Skid mounted water treatment unit, in Ethiopia, showing pump in background with suction side coagulant dosing, flexible pipe for flocculation, pressurized sand filters in foreground and chlorine doser at front, (IFRC LMS Unit – capacity 4,000 liters/hour)

Trailer-mounted water treatment unit (IFRC SETA unit – capacity 3000litres/hour) this set up also has activated carbon filters to remove any odors

Photos courtesy of IFRC

These units are quickly set up but require skilled operators to operate and maintain them and high levels of consumables.

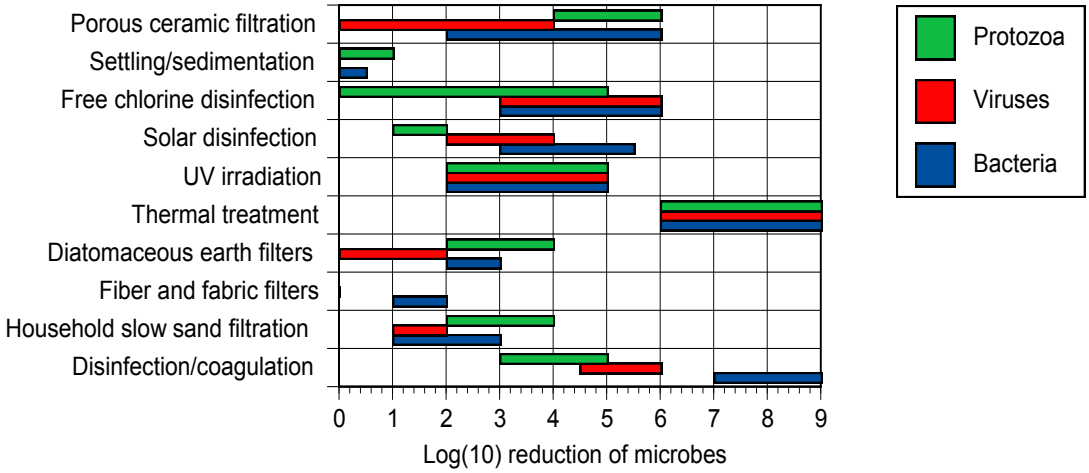
6.7.4 Household water treatment (HHWT)

Material is adapted from IFRC Household water treatment and safe storage in emergencies

Household water treatment (HHWT) uses a variety of methods to reduce the pathogens in the water when stored in the house. Some methods also reduce the turbidity of the water. HHWT will also treat pathogens that are introduced during collection and transport of the water (such as from dirty water containers or dirty taps or environment around the water source), which bulk water treatment should also do if enough chlorine is added to the water. If HHWT is combined with strong messages on water storage and use, it can be a major factor in reducing diarrheal disease.

For any HHWT, it is important that people are trained in both how to do it and why it is important so that they can reliably carry it out. It is also vital that hygiene staff carry out follow up visits and education to ensure the water treatment is carried out properly as it has been shown this can dramatically increase its effectiveness in the household.

The effectiveness of a variety of HHWT methods is shown below. Not all of these are relevant to typical households in Sudan:



***Sources**: Souter et al. 2003, Lantagne 2001, Sobsey 2002, Hijnen et al. 2004, Timms et al., Kaiser et al. 2002, Colwell et al. 2003, Huq et al. 1996, Logsdon 1990, Schuler et al. 1988, NAP 1997, Sobsey 1989, Batchley and Peel 2001, Walker et al. 2004, Meyer and Reed 2001, Reed 1996, Wegelin et al. 1994, Mendez-Hermida et al. 2005, CDC 2001, CDC.gov 2005, Brown and Sobsey 2005, Sobsey and Brown 2006*

Note: a Log(10) reduction – log (10) reduction is a 10 times smaller number i.e. 10^{-1} so:

- 1 on the graph is 1/10 of the original amount, or a reduction in amount of 90%
- 2 on the graph is a reduction in amounts of 99%
- 3 on the graph is a reduction in amounts of 99.9%
- 4 on the graph is a reduction in amounts by of.99%
- etc.

