project and were provided by adequate didactic material (flipcharts).

Project impacts

The impact of the project with respect to the pump use in northern Machaze is difficult to quantify accurately, as the available data showed population numbers of the Machaze district ranging from 73,085 to 142,183. In Northern Machaze the population data vary between 53,352 and 99,527. It is therefore concluded that the project resulted in a decrease in the ratio of users in northern Machaze to 1,778 - 3,317 beneficiaries per water point (30 water points) at the time of the evaluation. After the installation and repair of pumps on the remaining boreholes, the pump use will drop to 1,046 - 1,951 beneficiaries per water point in northern Machaze (51 water points).

It is remarked that the water situation in the southern part of Machaze district is still dramatic. At the time of the evaluation the pump use was 9,866 - 21,328 beneficiaries per water point (2 water points), that may decrease to 1,973 - 4,256 after the installation and

repairs of pumps on the remaining boreholes in this area (resulting in 10 water points). For this reason it is recommended to pay special attention to this area in future activities.

The criterion to have a reliable water source within 7 km for 90% of the beneficiaries was established at a time when the distribution of the population was completely different than the current situation. In 1994 the population was concentrated in the central towns of localities and administrative posts. After the elections of October 1994 the population scattered over the area. Considering this new situation, the project mobilized the population to open roads, generally parallel to the existing, mined roads, to the new inhabited areas. As a result 94 km of roads have been opened, specifically for borehole drilling.

Despite of these attempts, an estimated 16% of the population of northern Machaze will continue to live more than 7 km from the water point, after the installation and repair of pumps on the remaining boreholes in this area. In southern Machaze a larger percentage of the population will not have a reliable water source within 7 km distance.

1. INTRODUCTION

1.1. RURAL WATER SUPPLY IN MOZAMBIQUE

29% of the total population in Mozambique have access to improved water points, 30% in the rural areas. Records show considerable disparities in the coverage of water supply in various provinces and districts of the country.

The goal for rural areas in the year 2000 is to increase the level of coverage to 40% of the population, with a level of service in which a borehole or shallow well equipped with an operational manual pump serves 500 people within a radius of 500 m.

The Rural Water National Program (PRONAR) of the Ministry of Public Works and Housing is the institution in charge of planning, implementing and supervising the activities of rural water supply through the Provincial Directorates of Public Works and Housing (DPOPH). Construction works are done by EPARs (Provincial Rural Water Workshops) or by Non-governmental organizations (NGOs).

The national water policy issued in August 1995 considers that: "the participation of the beneficiaries during the phases of planning, implementation, operational management and maintenance, facilitate the effective use of the resources and infrastructures and the availability of appropriate levels of services. The objective consists of providing services in accordance with the demands and economical capacities of the beneficiaries as well as to improve the sustainability of the systems".

PRONAR standardized the use of the Afridev pump for depths up to 45 m. Later on, with the improvement of the durability of the pump rods, this pump was also recommended for depths up to 60 m. The main objective of standardization is to facilitate the training of the local technicians in the installation and repair of the pumps as well as access to the spare parts.

For depths beyond 60 m, PRONAR recommended the use of the Volanta Pump. Due to some problems appearing in the functioning of these pumps in various areas of the country, PRONAR and the different NGO's involved in the supply of water are at the moment inquiring into existing pumps that might replace the Volanta. Also considered is the improvement of the parts of the Volanta pump that are causing problems, as is being done with the Afridev.

The Afridev pump is made in Maputo. Stenaks Enterprise, located in Maputo, commercializes these pumps and at the same time represents Jansen Venneboer, the Volanta pump manufacturer in Holland.

1.2 CARE INTERNATIONAL IN MOZAMBIQUE

CARE International has been working in Mozambique since 1984, essentially in emergency programs. In 1993 CARE became involved in water supply for rural communities in the provinces of Manica and Inhambane (see attached map 1).

1.3 MACHAZE DISTRICT

In 1986 with the division of the district of Mossurize, Province of Manica, the district of Machaze was formed, comprising the Administrative Posts of Chitobe and Save and containing 7 localities (Bassane, Chipudje, Mutefo and Chipopopo in the Administrative Post of Chitobe; and Sambassoca, Mavende and Mabzissanga in the Administrative Post of Save). The District of Machaze is located in the south of Manica Province with area of 13,112 km^2 (see attached map 1).

Since 1978 the population started to emigrate from the district, avoiding the forced villagization 1978/79, the war beginning in 1978, and the drought of 1979. The District population during the 1980 census was 66,951 inhabitants, with 73% of the residents living in the Administrative Post of Chitobe (in the north of the District).

In 1990 and 1992 the District was affected by the drought that hit the country. The rapid survey carried out by CARE in 1993 indicated that the main needs of the population were: water, seed, food, tools, transport, education and health. By the end of 1993 CARE realized that more than 40% of the population depended on food aid.

During the war the district was considered as a buffer zone between Zimbabwe and Renamo bases in neighboring Chibabava district in Sofala province. As a result, most of the population sought refuge outside the district. According to CARE in 1993 the population of the district was estimated at 38,000 inhabitants concentrating in the surroundings of the Administrative Posts and localities.

From 1984 until 1993 access by road to the district was difficult due to the fact that all the roads were mined, and only air access was possible. This delayed rehabilitation work greatly and meant that before any exploratory activity was undertaken, it was necessary to clear the mines from the roads.

At the beginning of the project there were no existing schools and only one Health post.

Currently the population is estimated at 142,183 by the district Administration, including 42,142 repatriated by UNHCR between October 1992 and May 1995, with 70% of the population residing in the Administrative post of Chitobe. The population lives extremely dispersed, and has a higher percentage of women than men, with 18 to 21% of households headed by women.

The district has 9 primary schools type EP1 and one school EP2 with a total of 3,065 students. There is a Health Center in the District seat and 3 Health posts functioning. Two more Health posts are planned to open soon.

1.4 WATER SITUATION IN MACHAZE

The District of Machaze is located in one of the driest areas of Mozambique. Historically, the annual precipitation was 500-700 mm. Currently, the precipitation is lower (about 400 mm). Surface water is scarce and subterranean water is found at great depth.

In 1993, only 5 boreholes of the 25 built in the colonial era were functioning. Some of the boreholes were surrounded by mines and many of the pumps were destroyed during the war. The cement cisterns to collect rainwater were also damaged.

The District also has some other sources of water such as shallow wells, rivers, seasonal ponds, and cisterns. These sources are mainly used during the rainy season and have more risks of being contaminated.

At least 22 shallow wells exist in the District, of which some are reported to be used during the dry season, however, not secure.

Two rivers retain water throughout the year: the Buzi River bordering the north and the Save River bordering the south. The southern part of the district has some streams flowing to the Save river which are: Surrue, Sambassoca, Vumauze and Honde, becoming dry during the dry season. The population living along the rivers supply themselves with water from them.

During the wet season in the north of the district there are seasonal ponds, 0.30 m deep, where the women obtain water supplies. These ponds dry up rapidly. In the south of the district the ponds are deeper, have a bigger surface, and retain water during a longer period. Mabzissanga has a big lake which is an exception in the area since it never dries up.

Particularly in the north of the district there is a practice of having cisterns, usually with a capacity of 5-18 cubic meters. During the 4 months of rain women collect rainwater that accumulates on the surface (in plastic buckets or clay jars) or in cement-lined cisterns.

1.5 CARE INTERNATIONAL IN MACHAZE

CARE projects in the district of Machaze started in 1993. This district was chosen for the reasons that it was severely damaged by the drought and the war, and that there was no other development organization working in the area.

In order to alleviate the problems some projects were designed, three of which are still being implemented:

The **"Manica Water Project,"** financed by USAID, Redd Barna and UNHCR, with an initial duration of 6 months, beginning in July 1993 and which became the "Machaze Emergency Water Project" in 1994. This project benefited the districts of Guro and Machaze.

In Machaze the results of the Manica Water Project were:

- Supply of 20,465 Kg of cement for the repair of 1,338 cisterns;
- rehabilitation of 3 of the 25 old boreholes
- completion of a hydrological survey and identification of at least 25 sites for the opening of new boreholes.

"Food Security and Community Infrastructure Rehabilitation Project" beginning in 1993 and ending 1995. The main activities developed up to the present are:

- construction of 7 schools equipped with their respective latrines, 2000-liter cisterns to collect rainwater, and houses for the teachers;
- Construction of 2 Health posts and houses for health staff
- re-opening of 150 km of road, essentially to allow the installations of water points
- nutritional education and collection of regular information on food security

"Food Security Project" beginning in 1993 with ending planned for December 1995, benefiting repatriated and general population affected by the drought that has affected the district since 1990.

"Machaze Emergency Water Project" beginning in May 1994, ending on 15 November 1995. Evaluated in this document.

The **"Sustainable Agriculture in Machaze (SAM)"** project is planned to start soon and to end in 1998.

1.6 MACHAZE EMERGENCY WATER PROJECT

On May 15 1994, the Machaze Emergency Water Project was started. The project was planned for 18 months (until November 15, 1995) with an initial budget of US$1,585,900 financed by USAID and ODA, with UNHCR subsequently contributing for the drilling of five boreholes during 1994. In 1995, UNHCR provided additional funding for ten more boreholes.

The project had the following objectives:

1. Construction of 50 boreholes equipped with hand pumps
2. Mobilization of the communities to guarantee maintenance of the water points. Also planned was the training of 10 mechanics in installation, operation and basic repairs of hand pumps as well as 88 community members responsible for the water points (two persons for each water point) trained in pump operation and basic maintenance, care of the water point, and proper supply, transport and conservation of water;
3. To provide sanitary education to the beneficiaries including information on transport and adequate conservation of water, the relationship between clean water, good hygiene and good health, and proper use of the hand pumps and boreholes, as well as correct disposal of waste;

4. To increase water consumption per individual (the consumption was estimated to be 2.5 liters per person before the start up of the project);
5. To reduced the average number of users per water point from 9 750 to 2 000 persons;
6. To reduce the distance to the nearest water point to 7 km or less for 90 % of the population;
7. To undertake a study on the viability of a cost recovery system covering maintenance and repairs of pumps; to implement a system to collect funds for the maintenance and repairs of pumps in 5 communities.

The principle technical inputs to the project were:

- A consultancy by Richard Wesson between January and March 1994 studying the water resources in Northern and Southern Machaze District;
- A consultancy by Water Systems Management between August and November 1994 for the supervision of drilling activities. The final report was completed in May 1995;
- A mid-term evaluation done by Ken Vinson in July 1994;
- A cost recovery consultancy done be Alan Malina in February 1995;
- A consultancy done by Karen Isakson on community animation and sanitary education in May 1995;
- An impact evaluation of the project done by Aurelio Gomes between August and September 1995. The final report of the study was not available by the end of the evaluation;
- A consultancy by Jim Barton for the supervision of the drilling campaign lasting from April to October 1995.

2. FINAL EVALUATION

2.1 OBJECTIVES OF THE FINAL EVALUATION

The evaluation's objective is to verify the realization of the following activities:

1. Drilling of 50 boreholes (35 funded by USAID)
2. The new water points are equipped with functioning hand pumps and provide safe water
3. A viability study covering systems for cost recovery for maintenance and repairs is done in five communities.
4. 10 mechanics are trained in installation and basic repairs of hand pumps
5. Community members responsible for each water point (two per water point) are trained in maintenance of hand pumps, basic repairs, care of the water point and collection and safe transport of water.
6. The beneficiaries of the water points receive sanitary education including; information on transport and storage of water, the relationship between clean water, good hygiene and health, the correct use of pumps and wells and the disposal of garbage.

The evaluation also has as an objective to evaluate the following impacts:

1. The use of pumps in the northern zone of the district went from 9 750 to 2000 persons per water point for the 68 000 residents and for the additional 12 000 persons whose return was expected during the project time frame.
2. Supply of safe water operating during the whole year at a distance less than 7 km for 90 % of the beneficiaries.
3. Evaluation of the benefits to the target population of the water points done by CARE.
4. Evaluation of the impact of the project activities in relation to the needs of the population of the district.
5. Evaluation of cost benefit ratio of the project activities.
6. Evaluation of the population's capability to keep the water point operational providing safe water after the departure of CARE.
7. The impact of the project activities on women and children of less than 5 years.
8. Environmental impact of the project activities as defined in the agreement with USAID.

2.2 METHODOLOGY OF THE EVALUATION

The final project evaluation took place during three weeks between October 12 and November 1, 1995. The evaluation team was composed of three consultants: one sociologist and two geohydrologists. (Annex 2 contains the terms of reference for the evaluation team.)

Annex 3 shows a summary of the activities realized by the evaluation. The methodology utilized for the evaluation was essentially based on the analysis of documentation. Annex 4 contains the bibliography of the documents that were consulted. It is necessary to emphasize that the results of the impact evaluation done in September 1995 by Aurelio Gomes were not available by the end of the evaluation and therefore no reference is made about this document in this final evaluation. Interviews with persons and entities involved in the project were done (see annex 5) and field visits and direct observation activities were undertaken. Besides this, the evaluation team participated in a seminar for traditional leaders and leaders of the Administrative Posts and communities in the District.

