Note on Shallow Borehole Drilling

Definition

In the Table below we have given some characteristics on the different types of wells that are being implemented in the country.

Type	Description	Depth (m)
Deep borehole	A deep borehole is a machine drilled (muddrilling or down the hole hammer [DTH]) well with a depth greater than the maximum depth defined for a shallow borehole. It is installed with 4-8" PVC casing/screens.	30 -100
Shallow borehole	A shallow borehole is a borehole drilled with a drilling machine to an undefined depth. It is installed with 4-6" PVC casing/screens. It can either be drilled with the mud rotary method or DTH. If the machine is only equipped with the mud drilling equipment hardrock cannot be penetrated as this can only be done by using the DTH equipment.	10-30
Dug shallow well	A dug well is a shallow well usually with a diameter of 1 m. It is dug with small tools that are not motorised. It is installed with concrete rings or lined with bricks. Depths range from 4-5 m in valleys to depths of 30 m further away from the valleys	4-30
Hand augured shallow well	A hand augured shallow well is a well, drilled with human power down to a specified depth. In reality typical depths are between 4-5 m in valleys and 10-15 m further away from the valleys. It is usually installed with 4" PVC casings / screens.	5-15

Ground water occurrence

The selection of a the source to be implemented in a certain area is based on the hydrogeological circumstances and the costs of the particular source type. Therefore, it is good to carry out a feasibility study first. This can be a short desk study if borehole and well data, topographical and geological maps are available. The figures below show the locations where the different source types can be implemented.

In Figure 1 the "productive borehole in weathered zone" is the place where the shallow boreholes can be drilled. The "low yielding borehole" spot could yield enough water for a handpump as well. In Figure 2 some more favourable locations for shallow wells / boreholes are indicated. Figure 3 shows the vertical built up of the underground. Shallow dug wells and hand-augured wells usually get the water from the CZ Soil B zone (collapsed zone). Wells tapping water from these aquifers are often subjected to significant water level fluctuations.

It is clear that only DTH machines can drill to the deepest target zone in the FB (fractured bedrock) and B (bedrock zone) since hard rock needs to be penetrated to tap this water. The disadvantage of the shallow borehole mud drilling equipment is that it cannot penetrate the hard rock, and the deep water table at the transition between the overburden and hardrock may not be reachable when some less weathered pieces of rock hinder further penetration.

Desk study / feasibility study

The first thing to do is make an assessment whether there is any shallow well potential in the area. Before starting a well survey, all available information on the area should be collected. It is important to get some insight in the geology of

the area, the prevailing recharge mechanisms, the occurrence of shallow aquifers and their yields, the hardness of the soil layers, the climatic data and the expected quality of the ground water. Other important information may be obtained from geological and topographical maps, aerial photos, drilling logs, existing water sources / supplies and the local population. If the target area already has some functioning shallow wells / boreholes than the potential should be sufficient. Also the District Water Office should be contacted to find out whether there is a shallow borehole potential in the area. After confirming the potential one should now look for the best place to construct a shallow borehole.

