ASSESSMENT OF THE NATIONAL DRILLING SECTOR CAPACITY FOR RURAL WATER SUPPLY IN MOZAMBIQUE

EXECUTIVE SUMMARY

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Contents

List of Tables and List of Figures

Annex 1: Bibliography

List of Abbreviations

ARA	Regional Water Administration
BOQ	Bill of quantities
DGRH	Department for the Management of Water Resources
DNA	National Water Directorate
DPOPH	Provincial Directorate of Public Woks and Housing
EPAR	Provincial Institutions for Rural Water
MIPAR	Manual for the Implementation of Rural Water Supply Projects
MOPH	Ministry of Public Woks and Housing
NGO	Non Governmental Organization
NWP	National Water Policy
MDG	Millennium Development Goals
PRONAR	National Rural Water Programme
RWSN	Rural Water Supply Network
RWSSI	Rural Water and Sanitation Supply Network Initiative, from the BAD
VES	Electrical Vertical Sounding

All photographs were taken by the Consultant. The photograph on the first page: Rig from Mozágua, type Hotline 310, working in Maputo Province using the mud drilling method.

1 Scope of the Study

The Mozambican government has pledged to realize the Millennium Development Goals (MDG) in the areas of water supply and sanitation. The most common sources for water supply in rural areas are boreholes. The main objective of this study is to identify the capacity of private sector companies to offer boreholes at a reasonable price and in the quantities necessary to realize the MDGs in Mozambique. A comparison with drilling sectors in other African countries was also elaborated.

The Water and Sanitation Program (WSP) is an international partner who helps the poorest in having sustainable access to the services that supply drinking water and sanitation. Within this context, the WSP jointly with the DNA opened a tender for the evaluation of the national capacity to produce thousands of boreholes that are necessary in order to obtain the MDG, and the contract has been placed with WE Consult.

The Rural Water Supply Network (RWSN) co-sponsors this study as part of its standard bearer Cost-Effective Borehole and also participates in an independent WSP-Africa project called Drilling Entrepreneur Support Initiative, which supports private sector drilling companies in improving their capacity to produce more boreholes at lower unitary costs.

2 Institutional Structure

The Water Law (Law 16/91) states that the natural resources of soil and subsoil and the continental waters are property of the state and of the public domain. The Water Law does not deal with specific aspects related to the use of groundwater. The most relevant Law is the one that established the Regional Water Administrations (ARAs) (Law 17/91), which delegate the daily operations and management responsibilities with respect to the national water resources to five autonomous and financially independent institutions, each one covering a series of basins.

In accordance with the present constitution, the MOPH is responsible for the licensing of drilling companies (DM 83/2002, Chapter I, art. 1) by means of a permit (*alvara*). In addition, there are categories and various subcategories for the different types of construction. The necessary classification of drilling companies is:

VI Category (groundwork and water entrapment), 6th subcategory: boreholes and wells

There are no official standards for projects exploring groundwater in Mozambique. Prior to the water sector opening up for private sector participation in 1992, groundwater projects were implemented by the DNA/PRONAR, through the GEOMOCs and the EPARs, using internal regulations.

3 Technical aspects of boreholes

The design most frequently used in Mozambique for rural groundwater projects is presented in Figure 1 (DNA, 1998). The borehole has a PVC casing / filter of 4" (101 mm) internal diameter right to the bottom. The AFRIDEV manual pump is recommended for boreholes with dynamic level not deeper than 45-50 meters. There is not a single standardized manual pump

for dynamic levels deeper than 50 meters, but in many cases the Afrideep pump is being used.

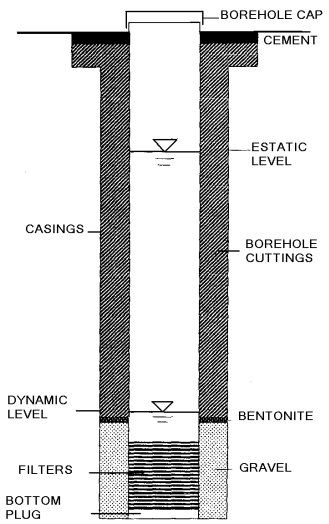


Figure 1 - Standard borehole configuration (DNA 1998)