The evaluation team visited 61 out of the 63 existing boreholes in the district. A survey was done on the situation in each borehole with respect to borehole siting, quantity and quality of water, presence of possible sources of contamination, pump function and verified breakdowns, and the state of sanitary protection. A standard form was developed for this survey (annex 6).

In each of the 55 boreholes opened or rehabilitated by the project in Machaze district, semi-structured interviews were done with groups of 10 women chosen for this, with members of the maintenance groups and with the executive committees of the location. Ongoing activities of the animators were accompanied such as the handover of pumps, training of maintenance groups, meetings with the executive committees and sanitary education discussions.

All technical staff involved in the project were interviewed individually following a pre-established questionnaire. At the beginning of the visit to Machaze a meeting took place with the animators.

The evaluation team was present in a meeting organized by UNHCR, CARE and the District Administration with 80 traditional leaders responsible at the level of Administrative Posts and localities. The District Administrator participated in the seminar as well as the project monitors with the objective to analyze the activities undertaken in the District under the various projects. The discussions and deliberations began with a discussion about the different aspects of the emergency water program for Machaze which resulted in the elimination of the other planned meeting on the same topic.

3. TECHNICAL IMPLEMENTATION

3.1 INTRODUCTION

The evaluation of the technical implementation of the project, which is the subject of this chapter, refers primarily to the borehole construction program. Chapter 4 covers community participation in the operations, maintenance and repairs of the boreholes and systems for cost recovery, together with the evaluation of their sustainability.

Within the technical implementation program five areas of activities can be distinguished, namely:

- the evaluation of groundwater potential
- site selection for the drilling
- the drilling campaign
- construction of sanitary protection (wellheads)
- the installation of the pump.

Although the first three activities cannot be done entirely separately, in this evaluation all activities referenced above are analyzed in separate paragraphs. Paragraph 3.2 covers the evaluation of potential. Paragraph 3.4 covers the aspects relative to the drilling campaign; construction of wellheads and the installation of pumps are covered under paragraph 3.5 and 3.6 respectively. Finally, paragraph 3.7 and 3.8 present the major findings and recommendations with respect to the technical implementation of the project.

3.2 EVALUATION OF GROUNDWATER POTENTIAL

First phase

During the first phase, the evaluation of groundwater potential was done by using the study of hydrological resources of Northern and Southern Machaze (Africa Water Development, March 1994).

The study indicates that subterranean water was the only reliable source. Other water sources such as shallow wells, rivers, dams and cisterns are mainly used during the rainy season and moreover they have major risks of being contaminated (see also paragraph 1.4)

Because during the 8-month dry season, the shallow wells become dry, it is necessary to access deep groundwater.

In the aforementioned study, besides the evaluation of potential in terms of hydrological resources, a hypothesis on the hydro-geology of the area was generated. The study indicated that the aquifers (layers in the subsoil that contain and can yield groundwater) are at great depth, often more than 100 meters.

The groundwater potential was not evaluated in terms of volume that could be collected. The study limited itself to recommending that the drilling campaign be accompanied by an evaluation of aquifer recharge (by calculating the age of the water) and by recording geological layers revealed by drilling.

Due to the weak foundations of this hydrogeological hypothesis, it was recommended to confirm it using a geophysical survey. It was also recommended that the first phase of the project be executed by a drilling contractor, a hydrogeologist and a geophysicist, all well qualified, in order to improve the knowledge of the area's hydrogeology.

On the basis of these recommendations CARE contacted DNA/SdG to accomplish the geophysical survey; however in the end this was considered not advisable due to the probable unreliability of the results. DNA/SdG doubted that the survey would yield accurate results because, if the hypothesis of aquifer depth were correct, their existing equipment and techniques would be unable to scan that deep. Hiring a foreign geophysical company with different techniques would incur high costs with the risks of obtaining no better results; therefore CARE never considered that option. It was assumed that there were enough indications of the existence of a productive aquifer. In this way it was decided that the first phase of the project would be executed without a geophysical survey.

In conclusion, the first phase of the drilling was executed without an in-depth evaluation of groundwater potential. Given the conditions mentioned above, the decision to not do the geophysical survey or any other study evaluating the groundwater potential is considered logical and well-considered. It is considered that CARE's attitude to involve the opinions of many parties in this phase of the project was professional.

Second Phase

For the second phase the groundwater potential was evaluated based on the information and experiences from the first phase, the above mentioned water resources survey (Wesson, March 1994), and two more:

- Evaluation of the drilling results in the Machaze district -- First phase of the project (WSM, May 1995);

- Geophysical Study (DNA/SdG, 1995)

Besides of the good results of the 1994 drilling, the first document gives a preliminary hydrogeological picture of the area, thus contributing to the evaluation of groundwater potential for the second phase.

In 1995 CARE, planning to enter unexplored areas, tried to clarify some doubts on the potential of these areas, especially concerning the depths of the water. Once again DNA/SdG was contacted to obtain recommendations on new drilling sites. From this contact it was decided to perform a limited geophysical survey, beginning with a calibration of the hydrogeological model using information obtained during the first phase of the drilling. Project staff reported to the evaluation team that, although additional data was obtained, the results were not encouraging, since the data were not easy to interpret (confirming the limitations of this survey technique in this geology). Thus, the geophysical survey did not give clear indications of groundwater potential, but nonetheless, DNA was able to make recommendations about drilling sites based on a geomorphologic evaluation of the area and an analysis of data of nearby boreholes.

During this evaluation it was not possible to analyze the results of the geophysical survey since the document was not available.

CARE considered that they had obtained all possible data, and there was no need to obtain more information. Considering all the activities above mentioned, it is concluded that it was logical to not perform more surveys on the groundwater potential for the second phase.

An important fact is that besides consulting the three documents cited above, the supervisor in the second phase of the drilling always analyzed carefully the results of each new drilling. His professional competence gave a clearer image of the hydrogeology of the area and the groundwater potential in terms of depths and yields (See 3.3).

In conclusion, the good results of the drilling in the first phase, including the hydrogeological interpretation, helped in the evaluation of the groundwater potential for the second phase. This information as well as the professional competence of the drilling supervisor facilitated evaluation of groundwater potential as much as circumstances permitted.

3.3. SITE SELECTION FOR DRILLING

During the first phase of the project the selection of sites to drill was based principally on the needs (areas where the population was concentrated) and accessibility of an area, more than technical considerations.

In March 1994 in the north of the district, most communities had to obtain water from distances involving 6-9 hours of travel from their houses. Women residing in farther communities had to walk up to 60 km round trip. During the dry season, waiting time at the pump was sometimes more than two days, in lines of up to 500 women. The south area was more favored, having surface water closer to the communities, although often contaminated.

The situation became more difficult with the repatriation of the refugees organized by UNHCR beginning October 1992. Until July 1994 the majority of the population was not

back yet to their original areas due to the uncertainty about the country's political future, and therefore most stayed crowded together in the central towns.

The first phase of the drilling (1994) benefited essentially population groups that at this stage were agglomerated in the central towns of the Administrative Posts and localities. In May 1994 there existed only one road in the district, allowing access between Chibabava and the district seat.

The project's orientation about which communities should receive a water point was pre-defined at the level of the district administration, in coordination with UNHCR. For each community the decision about the exact siting of the borehole was taken by an assembly with the participation of men and women, without giving any chance to women to decide separately. Due to traditional customs of relations between men and women it is suspected that often these decisions were based more on men's opinions. In this period, the project was in its initial phase and did not yet have much influence in gender relations.

In many cases, the population selected areas corresponding to their places of residence before the period of forced villagization. Consequently, they voluntarily opened many kilometers of road to replace old mined roads.

In the second phase the village of Usa was chosen by the district administration to receive a borehole, but this was not possible due to the impossibility of constructing more than 20 km of road between Bassane and Usa. CARE tried to organized the work but the population was unable to accomplish its task.

In the second phase of the project, technical issues were also considered during borehole site selection, given the improvement of road access within the district. Besides the priorities of the District Administration and the preferences of the population, the geomorphology and lithology of the area were evaluated. Some additional boreholes were constructed in the areas where results of the 1st phase showed good conditions. Map 2 shows borehole locations. In principle it was sought to site the new boreholes in areas with lower topographic levels. The drill supervisor analyzed carefully the results of each drilling to obtain a clearer picture of the hydrogeology. The fact that he accompanied the geophysical survey is important.

It is concluded that the technical aspects evaluated to select drill sites was logical, and the capacity of the drill supervisor to interpret data obtained from the drilling contributed to improve the selection (from a technical point of view) of drill sites. It was also considered that his involvement in the geophysical survey was very useful.

3.4. DRILLING CAMPAIGN

3.4.1. INTRODUCTION

For a successful drilling campaign the following are necessary (besides good hydrogeological conditions):

- Qualified personnel and good organization
- appropriate equipment
- proper borehole construction (being the drilling operation, installation of filters and casing, placement of gravel pack and backfill, cleaning and development of the borehole, and execution and analysis of pump testing);
- good data documentation

Personnel organization and qualifications are covered in Par. 3.4.2. Paragraph 3.4.3. presents the equipment used to achieve the work. Aspects of borehole construction are shown in paragraph 3.4.4, and Par. 3.4.5. treats the documentation of results obtained.

3.4.2. PERSONNEL AND ORGANIZATION

Drilling Company
The selection of the drilling company was done through a competition addressed to seven firms in Mozambique, South Africa and Zimbabwe (being all drilling firms known to CARE). In the second phase, a tender announcement was placed in the Maputo newspapers, fulfilling the recommendations of PRONAR for bidding procedures on work of more than 10 boreholes. In the second phase PRONAR participated in the analysis of the tenders. Terrasearch was selected for the execution of the job.

According to the drill supervisor as well as the government inspector, the work of Terrasearch was of good quality and demonstrated their capacity for such work.

Supervisor
For the first phase a consultant was contracted for the supervision of the drilling, responsible for the good technical implementation of the project. The technical supervision of the first phase was done by Chris Lomberg (1 month) and Pierre Wilkin (1 month), both working for WSM. While it was impossible to contact these people, both were considered competent based on the report done by them (WSM, May 1995) and the information provided by the government inspector.

In the second phase the technical supervision was done by Jim Barton, a Civil Engineer contracted by CARE. Due to his training and experience on other CARE projects he is considered to have the qualifications for this task.

Inspector

For the first and the second phase of the project an independent inspector was contracted, responsible for the monitoring fulfillment of national technical criteria for borehole construction, data collection, and quality control of the drilling company. This contracting of the inspector was in line with PRONAR recommendations. CARE contracted DNA/SdG for the monitoring of the first phase.

In the first phase the inspection was done by Sergio Bento, intermediary hydraulic technician (2 months) and Ben Lamoree, civil engineer (10 days), both from DNA/SdG. They worked together during the initial phase of the drilling program, as it was considered to be a critical phase, and due to the limited experience of Sergio Bento at that time.

The inspector of the first phase produced a report including the results of the monitoring, all technical data, record of hydrogeological data, results of test pumping and the siting of the boreholes.

From the reports it is concluded that the involvement of a good inspector is indispensable in this type of project. Especially in the initial phase of the drilling the presence of an inspector contributed significantly to the fulfillment of the technical norms of borehole construction by the contractor.

CARE contracted DPOPH-Chimoio for the inspection of the second phase. The inspection was done by Mr. Mikas and Luis Jange Bomba, the latter being a basic technician in water supply and sanitation. While their final report was not yet available during the evaluation, it is unlikely that Mr. Bomba has sufficient training and experience in this type of work to complete his duties. It was impossible to contact Mr. Mikas during the evaluation. It was reported that he had better experience. It must be pointed out that it was the responsibility of DPOPH to provide competent inspectors. Both monitors received a course in borehole inspection in 1994. It is considered that inspection of drilling is a very important activity which must be done conforming to the criteria of DNA.

Organization

The cooperation and communication among the different parties involved in the technical execution was reported as having been good, with the participation of all in decision-making. The project manager contributed significantly to the clarification of duties of all involved parties, participating actively in the initial phase of the drilling.

3.4.3 DRILLING METHODOLOGY AND DRILLING EQUIPMENT

The drilling contractor, Terrasearch, used a rotary-percussion drill rig equipped with a down-the-hole air hammer as well as a rotary drill bit with circulation of water or mud.

The first method uses compressed air that is injected into the borehole and hammers the drill bit while it rotates. The broken materials are forced out by air pressure. This methodology is very appropriate for consolidated formations.

The rotary method with water or mud circulation is applied in unconsolidated formations. The water or mud serves to maintain the stability of the borehole walls in unconsolidated formations.

Having both methods available, Terrasearch was able to drill in all locations.

The evaluation concludes that Terrasearch had the appropriate equipment for the execution of the contract. The availability of two drilling methods contributed significantly to the good results of the drilling.

3.4.4 CONSTRUCTION OF BOREHOLES

The construction of a borehole consists of the following separate operations:

- Drilling
- installation of screen and casing
- placement of the gravel pack and backfill
- cleaning and development of the borehole
- test pumping and analysis of the water yield

Drilling
Paragraph 3.4.3 covers the different methods of drilling applicable. Problems were observed when the rotary percussion method with air injection was applied in unconsolidated formations. At times, the chemical material (foam) used to maintain stability in the borehole walls was not sufficiently viscous, which required the use of a different method (using mud) leading to some delays.