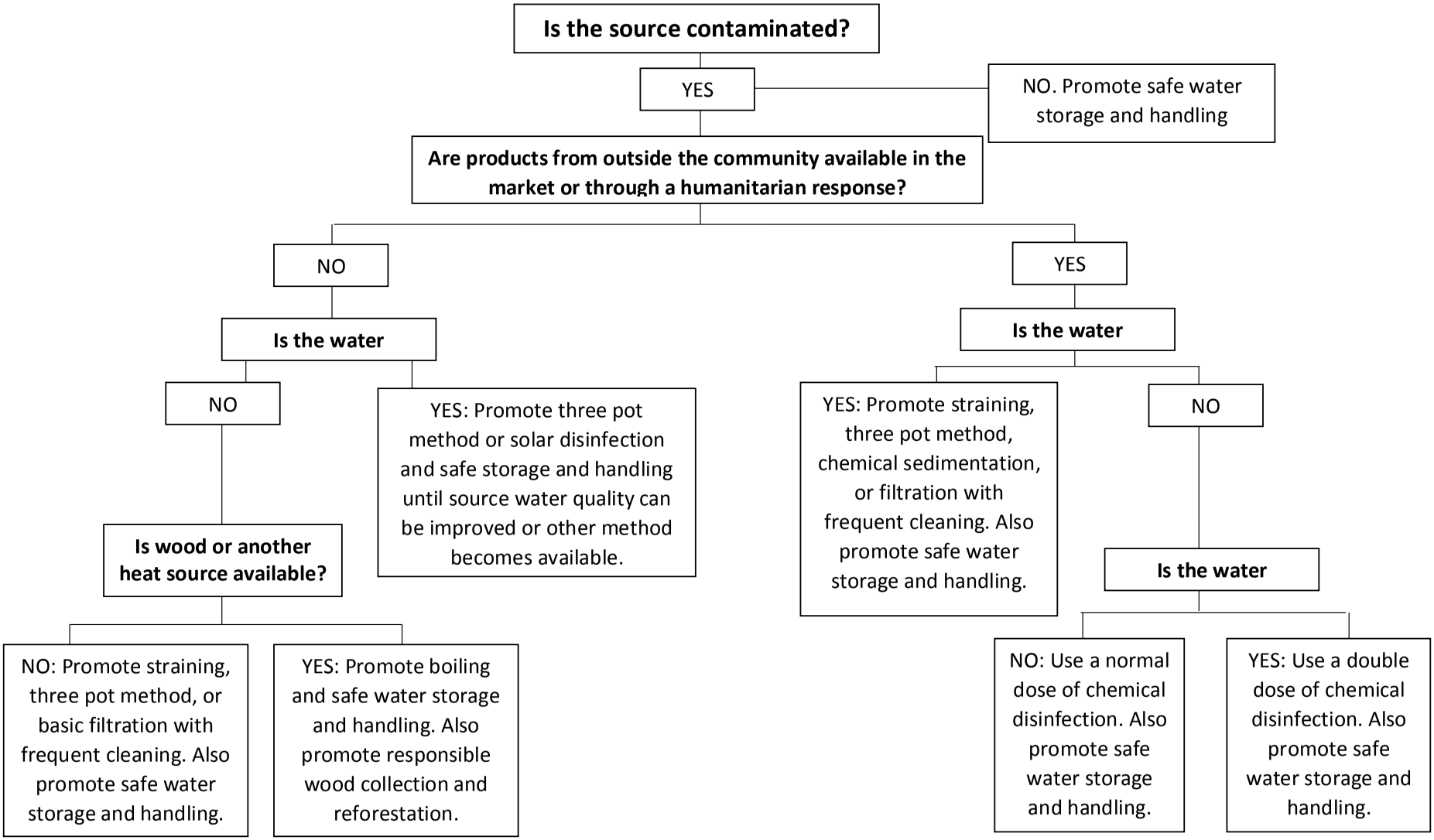
So for example, **Household slow sand filtration**,

- the reduction in protozoa is 99% to 99.99% (i.e. 0.01% to 1% protozoa remain),
- reduction in viruses is between 99% to 99.9% (i.e. 0.1% to 1% remain) and
- reduction in bacteria is between 99% to 99.99% (i.e. 0.01% to 1% remain)

The different methods outlined here are:

- **Disinfection** – making sure water is free from disease causing germs. This may be done by chemicals, heat, or even sunlight.
- **Sedimentation** – allowing dirt to fall to the bottom of a water container over time.
- **Filtration** – physically removing dirt by passing the water through a material such as ceramic or sand.

