Repairing, cleaning and disinfecting hand dug wells

Hand dug wells may need repairing, cleaning and disinfecting after inundation by flood water, inundation of seawater as in the case of a tsunami, materials entering as the result of mudslides or as a result of hurricanes, or simply after long periods of limited maintenance or neglect. If work has been undertaken on the well to try to increase its yield through, widening or lining the well, then cleaning and / or disinfection will also be appropriate.

This Technical Brief identifies the process for repairing, cleaning and disinfecting hand dug wells and also discusses the OXFAM kits which can be used for these processes.

Hand dug wells

Hand dug wells can come in many forms, from simple holes in the ground with limited protection, to covered wells with a handpump for extracting the water. It is important when rehabilitating wells or cleaning and disinfecting them that wherever possible, the source of contamination will be prevented from re-entering the well. If the cause of contamination was an unusual event such as a flood, the process of cleaning and disinfection may be enough. Care should also be taken to ensure that the headwalls, drainage curtain and any protective covers are in good condition to prevent the well becoming contaminated again from every day, non-disaster related routes.

Repairing, cleaning and disinfecting wells

Steps to repair, clean and disinfect hand dug wells

1. Determine the history of the well from the users – how deep it was originally, what was the previous yield of the well versus the current yield of the well etc.
2. Determine the equipment need to empty, repair, clean, disinfect and dewater the well, including the items required to ensure the safety of workers.
3. Undertake any repairs to the headwalls, drainage curtain, sanitary seal, cover and lifting mechanisms, which are possible before emptying and / or disinfecting the well.
4. Empty the contents of the well – water, sludge and debris.
5. Repair damage to the inside of the well - deepen, undertake localised repairs to the well lining, or add a lining depending on the need.
6. Clean the walls of the well using a 200 mg/l chlorine solution and long handled broom.
7. Disinfect the water in the well with a 50 – 100 mg/l chlorine dosage (depending on the level of contamination), and leave for a minimum of 30 minutes.
8. Dewater the well and allow it to fully recharge.
9. After recharge check the chlorine residual in the water.
10. Where necessary repeat the process of dewatering and recharging the well until, the chlorine level has reduced to 0.5mg/l or below.
11. Make any final repairs to the well cover and water lifting mechanism.

Safety

Care must be taken when working around or inside of wells.

Risks when repairing and maintaining wells

a) Poisonous gases, particularly carbon monoxide, can enter the well from diesel or petrol engines powering pumps.

b) Inhaling chlorine gases when cleaning the walls of the well. Wherever possible the walls of the well should be cleaned from the surface using a long handled brush.

c) Incoming water filling up the well and a person inside not being able to exit the well quickly enough.

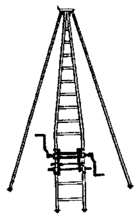
d) Items falling into the well from the surface or collapse of the well walls if not lined or protected.

e) People falling into the well from the surface if the well does not have a headwall or other protection.

f) Faulty equipment such as ladders, ropes, tripods, hooks, buckets.

Health & safety good practice

1. Under no circumstances must a diesel or petrol powered pump or its associated engine be lowered into a well and their gases must be diverted away from the well even when they at ground level. This is essential as carbon monoxide is heavier than air and can sink to the lowest level. This could cause asphyxiation and death to the workers inside the well. Many people have died inside wells from carbon monoxide poisoning.
2. People involved in well repair, cleaning and disinfection should be fully trained on the risks and good health and safety practice.
3. Use a well tripod or other locally developed structure to facilitate safe entry to and exit from the well for the people removing debris or repairing inside the well. This is particularly useful for deeper wells.



kit, Code WT6/1

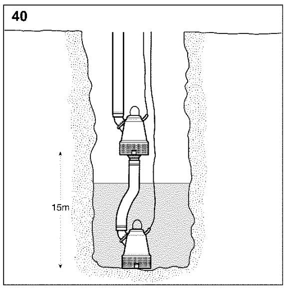
4. People who enter insic ld wear safety helmets and have fastened to them.
5. The working area should be fenced, a kerb constructed (of there is no headwall), and at least 2m around the well should be kept clear of objects which could fall in.
6. Keep a reliable person on top of the well at all times when people are in the well to operate the winch system. Secure any ladders.
7. Keep the well ventilated.
8. No smoking, matches, or naked lights except for use to test the air by lowering a lighted candle into the well prior to entry. If the flame extinguishes then do not enter the well. Lowering and raising a large brush of twigs/branches can help to clear the air in a well.

