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MANICA WATER SUPPLY PROJECT

MID-TERM EVALUATION

WORK BEING UNDERTAKEN IN NORTHERN MACHAZE DISTRICT

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EXECUTIVE SUMMARY.

The objectives of the Machaze district portion of the Manica Province water supply project were to provide immediate improvements to the water supply while working within the constraints of limited access and limited information. Mined roads had prevented vehicle access to the area during the civil war. Access within the district is still limited to walking and travelling by motor bike.

Existing water sources were identified as a traditional rain water harvesting system referred to as water cisterns, boreholes and shallow wells. The proposed work consisted of:

* repairing approximately 500 catchment cisterns,
* achieving at least 10 functioning boreholes by repairing or installing new pumps on the existing boreholes,
* identify sites for drilling at least 25 boreholes as soon as equipment can be moved into the area.

This work was evaluated by the following procedure:

* project documentation, including progress reports, the Water Resource Study report and specific documentation relating to the distribution of cement for the cistern repairs, was reviewed,
* field inspections of all work activities were completed,
* project staff were interviewed.

The project design was based on limited information and prepared quickly to try and complete some of the work before the 93/94 rainy season. Some changes then had to be made to the scope of work to accommodate the actual conditions found in the field.

Over 1.300 rain water cisterns were registered, considerably more than had been originally estimated. Repairing the cracks in the cement plaster lining to the cistern walls was identified as the first priority. 15 kg of cement were distributed to each cistern owner together with some instructions on crack repair. A national shortage of cement delayed the distribution until late in the rainy season which limited the immediate benefits. Between January and April, 20.465 kg of cement were distributed to 1.338 cistern owners.

The paper work recording the distribution of cement was reviewed and found to be in order. Field inspections were made to verify the number of cisterns and that the repairs had been made. Four villages were visited, Chipopopo, Guezanhe, Bassane and Tuco-Tuco. The village centres are small and the major portion of each village consists of scattered homesteads in the bush. A thorough survey was conducted over a portion of Tuco-Tuco village and the distance between many of the homesteads was

about 1 km. From these visits it was concluded that the cistern registers are correct and the cement distributed had been used to repair the cisterns. There was also evidence that many of the cisterns had partially filled during the rainy season.

To further improve this water collection system, the grading and surfacing of the catchment areas require refurbishing and better operating practices needed to be established. The specific advantage of the cisterns is that for the duration of the rainy season they can provide a very convenient water supply and significantly reduce the time and energy required to collect water.

Boreholes are the main dry season water source. During the civil war many boreholes were sabotaged or fell into disrepair. As much as possible has been done to increase the number back in service. Four existing borehole pumps were serviced and received maintenance support. Three boreholes were refurbished and equipped with new pumps, although one borehole has an accumulation of sediment which is causing frequent pump breakdowns. In addition, as part of the project work, a thorough search for more unsabotaged boreholes had been completed.

All the functioning boreholes were visited in the course of this evaluation. They are all being used to capacity. The area around each borehole and the drainage system for spillage water are being maintained by the caretakers.

Following from the inspection of the boreholes, the daily water consumption was estimated at 110.000 liters/day. This is considered an insufficient supply for the estimated population of 60.000 people. It therefore appears that the population estimate may be inflated. Although this will not effect the work currently proposed, checking the population estimate should be considered before more work is planned.

The water resource study has collected and documented useful information on current water resources and water use and collection practices. As there are no historic records of hydrological data none of the resources could be quantified. The principal conclusions of the study are:

-that the area is still in the grips of the drought which has been experienced in southern Africa over the lasted two years,
-rain water harvesting is a substantial wet season water source and contributes to an increase in average water consumption from 4 to 10 liters/person/day,
-the area is underlain by a primary aquifer with the principal water strike at about 90 m deep and boreholes can be sited as required to provide greatest convenience.

From a review of the document and the observations made in the field, it appears that the conclusions are the best that can be drawn from the limited information available. As the drilling will start at the sites of sabotaged boreholes, it is considered acceptable to proceed without the geophysical investigation that was recommended.

Community training and animation processes have been an integral part of the project. It has involved liaison work for the cistern repairs and training for pump maintenance crews and improved community hygiene practices. To assess these soft inputs is difficult. Good training techniques involving role playing and participation were observed. Where hand pumps have broken down the maintenance teams have attempted to make repairs before looking for assistance from CARE. The attempt to make the repair appears to indicate acceptance of ownership which is an important step in the process to achieving sustainability.

A proposal for a follow on project has been prepared. It consists of drilling and equipping 20 boreholes during the current dry season and another 20 during the following season and completing the associated training and advocacy work.

A critical issue in this programme will possibly be the selection of hand pumps to equip the boreholes. The Afridev is the preferred pump because of its ease of installation, maintenance and cost but its depth of operation is limited to 45 m. Although indications are that the principal water strike will be at 90 m, the static and dynamic levels will be much shallower, possibly 30 to 40 m, within the Afridev's range. The pump testing and data collection programme should be designed in detail, in accordance with national standards, and the feasibility of collecting sufficient information to confidently calculate the dynamic water levels should be assessed.

Currently there is no distribution system for pump spare parts and this will frustrate the village level maintenance initiatives if it is not rectified. Negotiating with the government to support its hand pump standardization policy by facilitating a spare parts distribution network should therefore be included in the advocacy work.

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1. BACKGROUND.

Machaze district is located in the south of Manica province, central Mozambique. During the civil war, roads in the district were mined and as a result access to the district was restricted to air travel from 1984 to April 1993 when the road from Chibabava in Sofala province to Machaze Sede was unofficially opened to traffic.

