

# **Towards cost-effective groundwater development in Sudan and in sub-Saharan Africa**

**Richard C Carter**

**Personal Report of Workshop on Cost-effective Boreholes,  
Khartoum, 18<sup>th</sup>-19<sup>th</sup> November 2009**



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## **Introduction**

This paper summarises my contributions to the workshop on “Cost-effective Boreholes”, jointly organized by UNICEF Sudan, the Sudan Public Water Corporation, the Government of National Unity (Ministry of Irrigation and Water Resources) and the Government of South Sudan, held in Khartoum 17th – 18th November 2009.

My roles in the workshop were to (a) make a formal presentation in plenary on day one, (b) chair the morning plenary session of presentations on day two, and (c) facilitate a discussion session in the afternoon of day two.

The paper first summarises my workshop presentation, then goes on to sum up the main discussion session which I chaired, and concludes with some reflections relating to the overall goal of the workshop.

## **Workshop presentation: Drilling cost estimation and analysis of cost-saving opportunities**

My presentation (Session 2, item E, see Annex) addressed the issue of drilling cost estimation. Drilling companies and their clients need a systematic procedure for quantifying the costs of drilling. The reasons for this are as follows:

- Drilling companies and enterprises need to know the costs which they will incur when they tender for a particular assignment. These costs form the basis of the price which they quote in a tender. It is crucial to understand the difference between cost (the actual expense incurred) and price (which includes a profit element and other additions reflecting perception of risk).
- Those paying for drilling (clients) need an independent means of estimating the likely cost of the operations which they will pay for. This knowledge can give the client an informed means of negotiating and engaging with drilling companies.
- Both parties to a drilling contract need to be realistic about costs, so that businesses can remain viable, and so that clients get good value for money.
- A systematic means of quantifying drilling costs enables the analysis of opportunities for cost reduction, while at the same time addressing the key issues of design and construction quality and functional sustainability.

The presentation<sup>2</sup> was divided into five sections, as follows:

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<sup>2</sup> Available separately as a powerpoint, together with all the workshop presentations on <http://www.wes-sudan.org/agendas.aspx?sector=n#>

- The first part summarised the Ethiopia Cost-effective Boreholes Study carried out in 2006 by a five-man team which I led. Some of the key findings of that study were presented visually and graphically.
- The second part of the talk showed how the Ethiopia Study led to the publication of the WSP Field Note “Ten-step guide towards cost-effective boreholes”. This document (see bibliography) sets out ten ways of reducing borehole drilling costs.
- The third part of the talk addressed the matter of costs, prices and cost-estimation. This part introduced a new user-friendly model for quantifying drilling costs, and showed some of its typical outputs.
- The fourth part showed an example of the application of the model to the analysis of cost-saving opportunities. Some outputs of this analysis were shown.
- Finally a number of recommendations were made (a) concerning the wider testing and use of the costing model, and (b) around the wider issues of drilling sector effectiveness – notably around better hydrogeological knowledge, improved construction supervision, more attention to issues of operation and maintenance, and creating a more conducive operating environment for the private sector to thrive.

The cost estimation model described in the talk was designed, built, tested and utilised by Tom Heath and Philip Tibenderana, who were MSc students under my supervision at Cranfield University, UK. The model will be released for general use, testing and evaluation in January 2010 (through RWSN).