Repair / improve structures

Consider potential contamination routes to the well and make any appropriate repairs to the headwalls, sanitary seal, drainage curtain, cover, lifting mechanism and fencing, to ensure that the well will remain hygienic after cleaning and disinfecting the well.

Removing dirty water and sludge

Hurricanes, floods and other natural disasters can leave wells filled with sludge and other debris. These wells will require specialised pumps to remove the sludge and debris as normal dewatering pumps will quickly become damaged. OXFAM has a portable desludging / dewatering pump kit (see box) which can dewater wells to a depth of about 15m. It can cope with solids up to 50mm in diameter and can also be used to desludge pit latrines.



When well depths are deeper than 15m, two of these pumps can be attached in series to reach a maximum depth of about 35m.

Submersible dewatering / desludging pump with generator, Code WSDP/6

Submersible dewatering / desludging pump with generator – OXFAM Code WSDP/6

- Lightweight electrical dewatering pump kit for handling heavily contaminated water with solids up to 50 mm in diameter.
- The maximum head of the Heron pump is 20m. This package is designed to dewater wells at around a depth of 15 m. If higher heads are required, then two WSDP/6s can be coupled together to give a maximum head of 40 m (7 m^3/hr at 35 m head).
- This pump does not pump air, but it does not need to be submersed to pump, as with the second pump when pumping in series. But when switching on there should always be water in the pump chamber or the seals will burn out after 1–2 minutes.
- The purpose of the base plate is to prevent the legs of the pump sinking into the mud causing the impeller to try and drill itself downwards, which results in the pump becoming clogged up. If the base plate is not present either suspend the pump just above the muddy bottom, turn it on its side or put it in a large perforated bucket.
- If the pump is near its maximum pumping depth the canvas layflat may need to be attached to a stake at the top of the well to prevent sliding back into the well. A hose connector can be attached to the end of the layflat to make it easier to tie to a stake.
- The Heron pump can be used for desludging latrine pits.

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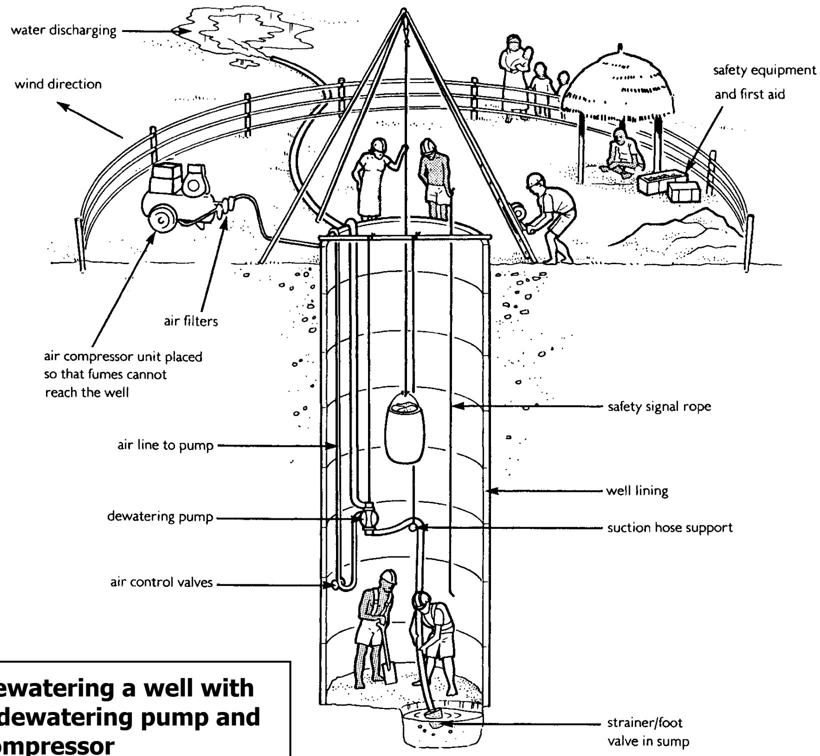

