Malteser International
Order of Malta Worldwide Relief

WASH Guidelines for field practitioners

PART 1: Water

Imprint

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Foreword

Malteser International is the relief agency of the Sovereign Order of Malta for humanitarian aid. With over 100 projects annually in some 25 countries throughout Africa, Asia and the Americas, we provide emergency relief after disasters and support rehabilitation efforts with a focus on sustainable development.

WASH (Water, Sanitation and Hygiene) is a key area for which Malteser International supports long-term and future-oriented development by combining short-term relief measures with a holistic and sustainable approach whenever possible.

The WASH Guidelines for field practitioners have been prepared to provide a high-quality resource for our staff members and partners, so that they can implement WASH projects according to the latest recognized standards. Part 1 covers the water sector, whereas part 2 and 3 deal with sanitation and hygiene respectively.

About 670 million[1] people (9% of the world population) are expected to still lack access to improved drinking water resources in 2015; many of them living in Malteser International intervention countries.

Malteser International is therefore actively engaged in providing safe drinking water to communities it works with, and the WASH Guidelines; part 1: Water have been developed to provide guidance for its projects that develop such access to safe drinking water systems and services.

I authorize the use of the WASH Guidelines for Field practitioners, part 1: Water, for application in Malteser International programs worldwide.

Ingo Radtke
Secretary General
Malteser International

1 UNICEF/WHO: Joint Monitoring Programme: Progress on Water and Sanitation, 2010 updates, p9.

This source is located close to the health center of Otha, near Mahagi in the eastern part of the Democratic Republic of Congo (DRC). It was upgraded through a project on "WASH measures in the health centers of the Health District of Aru." The pictures show the situation before and after the rehabilitation work. A 'Source Management Committee' has been formed to take care of the operational and maintenance aspects of this source.

Section 1: Introduction

The Millennium Development Goals (MDG) for access to safe water (Target 7.C), aiming at halving the proportion of the population without sustainable access to safe drinking water, is expected to be exceeded. Nevertheless about 670 million people (9 % of world population) will still lack access to improved drinking water resources in 2015, compared to 23%[2] in 1990.
Over 40%[3] of all people without improved drinking water live in sub-Saharan Africa.

These figures show that there is an urgent need to scale up interventions aiming at providing safe drinking water to those that are still missing out of these services. 84%[4] of the world population without an improved drinking water source live in rural areas. It is for this reason that Malteser International focusses its WASH interventions in the rural context.

Starting point of interventions should always be the existing capacities of the communities that Malteser International and its partners are working with. Activities initiated and undertaken by the communities themselves tend to be more sustainable then actions that largely depend on outside assistance. The innovative "self-help approach" mentioned in these guidelines is based on this principle.

This document provides an overview of the various water provision and treatment techniques and gives guidance on how to select options appropriate for the specific local context. Key is to always involve communities in all steps of the planning and implementation process, and to have a long-term perspective on how facilities will be used sustainably in the future, using technologies and approaches that are appropriate for the local context.

2 Progress on Water and Sanitation, 2010 update, UNICEF and WHO, p9
3 [http://www.un.org/millenniumgoals/environ.shtml] Accessed June 25 2014.
4 Progress on Water and Sanitation, 2010 update, UNICEF and WHO, p19

Particularly in the rural context, it is often not possible to easily expand the provision of safe drinking water to all communities that are not served yet. Many rural communities live scattered in remote areas or simply do not have safe sources nearby their dwellings, which makes the process of expanding access to safe drinking water time consuming and expensive. These communities often still depend on unsafe drinking water sources, which makes promotion of Household Water Treatment and safe Storage (HWTS) essential to assure access to safe drinking water.

These guidelines deal with the provision part of safe drinking water at community level, as well as actions that individual households can undertake at their own level to assure their access to safe drinking water. Development of these two components should go hand in hand to assure comprehensive water supply services within the target communities.

