Aquarius

Technical Issue Paper 5

Tube wells and hand dug wells

The purpose of *Technical issue papers* is to provide an easy and up-to-date point of reference on technical issues relevant for humanitarian interventions through the consolidation of field experience and current research

They aim at providing information to assist in funding decisions and monitoring of humanitarian projects and not at providing definitive answers

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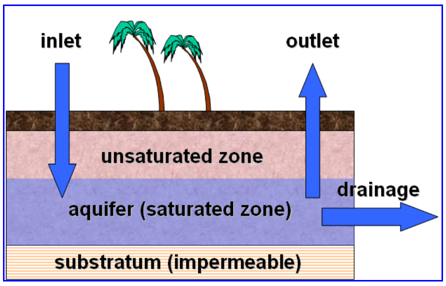
Most humanitarian projects and/or activities funded by DG ECHO in the sub sector of "Rehabilitation, Development and Operation of Water Supply and Treatment Systems" involve the provision of emergency and post-emergency drinking water services that rely on the use of groundwater. The purpose of this Technical Issue Paper (TIP) is to provide general guidance to assess project proposals and to monitor projects that include the construction and/or rehabilitation of wells. In this TIP the term "well" is used to refer to both "hand dug wells" or "tube wells" (including boreholes).

Overview of the Issue

Basics on groundwater and aquifers:

- 40% of the world freshwater reserve is found in the form of groundwater, whereas surface water (lakes, rivers, etc) only accounts for 0.5% of that reserve. The rest is stored as ice.
- Although groundwater is present in many places worldwide, the ease to extract it can vary significantly.
- Groundwater is usually drawn out by: a) gravity (springs, rivers, etc), b) extraction (with pumps) or c) evaporation.
- Unlike surface water, groundwater is often of good microbiological quality.
- Yet, in some cases chemical pollution and/or the presence of mineral toxicity (natural pollution such as arsenic/Bangladesh, fluoride/horn of Africa) may occur, potentially leading to chronic health problems.
- Groundwater levels will usually fluctuate between the beginning of the dry season (when it is at its highest) and the beginning of the rainy season (when it is at its lowest). These annual fluctuations may be significant, depending on seasonal variations and unforeseen events (drought, floods, etc).
- **Aquifers** are geological layers where groundwater gathers and is stored naturally through the infiltration of surface water and rain water runoff. Aquifer can be either confined or unconfined.
- If an aquifer is covered by an impermeable material (roof) or barely permeable material and the piezometric head (pressure level) is higher than the elevation of the roof, the aquifer is referred to as **'confined'**.
- An aquifer, of which the upper section (roof) is occupied by a non-saturated area, is called **'unconfined'**.



Storage and flow in an unconfined aquifer

- In principle, 4 types of **aquifers systems** are recognized. These are:
  - ⇒ Crystalline bedrock aquifers;
  - ⇒ Unconsolidated rock aquifers;
  - ⇒ Aquifers in major sedimentary basins;
  - ⇒ Highly heterogeneous aquifers.

Key definitions:

- **Hand dug well**: Open hole of large diameter which provides access to groundwater, mostly in loose geological formations (clay, silt, sand, etc.). Hand dug wells are qualified as "shallow when the aquifer presents a relatively high water table.
- **Tube well**: Open hole of small diameter (often drilled) to reach groundwater either in loose geological formations or hard rocks. Depth very according to the natural context. Tube wells can be machine or hand drilled.
- **Surface works**: Construction of well head, slabs and apron. Surface works are designed to avoid the presence of stagnant water and to direct waste water to a drainage channel or an infiltration pit. Surface works are also meant to prevent rainwater runoff or waste water from contaminating the aquifer.
- **Yield of the well**: Volume of water flowing out of the well per unit of time (usually expressed in cubic meter/hour - m3/h, or in litre/hour - l/h).
- **Well recharge**: Volume of water flowing from the aquifer into the well per unit of time. Usually expressed in m3/h or l/h.
- **Static Water level**: Stable water level measured in the well after recharge has occurred. This level is higher at the

beginning of the dry season and lower at the beginning of the rainy season.