One problem with the rotary method when using mud is the necessity of (in some cases large quantities of up to 10,000 liters) of water, which had to be transported over distances. There were cases in which the borehole absorbed a lot of water, more than Terrasearch had brought to the site, thereby leading to interruptions in the drilling.

These delays are however considered unavoidable.

The drilling was done with a diameter of 203 mm in the unconsolidated superficial sediments (generally to a depth of 5 to 20 meters), and a diameter of 165 mm to the bottom of the borehole. Therefore it was impossible to install screens of 150 mm diameter as recommended (Wesson, March 1994)

By applying a smaller diameter, the costs of the drilling were reduced, which also limited the capacity of each borehole. It must be noted that there is no capacity problem when installing hand pumps (see also paragraph 4.2.2) or small motorized pumps. Only in case of a future installation of large pumps, the diameter could result in limits in terms of yield. To augment the yield of the borehole, screens of greater length were installed in boreholes where this was expected to be required at a later date.

Given,
- that the life of a borehole is generally longer than the life span of a pump
- the shortage of water in the area (even after the end of the project)
- the uncertainties with relations to future migration of the population
- the demonstrated difficulties with hand pumps in the deep boreholes,

The application of a larger diameter in the drilling is recommended especially in the locations with heavy use of the borehole and in areas where a possibility exists of the installation of pumps with a larger capacity (for example diesel pumps). This guarantees more flexibility for the installation of water supply systems in the future. It should be noted however that the installation of screens of greater length guaranteed a certain flexibility in this context. It must also be pointed out that the contractor did not have screens and casing of different diameter available.

Installation of screens and casing
PVC filters were applied (110 mm and 125 mm of internal and external diameter respectively). Neither the supervisor of the first phase nor the inspectors supplied data on the opening area of the screens. It is recommended that the inspector include this information in his report (the drill supervisor of the second phase reported an opening area of 2.7%).

The length of the screens varies between 6 to 21 m, with values from 6 and 12 m. more frequent. Data provided by the supervisor and the monitor do not always match.

The slot size of the screens used in the first phase are reported to have not respected the dimensions requested to the drilling company, being slightly bigger. It was not possible to evaluate the risk of entry of fine particles because the granulometric information of the aquifers was not available. As an artificial gravel pack was put into place, the danger of this was minimal. In the second phase, better quality screens were used.

Nevertheless, we agree with the recommendations of the inspector, to apply screens with certified slot width to guarantee uniformity of the slots. It should be noted that the screens determine to a high degree the good function and productivity of a borehole.

According to the inspector, centralisers were not used to install the screens in the center of the boreholes. Considering that the screens could lean on the side of the borehole, this would diminish the function of the borehole and augment the risk of blockage of the borehole by fine aquifer particles. It would be prudent to use centralisers in the construction of boreholes.

Below the screen a sand trap must be installed to collect fine particles that enter the borehole. In cases where the sand trap was not installed, the length of the screen was increased (this was not done in a few boreholes). It is a practical alternative to increase the length of the screen instead of installing a sand trap.

Installation of the backfill and gravel pack
An artificial gravel pack was applied. Neither the drill supervisor nor the inspector provided data concerning the grain size or the placement of the gravel pack. It is recommend that the inspector include such information in his report.

The diameter between the casing and the borehole walls was filled with original material drilled from the subsoil, which is a correct practice. The inspector reported that such a backfill was requested by him, as the drilling company initially forgot this activity. This confirms how essential the inspector is

Cleaning and development of the borehole
After installing the screen, the casing and gravel pack, the borehole was cleaned and developed by pumping the hole with a submersible pump. The pumping was done at a rate of 2 - 5 cubic meters per hour.

Observations in the field indicate that the boreholes were well cleaned and developed, there was no presence of sand in the water.

A possible contamination of nitrate was noticed in two boreholes (see paragraph 4.2.3)

Execution and analysis of the pump test
The objective of a pump test is to quantify the production capacity of a borehole and to analyze the quality of the construction.

The capacity of the borehole was estimated during the drilling. The yield applied during the development and the cleaning of the borehole was not sufficient to rigorously quantify the capacity of a borehole. Also, the yield was not appropriately controlled, resulting in unreliable data.

The results obtained demonstrate that the capacity is sufficient for hand pumps. The majority of the boreholes proved to have sufficient capacity for the installation of larger pumps (for example diesel pumps). However, in case of a future installation of a motorized pump it will be necessary to carry out scaled yield tests (step tests) in the borehole. This will allow the installation of the appropriate pump. CARE had not considered the installation of any type of pump other than hand pumps; therefore these tests were not done during the first phase.

In conclusion, an appropriate yield test was not completed. In case of the installation of a motorized pump, step tests of yield must be done.

Drilling results

Given the weak knowledge of the hydrogeology and the groundwater potential of the area, the results of the first drilling phase (77% positive) are considered very good, and the results of the second phase (94 % positive) excellent.

Documentation
The drilling supervisor of the first phase and the inspector prepared a report on the drilling campaign. Both used different systems to record the boreholes, making it difficult to compare the reports. Generally, the reports are complete. In the monitor's report some essential data on the screens (opening area), gravel pack and sealing of the boreholes were missing.

3.5. SANITARY PROTECTION CONSTRUCTION (WELLHEADS)

Sanitary protection consists of sealing the boreholes by cementing the opening space between the casing and the wall of the borehole to a minimum of six meters depth below the surface, and the construction of a wellhead with drainage. Information of the sealing of the wellheads were not provided by the inspector. It was reported that the drilling company did not satisfy this requirement.

The wellheads were constructed by a private company. The fact that Rural Water Provincial Workshop (EPAR) was not contracted was discussed and approved by the Provincial Director of Public Works (DPOPH).

Table 4 (Annex 1) shows the situation of the wellheads during the evaluation. It was concluded that the wellheads were in good conditions. Wellheads built during the first phase were inspected by DPOPH employees in November 1994. It was concluded that the wellheads were built according to PRONAR criteria, but recommending that they have a drainage length of 4 instead of 3 meters. However, during the evaluation it was observed that the size of the wellheads do not allow an easy pumping operation by the users (see Par. 5.1.7).

3.6. PUMP INSTALLATION

The pumps were installed by CARE technicians, with the help of the communities. The mounting of the pumps during the first phase was supervised by the DPOPH inspectors in November 1994. It was concluded that the pumps were mounted assembled in accordance with PRONAR criteria.

The pumps installed in the second phase were not yet inspected. It was noticed that in some cases there were some defects in the installations of the pumps that made the pumping action difficult.

3.7. CONCLUSIONS

1. The first phase of the drilling was executed without a thorough evaluation of the groundwater potential. Given the conditions, the decision not to carry out any geophysical surveys or additional studies is considered logical and prudent.

   It is considered that CARE's attitude in involving more outside parties in the first phase of drilling was of professional character.

2. The good documentation of the results of the first phase of drilling, as well as the professional competence of the drilling supervisor in the second phase, made it easier to evaluate the groundwater potential in the second phase.

3. During the first phase of the project, the site selection for drilling was mainly based on needs and access to the area, according to the district Administration's priorities in coordination with UNHCR, and to the preferences of the population. During the second phase of the project, technical aspects were also considered such as geomorphology, topography and lithology of the area.

4. The drilling contractor TERRASEARCH, all the drilling supervisors and DNA inspectors proved to be qualified to achieve the job. Although the DPOPH inspector monitor had not yet finished his report at the time of this evaluation, there were some doubts as to his experience and training for this kind of task. The responsibility of providing an inspector is the Government's (DPOPH).

   Cooperation and communication among the different parties involved in the execution of the drilling activities were good, with the participation of all in the decision making process.

5. The contractor (TERRASEARCH) had the appropriate equipment for the task. The availability of two drilling methods contributed significantly to the good results of the drilling.

6. The application of a larger drilling diameter would be better. This would guarantee more flexibility concerning the type of water supply system to be installed in the future, especially in the zones with high population concentrations. It must be mentioned that longer screens were used in the boreholes where a possible installation of a larger pump is anticipated. This guarantees a certain flexibility in this context.

7. No appropriate yield tests were done in the boreholes that will be equipped with motorized pumps. Most boreholes were shown to have the capacity for the installation of such pumps (for example diesel pumps).

8. The involvement of a qualified inspector is essential in this type of project.

9. Given the weak knowledge of the hydrogeology and the groundwater potential of the area, the results of the first drilling phase (77% positive) are considered very good, and the results of the second phase (94 % positive) excellent.

3.8. RECOMMENDATIONS

1. In case of future installation of motorized pumps, a scaled yield test (step test) must be done and analyzed prior to the selection of the pump.

4. SUSTAINABILITY

4.1 Introduction

Sustainability is understood to be the capacity of the structures responsible at the national (DNA, PRONAR), provincial (EPAR), district, and community levels, to assure the good functioning of the water points after the end of the project.

To evaluate the sustainability of the systems, the technical reliability of the systems (paragraph 4.2) the human resources (paragraph 4.3), and the costs of systems implementation and maintenance (paragraph 4.4) are analyzed.

4.2 RELIABILITY OF THE SYSTEMS

4.2.1 Generalities

The evaluation of water resources in Machaze District (Wesson, 1994) showed that deep boreholes (groundwater) are the only sources that could guarantee good quality water during the whole year. Other water sources such as rivers, dams and cisterns are mainly used during the rainy season. Besides, these sources have greater risks of being contaminated.

This evaluation considers only the reliability of the borehole system, as other sources are not reliable in terms of quality and/or quantity.

The technical reliability of boreholes depends on the availability and quality of water, the quality (performance) of the pumps, and the capacity of the community to maintain and repair the systems. These aspects are analyzed in paragraphs 4.2.2, 4.2.3, 4.2.4 and 4.2.5 respectively. Paragraphs 4.2.6 and 4.2.7 summarize the major conclusions and recommendations.

4.2.2 Availability of water

Availability of water is defined here as the capacity of a system to produce water. This depends on the capacity of the borehole and of the pumps installed, and the number of boreholes in operation.

Borehole and Pump Capacity

Table 1 (Annex 1) shows the estimated borehole yields, measured after each borehole's construction. Although the determination of yields was not made in an exact way (see also paragraph 3.4.4), it can be concluded from this table that the availability of water at the water points is mainly conditional on the capacity of the handpumps installed, given that the boreholes in general show a greater capacity than the pumps. This observation was confirmed during field visits. Out of 34 boreholes operating at the moment of this evaluation, only two boreholes do not have the capacity to provide water during the whole day (when being operated continuously!). These are boreholes MCZ/95/016 and MCZ/94/R3. These boreholes have an intermittent operation with intervals of about 20 minutes in function and 10 minutes recuperation (for the water level to recover).

This means that the majority of boreholes have sufficient capacity for future installation of pumps of larger capacity (for example diesel pumps).

Field observations show that the pumping capacity of the AFRIDEV pump is on the order of 500 to 800 liters per hour.

Number of boreholes in operation

Table 2 describes the current operation of water systems in Machaze District. As of the period of this evaluation, 34 boreholes were operating. At the end of this project, 63 boreholes are planned to be operating. Communities will be responsible for 56 of those boreholes (see paragraph 4.2.5)

Of these 63 boreholes, 55 were rehabilitated or constructed as part of this project. As of this evaluation, 27 of the project's boreholes were equipped with pumps, 25 of these being hand pumps.

The low number of boreholes currently in operation is mainly due to the poor performance of the VOLANTA pumps. Many of the VOLANTA pumps have not yet been installed, pending resolution of technical problems (see paragraph 4.2.4). The installation of these pumps is planned to take place as soon as possible. The temporary installation of other types of handpumps was not authorized by PRONAR.

18 boreholes have no pump installed yet. Field observations show that boreholes with wellheads and still awaiting the installation of a pump are poorly protected, with the casing open, thereby allowing the entry of sand into the borehole, besides the risk of sabotage.

Table 2. Operational data on boreholes

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ConditionError! Bookmark not defined.	Hand Pumps			Motorized pumps		Not yet defined	Total
	Afridev	Volanta	Bush Pump (GTZ)	Diesel	Electric		
Working	24	6	1	2	1	0	34
out of order	3	7	0	1	0	0	11
Not installed	2	11	0	0	1	4	18
TOTAL	29	24	1	3	2	4	63

Long-term availability

To evaluate the availability of water over the long term it will be necessary to consider the replenishment of the sources, evaluating the recharge and the reserves of the aquifer under exploration. The evaluation done to date, using hydro-chemical methods, is still very limited and must be reinforced using more in-depth investigations. Additionally, the water levels of the boreholes must be monitored over time, for example by doing measurements when repairing pumps, in lieu of more systematic data collection.

4.2.3 QUALITY OF WATER AT THE WATER POINT

The quality evaluation of water for consumption was done by comparing the results of some chemical analysis of the water points with WHO and South African standards for drinking water. For the first phase of the project, 9 samples were analyzed with respect to pH, TDS, EC; and Ca, Mg, Na, K, HCO_3, Cl, SO_4, NO_3, Fl, and Fe. Of these samples, four were analyzed by the Maputo water utility, and five by the municipal laboratory of Pietersburg, South Africa. The Maputo laboratory did not analyze K and Fl in all samples, nor Fe in two samples.

