Baptist Well Drilling in Bolivia
An alternative to expensive well drilling
Designed for the poor to do it themselves!
(with their own resources)
By Terry Waller

An Idea Manual For Development Workers and Missionaries Working to Empower Poor People To Help Themselves.
(or anyone else who wants to drill a water well, cheap!)

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This well club just finished it's first well. They drilled 10 more, one for each family. The well is 200 ft deep!

Baptist Well Drilling in Bolivia. Designed To Help Every Family Have Their Own Personal Family Well.

The purpose of this booklet is to share a low cost family well drilling system. The system of well making was developed by Terry Waller while working as a Baptist community development missionary in Eastern Bolivia and West Africa . It is written to literate development workers, missionaries, volunteers or anyone who wants to learn to drill a well via a low cost technique and then teach others.

Most poor rural people in the third world are hands on/oral learners. Chances are the people who need a well most, will not be able to drill a well from reading this book. They will need hands on training. The purpose of this booklet is to give ideas to a literate development worker or concerned person who is willing to put a rig together, go to the field and try this technique out, and then work out any problems or modifications for a specific location. Every local situation will require modifications, some major and some minor. Then we hope you will pass on the information through hands on training. You will definitely have to get dirty for this book to be any use to you.

The good thing is that the technique was developed to be very, very, inexpensive, and to be so easily learned that poor village families can pass the knowledge along in an informal way to their friends and neighbors. We wanted families to be able to pay for

and make their own wells any time, without having to look for outside help. The purpose is to empower and equip people to have proper, responsible dominion over their own lives.

When the project was started a typical small bore well in Eastern Bolivia (Rio Grande River Basin) drilled with orthodox rotary machinery cost from $20 to $40 a meter. By the time of writing our "Baptist" technique allows rural families to make their own wells at an average material cost of $2/meter. This includes a hand pump also made by the families themselves.

The difference in cost is that families form clubs with other families, buy their own material, and do their own work. Families take their own risk rather than a hired well driller taking the risk (and charging for it!). The capital cost for our technology is also much, much cheaper than a standard motorized drilling rig.

Our goal was and is to make the technique a shared common knowledge in the culture. Along the lines of digging a ditch, or planting a tree. Water is too important to only be left in the hands of specialist. Too often specialist aren't around when you need them or else have to charge so much for their services that the poor can't afford them! To solve the water problem for poor rural people the people themselves have to be able to get water for themselves, if at all possible.

So our goal is not to provide jobs for well drillers (though that is a pleasant side benefit for some). Our goal is for every single family in our rural area to be able to afford their very own well. For that to happen the wells have to be much cheaper than what a driller would charge. Thus we train whole communities to learn and drill their own wells. The technology was designed with this approach in mind. We want knowledge of well drilling in our area to become common as mud. The ideal is for each rural family to have a shovel, machete, hoe, and well drilling rig in the back shed. When he wants a well he calls his neighbors and they go drill one.

Limits

The technology is limited to non cemented sedimentary deposits of sand and clay. (we are working on a rig for drilling through rock. Soft rock can be drilled through though progress may be unacceptably slow). Large stones may also cause problems. You also will need time (2- 4 days per well) and 4 – 8 people per well. Rural people in the third world usually have periods of the year between seasons when they have extra time on their hands when they are happy to drill wells if they have the tools and know how.

What you can do with our technology.

A bore hole 2 inches in diameter and 70 meters deep (or deeper we have never tried to go deeper) can be made in clay and sand deposits. You can drill through undesirable water bearing sands or clays and seek desirable aquifers below these. Most wells we drill are from 30 to 50 meters deep. Our normal well casing is 2 inch inside diameter, class 9

PVC. Our wells make from 1000 – 5000 liters per hour (tested with air compressor). Our hand pump or wind pump out puts average 10-20 liters/minute. (We have a nice aquifer and yours may not be the same.) We estimate. 1,200 wells drilled with the technology to date. The upper part of the well hole may be bored out to 4 inches for larger casing for larger pumps if so desired.

The drilling rig may also be motorized easily with a 3 hp. motor . With a motor 2 men can drill a well. This may be desirable if multiple wells for irrigation or for emergency water needs such as refugee camps etc. are needed.

We use plastic drill stem (the only rig of it's kind that I know of) to keep the drilling rig light weight and easy to use and maintain. This helps in transport, and allows villagers to do their own pipe threading on site with minimal tools. It also does away with the need for finely tuned, stable drilling derrick or tower.

Benefits of Being super duper cheap.

The technique and rig being so inexpensive means that individual churches and mission groups, small NGO's, and even caring individuals can learn to drill wells and then pass the knowledge along. No huge investment in money is required. (In Bolivia 2003 $100 approx for drilling rig material and approx. $2.00/m for well and pump materials) What is required is some warm body to take the time to put a rig together, and go to the area where water is needed and experiment and see if they can drill well.