Dewatering a well with a dewatering pump and compressor

Dewatering when there is no sludge

The traditional method of dewatering a well is to use large buckets to bale the water out manually. The buckets can be suspended and lowered into and raised from the well using the tripod and winch. A limitation of this method is where the yield of the well is too high to allow the water to be removed quickly enough manually and hence it will not be possible to reach the bottom of the well for cleaning, deepening or repair.

Where the well was simply inundated with water or simply needs emptying for cleaning or deepening purposes, an engine with compressor and an electric submersible pump can be used. However, care must be taken not to damage the cables and hence risk electrocution if the cable touches water in the well.

If there is no need to remove debris from the bottom of the well or to repair the well, then it is not necessary to dewater before disinfecting it.

Removing solid materials / deepening hand dug wells / repair

Once the well has been emptied, and water is being removed, debris can be manually excavated from the bottom of the well and then lifting it to the surface in buckets using a winch. Minor repairs can be made to the lining of the well or more major works can be undertaken to deepen the well, or to line a well which was previously unlined.

If there is time and it is felt appropriate, then this could also be an opportune moment to upgrade an open well to improve its cover or lifting mechanism, but this is probably not appropriate in the early stages of a fast onset emergency.

Whilst inside the well inspect the lining for any cracks, particularly in the first few meters from the ground surface, which should be sealed to prevent ingress of contaminated water from the surface. To repair cracks, chisel out the area around the crack and use a stiff mortar (mix 1:3 cement to sand) and keep wet for 24 hours before putting the well back into operation.

Cleaning the walls of the well

Using a long handled firm broom (with extensions made from thin GI pipe and sockets if necessary) clean the sides of the well with a chlorine solution of 200mg/l (refer to the section on the following page for details of how to make up this solution). Where the well is shallow enough undertake this process from outside of the well, but if there is a need to enter into the well then particular care must be taken as the strong chlorine solution will give off dangerous gases. The person undertaking the work must wear protective clothing, including gloves, overalls, goggles and a face mask with a filter. Wherever possible, also provide a strong air flow inside the well, such as through making locally designed bellows to blow fresh air into the well during the process.

The strong chlorine solution should remain on the walls of the well for at least 30 minutes before allowing the well to refill.

Disinfecting the well

When the well has recharged the water should be treated with a chlorine solution which will leave a free residual of 50mg/l in the well (or up to 100mg/l in particularly bad conditions). The chlorine should be allowed to stand in the water for at least 30 minutes, but preferably several hours, before it is pumped out from the well.

To mix the chlorine solution in the well, use a clean rock on the end of a long rope and move the rock around in the water, lifting it up and down while moving it around the well. An alternative method to mix the solution is to use a bucket and keep on drawing water and then pouring it back into the well.

For effective chlorination, ideally the water should have a turbidity of < 5TU and a pH of > 6.0 and <8.0. Use a pooltester with Phenol Red tablets and turbidity tube to test these parameters.

If the water is found to have a pH of less than 6.0, hydrated lime can be added. But with such a high dosage of chlorine (50mg/l or above) and a long retention time (over 30 mins and preferably several hours), there should be no problem if the pH is >8.0, unless the pH is significantly higher.

If the turbidity of the water in the well is >5TU, then the well can be dewatered and recharged before chlorination to ensure effective chlorination. However, with the high dosage, the chlorination should be effective against some turbidity. If unable to reduce the turbidity < 5TU and in doubt, increase the dosage from 50mg/l.

