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ST 1.5 THE HAND DUG WELL



Version : February 2009
Published by : Foundation Connect International
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Disclaimer

This manual is part of the main manual, named “ST 1 Wells”. Other manuals in this range are:

- ST 1.1 Geology and Site Selection;
- ST 1.2 Rota Sludge drilling;
- ST 1.3 Baptist drilling;
- ST 1.4 Finalization of the borehole;
- ST 1.6 Finalization of a hand dug well;
- ST 1.7 Training of care takers;
- ST 1.8 Training of drilling companies.

Each manual can be used separately from the other manuals.

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Although digging wells could be relatively simple, it has many details which can be best learned with practical training. Therefore it is highly recommended to use this manual in combination with practical hands on training that can be supplied by Connect International. Please feel free and contact Connect International if you have any questions.

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Table of contents

ST 1.5	The Hand dug well	0
	<i>Disclaimer</i>	1
	<i>Table of contents</i>	2
1	<i>Introduction</i>	3
2	<i>The tool list</i>	4
3	<i>Digging step by step</i>	5
3.1	Setting up the digging site and start digging	5
3.2	The well lining.....	7
4	<i>Safety measures and tips</i>	11



1 Introduction

People always need water to survive. Water is not only necessary for drinking but also for irrigation and hygiene. Water is been taken from taps, boreholes, springs, rivers but also from hand dug wells. People make hand dug wells since history. They dig until they find water. A hand dug well has normally a diameter of 0.8 up to 1.5 metre and varies in depth, depending on how deep water is found. When using a ventilator for fresh air during digging, it becomes even possible to dig up to 30 meter or more. A hand dug well can be made in hard soils as well as in soft soils. The soil structure and water level determines how to support the walls.

The quality of the water taken from hand dug wells varies. One thing is sure: the quality of a hand dug well improves immediately if it is properly lined inside and has a cover on top. These simple improvements of an open well prevents waste water from flowing back directly into the well, collapsing of the shaft, pollution by debris, animals and even from people from falling in!

Connect International improves continuously the way of digging and construction of a hand dug well and explains in this manual how to make a proper well lining. This manual explains which materials can be chosen for which circumstances. With this manual it becomes safer, quicker and easier to dig a well.



A hand dug well with Rope pump



2 The tool list

Below is a list with the most necessary tools that should be available during digging. Spare parts are not included and depend on the quality of the tools taken to the site.

Make sure you have enough cement, sand and stones available for making mortar and concrete and burned bricks for the top part of the well (see chapter 3.2 about well lining).

Tools	Purpose – Remarks *
Diviner	For site selection (see manual ST 1.1 Geology and Site selection)
Hoe	For digging and filling the bucket with soil
Long chisel	To loosen the soil while digging
Short chisel	To make foot steps in the wall
Buckets	For lifting the soil out of the well, for measuring amount of cement, etc.
Helmet	For safety reason if case something falls in the well
Measuring tape	For measuring e.g. well rings and the depth of the well
Windlass + poles	For lifting soil out of the well as well as the digger
Well fan	If expected to dig over 15 meters
Moulds	For making the well rings
Rope	For lowering the bucket, well rings and digger. Length depends on the depth of the well
Building line	For measuring depth and used to straight the wall

* See for further details the pictures and descriptions in chapter 3.

Avoid problems!

Keep the equipment in shape, organize the drilling site properly; know what you do, be up to date!