Time and dedication to "making it work" are what is required. Someone will need to live for some time where the wells are dug and really become an expert and take the time to train others. We work by forming clubs who elect from among themselves, one or two or three well drilling trainees. These are sent to work with clubs already working . There they work and help out for free and get plenty of hands on training. Usually after helping to drill 2 or 3 wells a guy will feel competent enough to go home and work with his newly formed club and drill wells. The wells are so cheap club members can buy their own material outright in most cases. We usually lend a rig if the club can't afford to by one right away.

By the time he is finished directing the work of his club, say doing 10-30 wells, the new driller(s) will be an expert himself. Also some of the other club members usually become competent drillers.. Out of a club a 10 families usually three or four people become very good well drillers/pump makers. Sometimes everyone becomes competent.

Be prepared for failures, for well collapses etc. If that happens, put another rig together and go try again. If you are working in a developed area where ground water is regulated be sure and follow all codes and laws and customs.

Use common sense. Don't make a well too close to a septic tank, or sewage treatment plant, or trash dump. If wells are shallow and fed by surface water seal of the wells

around the outside with cement and or clay grouting and channel excess water away from well. (Clay is the best filter you can have (why they use ceramic to make water filters).

The wells are small 2 inch bore holes, and thus the risk of contaminating the ground water from the surface is much less than say with a village communal large diameter hand dug well. But still, use common sense. Teach people from the beginning if the well is to be abandoned or gets ruined (by kids throwing rocks in it or something), that it is best to fill with clay soil and plug it with cement.

Final Philosophy

The system was designed with a philosophy of going from the, simplest, to the, just sufficient, to make sure minimum capital would be required and rig fabrication could be made in the widest possible area around the world. We use "off the shelf" inputs that are easily substituted when ever possible both for the drilling rigs and the pumps.

We want to foster indigenous well drilling movements, rather than just drill wells for people. At the village level we wanted to eventually see craftsmen building, selling, and renting drilling units. We want well making to be a commonly known art in a culture.

In the end our water ministry is about empowerment as much as it is about water. We all know water is physical life itself. Empowering common people to provide themselves abundant water is a huge step in empowerment and dignity. We think this pleases, and gives glory to God. We believe from Scripture that mankind was made in God's image and was meant to have dignity. So that is our true inspiration, to give glory to God.

Our desire is that this book may help you if you are out to learn for yourself or if you are out to help others have more dignity by having abundant water. God bless you in your effort!

"Who ever is thirsty, let him come; and whoever wishes, let him take the free gift of the water of life." - (The Sprit and the Bride)

Getting Dirty

The Reward

Above is a family well being drilled and a the final product. The well materials cost families from $50- $100 and includes the pump. The pump is 1.25 inch diameter plastic cylinder and rising main. It built and serviced by families well drilling clubs themselves. Average wells are 2 inch inside diameter, 20-50mts deep. Hand pump output average 10-15 liters per minute. Well outputs 1000-3000 liters per hour (when pumped with air compressor).

Most people in the world live in areas along the coast or in river valleys or basins where this or other low cost well drilling techniques would be applicable. For example this technique should work along much of the West Coast of Africa where rivers drain toward the sea, and where most of the people live too! (Our first attempts were in Equatorial Guinea years ago). This technique or something similar should be able to be developed locally in many areas all over the world. What is needed is someone to go and work out the details and get the ball rolling. It is not rocket science. The technique won't work everywhere but it should work in many, many places where poor families only dream of having their own family well.

Materials for the drilling rig.

1 six meter length of 1.25 inch standard (3mm thick) galvanized water pipe. Can be plain steel pipe. Galvanized is just easier to get where we are.

1 three meter length of 1.25 inch standard galvanized water pipe.

X number of 1.5 meter lengths of schedule 40 plastid pipes threaded at each end with a plastic or steel 1 inch coupling for one end of each pipe.

One of our specially prepared "tongue and dart" drill bits. (see below for instructions on preparation.

10 or 20 lbs of bentonite or clay soil dug from the ground.

2 -3 barrels of water (55 gal./200 liters/ barrel). This depends on drilling conditions. We have hauled water to drill wells from a mud hole a mile away on burros, horses, and on heads. You can use the nastiest water in the world, it doesn't matter. Make sure not to use water contaminated with pesticides. Bicycles make good water transporters if you walk the bicycle. Old inner tubes work well to haul water also if no buckets around.

10 meters of thick rope. 3/8 inch to ½ inch thick.

An outlet handle (see below). This is a 1 inch galvanized elbow fitting.

A pulley (type used to haul up buckets of cement or water in construction, three or 4 inch in diameter.)