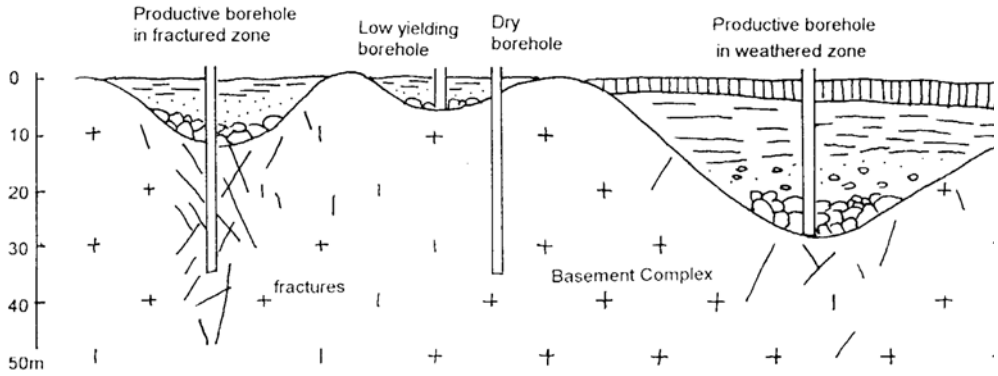

Figure 1: Potential sites for deep / shallow wells / boreholes

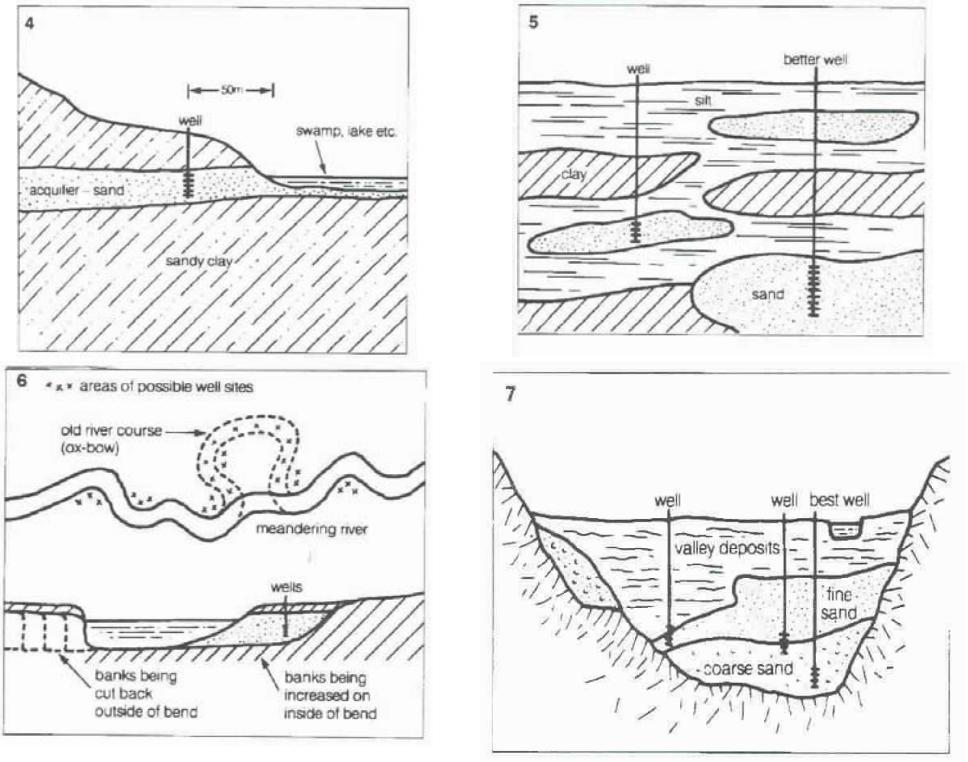

Figure 2: More Potential sites for shallow wells

Field assessment

The best areas for shallow wells can be determined using geomorphological features, vegetation indicators, location of existing springs, topographical features, geological features and a geophysical survey.

There are four potential aquifer types to be targeted for shallow wells:

- Spring aquifer
- Weathered bedrock
- Perched aquifer
- Sand lenses in fluviatile sediments