As a result of the destruction of infrastructure during the war and the drought that was experienced in the sub-continent, providing an improved secure water supply was identified as a high priority in the district. The fact that many thousands of refugees are expected to return increases the urgency for action to improve water supplies.

On gaining access to the more remote areas of Machaze district, CARE undertook Participatory Rural Appraisals and in response completed a successful seed and tool distribution programme. In addition plans were made to expand the scope of relief provided to include water supply, and the Manica Water Supply Project was proposed. This project was for emergency relief work in Guro district in the north of the province and in Machaze district in the south. Funding was received from UNHCR, Redd Barna and USAID and project implementation started in August 1993. This evaluation concentrates specifically on the work undertaken in Northern Machaze district.

The urgency of the situation in Machaze required the project design and proposal to be based on the information then available which was very limited. The Provincial and District Directorates of Construction and Water had some information on the status of existing boreholes. CARE staff had only made a limited number of reconnaissance trips into the district because of the limited access. However, a local rain water harvesting system had been identified, typically it consists of small graded catchments and open, cement plaster lined sumps. They are commonly referred to as cisterns. During the war years many of these cisterns had fallen into disrepair and were no longer water retaining because of cracks in the walls.

A major restriction on the project was that access within the area was very limited because of the danger of mines. Heavy plant and equipment, like drilling rigs could not be brought in and delivery of materials was limited to Machaze Sede and Chipudje.

As the rainy season was about to start and initiatives to provide immediate relief were required, the work proposed in the project consisted of:

* repairing approximately 500 catchment cisterns,
* achieving at least 10 functioning boreholes by repairing or installing new pumps on the existing boreholes as required.
* identifying sites for drilling at least 25 boreholes as soon as equipment can be moved into the area.

2 DISTRIBUTION OF CEMENT AND THE REPAIR OF CISTERNS.

2.1 Background

Before proceeding with cistern repair a register of families owning cisterns was prepared using information collected from the Regulo and Secretario in each village. This indicated that there were significantly more cisterns in the district than had been originally estimated. Over 1.400 cisterns were included in the register. Village leaders also informed CARE that the cisterns' locations were very dispersed. Therefore with the number of cisterns to be reapired, and because of their dispersed nature, the original proposal, employing local masons to complete the work, was no longer viable. Instead it was decided that 15 kg of cement should be distributed to each cistern owner and at the time of the distribution a brief explanation would be given on how the cement should be used to repair the cistern. The delivery of cement was delayed because of shortages in Mozambique and Zimbabwe, and the deterioration due to rain of the sole road into Machaze. As a result the actual distribution had to be completed as quickly as possible to achieve some benefit from the work during the 93/94 rainy season.

The CARE animation team assisted the Regulos and Secretarios to prepare the registers of cistern owners. When the actual distributions were made, the animators would ask the Regulos and Secretarios to inform the villagers of the distribution point and the date on which it would be made. The distribution process started with a short period of training. First it was explained how the cement should be used to repair cracks in the cisterns. Then a preliminary introduction into hygiene around the cistern and cleanliness of the catchment was given as the first step to improved water quality.

Providing chlorine for the disinfection of the water from the cisterns was not practical in the circumstances. The high level of suspended solids in the water would have made it very difficult to have made recommendations on the dosage required. In addition the only chlorine that could be procured was in a relatively high concentration granule form that was not suitable for untrained people to handle.

2.2 The Evaluation Process.

The cement distribution and repair of the cisterns was evaluated in the following way:

* the cistern register and paper work relating to the actual distribution of the cement was reviewed.

* field inspections of the repair work were made at the villages of Chipopopo, Guezanhe, Bassane and Tuco-Tuco,

* the project manager, Robert Smith, the technician, Antonio Chauque, and the animator, Merlina Banze, responsible for the distribution of the cement and the associated community liaison were interviewed.

2.3 Fieldwork Report on the Cement Distribution

The records reviewed were the summary of cistern numbers as detailed in the Project Implementation Report Dec 93 to Feb 94 and the file of 'Lista de Beneficiarios - Cemento'. Lists exist for each village. Each list details the name of the head of family, the weight of cement distributed, the date of the distribution and a signature or finger print confirming receipt. An addition on some of the sheets is a record of the number of cisterns each family owns. In general the lists have been completed in full. In some cases details of the distribution date and the confirmation of receipt have not been completed. The list for Chipopopo indicated that only 50% of the families actually collected their cement while in all other villages the lists showed that everyone had.

In summary, the lists indicated that the cement distribution had started mid-January and was completed by mid-April. 20.465 kg of cement were distributed to 1.338 cistern owners.

Conducting field inspections proved to be complex. Initially three villages were visited, Chipopopo, Guezanhe and Bassane. The routine followed in each village was similar. The Secretario was met and the purpose of the visit explained. In all cases there was a general comment that the cisterns were far away and difficult to travel to. Accepting this comment, some cisterns were visited in each village.

Chipopopo is approximately 30 km south of Machaze Sede and can only be reached by motor bike. The Secretario explained that the cement had been collected but to date the villagers had not used it to repair the cisterns. He further stated that the cisterns were dispersed within the area and there were none near the village centre. After further discussion one of the villagers was delegated to show us the location of

a cistern which we then visited. This cistern was a motorbike ride away from the village centre in an area cultivated with cashew trees and with no immediately visible dwelling. It was a large cistern with a well graded and prepared catchment that had obviously been plastered. There were a number of cracks in the walls of the cistern and there were no sign of any recent repair work.