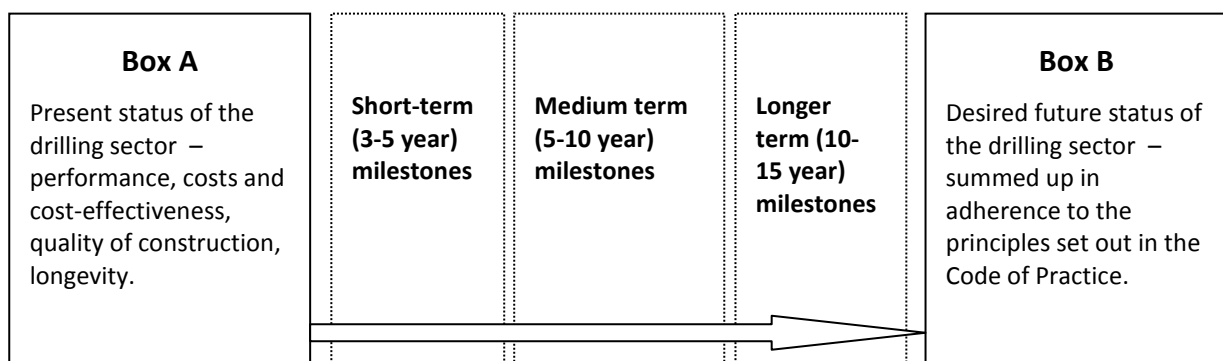
### Workshop discussions:

#### Code of practice for cost-effective boreholes, and drilling strategy for Sudan

The afternoon discussions on day two (session 6, group 2) attempted to cover the ten topics and 47 principles set out in the draft Code of Practice for Cost-effective Boreholes and summarised in Table 1 below (see also presentation C from the Workshop).

In order to structure the discussions, the group agreed the conceptual framework set out in Figure 1, namely that there is an “existing situation” or “present status” of drilling in Sudan (Box A); there is an ideal future status (Box B), reflected in the Code of Practice Principles or some modification of these; and there are short-, medium-, and longer-term milestones on the journey between “A” and “B”.

**Figure 1 Structure of code of practice/drilling strategy discussions**



## **Present status**

The necessarily brief discussions of the present status of drilling in Sudan emphasised the following points:

- The situations in North and South Sudan are significantly different, with more public sector drilling in the north, and more involvement of the private sector in the south.
- Similarly, north and south are at different stages of policy development, the policy in South Sudan having been approved in 2008 and in North Sudan the policy being in final stages of approval.
- In both north and south, operational guidelines and standards are set down.
- The 'baseline' situation, while known in general and qualitative terms, needs elaborating, quantifying and detailing as the first stage in Sudan's development of a formalised drilling strategy.

## **Code of Practice discussions**

In general, the principles set out in the draft Code of Practice were supported, with a few proposed modifications and additions. These included the following (note that wordings from the original draft Code of Practice have been modified in Table 1 to reflect these discussion points):

[Topic 1 Principle 2] recognise the existence of insecure areas or areas of difficult access where the private sector is unwilling to go.

[Topic 2] recognise the difficulties of implementing fair competition in the sector, especially in the context of 'unforeseen expenses'<sup>3</sup>.

[Topic 3] add the importance of training Government agencies in contract management and supervision. Also provide adequate resources to enable supervisors to be truly independent.

[Topic 4 Principle 25] remove the word "always", in recognition of the fact that community preference should be followed as far as possible, but within the constraints of hydrogeology.

[Topic 4] add reference to potential sources of pollution.

[Topic 4] it should be noted that the issue of geophysical survey was somewhat controversial, with some arguing for its use only as appropriate, and others advocating for its use in all circumstances. Simple cost-benefit analysis should resolve this debate.

[Topic 5 Principle 28] note that hydrofracturing only represents one innovative technology. Others exist too, and should be encouraged.

[Topics 5, 6 and 7] it was noted that these points are all reflected in national standards.

[Topic 9] it was agreed that the existing database in the north, and the more rudimentary database in the south need strengthening, not creating from scratch.

[Topic 10] it was noted that this is weak, and needs strengthening.

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<sup>3</sup> A euphemism for corruption.