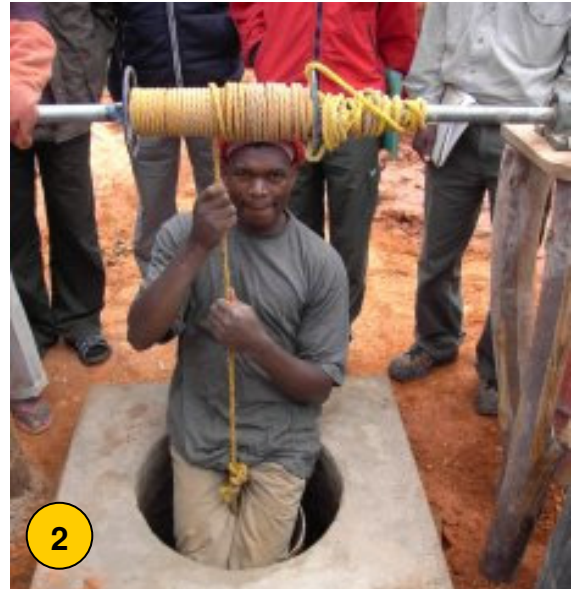


3 Digging step by step

3.1 Setting up the digging site and start digging



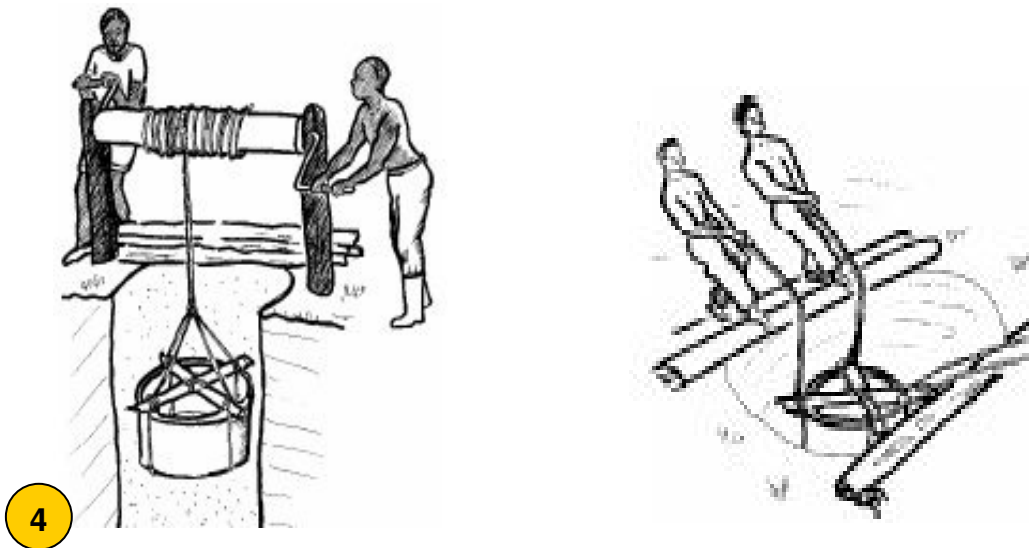
Start with digging by using the long chisel to loosen the soil. Use a hoe to put the soil in a bucket. These tools make it possible to dig wells with a diameter of only 0.8 meter.



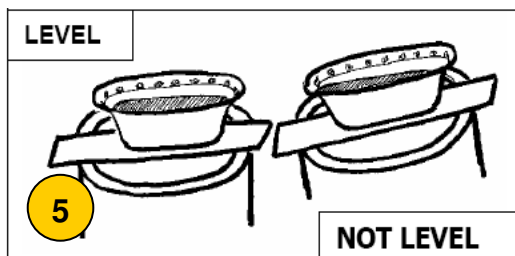
If you are digging deeper, install a windlass to lift the bucket with soil. The windlass can even be used to bring the digger up and down. Continue digging till you find water. The water table should be at least 0.5 meter in the dry season.



If it is not possible to install a windlass, lay down a horizontal beam and attach a rope on this for getting the bucket and tools up or down. Use a ladder or make food steps in the shaft of the well for climbing up and down. Make sure the shaft of the well will not collapse where the beam is. If you are not sure about this, dig until you find a hard layer and lay the beam on this layer.



After you found water, it is time to lower the well rings. Using well rings is only necessary if you expect that the shaft of the well can collapse. How to make well rings is explained in chapter 3.2. Tie a rope at sticks and tie the rope at least at four points for optimal stabilization and security. Lower the well rings with the use of the windlass (see also the picture on page 10). If you are not using a windlass, lower the rings with at least 4 people (see drawing above). Support the edge of the well with planks to avoid damaging the upper part.



Make sure the lowered well ring has a strong foundation at the bottom of the well. Level every well ring before putting another on top. Use a cup or a bucket with a straight edge to level. If the well ring is not water level, put stones below the ring to level out. Fill gaps between the well rings with mortar.



After installing the well rings, fill the gap between the shaft of the well and the rings with small stones. This will function as a filter as the water enters the well. Fill up till where you expect to be the highest water level. Then put a layer of cement on top to make a kind of hygienic seal. This prevents bacteria to enter the well water from above (see manual ST 1.1 Geology and Site selection). The top layer is filled with the soil you took out of the well.



3.2 The well lining

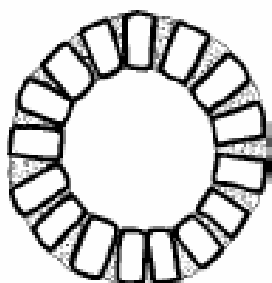
Well lining is a very important part of a proper functioning well but is also the most expensive part! Avoid using too many materials by working neat and precise and work like this manual tells you to do. It is not always necessary to make well lining with well rings or bricks. It is only necessary if the wall is collapsing during digging or if you expect the wall to collapse during e.g. the raining season.

There are many different types of lining. In this manual we will discuss only two: lining with bricks and lining with concrete rings. Those are the most common and most stable.

