



UNICEF WASH Field Note

October 2011

Improving Cost Effectiveness of Drilling Programmes in Mozambique and Zambia

Highlights

- ◆ Collaboration of UNICEF in the drilling components of the One Million Initiative in Mozambique, and the WASH Programme in Zambia has been a key factor to reduce costs by more than 30% and to improve cost-effectiveness.
- ◆ Revised contractual approaches such as clustered and turn-key (siting and drilling) contracts in Mozambique and Zambia have led to reduced costs without forgetting that a healthy and competitive private drilling sector can improve progress towards the achievement of sustainable access to safe water.
- ◆ Reconsideration of technical specifications such as borehole diameter has helped to improve cost-effectiveness of the drilling programme in Zambia.

Introduction

The Millennium Development Goal (MDG) target to halve the proportion of people without sustainable access to safe water by 2015 is unlikely to be met in sub-Saharan Africa where rural areas are especially poorly served (WHO/UNICEF, 2010).

Groundwater provides potable water to an estimated 1.5 billion people worldwide daily (DFID, 2001) and has proved the most reliable resource for meeting rural water demand in sub-Saharan Africa (MacDonald et al., 2002). However, the current rate of progress via conventional water supply

drilling programmes is insufficient.

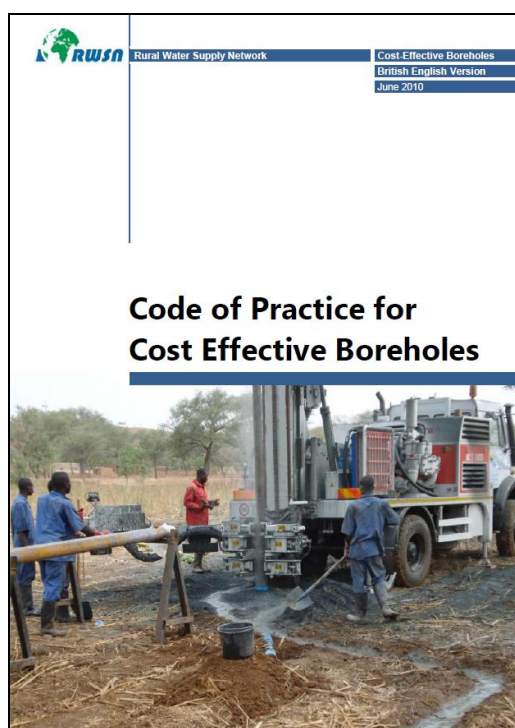
Among the reasons for this are the restrictive costs of groundwater development programmes. There is, therefore, a critical need to lower the costs of drilling programmes.

In recognition of this, the Rural Water Supply Network (RWSN), in collaboration with UNICEF, recently published a *Code of Practice for Cost Effective Boreholes*. This document outlines principles that provide a basis for the realisation of economical and sustainable access to safe water through the construction of boreholes in sub-Saharan Africa.

Evaluation of these principles in specific countries underlined the importance of improved contractual procedures and technical specifications for significant reductions in drilling costs. For example, Mozambique and Zambia have recently achieved more than 30% reduction in drilling costs mainly through changes in contract procedures. However, attention has to be paid when reducing costs as they might not be always achieved in agreement with cost-effectiveness principles.

The Code of Practice

Sustainable groundwater development is fundamental to providing universal access to safe drinking water. The *Code of Practice for Cost Effective Boreholes* (RWSN, 2010) provides nine guiding principles that relate directly to the practicalities of borehole construction. In this context, the term “cost-effective” is used to describe optimum value for money invested over the 20 to 50 years lifespan that boreholes are expected to function.



Front cover of the Code of Practice 2010

The *Code of Practice* is intended to be used as the foundation for the development of national protocols for cost-effective borehole provision. It provides a basis for stakeholders to examine whether they are working in accordance with international practices. Such an examination has been undertaken by UNICEF Mozambique (2010) and UNICEF Zambia (2009), and some findings are discussed in this note.