A tripod or 2 post with cross piece that is two and a half meters tall. (This is the "derrick") See pictures below for approximate sizes. Doesn't have to be all that good. Four inch soft wood will work if you are in a wooded area. You will need to experiment.

Two small pipe wrenches or water pump pliers (big enough for the one inch couplings.)

That is it! That is all you need to drill the well.

Miscellaneous. A shovel, post hole digger if available, stakes and rope to firm up "derrick" if it gets to wobbly. A couple of buckets of some kind to pour water from barrels to well or for someone to be hauling water to well site while drilling. Three – eight people to pull rope and do the work, depending on how fast you want to get done and how hard everyone wants to work. Some nice mariachi or bluegrass music playing on the radio is also nice to have while working, this is optional.

Digging the Pilot hole.

Fresh cut soft wood post for the “derrick”

The “derrick” set up with 6 meter long drill tool leaning against it.

Plastic Threaded 1inch PVC “Drill Stem”

Above are pictures of most of the material that you will need to drill the well along with two or three barrels of water. Now call your buddies, turn on the radio and start digging.

To case and finish the well you will need;

X meters of pvc 2 inch casing and glue or cement to go with it.

One standard woven pvc plastic flour sack. New with no holes in it. The kind that holds approx 100 lbs of flour or grain. Very common all over the world.

Some cobblers clue. The kind used to glue soles on to shoes. Also very common in the third world.

One ½"or ¾" foot valve.

X meters of ½" black poly plastic hose (3 meters more than the depth of the well you will be drilling.) This is the stiff black plastic hose that comes in roles. Also very common all over the world.

A "back wash pump" of some kind. (See diagram below).

A pump of some kind. (We teach clubs to make their own hand pumps of plastic tubing. These work fine (last years) for single families or even small villages or neighborhoods. All pumps need periodic maintenance. If clubs know how to make their pumps they will also know how to maintain their pumps. There are many low cost plastic pump designs available that work fine. (A diagram of our design is included). For single family use there is no need for an expensive hand pump. For our two inch wells a 1.5 inch orthodox brass cylinder single action lift pump works well for windmills and with heavy duty pump jacks where community use is be heavy. Our aquifer is strong so many have placed air lift pumps (air compressors) or motor powered rotary suction pumps in their wells

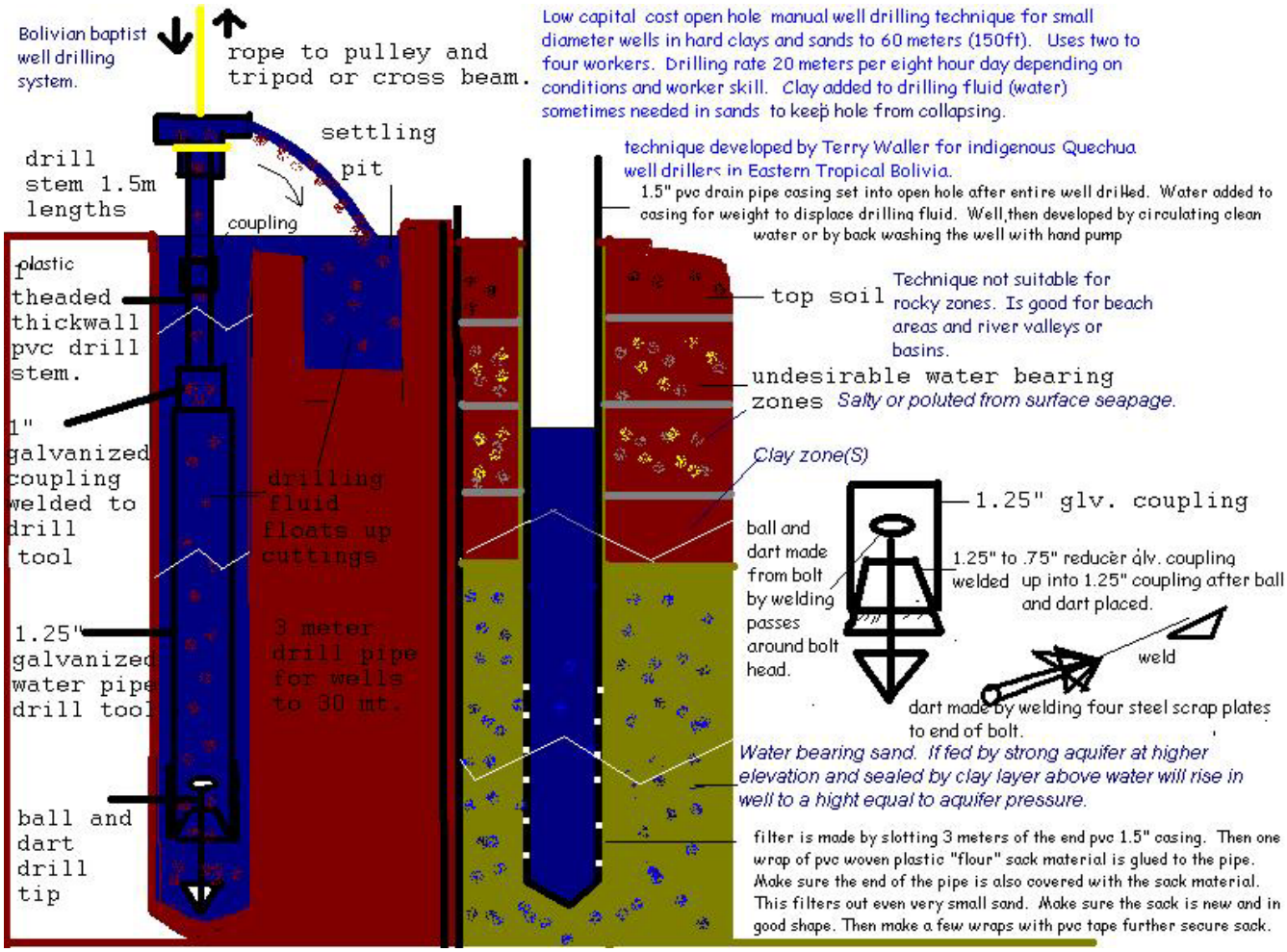
A brief non technical description of what you will be doing. (If you try this.)