(source: criteria for the construction of boreholes, second edition, DGRH, 1998)

The following aspects are part of the configuration:

- PVC casing with 4" internal and 4.5" external diameter until the base
- Bottom plug (non-specified material)
- Borehole of at least 6", with annular space of 2"
- Openings of 2 mm for filters
- Gravel
- Bentonite (Gravel seal)
- Filling
- Sanitary seal

Figure 2 – Large rig mounted on a truck

It has a compressor and a mud pump, Nampula province

In Mozambique there are no policies/ principles for carrying out geophysical drilling. Nonetheless, the VES is the most widespread, accepted and used. Normally surveys are carried out at three sites in each community. The success rate of analysed projects varies between 70% and 100%, but negative boreholes are not registered. An example of a project with a 40% success rate was also given.

In the rural areas, water is generally obtained by manual pumps installed on shallow boreholes (holes with a depth of less than 60 meters). The drilling techniques most commonly used for this type of boreholes are: manual augering, percussion drilling, rotopercussion drilling and mud drilling (Figure 2).

Drilling equipment is imported from South Africa, India, the USA and Thailand. The main suppliers of the other equipment are indicated in Table 1.

Table 1 – Main Suppliers

Item	Percentage	Name of Supplier	Location
Pump	55%	Agro-Alfa	Maputo
	23%	Kanes	Maputo
	14%	Not specified	Malawi
Casing	84%	Hansen & Boode	Maputo
	8%	Not specified	Malawi
	8%	Various	South Africa
Gravel	43%	Inharrime	Inhambane
	43%	Own preparation	Rivers in several provinces
	5%	Not specified	South Africa
	5%	Geosearch	South Africa
	5%	Eco Sands	Pretória, RSA
Bentonite/drilling fluids	80%	Bentonite de Moçambique	Boane
	7%	Geosearch	South Africa
	7%	Not specified	South Africa
	7%	Sam Chemics	South Africa
Spare parts for drilling rig	17%	Smith Capital Equipment	Gauteng, RSA
	17%	DDS drilling suppliers	Jetpark, RSA
	17%	Alberton	Johannesburg, RSA
Based on interviews with the operators			

4 Economic environment

The costs involved in registering a company in general vary between U$D 2000 and U$D 5000. Such amounts do not seem to be a limitation for many initiatives. However, the process is bureaucratic because it involves many different institutions, and a complete process may last between 6 months and 3 years.

The normal VAT to be paid by the end users of all items is 17%. Tax on profits for companies is 32% at the end of the year. As an additional incentive moderate tax rates during the first years have been introduced for companies of foreign investors or investors in some regions (for instance in Tete). Drilling equipment and material normally belong to the category of agricultural products, for which 5% import tax is charged.

As is the case in many developing countries, it is difficult to obtain credit facilities from banks unless one has assets, and even then credit is granted against high interest rates (20-40%).

Government projects do not have a standard rule of payment modalities. In general, an advance payment of up to 25% is made upon presentation of a bank guarantee (on good performance) for the same amount. Retention varies between 5% and 10%, generally for a one-year period. The main constraint mentioned concerns the delays in payment. Delays of 3 months are common in government projects.

5 Operators and capacity

Since the early 90s the number of drilling companies has increased and national competition is growing. Many drilling companies used to be based in Maputo but recently other companies have been established based in the provinces. This is probably due to the decentralization, which leads to more contracts being awarded at provincial level (Table 2).

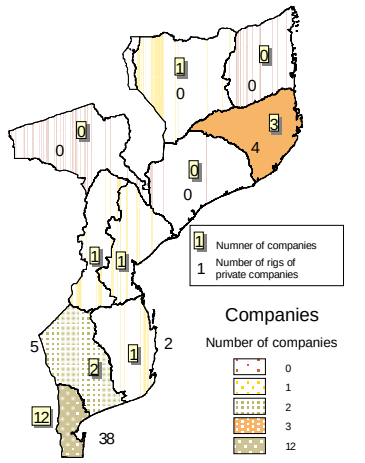


Figure 3 – Head office of the private companies

Table 2 – Seat of companies and number of drilling machines

Province	Number head offices all operators	NGO	EPAR	Private companies	Total of rigs	Rigs of private companies
Maputo	16	3	1	12	40	38
Gaza	4	1	1	2	8	5
Inhambane	2	0	1	1	3	2
Manica	2	0	1	1	6	1
Sofala	3	1	1	1	6	4
Tete	1	0	1	0	0	0
Zambézia	1	0	1	0	4	0
Nampula	4	0	1	3	4	4
Cabo Delgado	1	0	1	0	0	0
Niassa	2	0	1	1	0	0
Total	36	5	10	21	71	54