The Code of Practice is also informed by RWSN Field Notes on *Siting of Drilled Water Wells, Costing and Pricing and Sustainable Supply Chains for Rural Water Services*, as well as perspectives and experiences from practitioners in the field.

Drilling Interventions

If current trends continue sub-Saharan Africa will reach the MDG water target in 2040 instead of 2015 (UNDP, 2006). In 2009 it was estimated (Danert et al., 2009) that about 35,000 boreholes per year needed to be drilled in sub-Saharan Africa to meet the MDG target for domestic water supply.

The Netherlands government has put in place, in coordination with UNICEF, different programmes to address this situation and bring tangible and positive impacts to the lives and well-being of children and communities in sub-Saharan Africa. The One Million Initiative in Mozambique and the Water, Sanitation and Hygiene (WASH) Programme in Zambia are good examples of this partnership with borehole drilling components that are also seeking to improve cost-effectiveness.



WASH Programme in Zambia

The One Million Initiative in Mozambique

UNICEF in collaboration with the Mozambican National Directorate of Water and the Provincial Directorate of Public Works and Housing is implementing the One Million Initiative. The objective of the programme is to deliver water, sanitation and hygiene services to one million people between 2007 and 2013. The main form of water supply provided is from groundwater sources. Since 2007, more than 1,000 boreholes have been drilled in Tete, Manica and Sofala Provinces under the programme, providing water to around 900,000 people.

The Zambia WASH Programme

The National Rural Water Supply and Sanitation Programme, managed by the Ministry of Local Government and Housing in Zambia planned the construction of over 10,000 new water points (boreholes and hand dug wells equipped with hand pumps; spring protection; improved traditional water points; and piped water supplies at rural centres) between 2006 and 2015.

UNICEF committed to construct 3,650 water points in the timeframe 2010 – 2015 through the WASH Programme, covering 20 districts in six provinces.

Cost of Borehole Drilling

There are many different factors that influence the final cost of a borehole. It is well known that drilling costs in sub-Saharan Africa are considerably higher than in South Asia. Whereas the cost of drilling a borehole in India is about US\$1,000, comparable costs in sub-Saharan Africa are up to US\$20,000. The main three reasons for such marked difference have been found to be: 1) different geological formations; 2) type and cost of hand pumps installed; and 3) absence of extensive work programmes, continuous external support and investment in human resources (Danert, 2009).

Important differences in the cost of drilling are also found among sub-Saharan countries. While in Nigeria a US\$4,000 unit cost is typical, in Southern Sudan with a worse road network, shorter dry season and complex hydrogeological conditions, the unit cost ranges from US\$9,000 to 15,000 (Armstrong, 2009).

With these high drilling costs, the current rate of progress via conventional water supply drilling programmes is insufficient. There is, therefore, a critical need to lower the costs of drilling programmes without compromising cost-effectiveness.

Important advances in lowering the costs have been recently achieved within the One Million Initiative in Mozambique and the WASH Programme in Zambia through changes in contractual procedures and technical specifications.

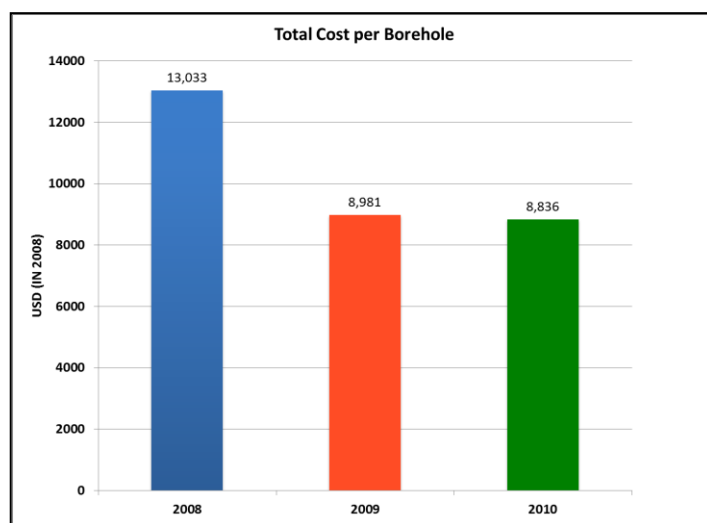
Contractual Procedures

It has been observed that UNICEF country offices lack guidance regarding preparation of drilling contracts

(Danert, 2009). Each country office is responsible for developing contracts with Government, or for UNICEF direct use. Clearly contracts need to fit in with the national scenarios. However, given that government contracts are rarely based on standardised templates, this is an area that requires careful attention.