Preparing the chlorine solutions

Preparation of 1 litre of 1% chlorine solution (1% chlorine solution has 10g / litre, or 10,000 mg/l, or 10 mg/ ml), Ref: Davies & Lambert, 2002, 2nd Edition

Chlorine source	Available chlorine %	Quantity required	Approx measure
High Test Hypochlorite (HTH) granules	70	14g	1 heaped teaspoon
Bleaching powder	34	30g	2 heaped teaspoons
Stabilized tropical bleach	25	40g	3 heaped teaspoons
Liquid household disinfectant	10	100ml	7 tablespoons
Liquid laundry bleach	5	200ml	14 tablespoons
Antiseptic solution	1	1 litre	No need to adjust as it is a 1% solution

Important tips for using chlorine

1. The strength of chlorine reduces quite rapidly over time and hence some allowances should be made for the age of the chlorine.
2. Do not mix chlorine in a metal container as chlorine reacts with metal.
3. Chlorine is a hazardous chemical and should be handled with care. It can irritate skin and eyes and HTH powder or strong solutions produce gases which are dangerous to breathing.
4. Chlorine must be stored in a cool, dry, well ventilated and dark location and should not be stored in the same room which a night watchman is using for sleeping in.

Calculating how much chlorine is required

A 1% stock solution made up as in the table above, has approximately 10g/l = 10 mg/ml of active chlorine.

To make a 200 mg/l solution for cleaning the well walls:

Add the following volume of 1% soln. to 1 litre of water

$$\frac{200 \text{ mg/l}}{10 \text{ mg/ml}} = 20 \text{ ml / each litre of water}$$

Calculate the volume of the water in the well using the following equation:

$$\text{Vol of water in the well} = 3.14 \times \frac{\text{Dia}^2}{4} \times \text{depth of water}$$

Measure the depth of the well using a rock on the end of a piece of rope. Drop the rock slowly to the bottom of the well. When the rope is withdrawn from the water, the wet part of the rope can be measured to determine the depth.

To obtain 50 mg/l of free chlorine in the well, then for each 1m³ of water (1,000 litres):

a) Using a 1% solution:

$$\text{Use } 1{,}000 \text{ l} \times \frac{50 \text{ mg/l}}{10 \text{ mg/ml}} = 5{,}000 \text{ ml} = 5 \text{ litres of 1\% soln}$$

b) Using 70% HTH (which has 70% active chlorine) and using a heaped tablespoon to measure it (which equates approximately to 14g per spoon):

$$\text{Quantity of chlorine required} = \frac{(\text{dosage} \times \text{volume of water})}{(\text{chlorine \%} \times 10)}$$

So, for 1,000 litres, the qty required is:

$$\text{Qty of HTH} = \frac{50 \text{ mg/l} \times 1{,}000 \text{ litres}}{70\% \times 10} = 71.4 \text{ mg}$$

1 heaped tablespoon = approx 14g

Number of heaped tablespoons required = 71.4 / 14 = 5.1

If calculating the amount of HTH chlorine to add to a well, do not add the powder directly to the well as it will not mix properly. Mix the required amount into a small volume of water for 15 minutes. Then decant off the clear liquid, leaving the solid deposits which can be discarded. The clear liquid concentrate should be added to the well.

Dewatering the well

Once the chlorine has been left for a minimum of 30 minutes the well should be fully dewatered.

Testing the chlorine residual

After disinfecting the well, dewatering and allowing the well to recharge, a pooltester should be used with DPD1 tablets to check the residual free chlorine level. If the residual is equal to or less than 0.5mg/l then the well can then be put back into use. If it is much higher than the 0.5mg/l then the well should be dewatered again and the process repeated.

Final reinstatement or repairs of the cover and lifting mechanism

Where necessary make any final repairs to the well cover and lifting mechanism.

Re-commissioning the well for use and on-going monitoring

When the well cleaning and disinfection process has been completed, the well should be decommissioned and put back into use. Discussions should be held with the users of the well to ensure appropriate maintenance and use of the well and where possible to limit the use of personal containers when taking water from the well. This will reduce one of the paths for future re- contamination of the well.

Where appropriate, such as when there are outbreaks of infectious diseases which could be attributable to the water source, a mechanism should be put in place for regular on-going chlorination of the wells in the affected areas (aiming for a chlorine residual of 0.2 mg/l to 1.0 mg/l). Locally made (using clay containers, plastic containers or strong plastic bags), or imported floating pot chlorinators using large pressed slow release chlorine tablets (imported or locally pressed) can be used (see Garandean et al, 2006 for more info).