A new road has been cut to Guezanhe and it was possible to travel to the cluster of houses where the Regulo lives by Land Cruiser. The cement distribution had been made at Chipudje approximately 15 km away.

The CARE improved prototype cistern is situated on the road to this village. It was inspected and is a substantial, well detailed and well built structure. 39 bags of cement were used in its construction. The water marks indicated that it had only filled to a depth of 0,5 m. Construction was only completed at the end of the rainy season, as the priority was to distribute cement to the cistern owners.

Guezanhe has no village centre, just dispersed groups of homesteads in clearings in the bush. The Regulo took us on a walk, approximately an hour, through the area and five cisterns were visited. All had recently repaired cracks and the water lines indicated that most had filled with water during the rainy season. When asked if there were more cisterns that could be seen, the Regulo explained that there were but that they were very far away, implying too far to walk.

Bassane is approximately 20 km southwest of Machaze Sede and can only be reached by motor bike. In the centre of this village was the most elaborate cistern arrangement seen. It consisted of a well defined graded catchment which had originally been plastered. Within this catchment were two large (4 m diameter) cisterns. The inner part of the catchment and the cisterns were enclosed in a fence. One cistern had a small amount of very green water in the bottom while the other appeared to be half full of water that was muddy but free from floating debris and algae. A rudimentary sieve for removing debris and a bucket and rope for drawing water were noticed. The owner explained that the water was used for washing and laundry but drinking water was collected from the boreholes at Machaze Sede. The owner had employed a builder for the construction but he could not remember exactly when. Some cracks in the walls had recently been repaired and the owner said he would also like to repair the plastering of the catchment but did not have cement.

This village has a defined centre and the walk to inspect cisterns was through machambas between clusters of huts and not through open bush. Four traditional and two Portuguese cisterns were visited. Five of the six had recently repaired cracks. One of the Portuguese cisterns collected water from the roof of a government building, through plastered channels at ground level instead of gutters. It was explained that this was a communal instead of a privately owned cistern. The walk to visit all these cisterns again took approximately an hour.

In addition to walking in the vicinity of the village centre some motor bike trips were taken to inspect more remote sites. Six cisterns were visited and they had all recently been repaired. When asked if there were more cisterns that could be seen, we were told they were very far away and could not be reached by motor bike. Leaving this village three additional cisterns were seen near the path. One had recently repaired cracks.

An initial analysis of the information collected in these three villages indicated that the cistern register had been inflated. Relative to the amount of travelling done, it appeared that more cisterns should have been seen if the register numbers actually existed.

It was decided that a more thorough and structured inspection would be required to verify if the cistern register was correct or was in fact inflated. An extra visit was therefore arranged to Tuco-Tuco, a village between Machaze and Chipudje and approximately 9 km west of the main road. There is a sabotaged borehole at Tuco-Tuco but the nearest working boreholes are now 10 km away at Chipudje.

Additional support was organised, consisting of a larger team including members of the animation unit which had experience of monitoring. The visit started with a meeting with the Secretario and it was clearly explained that we needed to see a representative sample of the repaired cisterns in the area. It was further explained that we were prepared to do the necessary travelling or walking as required. The list was available and the Secretario identified 12 cisterns which could be visited.

We travelled back to the Secretario's homestead by motor bike, approximately 5 km back along the track to the main road. On the way three cisterns were visited. Two had recently been repaired. From the Secretario's homestead we walked on paths through the bush between dispersed homesteads. To provide an indication of the distance walked, all walking times were recorded. The total walking time was 2 hours 25 mins and 8 cisterns were inspected. All the cisterns had recently been repaired. The area covered appeared to be a strip running north-south 6 km long by 1 km wide. On completion of this circuit, the Secretario explained that there were another 5 cisterns which could be visited as we travelled back to the main road. Because of time constraints we were unable to do this but because the Secretario had identified the names from the register and was keen to show them to us, we were confident that they did exist and could be included in the survey.

On completion of the field work, a desk analysis was completed to compare the distribution of cisterns in the sample area with the average for the whole village. The area covered was identified on a map and its proportion of the total village area assessed. It was concluded that 20% of the village area had been covered and the 14 cisterns visited represented 18% of the total number registered. Assuming a uniform distribution, this exercise confirms that the cistern register is correct and the cement

distributed had been used to repair the cisterns (with the exception of Chipopopo which reportedly has not yet used the cement).

2.4 Field Work Report on Cistern Repair.

A typical size for the cisterns visited was 2 to 3 m diameter by 2,5 m deep with a 10 m diameter graded catchment. Although the cracks in the cisterns themselves had been repaired little attempted had been made to refurbish the catchments. It appeared that originally the catchments had been well graded and plastered and often had a border of logs. In most instances this plastering had disintegrated and in some cases the grading had been destroyed through erosion. Where cisterns are located in the bush, the grading of the catchments were sufficiently preserved to still function. Where the cisterns are in the cleared areas around homesteads, there tended to be no defined catchment and water draining from the area would be channelled to the cistern. Recent water marks on the cistern walls indicated that these cisterns had filled completely during the last rainy season while those with defined catchments had filled to 75%.

2.5 Comments on the Effectiveness of the Cisterns as a Water Source.

To improve the effectiveness of the cistern system in the longer term more input will be required to improve both water quantity and quality. Initially both these issues can be addressed by improving the catchments. It will require a combination of training and labour inputs. Although this is considered to be a traditional technology, an awareness of some of the basic principles appears to have been lost. At many of the sites visited there had been some erosion of the catchment so that only a limited amount of run-off actually drains into the cistern. At very few of the sites had any recent attempt been made to re-grade although this initially only required a labour input.