- **Lining**: Physical protection installed to avoid loose geological formations from collapsing into wells. For tube wells, it normally consists of a tube (metallic or PVC) either plain (**casing**) or slotted (**screen),** which is placed in front of the aquifer to allow water infiltration into the well. In a hand dug well, (reinforced pre cast) concrete rings (**culverts**) are installed for the same purpose. Culverts placed in front of aquifer layers should be perforated.
- **Gravel pack**: Calibrated gravel placed in the annular space between the screens and the side of the tube well to impede excessive intrusion of fine particles into the tube well.
- **Grouting:** Grouting is an essential operation which protects the tube well from external pollution. Grouting can be done by pouring clay or with a mixture of bentonite and cement in the annular space, on top of the gravel pack.
- **Water point**: Site where water pumped from a well is distributed.

Fundamentals of well construction and/or rehabilitation projects:

1. Project implementation sequence:

A. Needs assessment and project identification:

a) Surveys & exploration: Collection and analysis of existing/new of geological, hydro-geological, geophysics and GIS surveys, maps, reports, aerial photos, field data, information on exiting water points.

b) Regional & local capacity/skills: Collection of data on local/regional capacity and availability (technical expertise/services-including drilling-, local materials & equipment, staff, logistics, security, etc.).

c) Consultations & agreements with beneficiaries:

Even during emergencies, some minimal involvement of beneficiaries is considered good practice (possibly through existing structures and/or leaderships). This not only means collecting data from beneficiaries, but consulting beneficiaries and providing them with basic project information. Such involvement makes partners more accountable to beneficiaries and strengthens community ownership of the project. It is also an opportunity to explore local resources (material, technologies, unskilled labourers, masons, etc.), preferences (such as well location), user fee systems (if any) and to define with the (existing) water committees and/ or local water agency on the modalities to operate and maintain the water points (including joint identification of training needs, equipment required, etc.). Ideally, this consultation process should be formalized by the elaboration of a MoU between the partner and the affected communities.

B. Basic steps to the construction & rehabilitation of wells:

⇨ Project support activities: staff recruitment and training (and/or sub-contracting the services of a specialized company), logistics, etc.
⇨ Well design & siting (using results of surveys, national standards / regulations, etc.)
⇨ Well construction/rehabilitation (including community mobilisation activities, etc.)
⇨ Well development /cleaning
⇨ Water quality testing
⇨ Well pumping/yield test
⇨ Selection of pumping device
⇨ Surface works
⇨ Installation of (motorized/hand) pump

C. Reinforcement of water points committees and/or local water agencies.

D. Handing over: Documentation & provision of well/tube well profile/data to local water authorities/ institutions;

2. Construction vs. rehabilitation of wells:

If possible, rehabilitation of existing wells should be given the priority over the construction of new ones. In chronically drought stricken area the creation of new water points should be accompanied by mitigation activities to avoid groundwater depletion (ground water level measurement, actions to replenish aquifers such as recharge wells, etc.)

3. Selection of the drilling – digging sites:

Technical (water quality/quantity, etc.), social (access to water points, etc.), legal (land tenure, etc.) and vulnerability aspects (exposure to natural hazards, contamination sources, etc.) should be considered.

Experience shows that:

- Properly conducted hydro-geological and geophysical surveys can significantly increase the success rate of extracting groundwater (particularly when drilling tube wells in hard rock layers). Yet, most (general) methods will neither guarantee the presence nor the significant quantity of groundwater. In difficult hydro-geological contexts (e.g. with little or no alluvial aquifer, or in the presence of multi-layered aquifers with some saline water levels), it is advisable to drill exploration boreholes. These indicate the presence and quality of groundwater and the nature of the aquifer, and allow calibration of the readings taken during geophysical exploration.
- The early involvement of local communities regarding the physical location, construction, planned use and maintenance of the water point is essential to encourage beneficiary ownership and proper maintenance.
- Prior identification of risk factors (flood prone areas, etc) is crucial to reduce the vulnerability of wells to natural disasters (appropriate design and siting)

4. Hand dug wells vs. tube wells:

The choice needs to be based on a thorough analysis of the local context.