Household Water Treatment Decision Tree



Simple filtration - Straining

Straining water, if done correctly, will improve the effectiveness of all the other methods discussed in the rest of this section.

Pouring dirty water through a piece of fine, clean cotton cloth will often remove a certain amount of the suspended solids and insect larvae contained in the water. In Bangladesh, folding a cotton cloth in four and straining water through that, reduced the cholera bacilli by 90% and in the villages where this was promoted, cholera rates reduced by 50% (New York Times, 2011).

Washing the cloth between uses will make straining more effective.

Straining alone is unlikely to make water from a contaminated source completely safe to drink. But by reducing the turbidity, it makes further household water treatment more effective.

Boiling – thermal treatment

Boiling, if done properly can provide safe water for a household with no other alternatives. Boiling on a rolling, bubbling boil will kill all pathogens. At sea level 1 minute of a rolling boil is sufficient; at 2,500m, the rolling boil has to be kept going for 5 minutes.

Advantages:

- Boiling will kill all pathogens.
- Boiling water is something people can do themselves.

Disadvantages

- It takes 1kg of firewood to boil I liter of water for one minute. Boiling should not be promoted in areas where wood is scarce and no other heating options are available.
- Boiling will not reduce turbidity.
- Boiling has no residual effect, so improper storage can lead to re-contamination.
- Boiled water should be stored safely and used within a few days.

Boiling is only effective if the temperature is high enough. Water that is simply steaming has not been boiled.

Solar disinfection

Exposing water to sunlight will destroy most pathogens. This is even more effective at higher temperature (although the temperature of the water does not need to rise much above 50°C). An effective method is to put clear plastic or glass bottles of water to the sun. In tropical regions, a safe exposure period is about five hours, centered around midday. For greater effectiveness place the bottle on a corrugated-iron roof.

The amount of time the bottle is exposed to the sun will need to be doubled (two days instead of one) when the water is turbid. On cloudy days, the length of time will also need to be increased.

Advantages:

- Solar disinfection will kill most pathogens if exposed to the sun long enough.
- Solar disinfection easily done at household level with widely available materials (clear bottles or clear plastic bags).

Disadvantages

- Solar disinfection has no residual effect, so improper storage can lead to re-contamination. Water treated by this method should be stored safely and used within a few days.
- Solar disinfection takes more time than other methods and requires sunny weather.

Free Chlorine disinfection

As with bulk water treatment, chlorine will provide a residual disinfectant.

Make sure all people who receive chemicals are trained how to use them. Because of quality control concerns and the wide range of concentrations, common household chemicals such as laundry bleach should not be utilized as a chemical disinfectant unless no other options are available and careful training and monitoring is carried out.

Chemical disinfection, especially a double dose, can leave a taste that people do not like. This could cause them to stop treating water. The problem of chemical taste can be removed by using the correct amount of chemical and by shaking the water in a bottle to increase the air content.

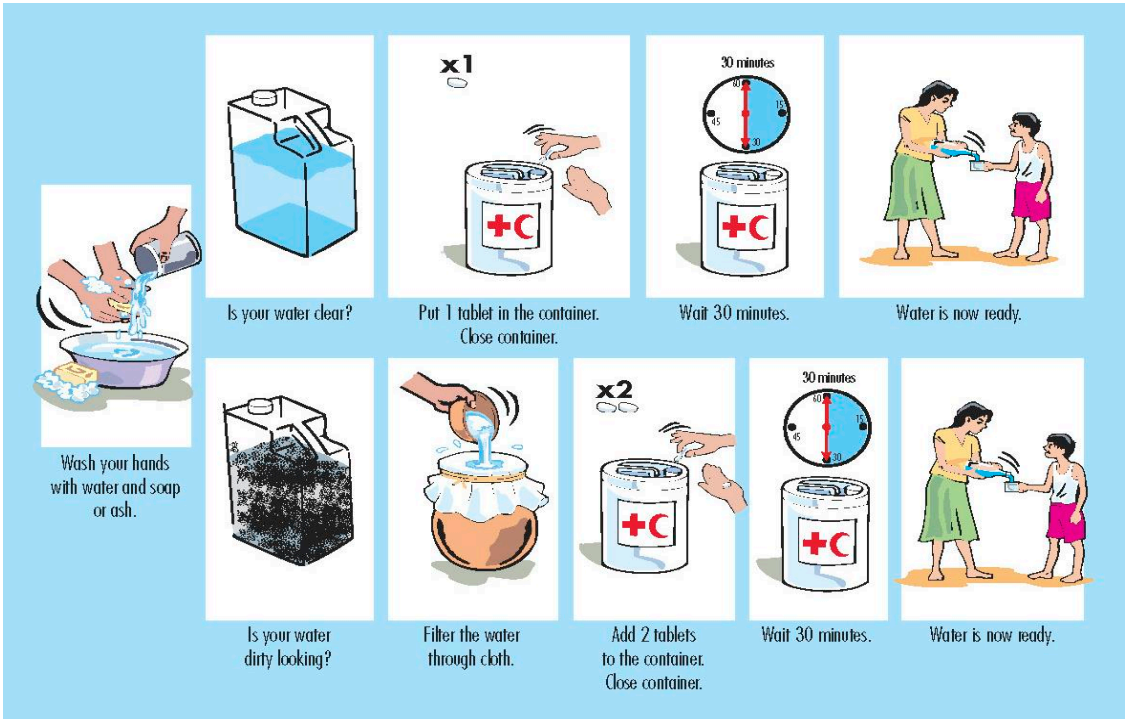
Advantages:

- These products are easy and safe to use.
- There is a residual effect of disinfection, which gives some protection against contamination after treatment.

Disadvantages:

- These products must be brought from outside the community; it is not something they can do with local resources.
- Chemical disinfection will not get rid of all germs that cause disease. Water should be strained prior to use of chemical disinfection in order to ensure all risks are eliminated.

How to treat water with chlorine tablets such as Aquatabs:



Coagulation/Disinfection

These are usually provided in sachets for treating a container of water (typically for 10 or 20 liters). They have a coagulant to produce flocs and a slow release chlorine product that will start disinfection after the flocs have settled. The actual ingredients and the processes of how they work in detail are often a commercial secret.

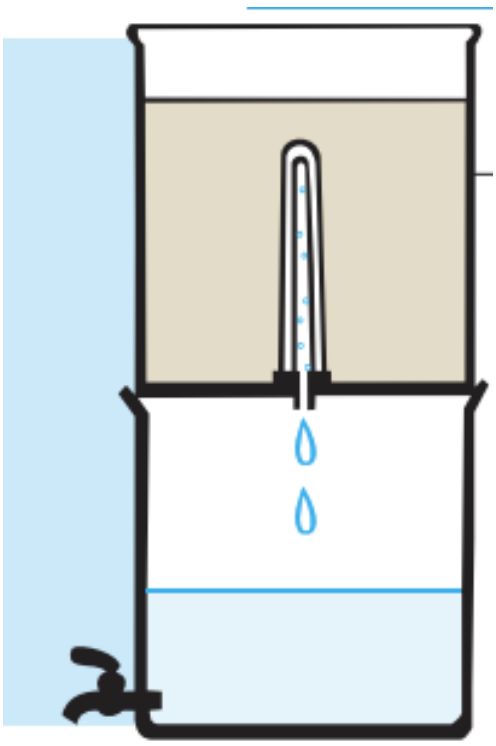
They are typically only used for turbid water as they are more expensive than chlorine tablets.

The water is stirred for 5 minutes once the product is added and then left for a further 5 minutes for the flocs to form. The water should be filtered through a cloth and then left for at least 20 minutes before drniking.

Examples of commercial water treatment sachets used in emergencies.

Candle filters

Candle filters are made of ceramic.



Water is poured into one container and slowly passes through the ceramic candle into another container.

The filter is scrubbed clean with a brush whenever it begins to be clogged and the flow rate between the containers becomes slow. If possible, the filter should also be boiled to kill germs that cause disease that are caught in the filter.

The dirtier the water is the more frequently the filter will need to be cleaned. Eventually the candle will be worn away from scrubbing and must be replaced.