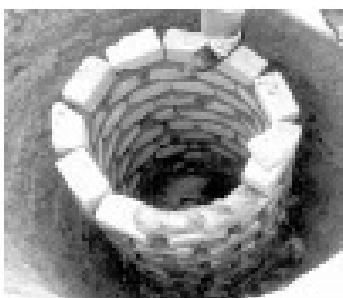
Bricks

Bricks are an excellent material for well lining. You should use well burned bricks. Those bricks are not crumbling if they stay below the water level for a long time.

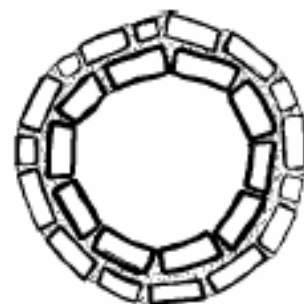
The first two courses of bricks at the bottom of the well, should be laid radially for a stable foundation. On top of this they are laid tangentially (see Fig 7.2 b) as this requires fewer bricks per meter. They should be mortared, but may prove stable even without mortar.



Radially laid stones



Tangentially laid stones



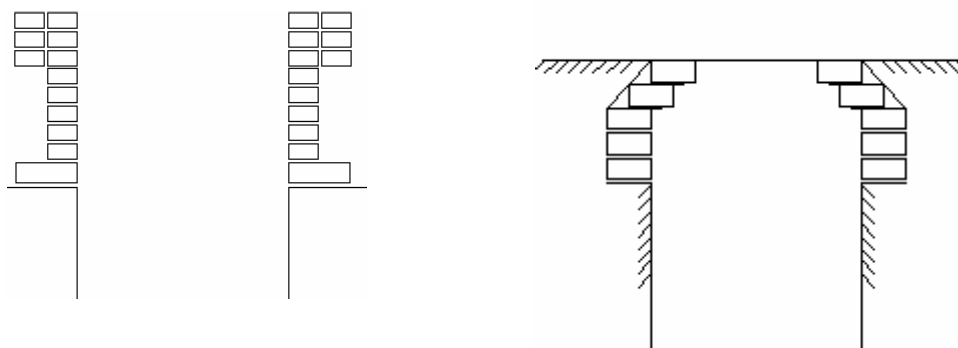
Two courses wide tangentially

When you have reached within three courses of the surface, the 'collar' of the well should be laid tangentially, but two courses wide. Continuing above ground level, there should be two more courses two bricks wide and finish with a radially top course of bricks. The apron will be installed on this (see manual ST 1.6 Finalization of the hand dug well).

In order for the bricklayer to be able to lay the bricks properly and even being able to reach his work, it may be necessary to set poles across the shaft at different heights as the lining progresses. This may be done by slotting two poles into the walls of the well and bricking around them. Alternatively the bricklayer can work from a platform, safely tethered to the windlass.



When a well shaft exists of strong and solid soil it may not be necessary to install a complete well lining. In that case only a top lining is made. This is done by widening the top of the well shaft till well-consolidated ground is found (stands up easily and is hard to dig) or 1.5 metres minimum. The width should be sufficient for the bricklayer to stand behind the ring of bricks, and for a course of bricks set radially. There are different shapes possible of making the top lining (see the examples below).



It may be necessary to deepen the well if it does not give water any more (this may occur in the e.g. dry season). In case of deepening, the soil is dug out under the bricks and new bricks can be placed under the existing ones.

Well rings

Using well rings for lining is more expensive than using bricks. However most of the times, it is the best way of construction a well lining. Sometimes well rings are only used for the wall that is expected to be below the water level. The lining above the water level is done with bricks. Other times the whole lining is done with well rings.

Well rings are made of concrete. The table below shows how to make the well rings with different concrete mixtures in different situations. The table gives the possibility of having in one well different wall thicknesses of well rings and different mixtures! Often people use too much cement (which is the most expensive ingredient!) so try to follow the mixtures as written below.

Ground Conditions	Depths (meter)	Mix cement:sand:stone (bucket)	Wall thickness (mm)	Cement required per ring* (kg)
Wet day soil/ river valleys	0-2	1:3:6	45	17
	2-6	1:3:6	50	18
Sandy top/ stable underground/ loose in wet season	0-6	1:3:6	50	18
	6-13	1:2,5:5	60	27
	13-15	1:2:4	60	34
Hard and stable most of the year	0-6	1:3:6	50	18
	6-15	1:2,5:5	60	27
	15-20	1:2:4	60	34
	> 20	1:2:4 + 6 mm re-bars	60	34

* for a well ring with an inner diameter of 80 centimeter and a height of 0,5 meter



For making concrete, use stones with actual sizes between 0.5 – 3 centimetres. Make sure it is free of dust and other pollutions.

Making well rings, it is necessary to use moulds. Below pictures give an example how to make them.