Where possible the catchment should be defined so that cleanliness of the area can be maintained. Plastering the surface of the catchment is the ideal but this requires an input of cement and this is not considered viable until the owners have demonstrated their commitment through making the labour input required to improve the grading and defining the area. Where cisterns are located within the cleared areas around homesteads, the owners must try and establish a dedicated catchment area which can be defined and isolated from the general water run-off. If there is the possibility of general run-off entering the cistern the advantage of improving water quality by plastering the catchment will be lost.

Although the system of cisterns as developed does not provide a perennial water supply, it does provide a convenient supply for the duration of the rainy season. In areas of limited water resources there is a growing realization that providing water security can only be achieved from the development of a number of sources using

different technologies. In Machaze, where villages are very dispersed, providing convenient water supplies is particularly difficult and there are advantages to providing assistance to further improve the cistern system particularly as there are few financial factors limiting its ultimate sustainability.

As the effectiveness of this system is very dependant on the discipline of the users much of the input currently required must be in training both in the actual maintenance of the system and an awareness of the health and hygiene related issues. It is only when people become aware and accustomed to the benefits of a clean water supply will they really value it and strive to maintain it. The principal objective of the training must be to create this awareness.

The principal limitation to this system providing water of an acceptable standard, is the discipline and will of the individual users. As a first step the user must ensure the cistern and the catchment is free of debris before the start of the rainy season. Floating debris and algae should be regularly removed from water stored in the cistern. If this is done the water will probably be of an adequate standard for washing and laundry. To provide water for drinking and cooking, a treatment process like slow sand filtration should be considered.

2.6 Conclusions.

Cement has been distributed to 1300 cistern owners and used to repair cracks in the cistern walls. The repairs have improved the water tightness of the storage portion of the cisterns and many of them filled or partially filled during the last rainy season.

Providing convenient water supply points is restricted by the dispersed way of living. Rain water harvesting can provide a convenient water source to dispersed households for the duration of the rainy season. As this is the season of highest agricultural activities there is a motivation for improving the effectiveness of this water source thus freeing family labour for farm work.

Further improvements to the cisterns have been identified. The catchments can be refurbished which will improve both water quantity and quality. Improved operating practices can be introduced. Improving water quality to an acceptable potable standard by slow sand filtration can be investigated.

3. REHABILITATION AND RE-EQUIPPING OF THE EXISTING BOREHOLES.

3.1. Background.

As explained in the project reports, the actual state of disrepair of the existing boreholes was found to be different from the information that had been received from the government. Of the ten boreholes that had been classified as repairable, seven had been sabotaged during the war and were beyond repair. The project objectives in terms of the number of pumps to be installed could not therefore be met. However in the course of the water resource investigation some detailed field work was undertaken and this resulted in some additional intact boreholes being found.

In terms of the original objectives, the four existing pumps were serviced and have had maintenance support for the duration of the project. Of the six new pumps due to be installed only three in fact were. Five of the six boreholes reported by the local administration to be intact and ready for pump mounting, were found, upon inspection by CARE staff, to have been sabotaged beyond salvage. Subsequent field explorations, by CARE staff, identified the existence of two previously unreported intact boreholes. These two, plus the one intact borehole from the administrator's original list, were equipped with hand pumps by the project, making the final total of three. No further recuperable boreholes were found.

In addition to the actual pump installation, apron slabs and draignage channels were constructed as required. As the principal source of water in the district during the dry season all the boreholes are being well used.

3.2 The Evaluation Process.

The re-equipping of the boreholes was evaluated in the following way:

* field inspections of all the pumps in the district,
* interviews with Robert Smith and Antonio Chauque,
* a review of the reports and correspondence detailing problems that had been experienced in the installation of the Afridev and Volanta hand pumps.

3.3 Fieldwork Report on the Borehole Equipping.

The pumps installed as part of this project are:

Machaze Missao	Afridev	(replacement for broken Volanta)
Tuera	Afridev	
Macundanhe	Volanta	(experiencing operating problems)

The Afridev pump at Missao is functioning well. When it was visited in the middle of the day, it was in continuous use but there was only a small queue of waiting containers. As part of the installation a standard concrete apron slab, open channel drain and wooden fence were constructed. The channel directs all spillage water away from the borehole and the area appeared clean and well maintained. One operating problem had been experienced with this pump. The piston seal had been installed upside down as part of the original factory assembly and quickly failed. The village maintenance team had removed the rods and piston but had been unable to identify the fault and had come to CARE for assistance. The installation of a new seal rectified the fault.

The Afridev at Tuera is providing a service but the pump appears to exceed the yield of the borehole. It is not possible to pump continuously as it appears the water level draws down to the pump and a few minutes are then required for the level to recover. When the pump was install the static level was 33,0 meters and the pump was installed at 45,0 meters, the limit of the Afridev's range. This is the remotest borehole being 30 km from Machaze Sede. As an indication of the demand for this borehole to be equipped, all the materials and equipment for its installation, including the cement for the slab, were carried from Machaze by the villagers. There was a queue of about 20 water containers. As part of the installation a new standard concrete apron slab, open channel drain and wooden fence were constructed. The area around the borehole was clean and the channel directed all spillage water away.