An analysis of the results showed relatively large errors in the ionic balance for the Maputo laboratory varying between 39 and 62%, while ionic balance errors from Pietersburg were between 13 and 57%. In two samples the limits for "low risks" were exceeded by at least one parameter (ion). In four additional samples, the maximum limit for "insignificant risk" was exceeded.

Later, samples from two boreholes with critical water quality were again collected and analyzed, in the Provincial laboratory of the Manica Water utility in Chimoio. These analyses indicated that the water in boreholes WSM-29 and WSM-13 are inappropriate for human consumption due to bacteriological contamination. There is however some doubt that these samples were collected correctly (i.e., in a sterilized bottle). This possible contamination must be confirmed by a water analysis using appropriate methods of sample collection.

This same analysis showed a difference in the nitrate content of a factor between ten and one hundred, relative to the analysis done in Pietersburg. It was impossible to calculate the ionic balance, as the analysis was incomplete. The values obtained in the other parameters showed inconceivable values and it must be concluded that the analyses done in the Chimoio laboratory are probably not reliable.

Besides these laboratory analyses, the electro-conductivity (EC) was measured after each borehole's drilling. Table 3 (annex 1) shows the results of this analysis. The data show that in many cases (20) the salinity levels are above the WHO limits. It was not possible to reconfirm these values (because not all boreholes yet have functioning pumps). However, a qualitative analysis done during the evaluation showed that in a significant number of boreholes (1/3) the water was hard.

An analysis done in the field of a sample of one borehole in Mussimbe (CARE/MCZ/95/013) showed a very high value of nitrate (almost 100 mg/l), which is ten times higher than the WHO recommended values and indicates water contamination.

On the basis of the results of the analyses, which show that the majority of collected samples contain elevated values in certain parameters, the conclusion is that is will be necessary to proceed with the analysis of samples from all boreholes. Only after such a program of systematic analysis can recommendations be made about a future periodic water quality monitoring program.

The closure of boreholes with nitrate values above the limits is not considered appropriate due to the shortage of water in the area. It is recommended to do a better analysis of the possible risks of high nitrate levels and to balance these risks against the use of water from other water sources. It must also be considered that if the high level of nitrate is due to a contamination of the borehole during the drilling activities, this contamination could be removed by pumping the borehole. It is recommended to pump the boreholes and periodically (for example every hour) analyze the nitrate levels to determine what eventual reduction occurs.

It is also clear that the water quality for the user depends not only on the quality at the source but also on the hygiene practices in the use and maintenance of the resources (see below for more on this point on hygiene education).

Protection against contamination
One of the activities necessary to guarantee the long-term reliability of the systems, in terms of quality, is the elimination of potential sources for contamination, for example latrines, septic tanks, abandoned boreholes that are not sealed, and seals and drains that do not satisfy the criteria for protection of boreholes. A summary of existing sources of contamination is presented in table 4 (annex 1). The conclusion is that there is still 8 latrines in a distance of less than 50 meters and that there are two old unsealed boreholes. The elimination of these latrines and old boreholes is recommended.

4.2.4 PUMP PERFORMANCE

In Machaze District, until now, 41 handpumps have been installed, including 27 AFRIDEVs, 13 VOLANTAs, and 1 Bushpump (GTZ borehole), as well as one electrical pump (by CARE, financed by UNHCR). There are also three diesel pumps (installed by other agencies; see paragraph 4.2.5). In this evaluation only the performance of the AFRIDEV and VOLANTA handpumps is analyzed.

The performance evaluation of the handpumps was done during field visits, through visual inspection and interviews with members of maintenance groups. Also, forms registering breakdowns were analyzed when available. The data obtained were verified with the survey done by CARE between June 22 and 28, 1995.

AFRIDEV
The installation of the AFRIDEV pump for depths of up to 60 meters was done in accordance with recommendations from PRONAR regarding the use of a standardized handpump suitable for decentralized maintenance.

Table 5 shows the performance and the verified breakdowns to date of the AFRIDEV pumps. The conclusion is that most pumps have broken down at least once since their installation. Of the 12 pumps in operation for more than one year, only 6 have never broken down or had only minor breakdowns (bearings or U-rings). The pumps installed at boreholes with relatively shallower water levels (up to 40 - 45 meters) show significantly less breakdowns than the AFRIDEV pumps installed on boreholes of greater depth. The most frequent breakdowns are worn-out plastic bush bearing and the rupture of the PVC rising main.

Probably, the excessive use of the pumps contributes significantly to the number of breakdowns registered (see paragraph 5.1.2). Field observations show that many pumps are operated continuously, thus serving thousands of people. The national policy is to install one pump for 500 people.

There is no systematic recording yet at the community level of breakdowns. The breakdowns are registered centrally by CARE in Machaze. It is recommended to introduce such a system, or improve the current system, to have the communities record breakdowns. This will allow for a future evaluation of pump performance and of the capacity of the communities to maintain and repair the pumps.

Table 5. Breakdowns of the AFRIDEV pumps

No. of BOREHOLES **Error! Bookmark not defined.**	Date of Installation	Cylinder depth	Bearings	"U" rings	Ruptures of pipes	Unions	Rods	Others
MCZ/95/013	07/9/95	58	0	0	0	1	0	----
WSM-22	20/10/94	35.2	0	0	0	0	0	----
MCZ/95/010	22/8/95	46.4	0	0	0	0	0	----
MCZ/95/022	7/9/95	58	0	0	0	0	0	----
MCZ/95/023	7/9//95	58	0	0	0	0	0	----
WSM-24	01/12/94	55.5	0	1	0	1	0	tubes separated
WSM-23	5/12/94	55.5	2	0	1	0	2	----
WSM-2	15/9/94	35.2	0	0	0	0	0	----
MWI/93/R1	--/11/93	35.2	3	0	0	0	0	----
WSM-27	17/12/94	35.2	0	0	0	0	0	----
WSM-28	12/12/94	35.2	2	1	0	0	0	fulcrum pin broke
WSM-19	17/11/94	60.85	2	0	3	0	0	----
WSM-17	27/10/94	60.85	2	0	4	0	1	----
WSM-18	27/10/94	52.30	1	0	3	0	2	----
MCZ/95/025	28/9/95	43.5	0	0	0	0	0	cylinder fell off
MCZ/95/003	7/7/95	49.3	1	0	0	0	0	----
MCZ/95/R2	7/6/95	52.2	0	0	0	0	1	rod centralizer
MCZ/94/R2	-/3/95	49.3	4	0	0	0	0	piston broke
MCZ/95/016	13/9/95	49.3	0	0	0	0	0	----
MCZ/95/017	12/9/95	49.3	0	0	0	0	0	----
MCZ/95/018	12/7/95	49.3	0	0	0	0	0	----
MCZ/95/019	15/9/95	43.5	0	0	0	0	0	----
MCZ/95/020	15/9/95	43.5	0	0	0	0	0	----
WSM-8	26/9/94	46.6	1	3	0	0	0	----
Chipudje (EPAR)	--/--/92	42.75	1	1	3	0	0	----
MCZ/95/011	23/8/95	40.6	0	0	0	0	0	welded handle
MCZ/95/012	23/8/95	49.3	0	0	0	0	0	----

VOLANTA

For depths between 60 and 80m, CARE installed Volanta pumps, as recommended by PRONAR.

From the beginning, Volanta pump performance has been bad. All VOLANTA pumps already installed (13) have broken down already at least once within 3 months. During the evaluation period only 6 of the planned 24 VOLANTA pumps were functioning. The registered breakdowns were mainly failures of the rising main unions. These unions were poorly designed, resulting in their breakage (or un-gluing) shortly after installation. The project was obligated to order new improved unions from Europe, which during this evaluation were still held up in customs. After the unions clear customs, the remaining VOLANTA pumps will be installed.

In August 1995 CARE installed 4 Volanta pumps with stronger unions, supplied from South Africa by the drilling company. As of this evaluation the 4 pumps were still functioning.

In conclusion, the performance of the VOLANTA pumps is poor. Of the 24 planned Volanta pumps, 7 of them were broken down during this evaluation and 11 more were not yet installed, waiting for the improved parts.

4.2.5. MAINTENANCE AND REPAIR

For good management of the boreholes and to guarantee their maintenance and repair, an adequate, well-trained and equipped infrastructure of human resources is necessary, as is the availability of spare parts at reasonable prices. The infrastructure of human resources and spare parts should harmonize with the technical system installed.

Management

Of the 63 existing boreholes in the district, 3 are under private management (2 boreholes in Mecupe plus CARE's borehole in Chitobe financed by UNHCR). 4 more boreholes are managed by public institutions (school EP2, which has a handpump; the Chitobe Health Center which has a diesel pump; and two old boreholes that are managed by the District administration in Chitobe and Save, both equipped with diesel pumps).

The maintenance and repair of the other 56 boreholes will be the direct responsibility of the communities (see table 6).

Table 6. Management of boreholes

Type of Management**Error! Bookmark not defined.**	Manual Pumps			Motorized Pumps		Not yet defined	Total
	AFRIDEV	VOLANTA	BUSHPUMP	DIESEL	ELECTRIC		
Private	0	0	0	0	1	2	3
Public	1	0	0	3	0	0	4
Community	28	24	1	0	1	2	56
TOTAL	29	24	1	3	2	4	63

The maintenance and repair system established in Machaze District is entirely based on local capacity. The Provincial Directorate for Public Works of Manica in Chimoio does not plan to establish a station (EPAR) in Machaze District or to organize any other type of technical support. In consequence, the District will not be able to benefit from any support from qualified personnel specialized in the repair or maintenance of pumps. The maintenance and repair of water points remains in the hands of local mechanics, maintenance groups and executive committees (see also paragraph 4.3).

Maintenance and Repair groups

The communities selected maintenance groups which among other duties are responsible for the maintenance of the pump and for the execution of simple repairs. The maintenance groups are not paid by the project.

The maintenance groups received training in maintenance and repairs of the AFRIDEV pump (see paragraph 4.3.3) and also received the necessary tools for such activities (1 24mm wrench, 1 19mm wrench, and one fishing tool).

From the beginning of the project in May 1994 until May 1995, maintenance and repair of pumps was done by CARE technicians and animators, accompanied by the existing maintenance groups. Spare parts were supplied by the project. In total 28 maintenance groups benefited from this support and in-service training, 11 of them in 1994. The conclusion is that only these 11 groups have sufficient experience to do the appropriate maintenance and basic repairs o the AFRIDEV pumps.

Mechanics

For the more complicated repairs, the project planned to train 10 mechanics, thus creating technical capacity at the district level. These mechanics would also be able to do major repairs on the Volanta pumps. It was intended that their activities would be coordinated at the district level. The mechanics would work as freelancers, not full-time.

During the evaluation it was concluded that the mechanics had not yet received adequate training to conduct major repairs on the AFRIDEV or VOLANTA pumps. To date they have been working in isolation from each other, with lack of means and of transport.

Unlike the Maintenance Groups, which are linked to a certain borehole, mechanics are not working within a well-defined structure. They do not have clear responsibilities, do not receive salaries and, in fact not all of them have the real capacity to make basic repairs.

Spare Parts

PRONAR is starting to introduce a spare parts supply system for pump repairs. Since May 1995 a local business (Mafuia Commercial LTD in Chimoio) in Machaze town sells (on consignment) spare parts for the AFRIDEV pumps. CARE, in order to provide an incentive for these merchants to commercialize spare parts and to give responsibilities to the maintenance groups and the executive committees to directly purchase spare parts, put its stock of Afridev spare parts in the store in Machaze on consignment.

The tools needed to repair pumps are cheap, and a set basic Afridev spare parts costs 61,000 Meticais (less than US$ 10).

Contacts with the manager of Mafuia in Chimoio revealed that he is slightly disappointed, due to the fact that non-governmental organizations continue to purchase pumps in Maputo, and to the weak interest to communicate with him shown by the AFRIDEV distributor in Maputo (STENAKS), leading to doubts about whether STENAKS is really interested in establishing an official Afridev agent in Chimoio.

To date, Mafuia has still not ordered any materials. CARE for its part reports to have asked the merchant for a quotation for pumps, and that this has not received the necessary attention from the merchant, having taken a long time to get any answer. Mafuia's owner however remains interested in being the agent as long as he has the entire market of Manica Province.

A much more active attitude on the part of STENAKS will be necessary to implement a reliable and viable spare parts distribution system. PRONAR should watch and control the activities of STENAKS in this context.

Spare parts for the VOLANTA pump are not available in the District of Machaze or in Mozambique, as they are imported from Holland by STENAKS on order. There is also no infrastructure for distribution in Mozambique.

The tools and instruments required for the repairs of the VOLANTA pump cost 5,000,000 Meticais and a set of spare parts costs 1,000,000 Meticais (about US$ 127.00). These prices are considered to be very high.

AFRIDEVError! Bookmark not defined.
The AFRIDEV pump is considered by PRONAR to be VLOM (Village Level Operation and Maintenance). Tools to repair the pump and spare parts are cheap. Maintenance and repair of the pump are relatively easy and do not demand much technical ability.

Given the short time that has elapsed since the end of the project and uncertainty about the long-term supply of spare parts it is still not possible to evaluate the sustainability of AFRIDEV pumps for Machaze district. However the AFRIDEV pump is considered to have potential as a VLOM pump, subject to ongoing training for the Maintenance Groups, who still have little experience, and the establishment of a solid infrastructure for spare parts distribution.