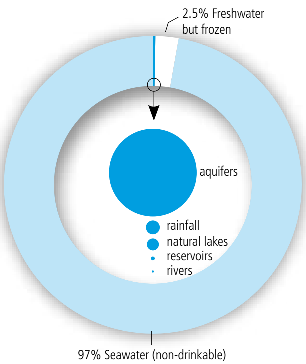
Access to safe drinking water should be an integrated aspect of the wider WASH (Water Sanitation Hygiene) context, and always be implemented keeping the sanitation and hygiene considerations in mind that are dealt with in part 2 and 3 of the Malteser International WASH Guidelines for Field Practitioners.

For the sustainability and continued functionality of any drinking water system, it is essential that "software" components, including awareness on the need for safe drinking water and proper set up for operation and maintenance, should precede "hardware" interventions in which systems are constructed.

Water supply project community meeting, Vietnam

Section 2: Global availability of fresh water

Human beings depend on the access to sufficient quantities of fresh water for their survival. However, as the figure[5] shows, about 97% of water globally is salty, and therefore not suitable for the majority of human uses.



The figure further illustrates that roughly 2.5% is fresh water captured in permanent ice or snow or in deep groundwater aquifers and only the remaining 0.5% is more or less easily accessible in form of lakes, rivers or shallow groundwater basins[6]. What is more, freshwater is distributed very unevenly over the world: Fewer than 10 countries possess 60% of the world's available freshwater supply[7] and only 80% of the world's population is served by renewable and accessible water. Moreover, a fifth of the world population relies on ancient aquifers (groundwater sources that are not renewed any more presently), interbasin transfers (complex and environment-damaging systems of canals, pipes etc. to lead water from one basin to another) or on expensively desalinated seawater[8].

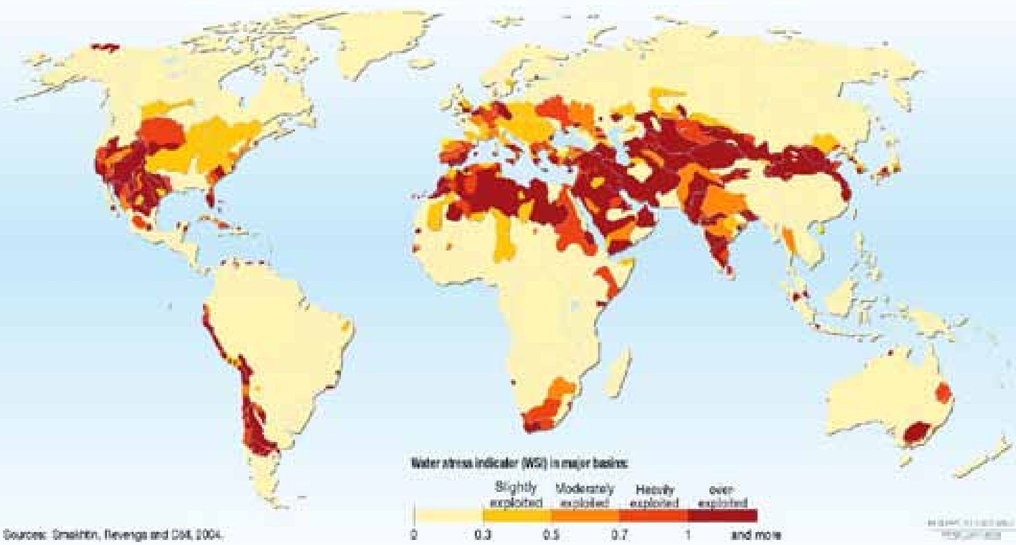
Water resources are under increasing pressure. Population growth, urbanization and a steep increase in water consumption for domestic uses, agriculture, livestock and industry have significantly heightened water consumption. Climate change further exacerbates the problem. This development can lead to water scarcity and

5 WBCSD (2009): Facts and Trends. Water (Version 2). Geneva: World Business Council for Sustainable Development (WBDSC)
6 INFORESOURCES Focus 2006; [http://www.unep.org/geo/GEO3/english/pdfs/chapter2-5_Freshwater.pdf] Accessed June 25 2014.
7 WBCSD 2009
8 Marco Bruni; Seecon International Group, The Water Cycle

possibly even future conflicts as water sources are widely shared among different nations, regions and ethnic groups[9].