The Volanta pump at Macundanhe is currently not functioning reliably. It appears that there is an accumulation of sediment in the borehole which is being drawn into the pump cylinder and preventing the valves from closing. The borehole is 33 years old and has been not been used regularly. The normal approach to this problem would be to clean out the hole with a bailing tool on a cable rig and assess if the casing needs replacing. In the circumstances this is not possible so some experimentation with filters on the pump inlet is being carried out. The filter supplied by the pump manufacturer has been incorrectly designed or manufactured as insufficient water is able to flow through it for the pump to operate.

In addition to the installation work, CARE have provided a maintenance service as part of this project. At this time there is no government water department based in Machaze. Although the pumps installed are ostensibly VLOM, a source for spare parts is required and as part of the training process additional expertise must initially be available. At this point in time a number of the pumps are being used continuously and the wear being experienced and maintenance required far exceeds

what can be expected in normal use.

The existing pumps that have been maintained are:

Machaze Sede	Mono with diesel motor
Chitobe Cantinas	Volanta
Chipudje	Afridev
Chipudje	Volanta
Save	(Machaze south, not included in this evaluation)
Tuco-Tuco	Volanta (not working, repair attempted)

Machaze Sede borehole equipped with a diesel powered pump, header tank and 2 No. standpipes. As part of their maintenance function CARE cleaned out the header tank. The standpipes are continuously used during the day from 06h30 to 17h30. Queues form at the taps with up to 30 water containers waiting. Many of the women who come to this borehole do their laundry and personal washing next to the borehole. They therefore collect water to use immediately and will then collect more water to carry home. The area where the washing is done is not well drained and as a result these activities are creating unsanitary conditions around this borehole.

Chitobe Cantinas borehole equipped with a Volanta hand pump. This pump is used continuously during the day. When it was visited at 10h00 there was a queue of about 80 water containers. It was twice visited at 18h00 and at that time there was no queue but people were still coming to collect water. There is a small concrete slab to collect spillage at the pumps with a short concrete channel and a much longer unlined channel which successfully directed the water away from the borehole. The area around the pump was clean and no area was seen were people did their laundry and washing.

Chipudje boreholes, one equipped with an Afridev and one with a Volanta. The Afridev has required the handle, the fulcrum pin and the nylon bearings to be replaced. The Volanta has required routine greasing of the bearings. These two boreholes appeared to be in use 24 hours per day. When they were visited at 08h00 there were over 300 water containers in the queue waiting to be filled and it was obvious from the embers of numerous fires that people queue all night at these pumps. In general the area were the people queued appeared clean and spillage water channelled away. No area was observed were people washed and did laundry around these boreholes but the area were people did not queue was badly fouled with excreta. During the rainy season this area could become a health hazard and possibly lead to contamination of the borehole.

The Volanta pump at Tuco-Tuco was installed by another agency. Either during or immediately after installation, one of the joints in the rising main failed and resulted in a large section of the rising main falling into the borehole. CARE have tried to

retrieve it but to date have been unsuccessful. The end of the main can be caught with the fishing tool provided by the pump manufacturer but its grip is not tight enough to lift the main out of the borehole.

3.4 Comments and Conclusions on the Borehole Equipping.

Currently there are six boreholes in Machaze North and one in Machaze South with functioning pumps. In addition there are two more (Macundanhe and Tuco-Tuco) where work to refurbish them is still on going. There was a fairly intensive search and all the other boreholes that were found are sabotaged beyond rehabilitation.

The project objectives have not been fully achieved in terms of the output of functioning boreholes. This failure however relates to the constraints on information when the objectives were defined and not the activities of the project implementation staff.

Three of the six functioning boreholes were completely refurbished as part of this project and other borehole pumps received major maintenance inputs. In view of these boreholes being the principal dry season water sources in the district, this work has had significant impact and has probably provided some benefit to the entire population.

4. COMMUNITY TRAINING AND ANIMATION PROCESS.

4.1 Background.

Community liaison and consultation has been an integral part of the work completed. The community have been a principal source of information for the more detailed planning and design of the work. The implementation has been an interactive process. To repair the cisterns CARE's role has been to provide materials and facilitate the process. The actual repair activities were completed by individual community members.

The principal activities of the animation work have been:

- to liaise with community leaders and prepare the registers of cistern owners, organise for the collection of cement from distribution points and assist the technical staff with instruction on how the cement should be used to repair the cisterns.
- to start a programme of training to improve hygiene practices.
- provide training in the maintenance of water sources including the maintenance of hand pumps.

4.2 Comment on the Work Completed.

Part of a community hygiene training course was attended and there was a good approach to the work. Community members attending the course were being required to participate through role play activities. There was a language difficulty and the detail in which this work could be reviewed was therefore limited.

As part of the evaluation of the cement distribution process, members of the animation team assisted. They obviously knew the Regulos and Secretarios and other individuals in each village. It did however appear that their visits to the villages had been limited to visiting the village central points and they were not aware of just how dispersed the homesteads are. This issue is however being addressed by establishing localised trainers in each village.

As commented, the areas immediately around the pumps are being kept clean. Where pump break downs have occurred, the village maintenance team have tried to make repairs. This is a clear indication that community ownership of the facility has been clearly explained and is an important first step in achieving a local maintenance capability.

Improving community hygiene practices is a long process and it is unrealistic to expect the work completed to date to have any immediate impacts. If there is continued perseverance it will be the starting point for long term improvements.

5. WATER RESOURCES STUDY OF NORTHERN MACHAZE.

5.1 Background.

The initial design of this study, similar to the main project, was completed from a limited information base. The original scope of work concentrated solely on assessing existing rain water harvesting practices and their potential to provide a secure supply of potable water. In the course of the work, the scope was revised to include a wider water resource study and a basic investigation of demography.