4.1 Hand dug wells: Hand dug wells are usually a good option where soil layers can be easily excavated, aquifers are relatively shallow and machinery is not available or difficult to access, uncontaminated and groundwater recharge is limited. Their larger diameter (compared to that of tube wells) allows greater reservoir capacity, thus increasing water availability at the water point. In some contexts, hand dug wells may be less costly than tube wells. However, these may take time to dig and to equip, before they can be used.

4.2 Tube wells: Tube wells can be used in any geological context, and can be opened quite quickly even in hard rocks. Tube wells are usually (but not exclusively) appropriate in case of deep aquifers with sufficient groundwater recharge. Unless groundwater recharge is sufficient, the narrower diameter of tube wells may be a limiting factor in terms of yield and storage capacity. Tube wells construction may require sophisticated machinery and specialized technical supervision. The most common drilling methods for tube wells are:

⇒ Percussion drilling

⇒ Hand-auger drilling
⇒ Jetting
⇒ Sludging
⇒ Rotary drilling
⇒ Down the Hole (DTH) percussion drilling
⇒ Rotary drilling with flush

The method used depends largely on the amount of energy required to drill, and therefore on the type of rock/ground layers. Unconsolidated formations such as sand, silt or clay are weak and much easier to drill than consolidated rocks such as granite, basalt or slate which are hard, strong and dense. In practice though, the method is often conditioned by the type of equipment available locally

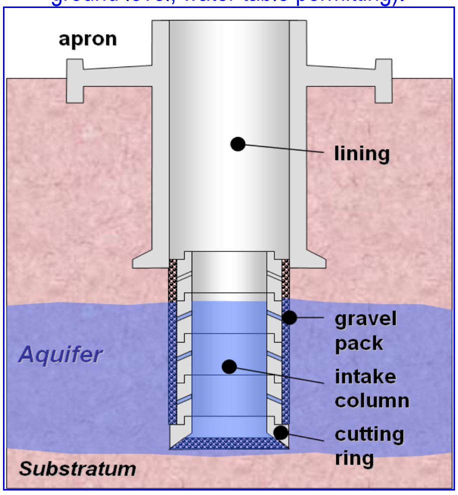
5. Well design and construction:

Experience shows that:

- Properly designed and maintained wells can operate between10 to 20 years (at least).
- The adoption of national standards (type of well design; pumping device, etc.) facilitates handing over the responsibility for the operation and maintenance of water points to local institutions/communities.
- Implementation of basic safety rules to protect workers and beneficiaries during the construction of wells is a must (site access, excavation, etc.)
- Properly designed and placed screen, gravel packs and/or perforated culvert (in front of the water bearing layers) facilitate the highest recharge into wells with the lowest possible turbulence.
- Shallow aquifers that are (at risk of being) polluted, should be isolated from the water column so that deeper aquifers can be exploited without becoming contaminated.
- Disinfection of wells is strongly recommended, both when rehabilitating a well and when digging a new one. Wells having significant occasional pollution, or those that are likely to be polluted should be systematically disinfected.
- If wells are sited too close together (hence interfering with each other) yields may be reduced.
- Continued over-exploitation (pumping) of groundwater may lead to **aquifer depletion** and saltwater intrusion (along coastlines).