At present there are three different types of drilling operators in the country: private drilling companies (21), (semi) public drilling operators (10 EPARs) and NGOs (5), operating a total of 71 rigs of various types and capacities, with a joint maximum drilling capacity of 2220 boreholes in theory per year. However, maximum capacity is almost never reached. According to the capacity evaluation on the basis of realized boreholes, it was noted that in practice the rigs are operating at some 60% of their maximum theoretical capacity (Table 3).

Table 3 – Capacity 2005 and 2015

	Annual capacity 2005	Annual capacity 2015
Maximum Capacity	2200	2674[1]
Efficiency (60%)	1320 (60%)	1872 (70%)[2]
Available for rural water (75 %)	990 (75%)	1404 (75%)

[1] *Assuming 5% more capacity / rigs each 2 years*
[2] *Assuming 5% increase in efficiency each 4 years*

In order to meet the MDGs, to the current 7111 boreholes should be added 9285 boreholes in the next 10 years, assuming that a borehole serves 500 people. On the basis of the capacity present in the country, it would normally be possible to drill 11.715 boreholes, which surpasses the capacity that is required. However, this capacity can only be maintained if it will be possible to reduce the main constraints of the sector (chapter 8). It should be noted that the number of 500 people per borehole is debatable and a smaller number would completely change the situation.

6 Costs and prices

The average drilling cost in Mozambique was determined at US$ 151 per meter. This amount includes all investigations, drilling work, construction work, the supply of the AFRIDEV pump, plus the VAT.

This leads to a national average of U$D 6.500 per borehole, assuming an average drilling depth of 43 meters (Table 4). Based on the depths and additional price levels, one may assume the following indicative prices per province:

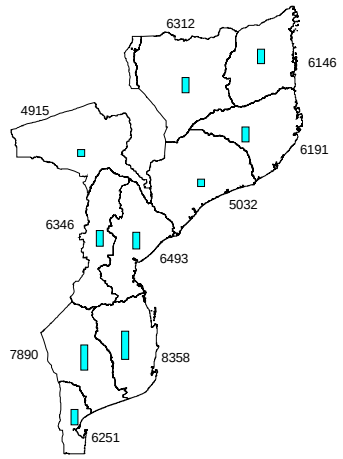


Figure 4 – Indicative prices per province

Table 4 – Indicative prices per province

PROVINCE	Average Depth	% pricce of national level	Price Incl. VAT	Price borehole $	Price Borehole meticais
MAPUTO	46	90%	$ 136	$ 6,251	150,033,600
GAZA	55	95%	$ 143	$ 7,890	189,354,000
INHAMBANE	54	103%	$ 155	$ 8,358	200,588,400
MANICA	41	103%	$ 155	$ 6,346	152,298,600
SOFALA	43	100%	$ 151	$ 6,493	155,832,000
TETE	31	105%	$ 159	$ 4,915	117,961,200
ZAMBÉZIA	31	108%	$ 162	$ 5,032	120,769,800
NAMPULA	40	103%	$ 155	$ 6,191	148,584,000
CABO DELGADO	37	110%	$ 166	$ 6,146	147,496,800
NIASSA	38	110%	$ 166	$ 6,312	151,483,200

Source: DNA data base & the consultant

Price includes mobilization, investigation, drilling, platform, pump. Exchange rate 1 $=24000

Most contracts are for positive boreholes. In this case, profits depend on the success rate. A success rate of 100% leads to profits amounting to some 8%. Success rates under 80% may lead to the company not making profits or making losses.