At the occasion of World Water Day 2013, the UN presented a fact sheet[10] which highlighted water scarcity as one of the main problems faced by many societies in the 21st century. Other major findings include:

- Water use has been growing at more than twice the rate of population increase in the last century
- By 2025, 1.800 million people will be living in countries or regions with absolute water scarcity and two thirds of the world population could be under stress conditions
- Increase in water withdrawals by 2025 is expected to be 50% in developing countries and 18% in developed countries
- Although there is no global water scarcity as such, an increasing number of regions are chronically short of water as the map below illustrates.



9 [http://www.unep.org/geo/GEO3/english/pdfs/chapter2-5_Freshwater.pdf] Accessed June 25 2014.
10 [http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/water_scarcity.pdf]

Water scarcity is both a natural and a human-made phenomenon. There is actually enough freshwater on the planet for seven billion people – roughly today's world population – but it is distributed unevenly and too much of it is wasted, polluted and unsustainably managed.

Promotion of water supply systems that do not deplete groundwater sources, and proper maintenance and management of distribution networks are some of the actions covered in these guidelines that aim at contributing to responsible management of scarce fresh water resources.

The map also shows that all continents in the world as well as both developed and developing countries are affected by scarcity and already exploited water sources. Coping mechanisms however vary and developing countries are more vulnerable, especially towards the consequences of water scarcity such as the spread of water-related diseases, food crises and natural hazards. This raises attention to access to water for the most marginalized, and the need for a legal framework to assure the right to water as the most critical factor for future developments.

Water is a precious commodity in drought-prone Ileret, North Kenya

VIOLENCE GENDER & WASH

A PRACTITIONER'S TOOLKIT

Making water, sanitation and hygiene safer through improved programming and services

The Violence, Gender and WASH Toolkit, of which Malteser International is co-publisher, was launched on June 9th, 2014. The toolkit can be accessed through this link: http://violence-wash.lboro.ac.uk/

Although the lack of access to appropriate sanitation, hygiene and water services is not the root cause of violence, it can lead to increased vulnerabilities to violence of varying forms, with incidences reported from a wide range of contexts.

The toolkit is designed to help practitioners to better recognize the risks of violence linked to water, sanitation and hygiene (WASH) and provide guidance on what WASH practitioners can do to reduce these vulnerabilities to violence.

It brings together evidence, best practice, tools and policy responses to help make WASH safer and more effective – particularly for women and girls and people from marginalized groups.

Access to drinking water in Punjab, Pakistan
JORGE SCHOLZ

Section 3: Water-related global development frameworks

3.1 Right to water

On 30th September 2010 the UN Human Rights Council, responsible for mainstreaming human rights within the UN system, adopted by consensus a resolution[11] affirming that water and sanitation are human rights. This means that for the UN, the right to water and sanitation is now included in existing human rights treaties and therefore legally binding.

The resolution recognizes that water is not a charitable act but a human right that is equal to all other human rights, thus making it enforceable and placing the primary responsibility upon governments to ensure that people can enjoy "sufficient, safe, accessible and affordable water, without discrimination" (cf. General Comment 15). Governments are expected to take reasonable steps to avoid contaminated water supplies, provide the necessary infrastructure for clean water and closely monitor that all citizens have access to water and sanitation.

For this purpose, a "Special Rapporteur on the human right to safe drinking water and sanitation" has been appointed in order to elaborate recommendations to governments and other stakeholders on how the right to water can be guaranteed. A second duty of the Rapporteur is to provide more insight into the topic and as a result WASH practitioners can access several useful reports for their project planning and implementation such as "On the right track: Good practices in realizing the rights to water and sanitation" or the "Fact sheet on the Right to Water"[12].