5.1 Hand-dug wells:

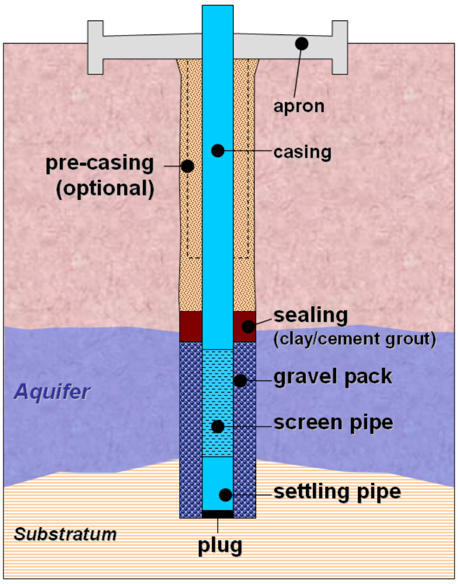
- It is recommended to dig wells during the dry season, to ensure the availability of water during all seasons.
- If wells have to be dug during the wet season (using dewatering equipment), then allow the possibility of deepening during the dry period by constructing wells with a wider diameter.
- In principle, all hand-dug wells should be lined to avoid loose geological formations from collapsing into wells.
- Wells may be fitted with a (hand) pump and a proper cover slab with manhole to carry out routine maintenance inside the well, in which case the manhole is used if the pump breaks down and is replaced by a pulley, rope and (single) bucket system. In some contexts where hand pumps are not recommended a properly operated bucket system may also well do.
- Well liners should be around 1.5m external and 1.3m internal diameters and 100mm thickness.
- A 1:2:4 mix ratio should be used for concrete ring (culvert) production. Culverts should be perforated when placed in front of aquifer layers.
- All hand-dug wells must have a minimum of 1m raised wellheads, and concrete aprons with proper drainage leading to gravel soak pits must be included.
- Homogenous gravel pack (or filters) must be included at the bottom and sides of wells and drainage channels.
- A sanitary seal should be incorporated (preferably a 1:2:4 concrete mix 1m from ground level, water table permitting).



Example of lined well

5.2 Tube wells

- Tube wells must have gravel packs, sanitary seals, concrete aprons with proper drainage to soak pits, and low-maintenance pumping devices.
- Tube well diameter should be 200mm greater than the Outside Diameter of screen/casing to incorporate a gravel pack.
- Screen slot size should be 0.5mm or 1mm with an open area of 10%. Slot size normally depends on the aquifer formation and the size of silt.



Example of lined tube well

6. Development, yield test & yield:

At the end of the digging or drilling operation, the inside of well should be cleaned from mud and particles until clear water can be obtained. At the same time the "gravel pack" is washed from particles to allow the best flow possible within the well. This part is called well "***development***". Following this, a "**step drawdown *test"*** should be performed in order to determine measures the efficiency of the well and its ideal conditions for exploitation:

⇒ Operating yield and pumping schedule;
⇒ Installation depth of the pump;

The following basic considerations should be respected:

- There should be at least 3 pumping steps in the test, each of them followed by a recovery of the same duration
- Each step should run 60 or 120 minutes, preferably 120 minutes.
- The pumping rates for each step should be spread evenly over the total range of pumping anticipated for the well.

The analysis of the result of the test should be left to professionals.

The ***potential yield*** of a well depends on the geological formation in which it is sunk, the contours and gradients of the land, and its own technical features. Sometimes, low yield arise as a consequence of poor design and/or construction rather than as a shortage of groundwater. Within the limits of the potential yield of the well, the ***actual yield (or output)*** depends on the pump fitted on the well.

Type of well	Max. depth (m)	Technique used	Comments
Driven tube well	10-15	Pipe with special tip is hammered into ground can be sunk in 1-2 days.	Small. Cannot be sunk in heavy clay soil or rock. Needs special filter 'well point' at tip of pipe.
Auger-bored tube well	25	Hole bored by hand using a suitable auger (different augers for different soils). Can be sunk in 2-3 days.	Larger than driven tube well. Augers may need to be imported, but locally available boring tools can often be used.
Hand dug well	30-40	Requires skilled workers, otherwise is dangerous. Speed depends on soil conditions: 2-10 m per week for a team of 4-8 men.	Needs no pump, but easily contaminated by misuse or if workmanship is poor. Convenient where such wells are traditional and other equipment/materials lacking.
Jetted tube well	80	Water is pumped down the well pipe to loosen and carry soil back up out of the hole, thus enabling the pipe to be driven further down.	Process of sinking requires much water. Can be done by hand in delta areas with little equipment but skilled labour; otherwise, special drilling equipment needed.
Drilled tube well (Rotary or DTH)	Over 100	Large mechanized drilling rig. Several days depending on soil/rock conditions.	Expensive equipment requiring skilled operators, good maintenance, sufficient tools, fuel and efficient logistic support.