Both Mozambique and Zambia country offices have recently undertaken studies (Armstrong, 2009; Gesti, 2011) that assessed contractual procedures with respect to the principles of the Code of Practice.

In Mozambique changes in the contracts with drillers, as well as with consultants, were introduced after the first drilling campaign of the One Million Initiative in 2008, leading to a reduction of 31% in the unit cost of a borehole from more than US\$13,000 in 2008 to less than US\$9,000 in 2009.



Total cost per borehole in the One Million Initiative

In Zambia by removing the siting or design component from the contract with supervisors and lumping it under the drilling contract, savings of up to 25% of the consultancy cost have been achieved without increasing the overall cost of drilling.

Clustered contracts and turn-key contracts have played an important role in improving the cost-effectiveness of drilling programmes in Mozambique and Zambia. Additionally, the categorization of risk has been suggested in both countries as a further way to improve cost-effectiveness. These aspects are described in more detail in the following sections.

Clustered Contracts

Contract packaging in terms of boreholes within close proximity helps to reduce mobilization and demobilization costs and facilitates contract supervision. Also, multi-borehole packages in fairly close geographical areas, where similar depth and hydrogeology can be expected, facilitate tender preparation and allow drilling programmes to use smaller, less costly rigs where appropriate.

In the One Million Initiative, procurement is provided for multi-borehole (up to 60 boreholes) packages across close districts, where similar drilling conditions can be expected. Bidding documents include a review of the hydrogeology of the provinces where the drilling campaign is operative and provide statistical information about borehole depth, water table and dynamic water levels in some of the districts.

In Zambia, UNICEF in collaboration with the Ministry of Local Government and Housing designed the contract document by “lumping” an optimal number of boreholes into one drilling-lot. This approach encouraged drilling companies to offer a reduced unit price given the stakes involved in fairly large contracts. Further, such an arrangement has proven very attractive for drilling companies as it helps achieve economies of scale.

Regarding demobilization costs, the current practice in Zambia is to cost and pay for demobilization depending on inter-site distances. This is expensive as it is not in the driller’s interest to develop a cost-effective demobilization plan by optimizing routes. This is also prone to subjectivity, micro-management and high transaction cost with regard to managing the contract. In the UNICEF contract, however, a lump sum demobilization pay-item for the whole contract is now devised. With this approach, the total demobilization cost for a 104 borehole contract has been recently reduced by 34% from US\$32,000 to US\$21,000 (US\$201 per borehole).

It could be argued, however, that when too many wells are in a package this may exclude small local contractors since they cannot compete with large companies. This issue was raised by the Drilling Association in Mozambique in the first year of the One Million Initiative and led to changes in bidding documents to provide opportunities to smaller drilling companies in Mozambique. Small companies are now allowed to form consortia in a flexible manner and in some cases, smaller packages are arranged.

The Code of Practice also suggests a mechanism to enable small companies to participate by awarding packages of boreholes to a pool of drillers, with the option for follow-on work. This process includes the following steps:

- Pre-qualify a number of contractors and undertake the bidding process.
- Identify contractors to be included in a pool of drillers for a specified term.
- Negotiate and set drilling prices for an agreed area.
- Award packages (of say 10 to 30 wells) to several contractors in the pool of drillers.
- As the packages are completed, subsequent work can be awarded depending on the performance of the contractor.

Turn-Key Contracts

A turn-key contract is a business arrangement in which a project is delivered in a completed state. This is one of the most important considerations that has helped to significantly reduce the cost of drilling in Mozambique and Zambia.