What is more, illustrating the relevance of the declaration's adoption for Malteser International's project interventions, the resolution refers to many of the topics discussed later in these guidelines such as:

[11] Resolution A/HRC/15/L.14
[12] [http://www.ohchr.org/EN/Issues/WaterAndSanitation/SRWater/Pages/SRWaterIndex.aspx]

- Without access to water, other human rights cannot be exercised and water is inextricably linked to other basic rights, especially health (see chapter on the link of WASH and health).
- Water needs to be available and affordable for all, taking into account the needs of population groups such as people with disabilities, women, children and the elderly (see chapter on cross-cutting issues).
- Water and sanitation infrastructure needs to be easily accessible, promoting that facilities should be within close proximity to schools, hospitals, refugee camps etc. (see chapter on schools and social infrastructure).

Through the resolution, this important dimension of access to water and sanitation has been picked up by the global WASH community while mapping out the post 2015 focus areas for WASH as further developed below.

3.2 Millennium Development Goals and post 2015 WASH Development agenda

It is needless to say that water is key to the achievement of all eight Millennium Development Goals (MDGs). However, especially Goal 7, Target 7C *Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation* integrates water into the MDG framework. To measure the progress with regards to this specific target, UNICEF and WHO have developed the Joint Monitoring Programme (JMP) for Water Supply and Sanitation. As stated by the UN[13], this target has been met already five years ahead of schedule. The latest JMP progress report[14] from 2013 highlights some of the related achievements:

- Between 1990 and 2011, more than 2.1 billion people – over 240,000 a day – gained access to improved drinking water sources.
- The proportion of people using an improved water source rose from 76% in 1990 to 89% by the end of 2011. Moreover, 55% of the world population had a piped supply on premises.

13 [http://www.un.org/millenniumgoals/environ.shtml; http://www.who.int/topics/millennium_development_goals/mdg7/en/]

14 [http://www.wssinfo.org/fileadmin/user_upload/resources/JMPreport2013.pdf] Accessed on June 25, 2014.

However, shortcomings remain:

- Huge total numbers: In 2011, 768 million people still remained without access to an improved source of drinking water.
- Regional divide: Over 40% of all people without improved drinking water live in sub-Saharan Africa
- Rural-urban gap: Urban dwellers make up three-quarters of those with access to piped water supplies at home. On the other hand, rural communities comprise 84% of the global population without access to improved drinking water source
- Sanitation targets not met: Despite progress, 2.5 billion people in developing countries – one third of the population – will still lack access to improved sanitation facilities in 2015. The MDG target of halving the proportion of the 1990 population without sanitation will be missed by approximately 8% – or half a billion people. Moreover, 15% of the world population continues to defecate in the open.

To tackle these shortcomings, access to safe drinking water, sanitation and hygiene will be prominently featured in the post-2015 development agenda. For this purpose, the JMP has created the five working groups Water Supply, Sanitation, Hygiene, Equity and Non-Discrimination (END) as well as Communications and Advocacy.

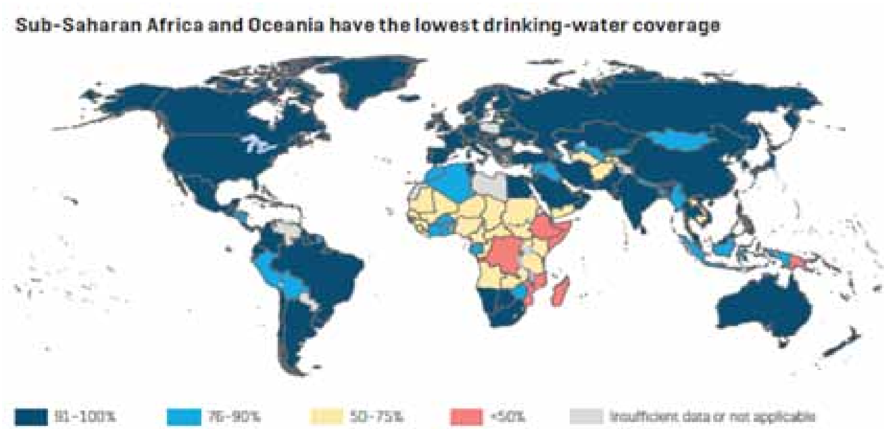


Figure 6. Proportion of the population using improved sources of drinking-water in 2011.