Characteristics of different types of well construction

Experience shows that:

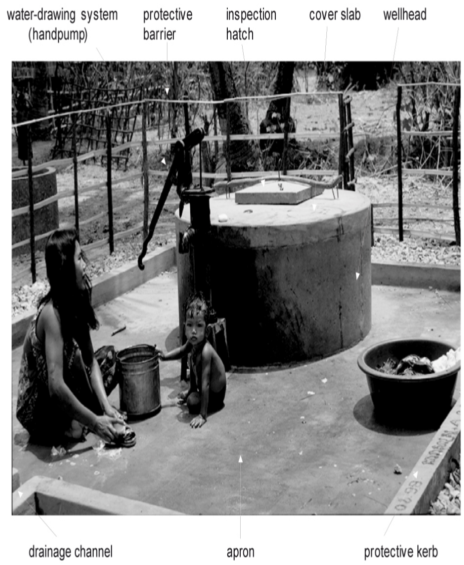
- Proper yield tests (such as step well tests) are rarely done. These tests are highly recommended to determine the characteristics of the (submersible) pump to be installed on (deep) wells.
- Data validation and interpretation of yield test is an expert's job.
- For (shallow) hand dug well, it is important to know the yield at the depth of installation of the hand pump. This can be achieved by emptying the well up to the depth of the hand pump's cylinder and measuring the time needed to recover the initial water level.

7. Water quality control

Measures to assess the quality of water should be implemented to ensure whether it is safe for drinking and to define possible corrective actions.

Experience shows that:

- Analysis should be carried out at least once after an intervention on a water point and before it is opened to the public. Analysis at household level can be done regularly to monitor the outcome of hygiene promotion activities and the availability of safe water containers.
- Sphere, WHO or even national water quality standards can be applied, depending on the context. Minimum parameters should include: faecal coliforms, pH, colour turbidity, salinity – conductivity, smell and taste. Other parameters such as chloride, fluoride, iron, manganese, nitrates, nitrites sulphate, arsenic, lead, may be of interest by only during the initial assessment.
- If faecal contamination represents an unusually high risk (e.g. during water borne outbreaks), water collected from wells may be treated at household level.



Example of surface work and equipment.
Source: ACF

8. Water points:

- The selection of pumping systems often fails to take national standards, practices or preferences into account. Yet these issues are critical for the sustainability of water points.
- Soak away pits and/or drainage channels of wells are often poorly maintained, leading to stagnant water pounds and vector proliferation. Yet, waste water can often be used to feed animal troughs, washing area, irrigation of small vegetable gardens, etc.
- Wells should be surrounded by a protective barrier/fence to impede animals from reaching them.

9. Reinforcement of local capacity.

This should include:

- ⇨ Definition of responsibilities of water committees and individual function of members, selection of members, etc.
- ⇨ Training (reinforcement of technical and managerial skills)
- ⇨ Distribution of tools and spare parts
- ⇨ Elaboration of basic operation and maintenance tasks and schedule, water points/system administration rules (with beneficiaries), etc.
- ⇨ Technical support prior to handover

Although user fee systems for water services are generally not recommended by ECHO, they may be appropriate in some cases (e.g. where they existed before), particularly after the emergency phase. As a general rule, access to basic water needs should never be restricted to the neediest populations as a result of the introduction of water fee systems.

10. Handing over facilities:

Wells and water points must be completely finished before they are handed over to the community (or local agency). The community/agency needs to agree that the facility is ready for handover and all the supporting elements have been put in place. A signed MoU is often the best way of doing this.

References

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- *Field Engineering. Peter Stern and F. Longland, Intermediate Technology Publications, London, 1983.*
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- *http://www.cee.mtu.edu/peacecorps/documents_july03/Visualizing_Gravity_Fed_Water_System_FINAL.pdf*
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- *PAT Drill Bangkok support http://www.pat-drill.com/support.asp*

Recommendations for ECHO funded operations:

Consult your DG ECHO Regional WASH expert.

1. Appraisal of the proposal:

- ❒ **Is this project integrated with other WASH activities (such as sanitation and hygiene promotion)? If not, why?**
- ❒ **Is there a need to integrate disaster risk reduction measures in the proposal?**

A. Needs assessment:

- ❒ Does the needs assessment reflect the fact that surveys and exploration activities have been carried out by the partner?
- ❒ Does the needs assessment show that groundwater is available in the targeted area and for human consumption?
- ❒ If not, will these be conducted before the project is implemented? When? By whom?
- ❒ Have the construction of new wells or the rehabilitation of existing one been considered?