Use the sheets of an oil barrel as a mould for making well rings. Put spacers between the walls to ensure the same thickness at all sides and make the moulds adjustable for having different wall thicknesses. Be aware that concrete shrinks when drying up.



Make the two lowest well rings with a filter so the water can enter the well. This filter exists of a mixture of stones and cement and should be 30 centimeters high in the middle of the ring.

Set up moulds in clean flat area, near where concrete will be mixed. Always try to make the rings in the shadow to reduce the effect of evaporation of the water from the concrete. Place the moulds on plastic or banana.

Fill the mould one quarter full with mixed concrete. Tap this down until it is compacted, and air has been driven out but not for so long that water comes to the surface. Add re-enforcing at this time if required. Continue with the next quarter and tamp again. Continue this process until all concrete and all re-enforcing (if used) have been placed in the mould. As it is setting, cut the concrete at the top with cross-marks so that mortar for filling up between the well rings, sticks better. If possible let the ring sit undisturbed for at least six hours (preferably 24 hours). During that time the concrete will begin to shrink as it cures and the moulds will come away easily.



It is very important for the strength of the well ring to keep it wet for at least 14 days and don't move or disturb it during that period. Concrete will reach 85% of his final strength after 14 days if watered properly but will lose all his strength if it is dry within 7 days. After 4 weeks it is almost at its strongest but will continue to get stronger for several months.

Do not forget always keep the concrete wet!

Normally the well rings are watered by the community. Be aware that they may forget to water the rings because of lack of knowledge. Make someone is responsible for this task and explain him/ her properly what the use is of keeping the concrete wet. If possible supply the rings with a cover with the text e.g. "Keep it wet, every hour". This cover can be made out of cassava- or cashew nut bags and reduces the evaporation of the water. It will remember the community to water the rings.



A cover will remind to keep it wet!



Lowering a well ring with a windlass

Normally the well rings are installed after finishing the digging (never roll a ring, always carry it). However if you have really sandy soils that could collapse at any time, install the well rings already during digging. Do as follows: place the first well ring if you have dug the height of one well ring. Dig for the same depth again and remove the soil under the first placed well ring. When removing the soil, the first well ring will come down by his weight. Now there is place on the top to install the second well ring. Continue digging and placing well rings in this way until you reach the right water table. This is a very save way of digging. Disadvantage is that it will take more time and you spend already money for making well rings without being sure you will reach water.

In case the well dries up after a certain period, the soil should be taken away under the well ring as written above. Normally the rings will come down themselves due to there heavy weight. If they are not coming down by themselves, use high-burned bricks or bricks of concrete to reinforce the wall. Place them under the existing well ring.



4 Safety measures and tips

Digging a well is not without risks. Common causes of accidents often include material or equipment falling down the well, collapsing of the shaft, the use of poor equipment and even children playing at the site may be a risk. Accidents do happen but they are minimised by taking care and by listening to those with experience of well digging. Sensible safety precautions include:

1. Check all ropes and equipment every day at the start of work;
2. When using a rope to lower or lift something from the well, knots should be made along the rope at metre intervals to stop the rope slipping through your hands;
3. Ensure that the handle of the bucket is firmly fixed and cannot slip off;
4. Put a fence or some sort of barrier around the digging site to stop people and animals falling in;
5. If possible, always use a windlass to lift and lower materials. Use a windlass with two handles and therefore two people if a digger is lowered or lifted. If one of the people loses the control of his handle, the digger will not fall back in the well because the other still controls his side.
6. Always wear a helmet in case something falls down in the well;
7. In narrow wells more than 15 metres deep, there may be a problem having fresh air at the bottom of the well. This is very dangerous and even poison gasses may appear. Air circulation can be helped by raising and lowering leafy branches in the shaft to 'stir up' the air. The best way is to use a ventilator to get fresh air in the well. This ventilator can easily be made by a local workshop and exists of local available materials.



Always use a helmet!



A ventilator for brining fresh air down in the well

8. While someone is working down the well there must always be someone in attendance at the top. Never leave someone unattended at the bottom of the well;



9. Heap excavated soil more than one metre from the edge of the shaft so that as the pile grows, it will not fall back down the well;
10. Cut steps into the side of the shaft to make it easier for people going up and down the well. This is only possible if the soil is strong enough to hold the weight of a person. When you doubt: do not make them!
11. Be careful while loosening the soil in the well with the long chisel. Don't cut off your toes! If possible wear shoes with a metal nose protection.



Make steps for climbing up and down



Watch you feet!

12. Put a plank across the edge of the opening to the shaft, so that people and buckets can be lowered over the edge without wearing away the ground at the side and causing it to cave in;
13. A system may need to be developed for signalling between people at the bottom and top of the well for lowering and raising equipment and people. Make sure everyone understands these signals and there is no miscommunication.