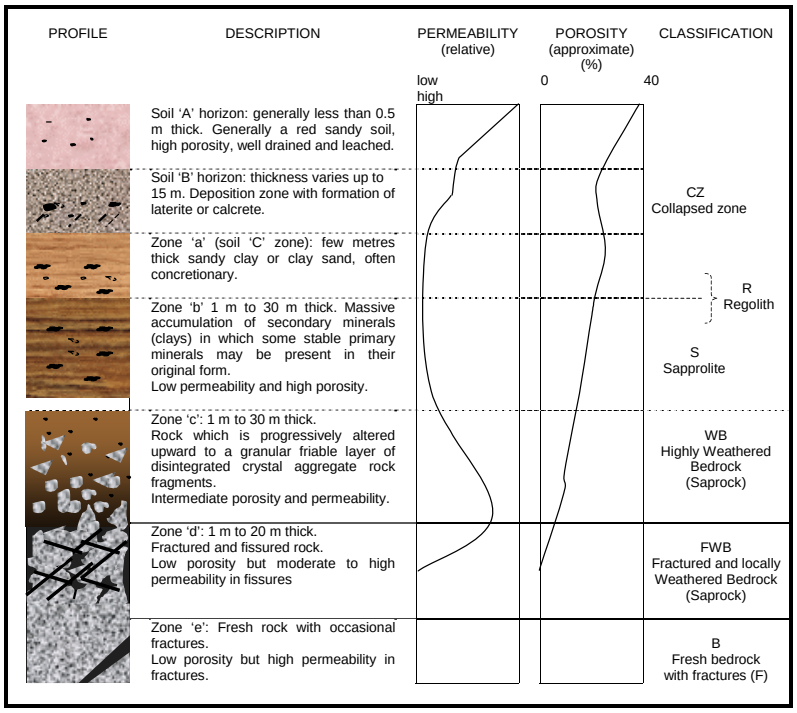

Figure 3: Vertical built-up soil

Advantages shallow borehole to dug and shallow wells

The dug wells and hand-augured wells are usually shallow wells that tap the unconfined aquifers that are sensitive to rainfall. These shallow aquifers are also more vulnerable to groundwater contamination.

The shallow boreholes however have their main supply from the transition zone between the hardrock and the soft rock (WB zone in Figure 3). If mud drilling is used then the drilling will have to stop when the weathered rock becomes too hard, this usually happens when the WB zone has been fully penetrated. Then DTH equipment is needed to tap the probable additional supplies within the first 10 m of hardrock. The DTH option becomes important when the transition zone is not well developed and/or when high yields are required for production wells.

The shallow boreholes usually penetrate between 5 and 15 m of clay before the main aquifer is penetrated. These aquifers are not very sensitive to rainfall and they are less vulnerable to groundwater pollution since impermeable clay layers cover them. This is well illustrated by Figure 1 to 3.

TGS Water drilling rig

TGS has purchased a shallow rig from PAT Thailand. The PAT301TP rig is equipped with a mud pump. The rig can be equipped with DTH tools but then a compressor is needed. TGS Water expects to purchase a compressor by December 2007.


Figure 4: The TGS Water PAT301 TP rig

Shallow well or deep well
It really depends on the area of interest whether one should go for a deep borehole or a shallow borehole. The latter are almost half the price of a deep well so if the potential is there the choice is obvious. TGS Water has been drilling shallow wells in areas where up to then, only deep boreholes were drilled. The deep borehole contractors have powerful compressors that may even make the small water strikes invisible. In addition, these contractors did not come to drill shallow wells, their quotations are based on 50-60 m of drilling and therefore they are more focussed on the deeper aquifers since they want to get paid for 50 - 60 m as well.

Well design and drilling approach
The wells will be drilled with a 6" diameter and a 4" ID casing will be installed. Alternatively, larger diameters can be used at request.

Water quantity and quality
Every well drilled by TGS Water will be test pumped to ascertain the sustainability of the water supply. If the supply is not sufficient then another well will be drilled. WE Consult carries out the surveys to determine the drill sites. The quality of the water will be tested for hydrochemical parameters.

Shallow well drilling cost
In general the cost for shallow borehole drilling are half the price of deep well drilling. TGS Water can offer different cost scenarios depending on the area of operation. A common scenario is that TGS will drill a maximum of 50 m on 1-3 different locations for a fixed rate (budget figure should be US$ 5,000 ex VAT but including pump and platform). When the number of meters or attempts is exceeded some additional payments are requested.

Community participation
TGS Water will work closely with the communities and will let them participate in the site selection and construction of the well. Of course, technical factors are emphasised during the discussions to avoid drilling on a village-preferred site without any groundwater potential. These constraints will be explained to the community. At the end of the construction, we will briefly train some members of the communities in the operation and maintenance of the water source.