Drilling the well.

Ground water exist between particles of either soil, sand, clay or rock. Our technique drills an open hole (no casing) down into a layer of sand that is saturated with water. The hole is made via hydraulic percussion by keeping the hole full of drilling fluid (water and or mud) and moving the drilling tool up and down and striking the bottom of the hole. After the hole is completed casing is added.

The drilling tool is a ball and dart point or bit on the end of a 3 or 6 meter 1.25 diameter drill pipe. To the top of that 1.5 meter lengths of 1.25 inch plastic drill stem is added as needed as drilling proceeds. The ball and dart point acts as a foot valve. Drilling fluid and cuttings enter the drill pipe and is forced up the pipe and drill stem and discharged via inertia and displacement on each down stroke of the drill string (drill tool and drill stem).

The drilling fluid and cuttings are discharged into a settling pit at surface and the fluid is recycled into the open hole. One can see what type of materials is being drilled through by checking the cuttings that are being deposited in the settling pit. The hole is kept completely full of fluid through entire drilling process. If permeable, loose layers such as sand are encountered clay or some other material must be added to the drilling fluid to make "mud" to seal of the hole and keep it from collapsing. (If high pressure water zones are drilled through the mud mixture must be heavy enough to maintain a higher pressure on the inside of the hole than the water pressure pushing in from the aquifer. If not the hole will collapse with probable loss of drilling tool and some of the drill stem (and maybe some cussing.) So don't skimp on the drilling mud especially as you are learning.



The above diagram should give you a basic idea as to how the process works. You will have to work out details for your local situation. When the drawing was made we were using 1.5 inch casing instead of the 2 inch casing we use now.

Casing the well.

When a pre determined depth has been reached (by talking to well drillers in the area, (or sometimes you just have to be a "wild catter" and drill blind and look for good water bearing sand) the entire drill string, is removed and an open hole full of mud is left. A "filter" is attached to the end of a length of prepared "screen" (a length of casing that is prepared). The filter/screen is closed at the lower end. This is shoved down into the open hole. Water is added to counter weight the buoyancy caused by the mud in the hole. Another length of casing is glued on to the top of the filter and this placed (shoved) on down the hole. More water is added, then another length etc. until the bottom of the

hole is reached. The casing is then tied off to keep it from shooting out of the hole (because of the mud that is being displaced).

Finishing the well.

Clean (as clean as you can find easily) water is pumped down the casing to back wash the well and remove the mud drilling fluid. This comes to surface until the fluid pressure decreases in the hole enough for the aquifer water pressure to cause sand to collapse around the filter. Then the well is hand pumped until water begins to clears up. The well is "swabbed" if need be to condition the sand around the filter. That is it! Then the hand pump can be permanently installed and the well is pumped until clean. You are done!

A happy well driller just finishing his well.

Some Details Explained

The Drill Point

Above is our "ball and dart" drill point. We make these by welding two 1.25 galvanized couplings together. Then we weld a 1.25" to ¾" reducer coupling into one end of the couplings. This forms a type of funnel inside. A long bolt, with the head dressed with a welder to form a type of ball, serves as the check valve. To the bottom part of the bolt wing tips are welded to form the digging point. We use old leaf spring which is fairly hard. On up stroke the valve closes and the fluid in the drill pipe can't escape. On the down stroke the "dart" is driven into the bottom of the hole and thus the valve is forced to open, allowing drilling fluid and cuttings to enter the drill pipe, and then to surface where discharged into a settling pit. The water is then channeled back to the well hole and the water thus recycled.