In the two consultation meetings conducted so far, these working groups have proposed the following initial four targets that go beyond 2015:

Target	Expected year of achievement
No one practices open defecation, and inequalities in the practice of open defecation have been progressively eliminated.	2025
All schools and health care facilities provide all users with basic drinking water supply & adequate sanitation, hand washing facilities and menstrual hygiene facilities Everyone uses basic drinking water supply and adequate hand washing facilities when at home and inequalities in the access to each of these services have been progressively eliminated	2030
Everyone uses adequate sanitation when at home The proportion of the population not using intermediate drinking water supply at home is reduced by half The excreta from at least half of schools, health centers and households with adequate sanitation are safely managed Inequalities in access to each of these services have been progressively eliminated or reduced	2040
All drinking water, sanitation and hygiene services are delivered in a progressively affordable, accountable, financially and environmentally sustainable manner	Throughout

For each target, supporting indicators have been identified. These can be found in UNICEF's "Fact Sheet on Post-2015 WASH Targets and Indicators"[15]. Although the above information is still in draft form, it gives an indication on the direction that future water supply interventions will focus on and which should be crucially considered in Malteser International's projects' planning, implementation and monitoring stages. Similarly, the report "World We Want 2015 Water Thematic Consultation"[16] facilitated under the umbrella of UN-Water, gives an idea on future considerations.

15 [http://www.unicef.org/wash/files/4_WSSCC_JMP_Fact_Sheets_4_UK_LoRes.pdf]
16 [http://www.unwater.org/downloads/Final9Aug2013_WATER_THEMATIC_CONSULTATION_REPORT.pdf]

Section 4: Water sources[17] and their development

There are three types of water sources; surface water, rainwater and groundwater.

4.1 Surface water

All water which rests on the surface of the earth is considered as surface water. In our context this are ponds, streams, lakes, etc where water is withdrawn from for drinking and domestic purpose. Such surface water sources, like ponds and streams, are often easily accessible but not always the preferred option mainly due to their high risk of contamination and high level of turbidity (particularly during rainy season). They often have a multi-use purpose with agriculture and livestock requirements competing, and often conflicting with the needs for safe water supply. Such multi-use requirements should be managed right from the design phase of a project onward, including all stakeholders in the process. This will be discussed more in detail in chapter 14 under the section on Multi-Use Services (MUS).

While developing drinking water facilities with surface water as source, it is crucial to address the need for water treatment simultaneously. This can be done at community level, through slow sand filters for instance, or by promoting Household Water Treatment and safe Storage (HWTS). In regard to this, it should be noted that community water treatment facilities require an already raised level of hygiene awareness of the community and a commitment to get involved in operational and maintenance aspects.

In order to keep the ponds as clean as possible, it is essential to avoid that people fetching water get in contact with the pond water. So called "stealing wells" as developed in Myanmar

[17] WEDC, Technical Note 55, Water source selection

divert water from the pond to a nearby well from which water can be safely extracted. Handpumps are another options, if the maintenance aspect is properly addressed.

Surface water sources like ponds are a preferable way to access drinking water for many communities in South East Asia. Malteser International has developed community ponds in Myanmar and Cambodia, and with the necessary care and maintenance, these ponds provide a reasonable quality of water, which needs to be monitored closely, and combined with HWTS interventions. WEDC has developed a Technical Briefing note[18] on how to protect and develop ponds for drinking water purpose.