B. Humanitarian organisations in the area of intervention:

- ❒ Has the partner (and/or its sub-contractor) worked in the area before?
- ❒ Will beneficiaries (and/or local water authorities) be involved in the project? When? How?

C. Beneficiaries:

- ❒ Have / will beneficiaries (and/or local water authorities) be involved in the project? When? How?

C. Activities, within the results presented:

- ❒ Does the description of the activities give enough information on the steps planned for the construction and rehabilitation of the wells (hand dug well and/or tube wells)? Are these steps respecting the recommendations made in the T.I.P (section 1.B, page # 2)?
- ❒ Consult the regional WASH advisor on the steps presented in case of doubt.

D. Budgeting wells and boreholes projects, description of costs and means:

- ❒ Consult regional WASH advisor on the appropriateness of the drilling / digging equipment proposed, including:
  - o Rig, compressor, truck, spare parts and consumable for tube wells; digging material, dewatering pump, tripod, pulley, survey equipment/expertise, etc.. for hand dug wells
  - o Development kit, pumping test kit and water testing kit/facilities.
  - o Design and material: pumps, casings, screens, gravel pack, cement, iron.
- ❒ The cost of wells and tube wells is extremely variable. It depends on many factors such as rock layers, diameter, depth, equipment, excavation technique, etc.
- ❒ ***Broad indication of cost for hand dug well and boreholes*** (*source:* ACF, 2005).

  a) Average cost of new hand dug wells (without equipment/pumps):

  1.4 m diameter well: from **1400** to **2800** USD (depth from 5 to 25 m)
  1.8 m diameter well: from **1700** to **3800** USD (depth from 5 to 25 m)

  b) Average cost of rehabilitated hand dug well (without equipment/pumps):

  Between **1000** and **1400** USD

  c) *Average cost of new borehole:*

  A programme of 30 boreholes at an average depth of 40 m with an 80% success rate, corresponds to a cost of **USD 7 000 per borehole**. As a comparison, a borehole drilled by a contractor (without pump), can cost as follows:

  ⇒ Haiti, 35 m deep, 8" diameter: **USD 8 500**;
  ⇒ Mali, 120 m deep, 6" diameter: **USD 12 000**;
  ⇒ Angola, a programme of at least 10 boreholes at a depth of 60 m: **USD 8 000** with cable tool drilling rig, and USD **13 000** with a rotary drilling rig;
  ⇒ South Sudan / Uganda, 50 m depth and with a 6" diameter: USD **12000-15 000**.
- ❒ The cost of a pump depends on factors such as its type (hand operated or motorized, yield, etc).

E. Human resources

- ❒ Are experienced engineers (field) and/or backstopping expertise (capital, regional/HQ) foreseen in terms of geology, hydrogeology; but also in terms of geophysics in case needed?
- ❒ To consult the regional WASH advisor on the appropriateness of the team put in place in case of doubt

F. Time schedule and delay

- ❒ What is the likelihood that the geological / hydro geological survey will be done in time?
- ❒ Does the implementation take into consideration seasonal water level variations?
- ❒ A single hand dug well may take 1 month to complete (provided equipment is on site), so a well campaign may last for 6 to 12 months.

G. Technical capacity of the partner

- ❒ Identification: Has the proposal been prepared by someone technically knowledgeable?
- ❒ Ask partners to include an annex with the design of wells and/or tube wells.

2. Monitoring & evaluation (Tips for field monitoring):

During construction: From a technical perspective, monitoring visits are more useful during the construction phase of wells. Complementary information should be requested to the partner to assess the quality of the "construction work" done and not only to assess the "condition of the water point" (centred on surface works).

1. Pre-feasibility study:

- ❒ Results of the geological survey for the digging / drilling site selection.
- ❒ Involvement of beneficiaries and local authorities in the selection of the water point location(s) and definition of broad arrangements for the future operation and maintenance of the water points.