VOLANTA
The mechanical complexity of the VOLANTA pump demands a high level of technical capability for its maintenance and repair. This technical capability is still not available at the community level nor at district level.

Tools to repair the pump and spare parts are expensive. Spare parts are still not available. It is concluded that the VOLANTA pump is in no way compatible with the maintenance and repair infrastructure existing in Machaze district. The VOLANTA is not a VLOM type pump and it is considered that in Machaze it also has no potential to be one.

Beyond the repair of pump breakdowns and the question of spare parts, it is recommended that technical capacity be created at district level to guarantee maintenance and repair of the VOLANTA pumps, since local structures will be incapable of undertaking their repair.

It is recommended to continue to seek alternatives to the VOLANTA pump.

4.2.6 CONCLUSIONS

1. Availability of water from the sources is principally limited by the capacity of the manual pumps. More water could be extracted from the boreholes with a pump of greater capacity. Nearly all the boreholes can supply water throughout the whole day, even when operated continuously.

2. Of the 63 boreholes existing in the district, 34 are functioning (October 1995). Of the 55 boreholes constructed or rehabilitated by the project in Machaze district, 27 are equipped with a working pump, of which 25 are handpumps.

3. The low number of operational boreholes is mainly due to the very bad performance of the VOLANTA pumps. Of the 24 VOLANTA pumps anticipated, 7 are broken down, while 11 had still not been installed, pending delivery of improved unions. PRONAR did not authorize the (temporary) installation of another type of handpump.

4. It is not opportune to close down boreholes whose water quality parameters exceed OMS limits, due to the shortage of water in the area and lack of reliable data about the risks relative to using other water sources.

5. It was noted that the majority of the AFRIDEV pumps broke down during the project's implementation. Pumps installed in boreholes with relatively shallow water levels demonstrated significantly fewer breakdowns than those with deeper levels. Very intensive use of the AFRIDEV pumps had probably contributed somewhat to the breakdowns recorded.

6. Of the 28 Maintenance groups, 11 (trained in 1994) have sufficient experience to carry out necessary basic maintenance and repair of AFRIDEV pumps.

7. The AFRIDEV pump has potential as a VLOM pump, subject to ongoing training for the Maintenance Groups, who still have little experience, and the establishment of a solid infrastructure for spare parts distribution.

8. The VOLANTA pump is in no way compatible with the maintenance and repair infrastructure existing in Machaze district. There are no spare parts for the pump and the prices of tools and spare parts are high. The mechanical complexity of the pump prevents maintenance and repair at community level. The VOLANTA is not a VLOM type pump and it is considered that in Machaze it has no potential to be one.

4.2.7 RECOMMENDATIONS

1. Open boreholes where pumps are still not mounted should be protected.

2. It is necessary to make systematic measurements of static water levels in boreholes. Initially levels might be recorded whenever pumps are repaired.

3. It is necessary to proceed with hydro-chemical and bacteriological analyses of water samples from all the boreholes, including analysis of nitrate, fluoride and iron. On this basis, recommendations can be established for a future program of water quality monitoring. It is suggested that the analyses be done in a reputable laboratory, since results from the Águas de Manica laboratory are probably not reliable.

4. Possible risks from the high nitrate levels detected in certain boreholes should be analyzed and balanced against the risks of using other water sources.

5. It is necessary to improve the boreholes' protection against possible contamination, given their intensive use. Potential sources of contamination, such as latrines and septic tanks still existing close to the boreholes, should be eliminated.

6. Introduction / improvement of the system for recording breakdowns at community level will permit a future assessment of pump availability and of the communities' ability to maintain and repair them.

7. A much more active attitude on the part of STENAKS towards implementing a system for distributing spare parts should be promoted, and on the part of PRONAR in monitoring and controlling STENAKS' activities in this field.

8. It is necessary to continue training the Maintenance Groups, especially those trained in 1995.

9. A structure should be created at district level with technical capacity for the maintenance and repair of VOLANTA pumps and to support the Maintenance Groups. It is essential that the activities of the group of local mechanics be coordinated-.

10. It is necessary to continue to seek alternatives to the VOLANTA pump.

4.3 HUMAN RESOURCES AT COMMUNITY LEVEL AND CAPACITY OF LOCAL INSTITUTIONS

Evaluation of human resources at community level and of the capacity of the institutions principally refers principally to the study of the animation work performed so as to enable the community to maintain the 56 water sources under its control.

In the absence of a delegation of PRONAR or of DPOPH at district level, supervision of water sources can only be accomplished by the district administration. However, at present there exists no structure created to accompany activities, centralize information, and communicate with the Provincial Directorate of Public Works and Habitation.

The analysis of human resources covers:
- the animators (par. 4.3.2)
- the maintenance groups (par. 4.3.3)
- the mechanics (par. 4.3.4)
- the executive committees (par. 4.3.5)

Paragraph 4.3.6 sets out the conclusions of this study. Paragraph 4.3.7 presents recommendations intended to reinforce the present capacity for managing the water sources at community level.

4.3.1 GENERAL OBSERVATIONS

To realize the work at community level, the project established an animation structure with 2 supervisors and 16 animators. Skills at community level were developed within this project using a model by PRONAR called PEC (Community Education Program).

First phase
Implementation of the community development program was the responsibility, from the beginning of the project, of an animation supervisor experienced in working with OMM and rural communities.

23 boreholes were opened, above the 20 planned, in the initial phase. The activities developed in this phase were essentially the choice with the community of the drilling site, opening roads, and training the maintenance groups in the use, maintenance and repair of the water sources.

Second phase
The project's original second-phase objective was the opening of 20 boreholes. In fact, in this phase 31 were opened (10 supplementary, financed by ACNUR), plus 4 boreholes destroyed during the war were rehabilitated.

Starting in February, after the consultancy study concerning cost recovery by the consultant Alan Malina, the project opted to start organizing a system of financial contribution for the community to pay for spare parts necessary for maintenance and repair of the pumps.

The project, under pressure from USAID, opted to introduce this practice in all the communities rather than the 5 foreseen in the initial project document. In May 1995 there were created executive committees responsible for supervision of the maintenance groups and collection of money.

In May 1995 the consultant Ms Karen Isakson organized a program of sanitary education and monitoring. A second animation supervisor was hired to relieve the workload resulting from overseeing those pumps already working and activities that had to be carried out in anticipation of opening the new boreholes. This supervisor, trained in nursing, allowed the project to benefit from specialized knowledge in the field of sanitary education and thus to be better able to develop animation activities in this area.

4.3.2 THE ANIMATORS

The 16 animators (13 men and 3 women) chosen for the project from the candidates proposed by the community leadership, have levels of education ranging from 4th to 9th grade and speak Portuguese (as well as the local language Ndau). Each of them is responsible for a geographic region and several boreholes. Their work is accompanied and monitored once per two weeks by the 2 supervisors who are also responsible for defined zones.

The animators, unlike the maintenance groups and mechanics, are paid by CARE. They have clear terms of reference including all activities under their responsibility, which are:

- contact with the leaders and choosing the drilling site
- opening roads as necessary and clearing the chosen drilling area
- defining the composition of the maintenance group and of the executive committee
- accompanying drilling
- accompanying the local community construction of the wellhead
- training the maintenance team
- sanitary education from the initiation of drilling
- handing over the pumps and signature of the contract by the executive committee which stipulates that the community must accept responsibility for maintenance of the borehole and inherent costs
- participation in pump maintenance
- monitoring the health and hygiene situation around the pump

The animators received the following training courses:

- 2 weeks, in June 1994, on achieving work objectives jointly with the community
- 2 weeks, in June 1995, on installing and dismantling the Afridev pump
- 1 training day, in February 1995, given by Alan Malina, for introduction of the system of monetary contributions by families for maintenance and repair of Afridev pumps
- 1 week, in May 1995, on sanitary education, with the consultant Ms Karen Isakson, who prepared 6 modules giving guidance on presentation of lectures.

The system of supervision established from May 1995 with each supervisor accompanying a certain number of animators and a specific geographical area, is reasonable and efficient. Such supervision, together with the fortnightly meetings with the animators, provides extremely positive opportunities for in-service training.

Based on the activities carried out by the animators it may be concluded that they gain a certain prestige and that their guidance and advice are respected by the community. Thus they show their capacity for leadership and for coordination-ordination with other community administrators.

The animators believe that should the project terminate, the work of the maintenance groups and executive committees will be prejudiced, in so far as their (the animators') contribution to maintenance and repair of the pumps is important.

The animators, as members of the communities in which they operate, consider that even after the end of their work with CARE they will continue to support the maintenance groups and executive committees in carrying out their activities.

Despite this encouraging and clear position adopted by the animators with respect to their obligation to the communities, it is considered extremely important to maintain their positions and responsibilities for a period of 3 years under the new project to be established, to consolidate the maintenance groups and executive committees, and to continue training in the area of sanitary education.

4.3.3 THE MAINTENANCE GROUPS

For maintenance and repair of the pumps under community control, 43 maintenance groups were created controlling 53 water points. When the boreholes are close to each other the same maintenance group takes care of them. For example, in Chipudje center the same maintenance group looks after the 3 installed pumps.

3 boreholes do not have maintenance groups. (There is no pump installed at Chipambuleque. The Volanta pump at Mutondowumue has been broken down since April 1995, and as it has been impossible to repair it yet, the maintenance group dispersed for lack of activity. In Mabzissanga no animation work was done because of its great distance from other project sites and because the borehole was opened by GTZ.)

The maintenance groups have between 2 and 12 members, totaling 251 people of whom 21% are women. The significant number of women included in the maintenance groups is the result of motivation by the animators. See annex 1 table 7: "Composition of the maintenance groups and executive committees."

Early maintenance groups showed a rapid turnover of members, which makes the tasks of training and overseeing difficult for the project. This situation led the project to increase the number of persons in the groups so as to guarantee that activities would continue should any members leave or be absent.

The responsibilities of the maintenance group members are as follows:
- observe correct functioning of the pump
- carry out maintenance operations
- repair the wellhead as necessary
- secure together with the community a stock of spare parts
- organize lines at the borehole
- ensure correct pumping by the users
- ensure hygiene around the borehole
- regularly carry out sanitary education activities

The maintenance groups are taking their responsibility seriously. It may be seen that at three boreholes, shelters have been constructed so they can rest during the hot part of the day. Due to the time burden of the work, which requires daily monitoring of water source use, the Chipopopo executive committee decided to ask families to contribute in products as an incentive the maintenance group members who regularly perform their functions at the pumps.

In order to carry out their activities, the maintenance groups receive technical training in pump maintenance and repair, and training about water hygiene and transmission of diseases.

The maintenance groups also receive from the project, free of charge, tools needed for their work with the Afridev pumps.

Table 8. Characteristics of pumps for which the maintenance groups are responsible.

Error! Bookmark not defined. Year	Present situation	Manual pump			Electric	Not defined	Total
		Afridev	Volanta	Bushpump			
1994	Working	9	2	1			12
	Not working	2	6				8
1995	Working	14	4				18
	Not working	1	1		1		3
	Not installed	2	11			2	15
Total		28	24	1	1	2	56

Only 27 of the 56 water points that are community responsibilities have Afridev pumps. As to the other pumps, the maintenance groups did not receive training in their repair. They only had training in use of the pumps and sanitary education. See pars. 4.2.4 and 4.2.5 on this subject.

Groups trained to maintain Afridev pumps in 1994 (first phase)

11 maintenance groups had training for the Afridev pump in 1994. Those groups have experience in maintenance and repair of the pumps. They were accompanied by the technicians during the first half of 1995 and have greater skills and capacity than the other maintenance groups trained subsequently.

Groups trained to maintain Afridev pumps in 1995 (second phase)

In 1995, 15 Afridev pumps were installed and their respective groups received training. Due to the recent installation of these pumps the groups have no experience of repairs since the pumps rarely break down within 6 months of installation. 2 Afridev pumps had not yet been installed at the
time of the evaluation.

4.3.4 THE MECHANICS

The situation of the mechanics is studied in par. 4.2.5 which covers aspects of the maintenance and repair of the pumps.

4.3.5 THE EXECUTIVE COMMITTEES

In May of 1995 the project took the initiative of creating executive committees, whose main job is to supervise the maintenance groups, collect financial contributions from the families and undertake the purchase of spare parts necessary for the maintenance and repair of the pumps. About the community contribution towards pump maintenance, see par. 4.3.5 which analyses the amounts collected. This section only considers the capacity of the executive committees to manage these funds.

The committees comprise the *regulo* (hereditary community leader), traditional chiefs, healers and religious leaders. They generally constitute the authority recognized at community level and have the knowledge and skills necessary to resolve any conflict or problem that may arise within the community.

29 committees were established made up of 164 members, 8% of them women. See annex 1, table 9: "Composition of maintenance groups and executive committees."

Despite having to assume responsibility suddenly, without preparation and with no opportunity to consider alternatives, the community leaderships show great willingness to rise to the challenge. Water is a subject that, in Machaze, cannot be treated lightly. The leaders had no choice but to accept the task they were given. Water management and collection of funds from the community are prestigious matters that allow, in certain communities, the community leaders to mark their superiority over others. For example, by making people from other communities pay more for their water, and deciding the times at which the water point is opened and closed without consideration for the concerns of women coming from other, distant communities.