It is clear that surface water is easy to access, but also easily contaminated. It typically also gets impacted by seasonal variations in turbidity (muddiness) and flow. The quality of surface water is usually poor, and normally needs treatment before it can be supplied as safe drinking water, which will be discussed in chapter 7 under section “C”.

4.1.1 Ponds

Water ponds are a common technique in countries like Myanmar and Cambodia to store rainwater used for different purposes, e.g. for drinking water, livestock, fire fighting, and irrigation. In some villages, ponds serve multi-purpose functions, however it is preferred if a pond is used exclusively for drinking water.

Ponds are filled with rainwater during the rainy season to store water that can be extracted throughout the year. In areas with a high yearly rainfall, direct rainfall is sufficient to fill the pond. In dry areas a larger catchment area is needed. Here the pond is usually supplied through an inlet stream collecting rainwater of the surrounding area. Ponds with direct rain catchment are preferred for utilization for drinking water purposes. In the aftermath of cyclone Nargis in 2008, the Myanmar WASH cluster developed guidelines[19] on how to rehabilitate ponds after seawater intrusion.

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18 WEDC (Water, Engineering Development Centre), Technical Brief No. 47, Improving pond water

19 WASH Cluster Myanmar, Technical group, Rehabilitation RWH and ponds, 2008

Adequate environmental hygiene measures are required around the pond to keep it safe for drinking water purpose, as described in the Malteser International WASH Guidelines for Field Practitioners; Part 3 Hygiene, page 21.

The application of life fences around ponds is an example of a sustainable practice that will help to keep the pond clean.

Ponds differ in size, shape and construction. Bottom and embankment of most ponds are built with clay, forming a watertight layer. A dam separates the pond from the surrounding area to protect it from external influences such as surface water runoff or contamination by animals.

The Malteser International Myanmar program has developed a document[20] describing the methodology to rehabilitate ponds for drinking water purpose.

Together with the villagers, ponds are fenced to avoid contamination by animals. Photo

VALERIA TURRISI

[20] Malteser International Myanmar Country Office, Yangon, Methodology for rehabilitation of drinking water ponds

Pond water extraction options comparative chart

Option	Advantage	Disadvantage	Remarks
Stealing well	No direct contact with pond water while collecting	No natural filtration	
Embankment well	Filtration process provides safer water	Risk of clogging embank-ment filter material with low flow rate	
Handpump	Convenient extraction of water	Maintenance issues	
Motor pump	Convenient extraction of water Possible to link to overhead tank with distribution sys-tem	Maintenance issues Expensive operations	
Buckets	cheap	Higher contamination risk Dangerous for children	Jetty required

4.1.2 Rivers and lakes[21]

Water can be abstracted from surface water sources like rivers and lakes.

Flow diversion

Water can be pumped or diverted directly from the lake or main stream into a side channel or pipe. Caution should be taken of the fact that the intake may dry or flood as water levels vary.

River/lake side wells

If the permeability of the embankment soil is sufficient, filtered surface water can be collected from a well adjacent to the source. The wells should be sited above the river flood level, and at least 20 m, or more, from the river/lake bank to give sufficient time for the natural purification of the water through the soil to happen. This will also protect the well from bank side erosion.

[21] Adapted from; Engineering in Emergencies, Davis et al, Rugby, 2002, p 214

Infiltration galleries/wells

These are constructions to tap a supply of water from a river where the banks are made of porous gravels or sands. The gallery is made close to and parallel with the river. The intake works consist of pipes placed in a trench or sinking well in the porous banks, where the water can be pumped from.

The quality of surface water collected from rivers, lakes and ponds is usually poor and normally needs treatment before it can be supplied as drinking water. Treatment options are discussed in chapter 7.

4.2 Rainwater

4.2.1 General

The most common way in which rainwater can be used to support drinking water purposes is by collecting it from roofs of individual houses or public buildings like schools or health posts to be stored in nearby tanks. Roofs made of solid materials give the best results, but water could also be collected from ground surface level to underground tanks if the local housing is not suitable to collect water or if a larger catchment area is required in areas with limited rainfall.