The width of the point needs to be just wide enough to make a hole just bigger than the outside diameter of the casing. It is good to make several so that as they wear one can be taken to a welding shop to be "dressed" or sharpened and the work continue with another. Depending on conditions, we can drill up to 10 or more wells before a point needs to be re dressed. Welding passes are simply run down worn edges and then ground with a bench or hand grounder to "dress" or "sharpen" the points. Fabrication can be very rough. In harder ground or soft rock mush less of a point is needed. This bit works very

well in both hard, hard, clay, or sand. In sand the fluid must be “thickened” clay to make “mud”.

Drilling with “Mud”

This shows drilling in progress with the “mud” or “fluid” being discharged on down stroke. Notice how the well hole is full to the top of the hole. In the photo the settling pit is difficult to see do to mud splatter. The mud in this pictures was made naturally while digging through a clay layer. This mud can be saved for use later when digging through sand. Below another length of plastic drill stem is threaded on to the previous length. Using plastic allows easy pipe threading on the spot when needed.

Another picture of down stoke. Velocities are high enough to float big courses sands and even gravel to top if the fluid or “mud” is thick enough.

The Derrick

This shows how we make our “derrick”. Four men are pulling on the rope very comfortably at a rate of about 60 strokes per minute. We usually drill 20 meters or so per day through alternating layers of sand and very hard clay.

Note that the settling pit and bore hole are full of fluid. It is important to keep the hole full to the top at all times while drilling. The "mud" here is from the clay we are drilling through. This can be saved and the mixture "thinned with water" when in clay.

Drilling through sand with "Mud"

Above we are mixing up bentonite clay to add to the drilling fluid to drill through sand. Simple clay soil or clay saved from drilling through clay layers can be used as a substitute. Making the mix about milk usually works for us. If the fluid in the hole suddenly drops you need to hurry and add clay till it stops leaking away. So have your mix ready at all time. Sudden fluid loss means you are drilling through a something with holes in it or very loose sand. This is the exact same problem oil well drillers face. If you don't stop the leak your hole may collapse and you might loose your drill tool!

This is also why it usually cost a lot to have someone else take the risk of drilling a well. With our rig, even if you do occasionally loose a tool it isn't the end of the world. Only some lengths of pipe and time.

Our hydraulic percussion technique usually causes the well hole walls to be thoroughly mud impregnated and plastered and thus hole failures are very uncommon.

With our rig sometimes progress through sand slows if the mixture isn't thick enough. If progress slows when in sand, add more clay mixture and keep adding till progress begins. In sand if you aren't progressing and fluid is circulating you are making a big cavity that might cave in. It can't be stressed enough to thicken the mud mixture when drilling though sand and progress slows. This is an art and can only be learned by practice.

Notice the size and velocity of the stream. This technique should be applicable to larger diameter wells by simply increasing the tool and drills stem diameters, as velocities will correspondingly increase. Dug material (cuttings) float in the fluid and are raised and

ejected with the fluid steam. Progress is made when upward fluid velocity is greater than the rate that cuttings sink or descend in the stream. Thus if the stream velocity remains fairly constant, to remove large particles of sand or gravels higher viscosity fluid (thicker mud) is needed to keep the particle "sink rate" less than the upward fluid velocity. The weight of the mud in the hole also keeps the pressure from the surrounding water bearing sand from collapsing the hole. We have had suspend drilling and left a hole for days at a time without loss of the hole. With this technique you can go eat lunch. Just make sure you remove the tool (below). We don't have to dig around the clock which is a great benefit for villagers with farm chores to do.

Taking a break while drilling.

Here is a well in progress with the six meter long drill pipe leaned against the “derrick”. We went to eat lunch! Notice the mud splatter around the settling pit.

Taking care to start a straight hole.
Drilling begins by making pilot hole by hand. A small hole is dug with a shovel and filled with water. A shorter 3 meter drill pipe with point attached is dropped up and down in hole always stopping on up stroke. The pipe thus fills with water via inertia pumping. When it is full it is removed and the water discharged into the settling pit by dropping the point on a piece of wood or stone. Great care must be done to start the pilot hole straight. This is continued until the hole is a meter and a half deep. Then the rope can be attached to the top of drill pipe and helpers can pull the rope.

Once the three meter drill pipe is in a length of plastic pipe (drill stem) can be added . Wells to 20 meters or so can be drilled with the three meter drill pipe. If going deeper we pull the three meter pipe out of the hole and replace it with the six meter pipe shown above.