When the executive committees were first created, at the initiative of the project, posts with specific responsibilities such as president, deputy, treasurer, procurement officer, etc., were not established. At the time of this study such responsible posts had already been created in some cases, as a means of facing the various duties.

Handling the funds presents difficulties to the committees who are seeking to find an effective system of control. One factor limiting the activity of the executive committees in the area of financial management is that the majority of leaders are unable to write in Portuguese and do not have the necessary knowledge to keep contribution records, make water cards to regulate use of the pump, and prepare financial accounts of moneys collected and parts purchased. Despite and in response to these difficulties there are notable initiatives to involve people with better financial management capabilities.

The maintenance groups from the Chitobe Locality center opted to deposit their money in the village shop. Thus the manager of the shop, a branch of Mafuia, deducts the cost of bought parts directly from the money deposited.

In connection with the established monetary collection system, it was confirmed that water card systems have been set up at 33 of the pumps to regulate the users of the borehole. The introduction of water cards, an initiative first taken by one community and subsequently disseminated by the project, demonstrates the capacity of the leaders to set up mechanisms to control use of the pumps.

The existence of a contribution and a card permitting access to a pump presents the problem of the attitude to be adopted should the pump break down, necessitating recourse to another pump other than that for which the contribution was made. In certain cases it was confirmed that the executive committees had established mutual agreements for use of the pumps on a reciprocal basis. In cases where such a system did not exist, the point was reached where users were actually prohibited from accessing the sources.

In several communities (Chipopopo, Butiro etc.) the executive committees are responsible for various water sources and are organizing a system of regular monitoring by organizing monthly meetings. Such initiatives, not promoted by the project, lead one to believe that the community leaders are capable of treating the water sources as something they can handle competently, using existing resources and mechanisms to contend with this new responsibility.

It is considered extremely positive to try to make the community assume responsibility for the water sources. But it is believed that the transfer of responsibility should not be decided on a unilateral basis, the project telling the population and its community leaders to collect money for future repairs. Handing over such a responsibility warrants a study with community participation so as to establish adequate methodology and mechanisms. For this reason, the decision to introduce a system of collecting funds 6 months from the end of the project was injudicious.

The problems encountered at community level result from implementing a system of contributions without community participation in its organization and without previously studying the various aspects to be taken into consideration. The study by the consultant, Mr. Malina, does not make recommendations in this respect and favors the project taking unilateral measures from above. He refers to the introduction of community financial contributions as a "weaning" process (treating the community as a child) and not as a process in which the community should analyze and study the best ways to take on its new responsibility.

It is important to remember that in Mozambique people had experience of communal management of collective assets: consumers' co-operatives and production co-operatives. Analysis and discussion of this experience will allow that the same mistakes are not repeated.

4.3.6 CONCLUSIONS

1. The two supervisors demonstrated good organizational capabilities. Their knowledge and skills are complimentary in that one has more experience in working with the community, and the other in the area of health, enabling them to confront

the range of tasks under their responsibility. There was evidence of gaps in the field of monitoring through lack of aptitude.

2. In Machaze district 56 pumps will be the responsibility of the community by the end of the project, whilst there is only experience at community level in maintaining and repairing the 11 Afridev pumps installed in 1994. The 15 groups with Afridev pumps trained in 1995 also received equivalent training, but will have had no opportunity to gain experience in repairing them since no breakdowns occurred in their six months of operation.

3. 28 water points of the 56 under community responsibility will have Afridev pumps at the end of the project. For the remaining 28 water points the maintenance groups created at the level of each community will have to rely on outside support.

4. The executive committees are a very good way of effecting supervision of the maintenance groups. They show interest and competence in doing so.

5. The introduction of a system of collecting funds for the maintenance and repair of the pumps corresponds with the national political policy of making the community responsible for the inherent costs of using water sources. The system of collecting the fund is not the same in all the communities and is not very transparent. The established control is inadequate and there may soon be cases of diversion of funds and discontent among the population. It is considered that such an initiative should have been implemented in a primary phase, as a pilot experiment in only 5 communities, as foreseen in the original project document, so as to establish appropriate mechanisms and training for financial management. The pilot experiment would also have had as an objective promoting greater community participation in taking decisions about the most appropriate mechanisms for implementing the initiative.

6. Although the project was conceived as an emergency project, it is noted that all conditions are in place to begin developmental work.

4.3.7 RECOMMENDATIONS

1. The maintenance groups which were created need technical support for at least one more year until solutions are found to the following problems:

- only 11 groups trained in maintaining Afridev in 1994, with sufficient capacity to carry out maintenance and repair
- 14 pumps will shortly be installed and the respective maintenance groups have not started to do their jobs
- 27 water points with a pump that is not Afridev type and with no capacity at district level to guarantee their repair.

2. To have a better exchange of experience between the maintenance groups, it is suggested that regular meetings be held at Locality level. This would also give

them a regular opportunity to discuss their technical duties as well as those connected with sanitary education.

3. Constitute a structure at District and administrative post level capable of supervising the water sources under community control, carrying out major repairs, and serving as the connecting link between the community and the Provincial Directorate of Public Works and Housing.

4. Strengthen the capacity of the executive committees by promoting training courses and exchanging experiences at the level of Administrative Posts and localities. The training should cover accounting and recording contributions for the treasurers. For the leaders short courses such as democratic leadership, transparency in managing resources, and community participation in resource management could be given.

5. It is thought to be necessary to develop the capabilities of the CARE animation supervisors in monitoring, evaluation, community participation and similar subjects. Also, due to the volume of data with which they struggle, it is considered important that they be trained on computers.

6. Strengthen the training of the CARE local animators in accounting and financial management so they may support the executive committees in the difficult job with which they contend. The animators also need supplementary training in community participation and such matters so that they may better involve the men and women in taking decisions.

4.4 COSTS OF IMPLEMENTATION AND MAINTENANCE OF THE SYSTEM

4.4.1 INTRODUCTION

As well as the contributions from the funding agencies there was participation by the community in paying the costs of the project. Paragraphs 4.4.2 and 4.4.3 present a brief coverage of these contributions.

It was not possible to separate the total project expenditures into costs of the various activities. Only the unit costs of drilling the boreholes were analyzed, given that the drilling campaign was one of the most expensive activities (par. 4.4.4).

Paragraph 4.4.5 covers aspects of the contribution by the community towards maintaining the system. Finally paragraphs 4.4.6 and 4.4.7 present the major conclusions and recommendations.

4.4.2 COMMUNITY CONTRIBUTION TO THE IMPLEMENTATION

The population voluntarily opened 94.4 km of roads to allow the drill rig to reach the chosen sites. One kilometer of road is valued by the CARE construction and rehabilitation project at US$100.00. This means that the population contributed with their labor a value corresponding to US$9,440.00.

In constructing the wellheads some men worked for free. This contribution to the total work carried out is valued at US$100.00.

It is concluded that the contribution by the community towards implementing the project is of the order of US$9,500.00.

4.4.3 AGENCY CONTRIBUTION TO THE IMPLEMENTATION

The total project budget for the first and second phases is US$1,854,714, comprising US$1,585,900 initially made available for drilling 40 boreholes, and US$268,814 to open 10 supplementary boreholes in 1995 financed by UNHCR.

4.4.4 UNIT COSTS

In the first phase of the project the costs of actual drilling by TERRASEARCH were US$9,225 per borehole (US$9,124 per positive borehole), excluding the pump. In the second phase drilling costs were US$7,011 per borehole (US$7,110 per positive borehole). Over the 2 phases the average cost of positive boreholes was US$7,968 each.

The average depth of positive boreholes during the first campaign was 103 m. Data from the second campaign (which finished during the evaluation) were not analyzed. AFRIDEV pumps cost on average US$1,575 each and VOLANTAs US$4,300.

In Mozambique the price of drilling varies between US$65.00 and US$120.00 per meter for a positive borehole, including mounting the pump. The price per meter for actual drilling generally increases with depth. It is concluded, then, that the price of constructing boreholes equipped with AFRIDEV pumps was in the region of US$93.00 per meter, which is reasonable.

Construction of boreholes equipped with VOLANTA pumps cost around US$120.00 per meter, being more expensive due to the higher cost of the pump.

The actual construction of the borehole and installation of the pump cost around US$9,500.00 - US$12,500.00 per water source. This value is based only on the positive boreholes, because in principle a future substitution of the borehole could be made at the same site. The cost per capita would be around US$20.00 - US$25.00 if 500 people were to benefit from the borehole (the project objective was 1 borehole per 2,000 beneficiaries).

The costs of drill supervision are placed at 10% of the costs of actual drilling. It is considered that the involvement of well-qualified people in supervision made a considerable contribution to the success of the drilling exercise. It is noted that the costs of investigating groundwater potential were negligible.

If the beneficiaries of the project are taken to be the population having a borehole within a distance of 7 km, the cost per beneficiary is calculated as US$15.00.

4.4.5 COMMUNITY CONTRIBUTION TO THE MAINTENANCE SYSTEM

Starting in February 1995 (after the study about recovering costs of maintenance and repair), each executive committee became responsible for the collection of 500,000 Meticais to purchase a set of spare parts. This value corresponds with the estimated cost of maintaining an AFRIDEV pump for one year [Malina, Feb. 1995]. The project applied collection of this amount as a condition for mounting the pump. See paragraph 4.3.5 for more information about the executive committees and human resources existing in the community to assume this responsibility.

The communities with Volanta pumps were excluded from the study of recovery of costs of maintenance and repair, because it was obvious from the outset that operation and maintenance of the pumps was not going to be supportable.

In May of 1995 there was implemented, at the level of the 53 pumps managed by the community, a system of financial contribution. Responsibility for defining the amount to be charged to each family and collecting the money remained the task of the executive committees.

Up to the date of the present evaluation, 23,451,000 MT has been collected at 46 boreholes, an average value per borehole of 509,804 MT.

7 boreholes do not have data available about the amount of money collected, but it is known that funds exist. See table 9, annex 1 "Contribution by the community to repair and maintenance of the pumps."

3 boreholes have not collected money. These are Macundanhe and Mutondowumue, because the Volantas are broken down, and Mabzissanga, because the pump was installed by GTZ rather than the project and no work of animation was carried out.

It is confirmed that the system of collecting funds is being implemented in communities that possess a Volanta, and also in communities that still do not possess a pump, as a way of

demonstrating their interest in having a source of water and their good faith towards the project that promoted this initiative.

During the evaluation it was found that an adequate system for collection, management and control of the funds had still not been implemented, nor even studied. Various communities reported problems in this respect.

It is concluded that it will be necessary to pay closer attention to the persons responsible for the funds, and since bad performance of the cost recovery system could result in a very negative attitude among the population, this should be done at district level.

4.3.6 CONCLUSIONS

1. The communities contributed to project implementation a value that may be estimated to be of the order of US$9,500.00.

2. Actual construction of the borehole and mounting the pump cost around US$9,500.00 (boreholes with AFRIDEV) and US$12,500.00 (boreholes with VOLANTA) per water source.

3. The costs of supervision were around 10% of the costs of actual drilling. It is considered that the involvement of well-qualified people in supervision made a considerable contribution to the success of the drilling exercise.

4. Since May of 1995 there was implemented a system of financial contribution at 53 of the 56 boreholes managed by the community. At 46 boreholes the executive committees collected, between May and October 1995, an average of 509,804 MT necessary to effect maintenance and repair of the Afridev and Volanta pumps.

5. The 509,804 MT collected per borehole will only cover the expenses of maintenance and repair of the 29 boreholes that have or will soon have an Afridev pump. The money collected at the other boreholes is insufficient to cover the expenses of the Volanta pump.

4.4.7 RECOMMENDATIONS

1. Monitor the collection of money at each water source so as to be able to promote initiatives with a view to resolving conflicts when necessary.

2. Foster involvement and guidance by the District Administration in those aspects connected with collection of funds for maintenance and repair of the pumps. At the end of the project it is this body that, in the absence of others, will continue to oversee the good functioning of the water sources in the district. On the other hand, the District Administration is the only body capable to further resolution of conflicts between the communities.

5. USE AND IMPACT OF THE WATER POINTS

In this section actual use of the water sources (par. 5.1) and their hygienic use (par. 5.2) are analyzed.

5.1 ACTUAL USE

Paragraph 5.1 concerning actual use of the water sources includes the following aspects:

- number and characteristics of the users (par. 5.1.1)
- number of users per borehole (par. 5.1.2)
- distance to the water sources (par. 5.1.3)
- quantity of safe water (par. 5.1.4)
- daily usage profile of the installations (par. 5.1.5)
- annual usage profile (par. 5.1.6)
- ease of use of the installations (par. 5.1.7)

Paragraph 5.1.8 includes conclusions about actual use of the water sources and paragraph 5.1.9 introduces our recommendations.

5.1.1 NUMBER AND CHARACTERISTICS OF THE USERS

The objective of this project was to reduce the number of users from 9,750 to 2,000 people per borehole. This objective was estimated based on the population predicted at the beginning of the project. It must be pointed out that at the time the project was designed, the population was estimated at 68,000 people and only 12,000 refugees were expected.