Unlike other partner’s contracts, UNICEF’s contracts have been designed in Mozambique and Zambia in such a way that the siting and drilling are grouped under one contract (turn-key contract). By removing a third party from the critical path of the work process of siting and design, such a contractual arrangement has improved drilling companies’ time management. It has also helped to increase the success rate of boreholes and speed of drilling as the onus is on the drilling company to do a timely geophysical investigation and start drilling. The turn-key contract approach has also encouraged drilling companies to use the most appropriate, practical and cost-effective geophysical equipment, ultimately reducing cost.

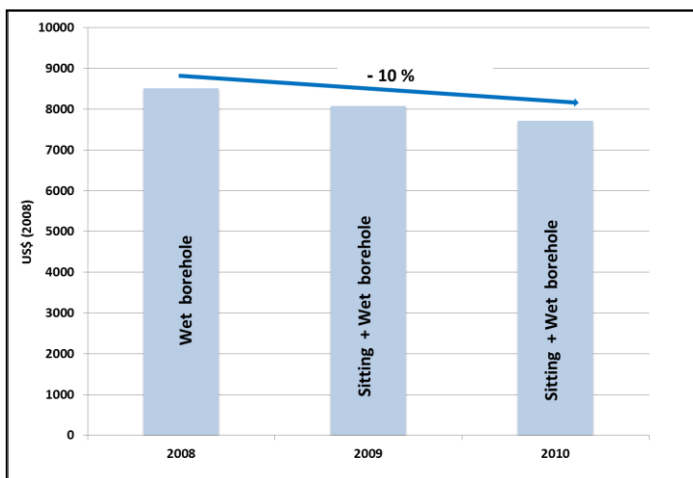
Furthermore, turn-key contracts have also helped to avoid the lengthy contractual disputes that can otherwise arise between supervision consultants and drilling companies in the case of consultants not being able to provide borehole sites and designs to the drilling company on time.

By removing the siting-design as a separate contract and lumping it under the drilling contract UNICEF Zambia has achieved a saving of up to US\$360 per borehole, equivalent to 25% of the consultancy cost. Based on UNICEF’s experience, this cost saving in consultancy cost is achieved without increasing the overall cost of drilling.



Geophysical equipment used for siting

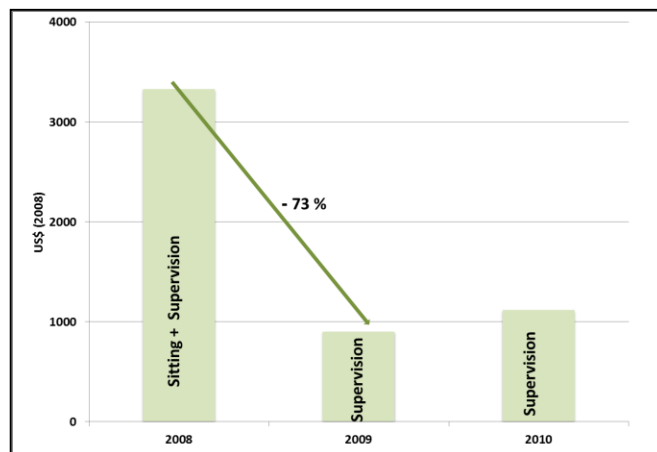
In the case of the One Million Initiative in Mozambique it is interesting to note that the actual cost per wet borehole that was paid to drilling companies in 2009 and 2010 was actually lower than in 2008 despite the fact that in 2008 drilling companies were not responsible for the siting of boreholes, and in 2009-2010 they had to cover that cost (and responsibility). This suggests that the true cost of siting by drilling companies is insignificant.



Cost per wet borehole in the One Million Initiative

In addition to this, during the 2009-2010 drilling campaigns of the One Million Initiative, and unlike the first drilling campaign in 2008, a ceiling was established in the bidding

documents for consultant supervisors. During these two campaigns (2009 -2010) tenders have been assessed on the most acceptable technical bid with a price lower than the ceiling basis. This has resulted in a 73% reduction in consultancy costs.



Consulting cost in the One Million Initiative

Categorization of Drilling Risk

One of the key challenges of borehole drilling, especially for drilling companies, is the risk of drilling a dry borehole.