**Table 1 Draft code of practice topics and principles (modified by the Sudan Workshop)**

Topic	Principles
1. Healthy Drilling Sector	<ol style="list-style-type: none"> <li>1. Emphasis on local private sector drillers or strategy for private sector involvement</li> <li>2. Avoid subsidised public drilling operations</li> <li>3. Registration and Annual licensing of drillers (consider Class Categorisation of drillers)</li> <li>4. Form Drillers Associations</li> </ol>
2. Procurement	<ol style="list-style-type: none"> <li>5. Develop &amp; Use of standard national systems</li> <li>6. Pre-qualify – experience, reputation, method</li> <li>7. Engage competitive bidding process</li> <li>8. Close locations of similar hydrogeology</li> <li>9. Consider roll-over packages and drillers pool</li> <li>10. Consider multi-year contracts</li> <li>11. Drillers are rarely competent at software</li> </ol>
3. Contract Management, Supervision & Payment	<ol style="list-style-type: none"> <li>12. Straightforward contract document</li> <li>13. Avoid over-specification</li> <li>14. Include defects liability period</li> <li>15. Involve community in supervision</li> <li>16. Provide professional training in contract management to drillers and supervisors</li> <li>17. Engage integrity/experience of driller</li> <li>18. Supervisors to be independent of drillers support</li> <li>19. Ensure timely payment</li> <li>20. Categorise dry drilling risk for “no water no pay”</li> </ol>
4. Borehole Siting	<ol style="list-style-type: none"> <li>21. Hydro-geological desk study</li> <li>22. Undertake Field Reconnaissance</li> <li>23. Identify potential sources of pollution</li> <li>24. Use of geophysics only where appropriate</li> <li>25. Always follow community preferences with respect to location</li> </ol>
5. Drilling Technology	<ol style="list-style-type: none"> <li>26. Adopt appropriate economical construction methods</li> <li>27. Engage Drilling Techniques which are “Fit for Purpose” to the location</li> <li>28. Consider innovative applications to drilling sector and how/who to introduce, eg hydro-fracturing and “lease to purchase” modalities.</li> </ol>

6. Borehole Design and Construction	<p>29. Material selection to be as per Government of Sudan Standards</p> <p>30. All “slim” boreholes for hand-pumps to complete with 4.5” dia casing</p> <p>31. Boreholes for submersible pumping to complete with minimum 6” dia casing</p> <p>32. Important for proper grading and quality of gravel pack, with &gt;95% silica</p>
7. Development & Test Pumping Requirements	<p>33. Procedures clearly specified in drilling contract as per the national Standards / Guidelines.</p> <p>34. Well developed until water is free of solids, fine materials and turbidity</p> <p>35. Realistic test pumping requirements (2 to 6 hours for a hand-pump); acceptable to test pump with installed hand-pump at &gt;2cum/hr</p>
8. Data and Reporting	<p>36. Standard drilling logs and completion report to be made by contractor for ALL boreholes</p> <p>37. Reports also to be mandatory for dry bores.</p> <p>38. All bores to have unique identification No.</p> <p>39. Record GPS location, depths, lithology, penetration rates, casing design, yields, test pumping and water quality details.</p> <p>40. As condition of licence renewal, drillers to submit compiled “Completion Reports” of annual output</p>
9. Record Keeping	<p>41. Government should enhance and strengthen national Database of all borehole drilling</p> <p>42. All drilling programmes should be required to feed into the database</p> <p>43. Information in database should be made freely available to all</p> <p>44. If there is no database, drilling records should be archived by sector support agencies</p>
10. Monitoring and Evaluation	<p>45. Establish mechanisms to monitor water source functionality and water levels</p> <p>46. Boreholes with hand-pumps (and motor pumps) to be monitored at say 1 year, 2 years, 5 years and 10 years after construction</p> <p>47. Monitoring results to be evaluated and published</p>

### Short-term actions

The limited time available for discussion meant that only a few short-term actions could be proposed. These were:

1. To form a Drillers’ Association in Sudan. This needs to be initiated by the industry itself, with support as appropriate from RWSN and/or from other Drillers’ Associations in Africa.
2. Undertake “drilling sector housekeeping”, namely the registration, licensing and pre-qualification of drillers (wherever this is not already being done).
3. Develop appropriate (simplified) forms of contract, with specified reporting requirements).