The analysis made of the quotations presented by the companies, shows that the components of drilling, casing and the pump, make up some 31%, 22% and 20% respectively of the borehole's total value. These three items represent the highest percentages, so that if one intends to lower borehole costs one should concentrate on these. However, it is also noted that the costs of casing and of the pump do not only depend on the drilling company but mainly on the suppliers of these materials.

7 Other African countries

Table 5 shows the drilling costs per borehole per meter, considering depths between 45 and 60 m.

Table 5 – Drilling costs in different countries

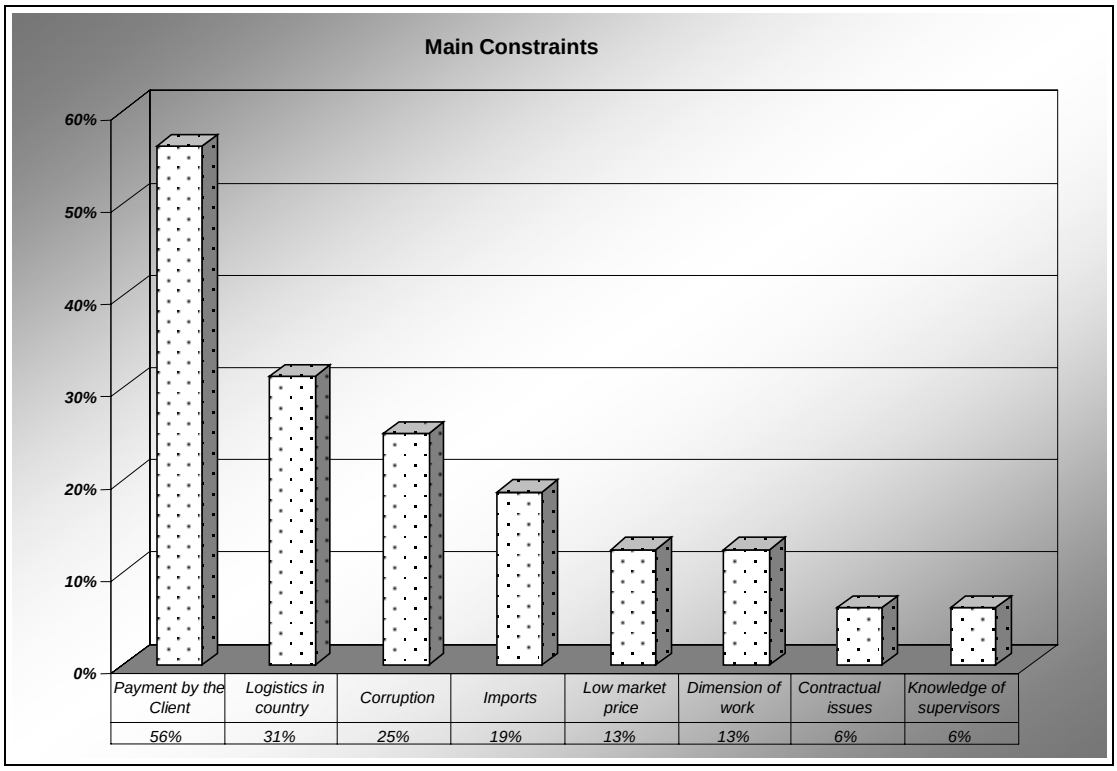
Country	Depth (m)	Cost per borehole	Cost (m)	Remarks	Comments
Ethiopia	45	$ 6,075	$ 135	per m	*General value independent of depth*
Ghana	60	$ 6,000	$ 100	per m	*General value*
Mali	60	$ 8,000	$ 133	per m	*General value*
Niger	60	$ 9,000	$ 150	per m	*General value*
Uganda	45	$ 5,570	$ 124	per m with VAT	*Based on BOQ, negative boreholes paid, casing down to the bottom*
	45	$ 6,570	$ 146	per m with VAT	*Based on BOQ, negative boreholes paid casing down to the bottom*
	45	$ 8,089	$ 180	per m with VAT	*Payment of positive boreholes, independent of configuration*
Zambia	45	$ 4,370	$ 97	per m with VAT	*Based on BOQ, negative boreholes paid casing down to the bottom*
	45	$ 5,157	$ 115	per m with VAT	*Based on BOQ, negative boreholes paid casing down to the bottom*
Mozambique	45	$ 6.870	$ 151	per m with VAT	*Based on BOQ, in general only payment for positive boreholes, casing down to the bottom*

The results indicate that it is very dubious to compare drilling costs between different countries, or to use a general value for drilling per meter, owing to the different variables involved. In general, drilling costs in Mozambique are comparable with those in other countries. The big difference concerns the costs of pumps in Mozambique, which are much more expensive. In comparison, the costs of pumps in Uganda and Zambia are US$ 550 and US$ 800 respectively, as against US$ 1,160 in Mozambique.