The One Million Initiative (contracting through state or provincial Government) pays according to a bill of quantities, but unlike in 2008 did not pay for dry wells during 2009 and 2010. The WASH Programme in Zambia also follows a “no-payment for dry borehole” policy within a contract based on a bill of quantities.

As has been explained before, turn-key contracts, where a drilling company is responsible for siting boreholes, can help to increase the percentage of drilling success. However, in general, a drilling company can be assigned to drill in all types of hydrogeological settings and often in places that while convenient for the communities served are not ideal for drilling. Since the use of geological surveys for siting cannot guarantee that a borehole is going to be successfully (wet) drilled, drilling companies in Mozambique expressed their need to cover the risk of drilling a dry borehole if they are not to be paid.

At this point it is necessary to consider the importance of the term cost-effectiveness in a drilling programme and realize how a healthy and competitive private drilling sector can improve progress towards the achievement of sustainable

access to safe water. It could be assumed that when a drilling company is not paid for dry boreholes the total average cost per successful borehole in a drilling programme will be reduced; however, as acknowledged in Mozambique, drilling companies can inflate their tenders to cover unpredictable risks leading to undesired increases in the final costs of drilling. Moreover, small drilling companies with less financial resources may not be able to participate in drilling programmes where dry boreholes are not paid, leading to an overall negative impact in the private drilling sector.

In relation to this, the Code of Practice states that lump sum contracts are more appropriate under conditions where there is no payment for dry wells. However, it is also stated that this can as easily be written into a contract which is paid according to a bill of quantities, such as in Mozambique and Zambia, explaining that in this case a categorisation of the risks of drilling a dry borehole should be undertaken previously.

The Code of Practice has suggested a model to categorize the risk of drilling a dry well and set out appropriate payment structures, and this model has been proposed to UNICEF drilling programmes in Mozambique and Zambia. This particular approach utilizes different contract and payment arrangements, depending on the risk of drilling a dry well. For example, in areas that have been previously categorized with a high probability of success, dry boreholes are not to be paid to the drilling company under any circumstances and even geophysical surveys of the terrain are not necessary for siting boreholes.