Evaluating the number of the population of Machaze district is complex due to the movement of the population to their zones of origin, and the entry and exit of people from the district.

At the last census in 1980 the population registered in the two localities that make up the present district of Machaze (Save and Machaze) was 73,090 people (70% or 53,402 in the Administrative Post of Chitobe and 19,688 in that of Save). Projections made for 1995 by the National Planning Commission based on the census indicate 73,085 persons.

UNHCR registered 42,142 repatriates since October 1992. It was not possible to learn the localities of the repatriates' destinations. It is believed that this information would be of interest for the present study in that the refugees lived in refugee camps in Zimbabwe for around 10 years and acquired habits that influenced their behavior with respect to environmental sanitation and to dependence upon donations.

A considerable number of spontaneous returnees was registered, but the total number and their destinations are not known.

The district Administration conducted a count of the population during the current year, and considers that the district population is 142,183. The present study is based on this information because it is the only population data broken down by community, even if one believes that these figures may be higher than the real population.

5.1.2 NUMBER OF USERS PER BOREHOLE

To evaluate the number of users per borehole, the situation encountered at the time of the evaluation is presented, and also the situation expected when all the existing boreholes are working.

Also analyzed is the number of users per borehole, taking into consideration the two existing sets of population data (from the District Administration and the National Planning Commission). It should be pointed out that the number of users per borehole varies over the year since most families draw their supplies from other existing water sources during the rainy season. See paragraph 1.4 and paragraph 5.1.6 about this subject.

Number of users per functioning borehole during the evaluation
Below is assessed the number of persons per borehole taking into account the pumps functioning during the period of the present study. 34 water sources were found in use, two of which (those of the CARE camp and the Chitobe Health Center) were utilized essentially for internal use. It should be noted that the project was daily providing a tank of water from its borehole to supply Bassane locality.

Table 10. Number of persons per functioning borehole during the evaluation

ADMINISTRATIVE POST**Error! Bookmark not defined.**	LOCATION	POPULATION	BOREHOLE	PERSONS/ BOREHOLE
Chitobe	Chitobe Town	37 219	9	4 135
	Bassane	20 304	0	- - - -
	Chipudje	26 834	9	2 981
	Mutefo	230	0	- - - -

	Chipopopo	14 490	12	1 245
Sub-Total		99 527	30	3 317
Save	Save	19 968	1	19 968
	Sambassoca	7 523	0	- - - -
	Mavende	4 834	0	- - - -
	Mabzissanga	10 331	1	10 331
Sub-Total		42 656	2	21 328
Total		142 183	32	4 443

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The objective of the project was to reduce the number of people per borehole from 9,750 to 2,000 by the end of the project through the construction of additional boreholes.

15 days from the end of the project, the situation regarding water supplies continues to be dramatic in many zones. The number of users per borehole decreased considerably, going from 9,750 to 4,443 per borehole. The situation is most critical in the Administrative Post of Save with an average of 21, 328 persons per functioning borehole.

At the moment, the best water supply is found in the locality of Chipopopo with one pump per 1,245 persons.

If the District's population were to be less than the numbers found in the District Administration's survey, and in fact corresponds to the projections elaborated by the National Planning Commission (which based on the 1980 census projected 73,085 persons for the district), then the District would have an average of 2,283 persons per borehole.

For a population of 80,000 people as estimated at the beginning of the project, 2,500 people would be the average per functioning borehole.

Number of users per existing boreholes in the District

In the following section is a presentation of the number of users per existing borehole, in the case of all existing boreholes being in function.

For this evaluation we are working on the basis of 61 boreholes and not 63, assuming that the boreholes managed by the Chitobe Health Center and by CARE will continue to be used for the same purpose in the upcoming months.

Table 11. Number of persons per borehole considering 61 functioning boreholes.

Error! Bookmark not defined.ADMINISTRATIVE POST	LOCATION	POPULATION	BOREHOLES	PERSONS/ BOREHOLE
Chitobe	Chitobe Town	37 219	15	2 481
	Bassane	20 304	3	6 768
	Chipudje	26 834	19	1 412
	Mutefo	230	0	- - - -
	Chipopopo	14 490	14	1 067
Sub-Total		99 527	51	1 951
Save	Save Town	19 968	6	3 328
	Sambassoca	7 523	3	2 507
	Mavende	4 834	0	- - - -
	Mabzissanga	10 331	1	10 331
Sub-Total		42 656	10	4 256
Total		142 183	61	2 330

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Under the hypothesis presented in the above table, the localities of Chipopopo and Chipudje in the Administrative Post of Chitobe have the best water supplies. These are the only locations where the objective of installing a functioning pump for less than 2 000 people was achieved.

It must again be highlighted that the estimate of persons per borehole depends on the population data supplied by the District administration. If the population is 73,085 as projected by the National Planning Committee based on the 1980 census, the supply situation would be entirely different with an average of 1,198 persons per borehole, and the objective of the project would be achieved.

5.1.3 DISTANCE TO THE WATER POINTS

In paragraph 3.3 the selection of locations for the drilling was analyzed.

In this paragraph, only the distance of the water point users to the water point will be analyzed.

With the establishment of 50 boreholes, the objective of the project was to provide safe water for 90% of the population at a distance less than 7 kilometers.

The table below indicates that 16.7 % of the population of the Administrative Post of Chitobe (estimated 99,527 people) live more than 7 kilometers from a water point.

A similar exercise for the Save Administrative Post was not possible due to the absence of detailed population information per locality. The belief is that due to the dispersion of the population in the Administrative Post of Save, the proportion of residents that live more than 7 kilometers from a water point is certainly higher than the proportion found in the Administrative Post of Chitobe.

Table 12 Population of the Administrative Post of Chitobe residing more than 7 kilometers from a water point

Error! Bookmark not defined.LOCATION	COMMUNITY	POPULATION
Chitobe	Zihanga	2003
	Matenguana	923
	Nhabeze	500
	Mapetane	1 300
	Macupi	1 903
	Quia-Quia	1 018
Mutefo	Chimbia	120
	Mupombo	110
Chipopopo	Mutane	244
Bassane	Usa	3 047
	Mupaique	629
	Chiungo	700
	Chifomoti	1 500
	Chiraja	1 974
	Chove	727
Total		16 698

Error! Bookmark not defined.

The reasons that prevented reaching the objective of supplying drinking water to 90% of the population from a distance less than 7 km are as follows:

- Not knowing the size of the district's population. From the beginning, of the project the population was estimated to be 68,000 inhabitants counting on the return of 12,000 refugees; however, to the moment the population of the district is estimated to 142,183 inhabitants.
- The massive return of displaced people and refugees to their original areas after the October 1994 elections.

- Not knowing the volume of population in these newly dispersed groups.
- Difficult access to remote areas due to nonexistent or mined roads;
- Aspects related to hydrogeology analyzed in Paragraph 3.3.

5.1.4 QUANTITY OF SAFE WATER

In March 1994 a questionnaire answered by 120 women in 4 communities in northern Machaze district (Chipudje, Guezanhe, Bassane and Chipopopo) indicated that the average daily use of water per person was 9.9 liters during the rainy season, and 4.4 liters during the dry season.

This section does not cover general water availability, but only the availability of safe drinking water during the dry season (the time of the evaluation).

The study of safe water consumption was done with 80 women, at 8 functioning water points. 10 women were selected at each borehole. Each woman was asked how many people in her family usually go get water at the borehole. Next, each was asked how many times each family member went to the borehole in the past week, and the volume of their water vessel. In this way was established the number of trips to the borehole per week and the quantity of water taken in that period. The women were also asked the number of people living in their households, in order to establish the availability of water per person per day.

Table 13. Quantity of safe water available per person**Error! Bookmark not defined.**/per day

Location**Error! Bookmark not defined.**	Community	# Buckets in line	Waiting Time	Trips to the boreholes per week	Liters per person per day
Chitobe Town	Chinavana 1	59	2 hrs	4,2	2.1
	Macovane	41	1 h 20'	7,7	4.2
	Primeiro de Maio	124	4 hrs	3,6	1.5
Chipopopo	Fucuzane	59	2 hrs	6,6	4.4
	Chipandire	22	45'	7,7	4.3
	Chipopopo	34	1 h 10'	8,5	4.1
	Chalane	50	1 h 40'	8,5	3.8
Save	Save	178	6 hrs	4,9	1.8
Total		70,8	2 hrs 20'	6,4	3.2

The results obtained shows that the available amount is between 4,4 liters and 1,5 liters depending of the area. It is possible to conclude that in terms of quantity, the amount of

safe water (coming from boreholes) per person in the dry season is extremely dramatic. However, it must be pointed out that not all boreholes drilled are yet pumping.

The boreholes with larger streams of people such as Save (178 persons lining up) and in the "Primeiro de Maio" suburbs (124 persons lining up) are the communities where the available safe water per person per day is least. In Save, in order to ration available water among everyone, the maintenance group limited each family's access to the boreholes to once per day, recording the date of each family's turn at the water point. In another instance, the "Primeiro de Maio" borehole supplies 3,603 inhabitants of Chechene (as well as those in the bairro around the borehole) which is less than 7 km from the borehole, for which reason there is an observably larger crowd of borehole users, and less water available per user from this borehole.

Length of time needed to fill up a 20-liter bucket from a handpump was measured as about one and a half minutes. On some boreholes pumping takes longer. If we include dead time between one user and the next, and the time needed to rinse out each bucket before filling, one can consider an average time of 2 minutes per bucket. This means that in an hour it is possible to fill up 30 buckets of 20 liters. In ten hours it is possible to fill up 300 buckets, which means 6000 liters of water available.

The waiting time at each borehole varies from 45 minutes in Chipandire to 6 hours in Save.

The above-mentioned facts can be related to the tables presented in the chapter on number of users per borehole, Paragraph 5.1.2. Through this, we can confirm that in Chipopopo, where the number of users for the borehole is smaller, the available water per person per day is greater than in Save where the number of users per borehole is larger.

In conclusion, the quantity of safe water per person per day depends on the composition of the family group (number of persons available to bring water from the borehole), the distance to the borehole, and the waiting time lining up at the borehole.

It must be pointed out that in some boreholes there are three or more queues organized by people's zone of origin. At some boreholes there are queues formed only by men who carry water in jugs on bicycles. Usually these queues are shorter than women's, and since the practice is to fill buckets in turn at the same rate from each line, the men's waiting time is less.

5.1.5. DESCRIPTION OF DAILY USE

Women who reside far from the boreholes prefer to leave their houses as early as possible when it is not so hot. During this time of the day, the larger number of users is recorded. Women who live close to the borehole prefer to fetch their water later when the crowd has diminished.

The boreholes with larger crowds of people queuing (Primeiro de Maio, Save, Chipudje) stay crowded all day.

Duration of borehole use varies from borehole to borehole, depending on user population and season.

The pumps in Save start working early in the morning and close at midnight after supplying all the persons queuing.

We also visited boreholes closing at 1600 hours (4:00 p.m.) due to having no crowd.

The boreholes are closed at night to let the pump rest and avoid abuse.

5.1.6. DESCRIPTION OF ANNUAL USE

The project's construction of 50 boreholes with pumps allows the population to obtain good quality water during the whole year.

During the rainy season, there is no doubt a large part of women that prefer to obtain their water supply from the nearest water points to their houses, therefore, obtaining contaminated water.

It rained on the night of October 17, during this evaluation. The following day the crowd at the boreholes decreased considerably; we visited 10 boreholes deserted or with less than 20 women using it.

5.1.7. EASE OF USE OF THE INSTALLATIONS

During the observation of the 34 working boreholes it was confirmed that the wellheads, despite being constructed to PRONAR standards, still made it difficult to use the pumps. The Volanta and Afridev wellheads are small in size, obliging women to pump from an uncomfortable position. In the case of AFRIDEV, with the lengthened handle, women have to pump with one foot inside and the other one outside the wellhead. With the Volanta pumps, the situation becomes even more uncomfortable since women have to stand on a high platform and pump with one foot balancing in the air.

It is worth mentioning that the project tried to solve this problem by installing an extra platform, either inside or outside the wellhead (to the height of the edge of the wellhead) so the women would have a better position to pump. In spite of this effort, in many cases the situation continues to be difficult for the users.

Pumping action is extremely heavy due to the depths of the water. To fill up a bucket of 20 liters, two persons need to pump between 60 and 130 times using an AFRIDEV pump. Old and young women are not able to pump by themselves. Adult women also pump in pairs. Because of this, in future installations it is recommended to study thoroughly better forms of constructing wellheads.

5.1.8. CONCLUSIONS

1. The estimated number of users per borehole depends on the evaluation of the district's population: 73,085 persons according to the projections by the National

Planning Commission based on the 1980 census, 80,000 persons based on CARE estimates made at the beginning of the project, or 142,183 persons from the survey done by the District Administration. The estimated number of boreholes users also depends on the season of the year. During the dry season the number of the borehole users is larger than during the rainy season.

2. The number of boreholes users decreased during the project from 9,750 persons per borehole to 4,443 during the period of the evaluation (considering a total population of 142,185) or to 2,283 persons per borehole according to the estimates done by the National Planning Commission based on the last census.

3. If all 61 community pumps were functioning, the number of users would go down to 2,330 considering a population of 142,183, or to 1,198 based on a calculation of 73,085 people.