If the pilot hole is straight up and down the plastic pipe will follow. Thus it is not necessary to have a firm “derrick”. This is a great advantage to villagers as each provides his own “derrick” by cutting soft wood trees. During drilling the derrick may wobble around but it won’t matter. Any type of fairly sturdy tripod would also work. They poles can be lashed together with rope.

Notice how the plastic one inch drill stem is bent slightly during down stroke due to the pulley placement not being centered over the hole. This is ok. With our rig using plastic drill stem that follows the steel drill pipe perfectly centered firm derrick is not needed as with most other drilling techniques.

Preparing to Complete the well.

At some point during the drilling process a section of the PVC well casing needs to be prepared as a screen and filter. This is an important process and the screen/filter needs to be ready for placement as soon as the desired hole depth is reached. When drilling is finished the screen/filter is the first length of casing to be place in the well. Then successive lengths of casing are glued and added until the well is cased.

Making the Screen and filter.

Here the "screen" is being prepared by slotting a length of casing with a hack saw for thee meters up and down two sides of the tube. Cobbler glue is smeared on the two un-slotted sides and a "filter" sack is glued on.

Glue is smeared on the un-slotted sides of the casing and one or two wraps of a good (no holes) woven plastic flour sack are placed. Then PVC wraps are applied. It won't come off. Don't worry. Be sure and don't smear glue over your slots. That is where the water

seeps into the well? We found this PVC sack to be better filter material than expensive industrial made filter screens. You can do a test by filling a sack with sand and water and seeing what gets through. It should last years and years underground out of the sunlight. It is the same material as the casing!

Before applying the filter sack, the end of the casing tube is cut and heated and the flaps folded in toward a point. The end is overlapped when the sack is attached. The end is taped closed. No need for plugs in high pressure aquifers or for gravel packing.

A ready to place filter/screen, made on site. We always penetrate into at least three meters of what we hope is water bearing sand. The object of the whole exercise is to place this filter in a water bearing zone with no clay horizons running through it. You

have to pay attention as you dig to what you are passing through. If clay horizons run through the filter zone the water will never clear up no mater how much you pump.

This is the upper end of the screen/filter.

This should give you an idea of the approximate spacing of the slits.

Completing the well.

Here the entire drill string is being removed. The well drilling is completed and the string, (drilling tool and drill stem) is removed leaving an open hole full of mud.

Here the six meter drill pipe is being removed.

Casing the well

Adding water to each section of casing to counter weight the buoyancy of the mud in the hole. Water is added to each section.

After adding water the joint is dried with a cloth and PVC cement or glue is applied liberally.

Then another section of casing is added. Notice the men holding the lower section in place. Even with the added water it still wants to shoot up out of the mud filled bore hole. This process is repeated until the entire well is cased.

Here water is being added to the final section of casing before cutting at the desired height.

Fully cased well with bore hole still full of mud. The cross piece will be used to tie off the casing to keep it in place until the casing can be back washed to remove the mud.

Tying off the casing so it doesn't float up in the mud.

This is a back wash pump. It is placed in a barrel of water and pumped. A half inch poly line from the pump goes all the way down to the very bottom of the well casing. The top of the well casing is tied of with rubber inner tube. The back wash pump is a simple piston/plunger in a cylinder with a one way brass foot valve on the intake and one on the outlet T handle where the water exits.

Above shows how the half inch hose from the back wash pump that goes down into the filter is sealed at the top of the casing with rubber inner tube.

Water is thus pushed down through the casing under pressure and at the bottom passes through the filter/screen and then up the outside of casing, cleaning the mud out of the bore hole. This is done until the flow at surface stops. It stops when enough mud is cleaned out of the hole and the water being pumped begins to mix with water in the aquifer. Usually about a barrel (200 liters) is enough. This back washing also causes sand to collapse around the filter.

This water being pumped from the barrel back washes the new well. Water passes from inside the casing through the filter and up the sides of bore hole and into the settling pit.

When back wash flow slows or stops a trial pumping of the well can be done with a simple inertia pump. The pump is the same half inch poly tube with a foot valve on one end. It is place in the casing and pumped up and down.

Water is pumped until the well can not be pumped dry. If it is pumped dry, water can be added to the casing and the well pumped again. Or the well can be back washed some more. The pumping action of the inertia pump helps to "condition" the well. The surging action of the water caused by the up and down movement of the foot valve causes larger size grains of sand to collect on the outside of the filter. This increases the water making potential of the well. The action of making the water to surge in and out of the filter is also called swabbing (a simple swab of cloth can also be made). It can be done to unstop or "condition" an existing well with a stopped up filter.

Here we see the man in the back ground pumping with the simple inertia pump. The water is being tasted to see if it is salty or not. This is always an anxious moment.