Advantages:

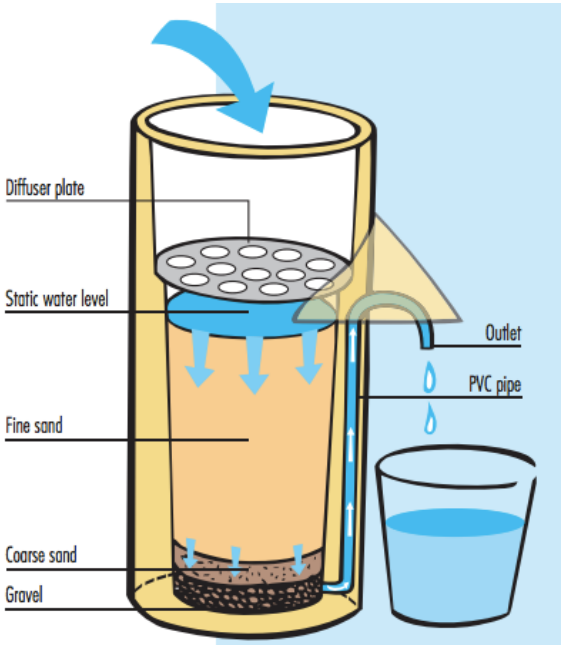
- These products are easy and safe to use.
- If properly maintained, this product can be used to produce clean water for a long time

Disadvantages:

- These products are expensive and often fragile.
- It can take a great deal of time to treat water, especially when the water is very dirty.

- There is no residual effect of disinfection, the clean water container must be covered to protect against contamination.
- These products need regular maintenance and require more training and follow up.
- If produced locally, the quality of the ceramic candle might not be good enough for effective filtration

Household Slow Sand Filter



Although not commonly used in emergencies, slow sand filters are an effective and long lasting method of household water treatment. They filter water through the sand and the biological material that grows on the top of the filter. The filter is cleaned when it becomes clogged.

Because the biological layer needs time to grow, the filter will not treat water properly when it is first put into use and after cleanings.

Although these filters are simple to use, they require hands on training when they are distributed.

Advantages:

- If properly maintained, this filter can treat water for a long time

Disadvantages

- It can take a great deal of time to treat water, especially when the water is very dirty.
- There is no residual effect of disinfection, the clean water container must be covered to protect against contamination.
- These filters need regular maintenance and require more training and follow up.

6.7.5 Household Water Storage and usage – hygiene promotion

Improvements in water quality due to household water treatment or bulk water treatment are lost if the water is not stored and used properly.

This means that the population must have access to sufficient suitable storage containers: either wide-necked containers that are easily cleaned and which should be kept covered or narrow necked containers that are less easily polluted but more difficult to clean.

It also means that people need to understand and try out new methods of treating water, especially if chemicals are involved – hygiene education is an important part of a successful household water treatment programme.

Four basic steps in hygiene promotion for household treatment and storage are:

1 **Conduct an assessment** of current hygiene practices and identify high risk practices. The table on the next page identifies key WASH practices that can be promoted in emergencies.

2 **Select target groups** for directing the specific messages and behavior changes. For example, children can be targeted about how best to collect and transport water as they are often the ones that collect the water.

3 **Develop hygiene messages** - These should focus on a few key practices: initially no more than 3 to 5 maximum. Present these in a positive light and make use of humor wherever possible, using simple locally understood words. If possible pre-test the messages with a group of similar age, educational level and culture to those the message is trying to reach.

4 **Select communication methods**: The choice of communication method depends on the nature of the audience and the resources available. In an emergency, mass media is the most commonly used method for the rapid spread of messages to the widest audience at the lowest cost.

Distribution points or water collection points are good places to disseminate messages**:** conduct different activities using popular media like drama, songs, puppets, and story-telling, etc. (they combine entertainment with practical advice) or mass media delivering through loudspeakers, posters, leaflets, notice boards, stickers, t-shirts, etc.

Messages delivered through mass media can be reinforced by face-to-face activities. These activities, like house to house visits might be conducted in parallel with the NFI distribution activities.

House to house visits offer an opportunity for the hygiene promoters to assess the domestic environment and tailor hygiene messages to the specific needs of the family.

Monitoring

For behavior change to sustain, follow up training and monitoring should be carried out after the initial training.

Hygiene promoters should be able to track changes in the community in relation to:

- People's satisfaction regarding the product selected
- Correct use of the products
- People's hygiene practices at household level in relation to water handling and storage.