The water quality of wells in the area of an emergency should be monitored on a monthly basis for the presence of faecal coliform, and when chlorinating also on a more regular basis for the chlorine residual. The regularity of monitoring for faecal coliform levels can be increased if an outbreak of a diarrhoeal disease is causing concern, to either identify the wells as a concern or to eliminate them as one of the causes.

Special scenarios

Wells which have had human or animal corpses inside

In the event that a dead body, either human or animal, is found in a well, such as through an accident, through being washed in during flooding, or the disposal of a dead body, then additional precautions will be required.

Risks to life from human or animal corpses in water sources

Recent literature (PAHO & WHO, 2004) has noted that in most cases the risk to human health through the presence and handling of dead bodies is minimal in areas where certain highly contagious diseases are not endemic, and where the person or animal died through natural causes and not due to a contagious disease, is minimal. However, it also notes that:

1. In areas where cholera is endemic, corpses can play an important role in the increased rate of infection, *'especially if there are decaying bodies in contact with water sources'*. It has noted that in the case of Zaire when approximately 12,000 refugees died during a cholera outbreak that in a few cases the transmission of the disease was believed to be *'due to the fact that dead bodies contaminated drinking water sources'* (p73).
2. Dead or decayed human bodies do not generally create a serious health hazard, unless they are polluting sources of drinking water with faecal matter or are infected with plague or typhus (Wisner and Adams, noted in WHO, 2004, p77).
3. *'There are two specific situations in which animal bodies can be a risk to humans: the presence of specific infectious agents and the contamination of water by feaces and discharge from lesions. The micro-organisms of greatest concern are Cryptosporidia, Campylobacter, and Lysteria, but only when the bodies are in water'* (p78-9).

Considerations if a dead body is found in a well:

1. If it is a human body that is found in the well cultural constraints may mean that people will reject using the well again, even if it is microbiologically safe.
2. The body will need to be removed from the well and buried, cremated or temporarily stored until this is possible, in a way which is appropriate to the local culture.
3. The well will then need emptying of water and debris as described above, the walls to be cleaned and the recharged well dosed with 100mg/l of chlorine, higher than the usual dose for disinfecting a well.
4. The dewatering and checking of chlorine residual should then be repeated as usual. If the local population is particularly concerned then the process of chlorination, dewatering and recharge could be repeated for a second time.

Wells which have been inundated with seawater

If wells have been inundated with seawater, they will also require additional steps to return them to a functioning state.

How quickly the salinity in the wells will reduce, will depend on how much infiltration has occurred into the groundwater table. Dewatering the well and allowing it to recharge and repeating this process a number of times may reduce the salinity. A conductivity meter can be used to determine the change in the salt concentration in the water. The recommended WHO guideline for Total Dissolved Solids is 1,000 mg/l based on a taste threshold above which some people may reject the water because of its taste of saltiness. However, this will depend on how salty the water was that people have been used to drinking and the form of the salts in the water. 1,000 mg/l of TDS converts approximately to 1,400-1,500 μS/cm. Brackish seawater has a conductivity of approximately 10 – 50,000 μS/cm.

Where repeated dewatering and recharge does not reduce the salinity of the water in the well, it is likely that the groundwater aquifer has been contaminated and it may take several years of recharge during the rainy season to reduce the salinity levels in the groundwater. Alternative water sources will be needed in the interim years.

Conductivity sensors which can be used to assess the salt content of water

The following pocket sensors are supplied by Palintest:

LR – 0 – 1990 μS/cm (PT159)

HR – 0.1 – 19.9 mS/cm = 100 – 19,900 μS/cm (PT160)

Sensors should always be purchased with a standard conductivity solution, with which the instrument can be calibrated. Both of these Palintest conductivity sensors can be calibrated against a mid range solution (PT142/3)

During the South Asian tsunami in 2004, many shallow wells around coastal areas were inundated with seawater. Dewatering wells to encourage recharge was effective in some cases in reducing the salinity of the wells but not in others. It is expected that some wells will take a number of monsoon seasons to recharge the aquifers adequately with new freshwater.

Further information

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