Water flow from inertia pump. This is the first water this well is making. Water from the aquifer will usually be colder than water used to wash the well and will begin to change color from dark to light and back and forth as the well cleans up. The well may have to be pumped dry and refilled many times or re back washed again. Don't walk away from a good well thinking it is dry for lack of washing and conditioning. We have had wells abandoned thinking they were dry holes only to be washed and conditioned to make excellent wells.

When the well will not be pumped dry with the inertia pump the permanent hand pump can be installed. Pump jack is optional with our pumps.

The well may clear up and then get cloudy again for days or even weeks. Continual pumping is the best way to clean up a well.

Happy well making. Guys like the little girl above needs the water. Go for it! The well shown is serving a whole neighborhood and is three years old. The neighborhood maintains it.

Below are some more photos of wells and pumps made and maintained by poor rural families themselves. Note the simple home made pump jacks.

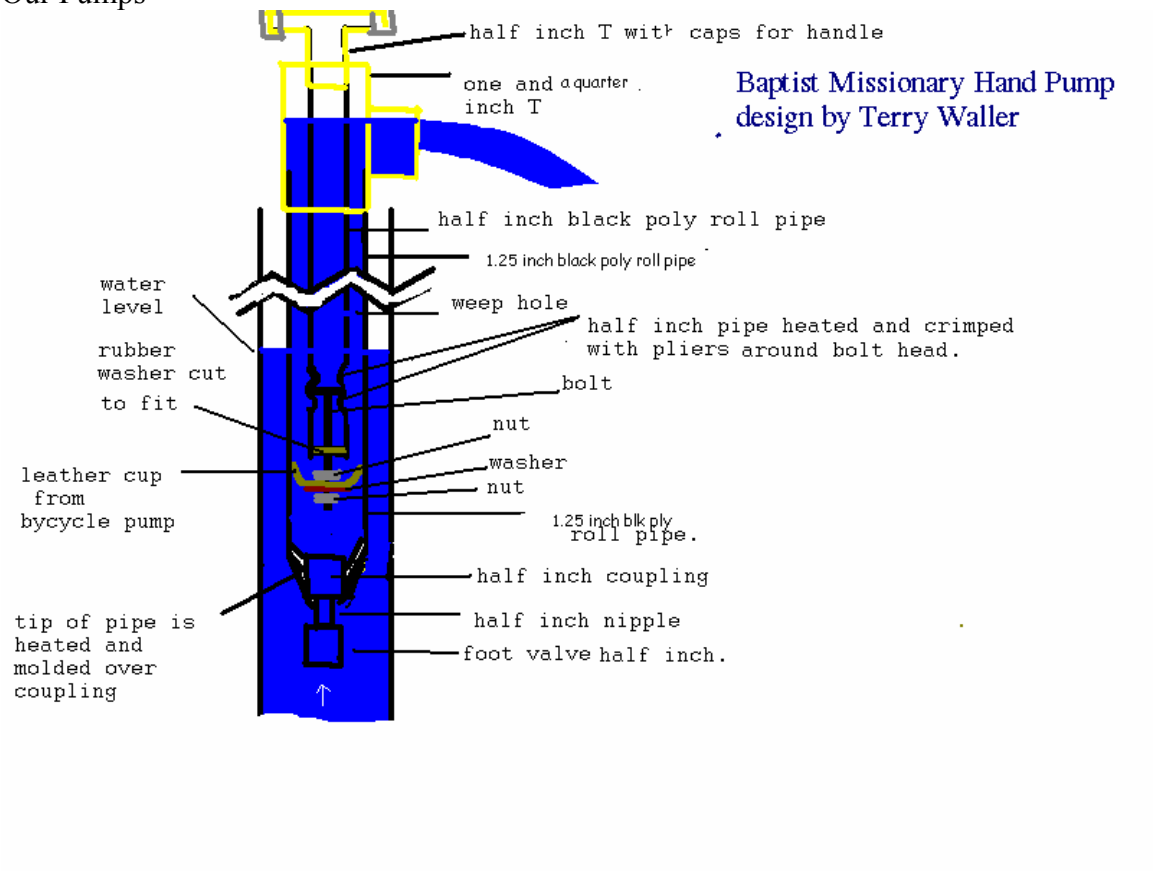
Sincerely in Christ

Terry Waller

PS. The most important thing our project does is to share "Living Water" with people. It only because the love of Jesus compels us and our supporters that this project exist.
To God be the glory!