4. Develop more effective arrangements for drilling supervision, carrying out necessary capacity building and resourcing.
5. Start to modify or develop appropriate legislation, as policies become better established.
6. Undertake the proposed Drilling Strategy study and consultation exercise.

## Reflections and conclusions

The following are my personal reflections and conclusions from the workshop:

- The effective participation of a wide range of stakeholders (north and south, public, private and NGO) in this important meeting was very encouraging. There appears to be a real willingness to take steps towards more effective groundwater development in Sudan and further afield.
- The willingness to consider manual drilling (and by implication hand-dug well construction also) alongside mechanized drilling is also encouraging. All types of groundwater development have their place in serving the needs of the population.
- The draft Code of Practice (CoP) is relevant to all forms of groundwater development, and its observance should be seen as the aspiration for all stakeholders engaged in groundwater development (with appropriate modifications for context).
- The CoP is an important means of advancing construction quality in regard to groundwater development, as well as professionalizing the sector.
- There is a wealth of good sector experience across the continent, and it is important that this experience, knowledge and expertise is shared more widely. The Rural Water Supply Network, UNICEF, WaterAid and others (such as WSP) have key continent-wide roles in facilitating this networking.

## Bibliography

The following listing includes some key documents relating to drilling costs. The RWSN website ([http://www.rwsn.ch/documentation/prcollector.2009-04-03.5513012969/prcollector\\_view](http://www.rwsn.ch/documentation/prcollector.2009-04-03.5513012969/prcollector_view)) contains a wider selection of materials.

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Talbot, Rupert. 2004. India's Water Well Revolution – Achievement and Challenge. Paper for International Groundwater Conference, Addis Ababa, 25-27 May 2004.

Wurzel, Peter. 2001. Drilling Boreholes for Handpumps. SKAT Working Papers on Water Supply and Sanitation, No 2, SKAT, St Gallen, Switzerland.

## WORKSHOP AGENDA

DAY 1: Wednesday, 18 Nov. '09	
<b>SESSION 1: Inaugural</b>	
08.30-09.00	Registration of Participants
09.00-09.10	Invocation/ Prayer
09.10-09.45	Welcome Remarks by Mr. Ammar, DG, PWC Key Remarks by Mrs. Iyabode Olusanmi, Deputy Representative, UNICEF Sudan. Opening Remarks by H.E. Mayom Koj Malik, State Minister of Irrigation & Hydrological Resources Government of Sudan.
TEA/COFFEE BREAK (15 MINUTES)	
<b>Duration: 3h</b>	<b>SESSION 2: Cost Effectiveness of Drilling Operations in Sudan</b> Chair: Modawi Ibrahim, PWC / Rapporteur: Ram Koirala, UNICEF
A: 10.00-10.20	<i>An Overview of Drilling Operations in Sudan</i> , Tayalla El Medani, National Coordinator, PWC (20 minutes)
B: 10.20-10.40	Drilling of Cost Effective Boreholes in Southern Sudan by Manhiem Bol Malek Director of Water Supply Development, MoWRI, Juba (20 minutes)
C: 10.40-11.25	<i>International Perspectives and the Code of Practice for Cost-Effective Boreholes (including policy &amp; institutional issues and pooling resources)</i> by Tom Armstrong & Kerstin Danert (45 minutes)
D: 11.25-11.45	<i>Low Cost Drilling in the Sudan: from an NGO Perspective</i> , by Leif Zetterlund, IAS (NGO) (20 minutes)
E: 11.45-12.30	<i>A Systematic Process for Estimating Drilling Costs, and Some Findings from Drilling Cost Analysis</i> . Richard Carter, Head of Technical Support, Water Aid, London (45 minutes)
F: 12.30-13.00	<i>Discussion</i>
LUNCH BREAK (60 MINUTES)	
<b>Duration: 3h</b>	<b>SESSION 3: Potential for Manual (Hand) Drilling in Sudan</b> Chair: Manhiem Bol Malek, MOWRI, South Sudan / Rapporteur: Leif Zetterlund, IAS
G: 14.00-14.15	<i>Video Screening on Manual Drilling</i> , Silvia Gaya, UNICEF, USA (15 minutes)
H: 14.15-14.45	<i>Manual Drilling: International Experience</i> , Silvia Gaya, UNICEF, USA (30 minutes)