Water resources relate to the natural hydrological cycle of rain, runoff and recharge of ground water aquifers. To study these resources in detail, good historical records are needed of these different events. The current situation in Machaze is that these records do not exist and therefore the detail and accuracy of any water resource study will be limited. Much of the study completed has centered on collecting information on "traditional" water sources and collection practices as a substitute for longer term hydrological and hydrogeological records.

5.2 Information Collected in the Study.

The water resources currently being utilised were identified as:

rain water which is collected directly through a harvesting system,

ground water which is collected from shallow wells and boreholes.

It was further identified that there is no perennial surface water in the district.

A household survey was conducted to collect more detailed information on:

wet and dry season domestic water consumption;

the distance people are walking to collect water;

the traditional system of rain water harvesting into cisterns.

As no data could be found in official borehole records, people who had been present when the boreholes were originally drilled were found and interviewed to obtain more information on the geology of the area and the ground water.

Additional data was collected on water collection and use and hygiene practices from general observations made during field visits.

The collection and documentation of data on water resource and water use practices has made this report a useful reference document in the lack of other information.

5.3. Principal Conclusions and Recommendations of the Study.

The study concluded that the two years of sub-continental drought has not yet broken in the district and this is influencing the current water availability, in particular the reliability of shallow wells.

Rain water harvesting by collection in cisterns and by bailing from puddles and other local depressions appears to contribute to a significant increase in rainy season water consumption. The survey completed indicates an increase in average consumption from 4 to 10 liters/person/day.

The underlying geology of the area is marine sequences and the principal aquifer is a confined sandstone or limestone horizon at about 90 m deep. In addition to this main aquifer there may be shallower perched aquifers, some of which may be saline.

5.4 Comments on the Water Resource Study.

The collection and documentation of data achieved as part of this study is considerable. It is a valuable resource for future water supply development work in the district.

The principal hydrogeological conclusion that the area is underlain by a primary aquifer appears correct based on the available information. The borehole water supply at the CARE camp in Machaze is hard water indicating that it comes from a limestone aquifer.

Requiring the scope of work to evolve from studying rain water harvesting practices to total water resources, as the work progressed, has resulted in some gaps in the study. The effects of rain water in terms of recharging ground water has not been considered and no attempt has been made to construct a hydrological water balance.

In terms of the existing situation, new boreholes at the site of existing sabotaged boreholes can be drilled with a high degree of confidence of success. Logging this drilling will confirm the existence of the primary aquifer and provide details of the geological sequences. The logic of undertaking an initial geophysical survey as recommended is therefore questioned.

The detailed logging of the drilling and the thorough yield testing of some of the boreholes was omitted from the recommendations, although it was mentioned in the text. This information will provide valuable data on the sustainable development of the ground water resources and its collection should therefore be appropriately prioritised.

6. GENERAL.

As part of the field work all the dry season water sources, with the possible exception of a few shallow wells, were visited. From an assessment of the delivery and use time of each source it was possible to make an estimate of current water consumption within the district. Based on the delivery from the hand pumps being 12,5 liters/minute and the total delivery from the header tank at Machaze Sede being 40,0 liters/minute, the total current daily water consumption was estimated at 110.000,00 liters. If the current population is 60.000 as estimated then the average per capita consumption is less that 2,0 liters/day. In the circumstances this appears too low to be a sustainable supply. The accuracy of the population estimate is therefore questioned. In terms of the work that has been done and the proposed next phase of the work, having an inflated population figure is not critical. The accuracy of population numbers should however be considered if further phases of the project are planned and detailed cost benefit analyses are undertaken.

The area around the Machaze Sede borehole where people do their laundry and wash and near the Chipudje boreholes where the ground is being fouled, are two areas where additional facilities could have been installed. Unsanitary conditions are being created at both these locations. Some well drained wash slabs and some pit latrines are required to rectify the situation. With the drilling of more boreholes, concentrations of people at individual boreholes should be reduced and the current problems may be resolved. An awareness of conditions like this occurring is required and if necessary consideration should be given to constructing other facilities as part of one of the future phases of this project.

A major part of the work undertaken under this phase of the project has been establishment and planning for subsequent phases when access to the area will be improved and major implementation programmes can be undertaken. It was therefore questioned if a cost benefit analysis would produce any meaningful conclusions when the outputs of the future work cannot be included. Completing such an analysis was further complicated by the project accounting being for the total project. To have completed an analysis exclusively for the work in Machaze would have required a division of costs within the project accounting system. It was therefore decided not to complete a cost benefit analysis as part of this evaluation as the results would not contribute meaningfully to the final conclusions.

7. REVIEW OF THE PROPOSAL FOR THE NEXT PHASE OF THE PROJECT.

7.1 The Proposal.

CARE have prepared a proposal for the next phase of this project which is currently being assess by possible funding organisations.

The principal activities proposed are:

- the drilling of 20 boreholes during the current '94 dry season,
-the drilling of another 20 boreholes during the '95 dry season,
-equipping successful boreholes with hand pumps,
-the construction of 4 shallow wells,
-continuing the community animation programme concentrating on water point and hand pump maintenance and water use hygiene education,
-investigate options for recovery of pump operating and maintenance costs.
-information exchange and advocacy with government departments.

7.2 Comments on the Proposal.

Drilling more boreholes is required to improve the water supply in Machaze and the basis of this proposal is therefore correct. The proposal to limit drilling to the dry seasons is also good. Providing access for the drilling equipment during the rainy

season could be difficult. In addition population movement within the area is uncertain and having some flexibility to locate boreholes where the people are settling because of other criteria could be advantageous. The monitoring of the use of the new boreholes should be considered as an indicator of areas of greatest demand.