The rain water collection can be introduced as main water supply option for the communities who do not have access to any other water sources such as villages located in coastal area and top of the mountains. Also it can be used as alternative option for the communities who do not have continued water supply throughout the year from existing water sources. Further rain water collection could be introduced in urban areas for domestic use in order to save safe drinking water provided through public water supply network.

The suitability of rainwater to satisfy drinking water needs depends very much on the annual rainfall pattern. In countries like Nepal, main rainfall is concentrated in a relatively short period of 3 months (mid June to September), whereas in countries like Sri Lanka, rainfall is more distributed over several periods in the year with higher occurrence of rainfall. If one is to assure its year round drinking water needs with rainwater in a country like Nepal, relatively big storage tanks would be required compared to what is the case in Sri Lanka.

Storage tanks can be made either above or below ground level. In case of underground tanks, these are relatively cheaper to construct and can be easier made bigger in seize than tanks above ground level. The main disadvantage of underground tanks is that they require some kind of pumping device to extract water. Ferro cement has proven to be a very appropriate building method to construct Rainwater Harvesting (RWH) tanks. Malteser International has implemented such tanks in several of its programs. The Myanmar program has developed a document on the “Methodology for rainwater collection systems”, which can serve as a useful guideline for the development of rainwater harvesting systems.

Whatever the system is that is selected, proper operational and maintenance procedures are essential for a sustained safe use of rainwater fed water provision facilities. It is also required to combine the use of this drinking water source with HWTS to assure access to safe drinking water

The acceptance of rainwater as a source of drinking water is different from country to country. In some cases, rainwater is only used for domestic purposes, like laundry. Rainwater is often better accepted in those communities where there are only few alternatives, and where communities traditionally depend on this source for their drinking water requirements. In some cases, RWH has a lower status than piped water systems, and communities are less interested to develop and maintain them. Others do not like the taste of rainwater.

In any case, RWH is an excellent method to increase the amount of water available in a community. In case water is not consumed for drinking purpose, it still can play an important contribution towards better hygiene standards as more water will be available to maintain a higher level of personal and domestic hygiene.

The effectiveness of the rainwater catchment system very much depends on the runoff coefficient of the material used for the catchment area, as can be seen in the table[22] below;

Runoff coefficients for various catchment surface materials:

	Material	Runoff coefficient
Roof catchments	Sheet material	0.8-0.85
	Cement tile	0.62 – 0.69
	Clay tile (machine-made)	0.30 – 0,39
	Clay tile (hand-made)	0.24 – 0.31
Ground catchments	Concrete-lined	0.73 – 0.76
	Cement soil mix	0.33 – 0.42
	Buried plastic sheet	0.28 – 0.36
	Compacted loess soil	0.13 – 0.19

The potential rainwater supply from a certain runoff area can then be calculated as follows[23];

S = R x A x Cr

Supply (in m^3) = Rainfall (in m per annum) x Catchment Area (in m^2) x Runoff Coefficient

4.2.2 Roof catchment[24]

Roofs are the most common type of catchment used for harvesting rainfall. Galvanized, corrugated-iron sheets and tiles are adequate roof catchment surfaces. Thatched roofs can make good catchments when certain palms (dependent on local availability) are tightly thatched. This should be well checked on forehand as most palms and almost all grasses do not produce thatch suitable for high-quality rainwater collection as they discolour the water. So, grass-thatched roofs should only be used when other options are not available. In case of use of painted roofs for rainwater catchment, it should be verified that the paint

[22] John Gould et al., Rainwater catchment systems for domestic supply, Rugby, 2008, p 53
[23] Adapted from; John Gould et al., Rainwater catchment systems for domestic supply, Rugby, 2008, p 51
[24] Adapted from; John Gould et al., Rainwater catchment systems for domestic supply, Rugby, 2008, p 23

used is not toxic.