I: 14.45- 15.30	<i>Geological formation in Sudan and the Challenge for Geophysical investigation &amp; Mapping of Manual Drilling Potential in Sudan.</i> Eng. Mustafa A/Rahim Yousif, GWWD (45 minutes)
J: 15.30- 16.00	<i>Discussion</i>
<b>TEA/COFFEE BREAK (15 MINUTES)</b>	
K: 16.15- 16.45	<i>Hand Drilling in Southern Sudan,</i> Paul Anei Kon, D/Director, NBeG, Juba (30 minutes)
L: 16.45- 17.00	<i>Discussion</i>
<b>Duration: 1h</b>	<b>SESSION 4: Is there a One-Size-Fits-All Solution?</b> Chair: Silvia Gaya, UNICEF / Rapporteur: Tayalla El Medani, PWC
M: 17.00- 17.30	<i>Pros and cons of a One-Size-Fit-all Option (costs of 4" &amp; 6" size boreholes, advantages &amp; disadvantages ,</i> Yasir & Sampath, UNICEF, Sudan (30 minutes)
N: 17.30- 18.00	<i>Discussion &amp; Wrap up,</i> Sampath Kumar, UNICEF

<b>DAY 2: Thursday, 19 Nov. '09</b>	
<b>Duration: 4h</b>	<b>SESSION 5: Imperatives for Cost Effective Boreholes</b> Chair: Prof. Richard Carter, WaterAid, UK / Rapporteur: Abu Obeida, UNICEF
O: 09.00- 09.40	<i>"Contract Management and Categorization of Risk",</i> Tom Armstrong, Kenya (40 minutes)
P: 09.40- 10.00	<i>Developing a Drilling Strategy for Sudan,</i> Ram Koirala, WES Manager, UNICEF (20 minutes)
<b>TEA/COFFEE BREAK (15 MINUTES)</b>	
Q: 10.15- 10.45	<i>Private Sector Perspective on Cost Effective Boreholes: North Sudan,</i> Private Sector Representative, Khartoum (30 minutes)
R: 10.45- 11.15	<i>Private Sector Perspective on Cost Effective Boreholes: South Sudan,</i> Malek Akek Majuc Awol, Director SSDSL, Juba (30 minutes)
S: 11.15- 11.45	<i>CEB: Social Responsibility</i> Marcello Goletti & Jean Kutukmbakana, IOM (30 minutes)
T: 11.45- 13.00	<i>Discussion</i>

LUNCH BREAK (60 MINUTES)	
<b>Duration: 2h</b>	<b>SESSION 6: Group Work</b> Chair: Tom Armstrong, MEDIC, Kenya / Rapporteur: Imad El Hasan, UNICEF
U: 14.00- 16.00	<p>Group 1: Action Plan to Promote and Strengthen Manual Drilling In Sudan Facilitator: Silvia Gaya</p> <p>Group 2: Action Plan for the Promotion of Cost Effective Borehole Drilling in Sudan Facilitator: Prof. Richard Carter</p> <p>Group 3: Does One Size Fit All? Pros &amp; Cons Facilitator: Sampath Kumar</p>
TEA/COFFEE BREAK (15 MINUTES)	
<b>Duration: 2h</b>	<b>SESSION 7: Plenary &amp; Wrap up</b> Chair: Sampath Kumar, UNICEF / Rapporteur: Dr. Vaddiparthi Haraprasad, UNICEF
V: 16.00- 17.30	Group Presentations & Action Plan
W: 17.30- 18.00	<p>Closing Address: Nils Kastberg, Representative, UNICEF, Sudan.</p> <p>Vote of Thanks</p>