From the recent experience of starting to work in an area with a minimal information data base, the need for good data collection during this phase of the project is particularly obvious. But to collect information to accurately assess borehole yields and dynamic water levels, some thorough pump testing, which is expensive to complete, will be required. In addition it must be assessed if PRONAR's standardised procedures are appropriate in the particular circumstances. The design of the borehole development and the scope of work for the drilling supervisor must be carefully considered. The advantages of being able to confidently specify the depths for hand pump installation must be assessed relative to the costs of collecting and interpreting the data required to do it.

Consideration should be given to assessing, possibly with assistance from an experienced geohydrologist, if enough information can be collected from borehole logs and detailed pump testing to confidently predict dynamic water levels when abstracting water with hand pumps. If this can be done, an informed decision can be made on the depth to which pumps must be installed. Having this information would possibly enable Afridev pumps, with their associated advantages, to be specified for boreholes with water strikes below 45 m. To successfully complete this investigation it needs to be well planned to ensure all the necessary data is collected while the field work is in progress. An initial assessment of the feasibility of completing the work must be made at this stage and an appropriate logging and test programme planned.

To assist in the retrieval of borehole data in the future all the boreholes must be officially numbered and that number displayed at the borehole sites in the field. A robust way of doing this is to stamp the number on a small aluminium plaque which is glued to the masonry work with epoxy resin. All the existing holes should be included in the register and possibly the sabotaged ones too.

Data collection will remain a component of the work and it is recommended that a record of basic weather data is started; rainfall and maximum and minimum temperatures.

Including the construction of some shallow wells in the programme is a good policy. In areas of limited water resources, the development of all viable water sources must be considered. People are using the wells and this a good motivation for making improvements so that the benefits of the project are as inclusive as possible. Consultation is part of CARE's process and improvements will be subject to the agreement of the existing users.

The project includes an extensive community training and animation programme which is essential to CARE's overall aim of providing sustained water supplies.

Recovery of operating and maintenance cost is an issue which must be addressed. In South Africa services have been provided without considering recovery of costs and this has created a precedent that has become very difficult to change. A better ethos in terms of paying for services has been established in other African countries and there are probably examples of suitable models. As part of the investigation careful estimates must be made of the costs to be recovered so that the amount required from each household or system user can be specified. In addition a system making pump spare parts available in the district must be established so that it is practical for community members to make the necessary purchases.

The project will include an information exchange and advocacy component. This work should possibly address procedures for data storage and support for the hand pump standardisation policy with the appropriate government departments.

At the end of this project there will be a significant amount of borehole data. This data should be handed over to a government department for storage. Based on the experience of this project in terms of retrieving data there is a case for ensuring appropriate structures are in place to efficiently do this.

Support for hand pump maintenance in terms of availability of spare parts and tools is required throughout the country. Accepting that ultimately responsibility for providing the service should possibly not rest with the government, there is a case for the government to give commitment to its policy and at least initiate and facilitate appropriate processes.

7.3 The Selection of Hand Pumps.

Current government policy is for all water projects to standardise on the use of two hand pump types; the Afridev where the dynamic water level is less that 45 m deep and the Volanta were the dynamic level is deeper.

Hand pumps are pieces of equipment that are subject to exceptional loading because of the variable amounts of energy input by individual operators. The ultimate reliability of a hand pump must relate as much to appropriate maintenance as to quality of manufacture. Maintenance must be seen as an integral part of operating the pump and not as something which must be done to rectify faults in the pump's original manufacture.

The Afridev is a proven VLOM pump. Although maintenance is required it is designed to be completed by a community maintenance team and requires a minimum number of tools to do it. The limitation on this pump is that it can only

for equipment.

These boreholes provide the major dry season water sources and are currently being used to far beyond their normal capacity.

A community training and animation programme has been completed. Liaison support for the cistern repair activities and training of village hand pump maintenance teams has been successfully completed. Training in improved community hygiene practices has started. The benefits of this training, if it has been successful, will however only become apparent in the future .

A water resource study has been completed which has collected and documented a significant amount of information. No detailed historical records of hydrological events could be found and this restricted the level of detail to which the study could be completed.

The principal hydrogeological conclusion made in the resource study, that the area is underlain by a primary aquifer appears correct.

The advantages of completing a geophysical investigation before drilling at the sites of existing sabotaged boreholes as recommended in the study is questioned. It appears more information will be obtained from logging the drilling and this can be undertaken with a high degree of confidence of striking water.

Available information indicates that the major water strike is at 70 to 90 m deep but the final static level is at 30 to 40 m. If the dynamic level when abstracting water can be confidently determined, a more informed decision can be made on which hand pump to equip the boreholes with. Equipping with Afridevs has several advantages including a financial consideration but it must be know that the dynamic water level will not exceed 45 m.

Improving the data base must be considered and every opportunity to collect data during the project implementation should be taken. Collecting basic weather data should be undertaken.

Reliability of hand pumps relates as much to having appropriate maintenance as the original manufacture. The Afridev and Volanta pumps are both VLOM pumps but village maintenance is dependant on having access to spare parts and tools. Currently there is no spare parts distribution system. To give commitment to their policy of standardisation, the government needs to facilitate the establishment of a system. Information exchange and advocacy with government departments is a project activity and facilitation of a spare parts distribution system should be advocated.