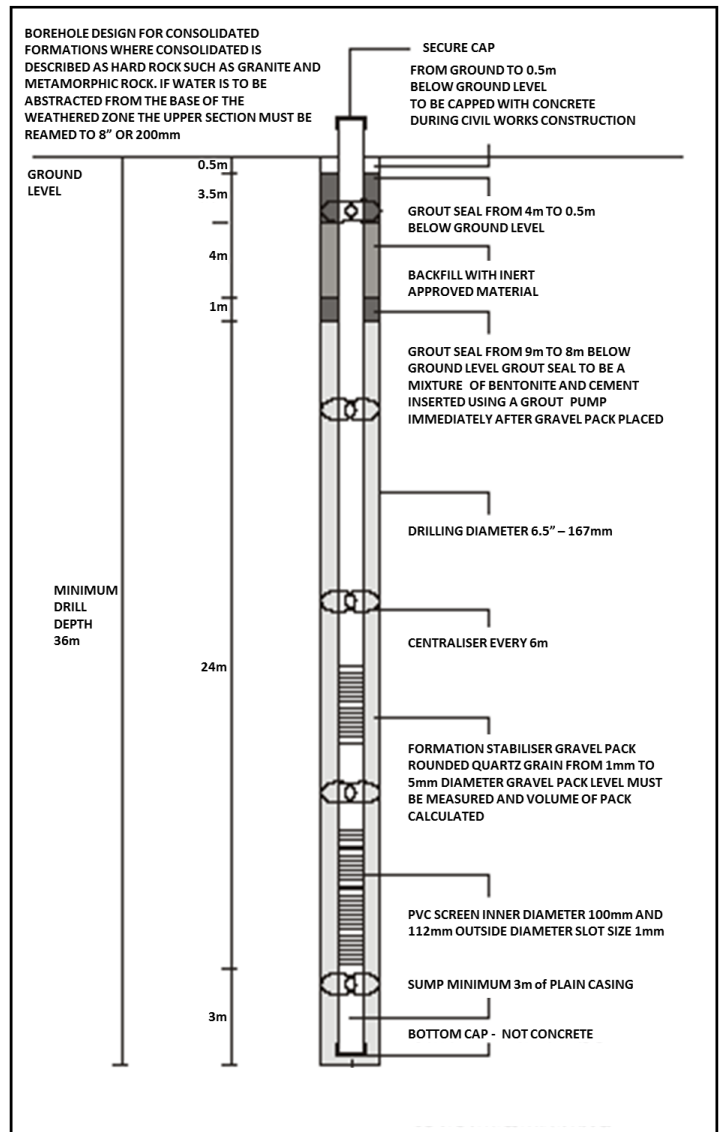
Technical Specifications

Selecting the right construction method and size of drilling rig plays a very important role, particularly in rural water supply where operational challenges are high, funds limited and terrain difficult. Indeed, the Code of Practice suggests that the feasibility of manual drilling and other very low-cost methods should be considered before mechanized drilling.

The diameter and depth of the well have a direct relationship to the size and cost of the drilling equipment, as well as to its operation and maintenance costs. Therefore, a careful design and selection of equipment are imperative for cost-effective operations.

In Zambia, the WASH Programme has successfully advocated for a reduction of the drilling diameter, from a

range of 8-10 inch (depending on geological formations) to a more cost-effective range of 6-8 inches.



Borehole design in bidding documents (Zambia)

Regarding depth of boreholes, drilling in Mozambique and Zambia is relatively shallow, to a depth of 60m or less on average with aquifers between 24m to 85m. However, it has been observed that active drill rigs, especially in Zambia, are generally heavier than required as they are suited to drill diameters larger than 6.5 inch to several hundred metres. Such rigs have higher operational costs, and because of their weight and dimensions off-road site access is restricted, particularly during the wet season.

In the One Million Initiative manual drilling techniques were not considered due to a predominance of hard geological formations across the areas to be drilled. Indeed, drilling companies there seem to agree that due to the presence of hard formations the ideal combination of rigs regarding capacity would be 1 or 2 big rigs and 3 small rigs. In Zambia however, manual drilling is now being utilized in favourable geological zones, to complement mechanized drilling operations.



Drilling with a small rig in Mozambique

Lessons Learned

The experiences of the One Million Initiative in Mozambique and the WASH Programme in Zambia have illustrated the advantages of revising contractual procedures and technical specifications of drilling programmes, not only to reduce costs but to improve cost-effectiveness. The following are the main lessons learned from these two experiences:

1. Drilling companies offer better unit prices when boreholes are geographically clustered in contracts.
2. Small drilling companies can benefit from clustered contracts through the enabling of simple approaches such as forming consortia.
3. Mobilization and demobilization costs are reduced when packages of boreholes are contracted.
4. The use of lump sums for mobilization and demobilization when a clustered contract approach is used can be fair for the drilling company and convenient for the programme manager.
5. Assigning the responsibility of siting boreholes to drilling companies in turn-key contracts improves cost-effectiveness:
 - Cost can be considerably reduced;
 - Drilling companies operate more efficiently on their own schedule;
 - The speed and rate of drilling success increases; and
 - Contractual disputes with third parties are avoided.
6. Reconsideration of borehole diameters to match pump design and expected water delivery helps to improve cost-effectiveness.



Drilling in Zambia

Next Steps

The dilemma of paying or not for dry boreholes is unresolved. Not paying for dry boreholes can be seen at first as an easy way to reduce costs but can lead to drilling companies inflating their tenders to cover unexpected situations if bills of quantities are used. A second unresolved dilemma is the mandatory use of geophysics.

An untested solution for both dilemmas has been suggested to Mozambique and Zambia country offices. The approach is a model to

categorise the risk of drilling as explained in the Code of Practice. Implementation of this approach would be a learning experience not only for both country offices but for the improvement of cost-effectiveness at a bigger scale.

Finally, greater effort is needed to convince contractors to match the size of drilling rigs to the specific design parameters such as borehole diameter, and expected hydrogeology.



Borehole in Mozambique

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