2. Design:

- ❒ Digging / drilling logs (should include a sketch with depth, geology, water level, water stroke and a representation of the lining)
- ❒ Results of the *pumping test*, *water quality test*, and *design sketch* (depth, water level, installation of the pump, etc.)
- ❒ Integration of DRR considerations and f national (and/or Sphere) standards in the design (type of pumps, etc.)

3. Construction:

- ❒ For Hand dug wells: Does the inner diameter of the well allow deepening operations in case of a decrease in the water level? It should not be below 0.9 m but can be much bigger in wells for pastoralists (up to 2m).
- ❒ Are shallow aquifers well isolated? A culvert (plain and not perforated) should be placed in front of these layers.
- ❒ For hand dug wells: The quality of the culvert should at least correspond to the following:
  - ⇨ homogeneous thickness of 10 cm,
  - ⇨ presence of an edge to allow the culverts to fit on top of each others,
  - ⇨ no cracks visible around, no part without concrete,
  - ⇨ Drying time for concrete curing (min 2 weeks, so that the concrete could at least reach half of its full resistance);
- ❒ Perforated culverts (hand dug wells) or slotted screens (tube well) should be put in front of the aquifer layers.
- ❒ The depth of the wells and the depth of the water level should be checked and compared with the normal and usual water level draw down at the end of the dry season.
- ❒ Is the pump installed at a sufficient depth to allow water delivery all over the year, even at the end of the dry season?
- ❒ Are sufficient safety measures taken to protect workers working on the project?

Monitoring of yield measurement:

- ❒ Was a yield test performed? Was the test method used appropriate? What are the main conclusions?
- ❒ Are the data well documented and results of the tests communicated to the local – national authorities?
- ❒ Is the pumping device installed matching the maximum yield of the well?

After construction: If monitoring during the construction phase is not feasible:

1. Observe for yourself:

- ❒ Yield of water points? To estimate flow rate from a well or tube well put a bucket under the outlet from the pump and measure how long it takes to fill. The amount of water pumped in 1 hour is (A/B) x C, Where:
  A = Volume of the bucket in litres; B = Number of seconds taken to fill the bucket; C = 3600 seconds; Q = flow (litres/hour)
- ❒ Uninterrupted supply (24hrs/day) of water throughout the day at the water points? Particularly for motorized pumps.
- ❒ Lines at the water points? How many users per /water point
- ❒ Distance to the dwellings? Water points should be less than 500m (with no unsafe water source closer to the dwellings).
- ❒ Safe distance from potential contamination sources such as latrines and waste pits?
- ❒ Drainage and evacuation of waste water adequate? Up to 80% of the water provided may have to be disposed of.
- ❒ Water points protected against animals. There are alternative water points for livestock.
- ❒ Cleanliness of the surroundings? To give you an indication if water points are well managed (also related to hygiene education).

2. Ask beneficiaries:

- ❒ Is the water point functioning properly since it was constructed? If it was rehabilitated is it working better than it used to?
- ❒ Have beneficiaries been consulted by the partner prior to the construction/rehabilitation of the water points? Is there an MoU?
- ❒ Did beneficiaries contribute to the implementation of the project? How?
- ❒ Does everyone have equal access to the water point(s)? Do they use other water point(s)? If so, why?
- ❒ Is there a system to cover the expenses of the operation and maintenance (O&M) -e.g. collection of fees? Do beneficiaries accept and recognize the benefit of such system? If so, how much do they pay and to whom? Do they know how the money collected is used? Are beneficiaries (users of the water points) involved in O&M? How?
- ❒ How to they carry and store water at household level?

3. Ask the local water point committee or water agency:

- ❒ Has the partner officially handed over the system to the local committee/agency?
- ❒ Has the partner provided training for the management of the water points? Who attended? Was it useful? Why?
- ❒ Has the partner provided tools and spare parts for the O&M of the water points? How many? Where are they kept? Are spare parts available on the local market?
- ❒ How is O&M conducted, e.g. is there an "O&M plan" and an up to date "O&M report"?
- ❒ Does the local committee/agency feel it is capable of managing the water point(s)? Is the management scheme sustainable?