An estimate of the current daily water consumption in the district is 110,000 liters/day. This is considered an insufficient supply for the estimated population of 60,000 people. The level of accuracy of the population estimate is therefore questioned and it is considered that it may be inflated. Although inaccuracy in the population estimate will not effect the work being proposed, it should be considered when future work is planned.

Part of the work completed has been preliminary to the larger drilling implementation programme now proposed. It was therefore concluded that a cost benefit analysis would not provide meaningful information and has not been completed as part of this evaluation.

MANICA WATER SUPPLY PROJECT

MID-TERM EVALUATION

WORK BEING UNDERTAKEN IN NORTHERN MACHAZE DISTRICT

ITINERARY OF FIELD WORK

94-06-13	Reviewing documents Maputo office.
94-06-14	Travel to Machaze.
94-06-15	General field visit, Missao, Macundanhe, Tuco-Tuco. General discussions with project staff.
94-06-16	Attend hygiene training course. Review cement distribution records.
94-06-17	Field visit Chipopopo.
94-06-18	Field visit to Chipudje, Guezanhe.
94-06-19	Interviews with Rob, Craig and Merlina.
94-06-20	Field visit to Bassane.
94-06-21	General discussions with Peter and Rob. Rechecking cement distribution records.
94-06-22	Field visit to Tuco-Tuco.
94-06-23	General writing up.
94-06-34	Travel to Beira for return to Maputo.
94-07-11 to 15	Preparation of final document Maputo office.

CARE INTERNATIONAL IN MOZAMBIQUE

MANICA WATER SUPPLY PROJECT

MID-TERM EVALUATION OF WORK BEING UNDERTAKEN IN NORTHERN MACHAZE DISTRICT

SUMMARY.

I. ACHIEVEMENTS AND OUTPUTS.

A. Objectives for Phase 1.

-prepared with constraints on access and information.
-to provide some immediate improvements in water supply.
-to plan for the design of a larger project.

The objectives were achieved.

-cement distribution to 1300 cistern owners and cracks repaired (because of cement shortages only completed at the end of the rainy season and immediate impact limited).
-7 functioning boreholes achieved.
-the water resource study concluded that the area is over a primary aquifer and identified 35 borehole sites.

B. Distribution of Cement for Repair of Cisterns.

-completed with some difficulty because of the very disperse nature of the villages, the distribution of cement and its use to repair the cisterns was verified.
-the repairs have improved the water-tightness of the cisterns.
-to significantly increase the effectiveness of this system of water supply improvements and repairs will also be required to the grading and surfacing of the catchments.
-better operating practice is required to improve water quality.

C. Assessment of Number of Beneficiaries and Impact on Women and Children.

-a preliminary balance of current consumption and water supply indicates that the current population estimates may be inflated.
-any improvement in the convenience of water sources will have an immediate impact on women who are the main collectors of water.
-the effective functioning of the rain water cisterns could therefore have a

significant impact for the duration of the rainy season.
-the main beneficial effect for children will be improved health through improved hygiene, in this respect the current work will have minimal immediate effect but could be the starting point for long term improvements.

D. Project Cost Benefit Analysis.

-the establishment and planning included in this project is for subsequent phases; a cost benefit analysis at this stage will therefore not produce a meaningful conclusion.

E. Water Resource Study.

-restricted by a lack of hydrological information.
-some detailed information on current water collection practices and details of previous borehole drilling collect from a survey.
-the conclusion that the area is underlain by a primary aquifer and new boreholes can be sited at points of convenience appears correct based on the information available.
-in general the recommendations from the study are appropriate and realistic.
-the need for a geophysical investigation before drilling is questionable but the detailed logging of the drilling is essential.
-although hydrological records are not available, investigating the effects of rainfall on the aquifer recharge, which must be significant in the longer term hydrological balance, should have been included.

F. The Project's Relationship with Government Water Structures.

-because of logistical problems this issue has not been addressed to date.

G. Community Animation Activities.

-improving community practices is a long process.
-from attending part of a community hygiene training course it appeared the approach to this work was good, involving participation and role playing.
-the areas immediately around the pumps were kept clean and spill water was being channelled away.
-where pump break downs had occurred the community maintenance team had initially tried to make repairs themselves.

H. Environmental Impact.

-the current congregation of people at water points is degrading the immediate environment; the establishment of more water points will reduce this.

II. RECOMMENDATIONS FOR PHASE TWO.

A. The Objectives.

-the proposed drilling programme is appropriate.
-because of the questions raised about the accuracy of the population estimates and because of the uncertainty of future population movements, use of the new boreholes should be carefully monitored.
-detailed consideration must be given to the scope of work for the drilling logging and aquifer yield testing.

B. Pumps.

-hand pumps are subject to exceptional loading, and ultimate reliability is as much a factor of maintenance as of original manufacture.
-the approach of standardising on pumps is good but to give meaning to this policy there must be appropriate support systems established. This should be advocated as part of this project.
-the Afridev is a proven pump for normal well depths.
-the Volanta is complex to install. If installed correctly it appears to provide reliable service. Although this pump is classified as VLOM its mechanism is complex and a number of small tools are required for maintenance.

Shallow Wells.

-Machaze is an area of limited water resources and to provide water security consideration should be given to developing all viable water sources.
-shallow wells are currently being used and there is scope for improving the water quality by protecting them.
-improvements should only be made in consultation with existing users.

Cisterns.

-catchments can be improved.
-operating practice can be improved.
-the use of sand filtration can be encouraged.

C. Community Animation Activities.

-an extensive programme is proposed which is good.
-women should be included in all aspects of the training.