One of the reasons justifying the fact that borehole costs in Zambia are that low is that the values quoted for drilling are lower. In addition, the contracts are bigger and there are more drilling companies, hence there is more competition. Profit margins for drilling companies are highest in Uganda. Note the difference in expenses/costs of structure and amortization of the real costs, which seem to be underestimated in the examples of Mozambique and Zambia.

8 Major constraints

Drilling companies operate under the same constraints as any other commercial enterprise in Mozambique. There are some factors that clearly hamper the rapid development of the sector. The main constraints mentioned can be seen in Figure 5.



Based on responses of 44% of the private operators

Figure 5 – Main Constraints

1. Delays in payment: this is the most cited constraint. The good implementation and efficiency of drilling projects call for a secure financial flow. The time indicated is 3 months, but there are examples of delays lasting several years. Delays in payments affect planning and efficiency. The prepayment of VAT poses an additional financial problem.
2. Logistics in the country: drilling for water supply in rural areas is per definition a logistical challenge. The main problems are communication and transport. Communication is improving rapidly with the increase of the mobile telephone network. Transport is most problematic during the rainy season. Therefore drillers prefer small works along major roads (for instance for Health Posts) during the months of January to March.
3. Corruption: drilling companies lose work if they do not want to engage in corrupt practices or they have to increase prices (accept lower profits) if they do decide to engage in such practices.

Another issue mentioned is the fact that no payments are received for negative boreholes: drillers are sometimes reluctant to accept all work-related risks on the basis of payment for positive boreholes only, because they are unable to properly determine the expected success rate. These uncertainties lead to an unnecessary increase in borehole costs because drillers try to cover an unknown risk.

9 Main Conclusions

1) An important aspect of the NWP is the involvement of the private sector. The private sector is known to work efficiently, committed to the need to reduce costs and obtain the expected profits.

2) The main constraints mentioned by the private sector are: delays in payment, the logistics in the country (communication and transport) and corruption. Another issue mentioned is the fact that one does not receive payment for negative boreholes.

3) Most EPARs are in effect insolvent and it can be concluded in principle that the drilling capacity of the EPARs no longer contributes much at national level.

4) At present the NGOs are working with a number of very specific portable and low-cost drilling machines. Not a single private company possesses similar drilling equipment and the NGOs may form a study platform for such technology.

5) Recently most contracts based on a map of quantities have been changed and based on positive boreholes. Normally these contracts attribute full responsibility for the final product to the contractor. Most contractors voiced serious complaints about the non-payment of negative boreholes, especially those who were not responsible for the geophysical investigation.

10 Main Recommendations

1) One should discuss who is to be held responsible for the water quality and productivity of boreholes. The DNA should re-evaluate whether the current contract of the type “positive boreholes only”, in which the contractor is also responsible for the hydrogeological survey, is still the best form of contract (cost-effective, more productive).

2) It is necessary to prepare principles and standards for borehole configurations (standardized) and standardized contracts.

3) In order to avoid conflicts of interests, the Client should elaborate separate contracts for the supervisors, consultants and contractors. One should not make supervisors responsible for negative boreholes.

4) During the seminar the lack of hydrogeological information was mentioned as one of the biggest constraints. Drilling companies cannot properly anticipate the risks they are running under a contract of the “positive boreholes only” type.

5) The process of awarding contracts should be clear and transparent, based on previous results (obtain details from previous clients) and on the proposed values. The opening of bids should be public.

6) Government payments to contractors should be swifter, especially for projects/contracts launched at central government level. In order to achieve this

objective, financial transfers from central level to the provinces should be carried out with the required promptness.