"If anyone is thirsty, let him come to me and drink" - Jesus

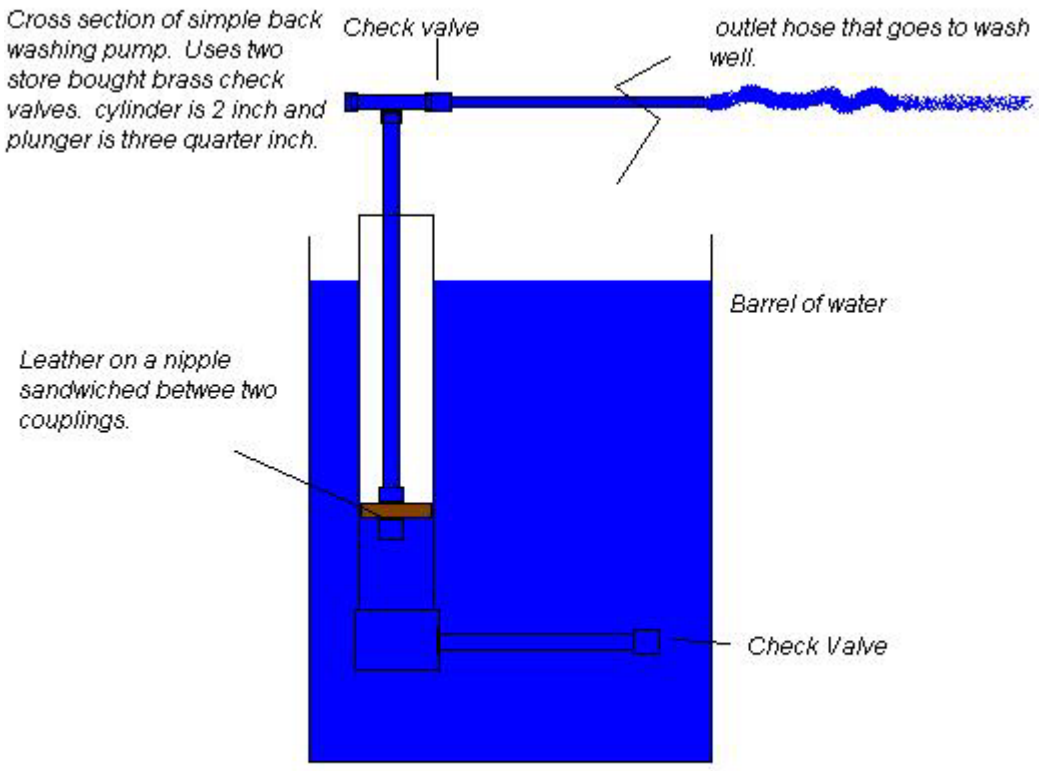
Our Pumps



This is an alternative piston that we designed for heavier use than the piston design shown in the drawing. It is made from a bolt, plastic nipple and coupling and tire treads for seals. Water passes between bolt and nipple on down stroke. The piston seats on up stroke and acts as upper check valve. The coupling is cut in half and they secure the rubber seals that are threaded onto the nipple. The lower seat is a rubber tip cut from an

inner tube valve stem. Both pistons work well. Try them or your adaptation of them for your situation.

The backwash pump.



The cylinder can be either plastic or galvanized. The leather seal on the plunger/piston can be either leather or rubber. Adaptation of a pump by Wolfgang Buchner.

You can also use the hand pump as back washing pump by inverting the piston and lower check valve. With that system you have to poor water down the "T" as you pump. The pump system shown is easy to make and works nicely pumping straight from a barrel.

Our low cost windmills, for abundant farm water, within the reach of poor families.

This is another subject but we have also designed a set of very low cost windmills to work with our well drilling technology. This is still under testing but about 50 have been installed to date with good results. The price installed over one of our wells and pumps is from $350. This compares to $2500 for a factory built windmill. These were designed to work with our wells and pumps and can also be used with orthodox brass cylinder pumps.

K1.8

Our locally designed direct transmission super inexpensive easy to build wind pump. (Poldaw Rotor)

Poldaw1.8

(by Poldaw Designs UK) Designed by Poldaw for our needs.

Our KP 7ft model with variable crank designed for our pumps and wells.

The above machine coupled directly to the pump handle with rubber inner tube. For quick pumping when no wind is available. Set up by user.

Other Technologies that we are developing for the rural poor.

Our motorized zero till seeder for small plots. No plowing needed!

Our hand sprayer cart and motorized sprayer cart for environmentally and economically sustainable zero till agriculture for small farmers. An alternative to slash and burn. To help families stay on the land with dignity and not be forced to migrate to urban slums.

Small Scale Zero Till Soy Beans yeilding 3- 4 tons/hectare. Grown with the tools above in a traditional field that has never seen a tractor. Pray for our work. Sincerely,

Terry Waller

Signature Not Verified

Terry Waller

Digitally signed by Terry Waller
DN: cn=Terry Waller, c=US
Date: 2003.04.29 02:12:02 Z