4. 16% of the population in the Administrative Post of Chitobe live more that 7 Km from a water point. In the Administrative Post of Save, the proportion of the population residing at more the 7 Km from a water point is higher, however it was not possible to do a detailed analysis due to the absence of any disaggregated population data for the villages in this zone.

5. During the evaluation, the best availability of reliable water (coming from a borehole) was found in Chipopopo (between 3,8 and 4,4 liters per person/day). At the same location the smallest number of people in a line were found (between 40 minutes and 2 hours of waiting time). In this location the number of users per borehole is the least with 1,245 beneficiaries per borehole (using the district population estimate of 142,183). These data presented reflect only the situation during this evaluation, as many boreholes are not yet functioning. The borehole in "Primeiro de Maio", in Chitobe town, is the one with the least available water per user, about 1,5 liters per person/day. The waiting time in the line was about four hours. In Save town, the largest number of users per borehole was observed in line, corresponding to a total proportion of 19,986 per borehole (population data of 142,183). The waiting time was about six hours. In this locality, 1,8 liters of safe water was available per person/day.

6. The amount of safe water available per person day varies as a function of the distance to the water point, the waiting time in the line and the size of the aggregate family, and particularly on the family's number of women of the age group that customarily goes to the water point.

7. The total daily utilization time of the pumps varied from 8 hours in Chipopopo to more than 14 hours in Save town.

5.1.9 RECOMMENDATIONS

1. Despite the number of users per borehole having decreased, it is still considerable and it does not allow the population to have enough clean water available per

person per day. Therefore, it is necessary to open supplementary water points to help supply the population, and reduce further the distances to the pumps and waiting time (especially the Administrative Post of Save).

2. It is recommended that future work focus particularly on the Administrative Post of Save, due to the high proportion of user to boreholes and the existing surface water in ponds and the Save River.

3. The boreholes are not used consistently over the whole year, making it necessary to reinforce education on safe water sources and the diseases related to contaminated water.

4. The wellhead design provided by PRONAR of the Volanta and Afridev Pumps, do not allow the comfortable and safe use of these pumps; therefore it is considered necessary to enlarge the wellheads of both pumps.

5.2. HYGIENIC USE

This section is related to the study of the sanitary education program (paragraph 5.2.1). and its impact on the community. The following aspects will be reviewed:

- water transport and conservation practices (paragraph 5.2.2);
- domestic practices to improve the quality of water (paragraph 5.2.3.);
- borehole hygiene/sanitation (paragraph 5.2.4.)
- personal hygiene (paragraph 5.2.5.)
- health indicators (paragraph 5.2.6.)
- schools hygiene (paragraph 5.2.7.)

Paragraph 5.2.8. presents the main conclusions on the hygienic use of water and installations.

5.2.1. SANITARY EDUCATION PROGRAM

Since the beginning of the project the maintenance groups, besides their responsibilities with the pumps, are also trained on sanitary issues in order to teach users the hygienic use of the water points.

In May 1995, the consultant Mrs. Karen Isakson analyzed the work and elaborated 6 modules on sanitary education for the community. The modules relate to water as source of diseases, safe and unsafe water sources, use and protection of water at the source and at home, treatment of water at home, personal hygiene, and disposal of excrement and garbage. The modules are presented in the form of illustrated discussions, with illustrations photocopied in black and white, format A4. Participants make comments on the illustrations and a debate about the topic is opened.

We attended two meetings in Chitobe town (one with 130 participants and the other one with 220, including children), presented by a female and a male animator respectively.

During the meeting of 30/40 minutes, the borehole is closed and people meet in the shade of a tree. We saw no rejection or dissatisfaction on behalf of the population for having to prolong their wait unexpected. The animators were capable of organizing the participants, they presented their didactic material, they had a good presence and were clear, dynamic and congenial.

A total of 164 community meetings were held between June and August 1995 with participation of 8,936 men and women. The data on the meetings for the current trimester were not available at the time of the evaluation.

During this evaluation, 35,8 % of the 120 users interviewed at 12 boreholes affirmed to have attended at least one sanitary education session. This percentage is very encouraging given the recent introduction of this activity. At the "Primeiro de Maio" borehole, all women interviewed had attended a session while at the EP2 School's pump and the Tuere and Chipandire pumps no women had had this opportunity. We conclude that this situation comes from the fact that women have a better chance of attending a session at a borehole where the waiting period is longer.

It is believed that the didactic materials used need to be renewed regularly to avoid becoming repetitive and tiring. It is suggested to use other methods such as puppet theater, presentation of videos, and theater.

A monitoring system of the sanitary education is done monthly. One animator visits a borehole that is not under his/her responsibility. He/she stays at the borehole from the opening to the closing, recording the number of users. The lines are usually organized at a small distance from the borehole and moved forward in groups of five buckets, thereby facilitating the counting. The animator, on a sheet specially prepared for this exercise, records the number of people who wash their container, and the number of persons with scabies, skin problems or conjunctivitis.

This system is well implemented, however it is noted that the information collected is not duly organized to establish an effective monitoring system and to take appropriate measures in response.

Following this section is a presentation of the data collected by the animators during the period June to August 1995 based on observations of 3,286 water point users. Also presented are observations made during this evaluation resulting from the discussions held at 12 boreholes with groups of ten women about aspects of personal and household hygiene.

Due the fact that the sanitation education program has only been introduced recently, it is premature to conclude a significant impact on the knowledge of the population. That is why we concentrated our attention on the observation of behavior of the maintenance groups and the persons in the lines during the visits to the boreholes.

5.2.2 TRANSPORT OF WATER AND CONSERVATION PRACTICES

Most of the vessels used by the women and men are properly closed containers transported by foot and less frequently by bicycle either by women or men.

Those who do not have jugs use buckets which are only transported by women. To avoid spilling water during transport, tree branches are put on top of the water.

The animators, doing the self-evaluation of their work, consider that with respect to the "prohibition" of putting leaves in the buckets, they have achieved positive results. The daily activity of the members of the maintenance group who stay at the water point promotes among other things the abandonment of this practice and substituting plastic bags or a cover for leaves. In fact, only in rare cases are leaves observed in the buckets in the vicinity of the pumps.

At the boreholes it can be observed that the introduction of the message is experienced by the women as an imposition in the sense that the members of the maintenance groups oblige them to throw away the leaves when they arrive at the pump with them. Consequently, the women keep the leaves hanging in a tree at some distance from the water point. One can deduct from this that the leaves are not understood as a source of contamination.

The trimestrial evaluation done by the animators of each borehole, by stationing themselves all day at a water point, shows that 23% of users bring leaves in the buckets which constitutes a low percentage.

The other data obtained during the trimestrial evaluations also show that 22.2% of women wash their container before filling it. It was observed in visits to 34 water points that this practice is more frequent at water points with lesser crowds.

5.2.3 HOUSEHOLD PRACTICES TO IMPROVE WATER QUALITY

When questioned concerning practices of boiling rain water when used to drink, the women explained that they could not allow for such precious water to evaporate. This affirmation allows to understand that rainwater collected in cisterns is not considered contaminated water, that boiling is not considered as a method of purifying water and that economizing the water is a determining factor for the introduction of any type of system to improve the quality of water.

5.2.4. BOREHOLE HYGIENE AND SANITATION

At all 34 boreholes visited, the cleaning of the water point and slabs in the immediate area of the pump is good. 35% of women interviewed who had attended an educational session mentioned care related to the hygiene of the borehole as one of the aspects that had been focused on during the presentations and subsequent discussions.

In Fucuzane, there was presence of bovine feces near the borehole, but upon our arrival the animals were chased away. At two other operating boreholes ("Primeiro de Maio" and at the cantina in Chitobe) it was observed that the women chase away the goats that get close to the water point.

A real effort was noted on the part of the maintenance group members to always promote good use of the borehole.

At eight boreholes (see table 4, annex 1), the standard to drill at a minimum of 50 meters from a latrine was not observed. In Save (borehole 95/024), according to our informants, the latrine was to be destroyed shortly and was no longer used due to moving of the owner.

At the borehole in Tuco-Tuco there is a water tank to wash clothes in the area of the borehole which showed the interest of the women to improve their working conditions around the borehole.

At none of the boreholes visited had any latrines been constructed to be used by the water point users during the long waiting hours. When questioned on the reason for the absence of such installations, the persons answered that it would not be well used, that the people would do their necessities around the latrine which would be a lot worse.

Despite the negative experiences with collective latrines it is considered that due to the crowding at the borehole, latrines should be constructed at some of the water points. At those points, the animators and the members of the maintenance group could promote the introduction of proper latrine usage and do monitoring permitting the progressive introduction and use at all water points.

5.2.5 PERSONAL HYGIENE

During the interviews done women explained that water for washing went as a priority to children and men. Women who live far from a water point used the opportunity of going to the borehole to wash when the lines where not very long. In general they do not use soap.

In two of the 34 boreholes visited, the community had constructed a bath stall for women to wash at a distance from the water point.

At the animation session at the borehole in Chitobe, one maintenance group member took the opportunity to call to the women's attention to not clean their feet on the wellhead slab of the borehole.

The effort done in the education of the users is considered very positive and should be maintained during a longer period to observe changing in behavior and create new habits.

5.2.6 HEALTH INDICATORS

In March 1994, a survey was done of the major health indicators related to the lack of water and contaminated water. 120 women were interviewed individually according to a pre-established questionnaire.

Questions formulated in the same way were made to 60 randomly selected women who were interviewed at 6 functioning boreholes. This method is generally used in rapid assessments.

Diarrhea in children under five years of age
51,3 % of the persons interviewed in 1994 indicated that they had children of less than five years of age who had diarrhea in the last two weeks.

In October 1995, 11,6 % of the women who were interviewed confirmed that they had at least one child of less than 5 years of age that had diarrhea in the last two weeks.

5.2.7 HYGIENE AT THE SCHOOLS

Hygiene at the schools is outside the scope of the current project, but the study of hygiene conditions within schools is considered pertinent.

There is a total of ten schools with 3,065 students (27,5 % girls) in Machaze District.

The Ministry of Health recommends that there should be water near the school and sufficient latrines for all students (one latrine for each 148 girls or 325 boys).

With the exception of the school in Save which has one latrine for 397 students, all schools have the necessary number of latrines for good hygiene. All schools have a borehole nearby with the exception of Guezanhe, where the borehole is five kilometers away. This school was built prior to the drilling of a borehole and no water was struck in the vicinity of the school.

Six schools have a water tank with a capacity of 2 cubic meters (Machaze Town, Bassane, Chipudje, Chipopopo and EP2). Only two schools (Bassane and Chipopopo) will soon have a water collection system to collect rain water in these tanks.

Considering the lack of water in the District, it should be considered to construct more cisterns in each school and equip these with a rain water collection system.

5.2.8 CONCLUSIONS

1. The animation work is showing encouraging results with respect to sanitation around the boreholes. The results obtained are the fruit of the labor of the animators, their supervisors and the maintenance groups who develop their activities with much efficacy.

2. The incidence of water-related diseases was not changed merely with the introduction of new boreholes.

3. The users of the new boreholes do not know the causes of diseases related to water and a sanitary environment.

4. The schools have good hygiene conditions in terms of the number of latrines per student with the exception of the school in Save.

All schools have water in proximity with the exception of the school in Guezanhe which is 5 kilometers from the borehole. The construction of the school in Guezanhe before the opening of the borehole was a dramatic decision.

5.2.9 RECOMMENDATIONS

1. In spite of the positive results registered in hygiene education it is necessary during the implementation of the Sustainable Water in Machaze Project (SWIM) to consider the possibility of undertaking new training courses. These could be administered by the health personnel of Machaze District or by an external intervention focusing in a specific way on water-related diseases.

2. A strong relationship between the District Health Authorities and the project should be established for the mutual benefit of both organizations in a way that experiences and monitoring results are shared. Joint activities are recommended in community meetings and other animation activities.

3. More innovative animation techniques must be applied to maintain the interest of the population. Live theater activities, puppet theater, video projection or the use of vehicles equipped with loud speakers could be introduced.

4. The data collected during the quarterly evaluations by the monitors are of extreme interest and should be organized and analyzed regularly to establish an efficient monitoring system and take appropriate measures. The skills of the animation supervisors must be developed to assure they are capable to do this task.

5. A borehole is an opportune place to introduce knowledge and hygiene behaviors, because a large number of people frequent the place for long hours. A pilot project is suggested to establish latrines and wash stalls at 5 water points (respecting the minimum recommended distance) and proceed with user education.

6. Due to the shortage of water in the zone and the recommendation made for the establishment of rain water collection in all public installations, it is considered deplorable to construct new schools without the installation of a rain water collection system with a reasonable storage tank (not of two cubic meters as is done currently).

7. Schools are considered an exceptional place to introduce new behaviors and knowledge, on rain water collection as well as borehole water utilization. An intensive education program should be established using all available communication tools during extra-curricular activities. Competitions amongst the different schools focusing on drawings, texts of poetry about health, water and sanitation could be introduced successfully. Small prizes such as a variety of scholastic or recreational materials could be made available. Expositions of the works in the presence of parents could be implemented. Singing, dancing and theater activities on the themes are initiatives that captivate the children and allow

messages to be memorized and transmitted to the families, serving thus as a liaison between the schools and the community.