7) It is extremely important to carry out an adequate discharge analysis so as to guarantee the correct depth for the installation of the pump. Many "borehole breakdowns" are in fact not breakdowns but boreholes that don't function properly because the pumps were installed at too low depths.

8) Contracts are in general for positive boreholes. The contractor is responsible for the success rate. The existing data on success rates, discharge and depths should be available to the contractors. The recuperation of the general database of the DNA and the DAR database could be useful to help companies in preparing realistic bids.

9) In the course of the various discussions held with the drilling operators the idea came up to create an association of drilling companies, which will be the focal point of the sector's questions for the government. A beginning has been made during the seminar.

Main Complementary Studies Recommended:

1) A study providing a detailed and specific analysis on all costs involved in drilling operations. From what success rate onwards will additional expenses destined for detailed hydrogeological studies lead to an increase with respect to successrates? It would be necessary to prepare both a calculating sheet that is easy to use and allows the drilling companies to change all relevant variables, as well as a clear user manual. This would be a useful tool, for clients and contractors alike, to better understand the economics of drilling.
2) A study to determine the impact of localization techniques / improved hydrogeological surveys on success rates in different hydrogeological environments, taking into account the minimum water quality and quantity standards. The results of the referred pilot study should produce information on which techniques are to be used in which areas of the country. Meanwhile the basic rules governing hydrogeological studies should be included in the standard drilling and/or localization contracts, which would obviously lead to higher success rates and hence to a reduction of costs and an accelerated project implementation.
3) A study concerning the concept of standard implementation procedures should be carried out. The study will be oriented by questions concerning standard-contracts, standard-designs and bidding proceedings.
4) An analysis should be made of the payment problem, and references should be established for each type of contract. Specific suggestions with respect to the payment of contactors should be examined.
5) It is necessary to have a better information flow between contractors, consultants and the government. Data should be available to the various partners, at low costs. Various methods of data collection and storage should be evaluated (for instance the open database on the Internet or the locally controlled database) and the critical parameters, such as depth, predominant geology, success rate, water discharge and the reasons for the occurrence of negative boreholes (dry or technical aspects) should be determined.

Annex 1. Bibliography

1. African Development Bank, *Mozambique Water and Sanitation Sector Review,* prepared by SEED, May 2002.
2. BAD, Rapid Assessment of Rural Water Supply and Sanitation - Mozambique Requirements for Meeting the MDGs, March 2005
3. Berger, Gerhard, *Poços, Furo, Captações de nascentes –Manual,* Helvetas, 1994
4. DNA, *Carta Hidrogeológica de Moçambique, Escala 1:1.000.000 & Notícia explicativa da carta hidrogeológica de Moçambique*, 1987.
5. DNA/DAR, *Manual de Implementação de Projectos de Abastecimento de Água Rural*, December 2001.
6. DNA/DGRH, *Critérios para Construção de Furos a serem equipados com Bombas Manuais em Moçambique*, Segunda Edição, Maputo, 1998
7. DNA/DGRH, *Curso de Fiscalização de construção de furos, Localidade de Chicomo, Distrito de Massinga, Província de Inhambane*, Documento Orientador, Maputo, November 1996.
8. DNA/DGRH, *Guião de Fiscalização para a Construção de Furos*, Maputo, September 1997.
9. Driscoll, F.G. *Groundwater and Wells*, Johnson Screens, 1986
10. MISAU, Regulamento sobre a Qualidade da Água para o Consumo Humano, Maputo, 2004.
11. *Política Nacional de Águas*, Resolução do Conselho de Ministros nº 7/95 de 8 de Agosto.
12. *Regulamento do Licenciamento da Actividade de Empreiteiro de Obras Públicas e de Construção Civil*, Diploma Ministerial do Conselho de Ministros nº 83/2002 de 22 Maio de 2002.
13. SADC-WSCU, *Development of a code of Good Practice for Groundwater Development in the SADC Region*¸ Report 1 and Report 2, GWC, November 2001.
14. World Bank, Millennium Development Goals for Water and Sanitation, Country Assessment – Mozambique, February 2004.
15. WSP, *MDG Roadmap Progress in Africa*, 2005.
16. WSP, *Solutions for Reducing Borehole Costs in Rural Africa,* Field Note, Peter Ball, November 2004.