Summary of Assessment of WASH practices for hygiene messaging

Water					Sanitation	Hygiene
Water source	**Water collection and transport**	**Water storage**	**Water treatment**	**Water use**	**Latrine use**	**Hand washing**
1)Water sources should be used with care and maintained in good condition. 2)There should be no risk of contamination from nearby latrines, wastewater drainage, animals, or objects falling into the well.	3)Drinking water should be collected in clean vessels, without coming into contact with hands. 4)Water should be transported in covered containers.	5)Water should be stored in clean vessels which are covered and regularly cleaned. 6)Drinking water should be stored in a separate container from other domestic water, wherever possible.	7)Water treatment procedures should be carried out at household level if the source is not clean and water is not stored properly.	8)Drinking water should be taken from the storage vessel with a dipper or ladle so that hands, cups or other objects can not contaminate water.	1)Latrines should be used instead of open defecation. 2)Latrines should be located away from water sources and be kept clean. 3)Pits need to be emptied or replaced regularly.	1)Homes should have soap and water for washing hands. 2)People should be washing their hands at critical times.

6.7.6 Water quality monitoring

If a Water Safety Plan (WSP) has been developed, then the monitoring process should come from that process (see Module 3 Water Safety Plans for more details).

Assessing the water quality when planning a water supply should be the starting point for long term water quality monitoring – see module 2 Water Source Selection for more details on the selection of water sources.

Water quality monitoring serves two purposes:

- to ensure that the quality of the water distributed to users or used by users, (depending on whether monitoring is carried out at the water point or at household level), is safe;
- to adjust water treatment processes for effective treatment as the water quality changes (due to increased turbidity during the rainy season for example) or as there is a change in the requirements for water quality (such as an increased chlorine residual during a diarrheal outbreak).

Tests for long term water supplies

Test the water comprehensively at a laboratory for the chemical and microbiological parameters listed below if the water is going to be used beyond 6 months to a year.

Refer to the Sudanese Drinking Water Quality Standards, 2016 for the maximum permissible levels.

More details on microbiological quality (testing for fecal coliforms) can be found in Annex 6.21.

Daily monitoring of treated supplies

If the water is being chlorinated then daily test for free residual chlorine in the taps, and monthly testing in representatively sampled households of stored water (see Annex 6.21 for testing details). Adjust the amount of chlorine used to treat the water according to the daily tests at taps. The amount of chlorine will need to be adjusted to allow for 0.2 mg/l at the household after 24 hours; and hence 0.5 – 1.0 mg/l at any point of distribution (tapstand, from a tanker or donkey cart) – both before and during an outbreak[5].

[5] During the process to develop the Sudan Drinking Water Safety Strategic Framework, 2017 it was agreed[5] to: 1) Maintain a free chlorine residual of 0.2 mg/l at the household level after 24 hours; 2) Increase the chlorine residual to leave at least 0.5-1.0 mg/l residual at public standposts in any hot climate condition, irrespective of outbreak or normal conditions, and to monitor the effects along the water chain to check: a) residuals in households, as well as checking b) the community acceptance of the chlorine taste/rejection levels; and then to adjust accordingly. This update in level for FRC at distribution points is to take into account the hot climate and the high risk of contamination in Sudan from issues such as open defecation and old piped networks with intermittent supply. The changes have been based on recent learning from research in South Sudan and elsewhere. The recommendation has been discussed with WHO Geneva and it has been agreed that the increased levels are in alignment with the principles of the WHO Guidelines for DWQ 2017 with the main priority for chlorination to have a residual of 0.2 mg/l in the household.

If pre-treatment is required to reduce turbidity (and possibly change pH) of the water to ensure effective chlorination, then the raw water will have to be tested daily for these turbidity and pH to ensure the correct dosage. Jar tests will need to be carried out for determining the amount of chemical needed for pre-treatment and for chlorination (See Annex 6.19 for details).

It is important to also verify the piped water supply does not have fecal contamination and so microbiological testing is required according to the table from WHO below.

Monitoring of non-treated small scale water supplies

Initially, carry out a sanitary survey or sanitary investigation to identify pollution risks and carry out field-testing of the microbiological quality of the water.

Carry out regular field-testing of the microbiological water quality according to the table below for point sources, depending on risk analysis.

Refer to the recommended schedule for sanitary surveys and water quality testing sampling for both the drinking water supplier and the surveillance agency, that is included in the Annexes of the Sudan Drinking Water Safety Strategic Framework (SDWSSF) (final draft 2017).