A single sloped roof will save on the cost of guttering since less material will be used. Low-income households with roofs that are unsuitable for RWH could therefore consider to change only one single side of their roof with GI roofing sheets or tiles first to make it suitable for rainwater harvesting. The other side of the roof could then be changed later when the household has saved sufficient means for it.

It is important that gutters are fitted properly with a constant gentle slope to lead water to the tank and prevent blockages. Metal and PVC gutters are most durable, but wood and bamboo may provide cheaper alternatives.

If a building has already a proper impervious roof, this can serve as catchment area with very limited additional costs to complete the rainwater catchment system. Moreover, using the roof as a catchment area also means that the water will be available at the point of use.

A typical roof catchment system consists of three basic sub-systems;

- Catchment area (roof)
- Delivery system (gutters and downpipes)
- Storage system (tank)

The roof area of catchment should be increased in case of low rainfall figures.

A “first flush” mechanism should be included to exclude debris from entering the storage tank. The purpose of the “first flush” is to divert the first few minutes of rainfall away from the tank to avoid that contamination collected from the roof is entering.

A “floating out-let” can be used to get the water from middle of the tank in order to avoid getting sediments.

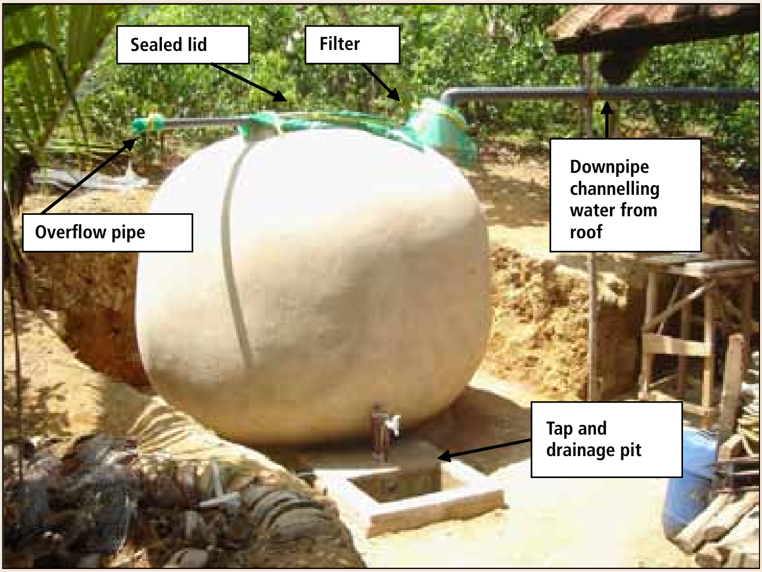
4.2.3 Ground catchment[25]

Ground catchment systems use the ground surface as a rainwater catchment area. Such surfaces can be natural, treated or covered. Ground catchment systems are cheaper than roof catchments and are normally used where suitable roof surfaces

[25] Adapted from; John Gould et al, Rainwater catchment systems for domestic supply, Rugby, 2008, p 25

A basic roof catchment RWH system with tank above ground level is described below in an example from Malteser International in Sri Lanka:

The RWH system consists of a 5m³ ferrocement tank that stores rainwater collected from the roof catchment. Debris, dust, droppings and dirt washed from the roof during the first rainfall can reduce the quality of water if collected in the tank. A means of diverting this 'first flush' is therefore necessary. PVC guttering along the side of the roof channels water towards a downpipe with a removable plug at its base. The plug is inserted after about 15 minutes of rainfall, allowing 'clean' rainwater to then pass through to the tank via a bucket of filter media to remove any remaining particles (see figure below).



are not available. The main advantage of systems that use the ground as a catchment surface is that water can easily be collected from a larger area, which makes this approach suitable for areas with low rainfall. The main disadvantage of using the ground as a collecting surface is that the water supply can easily become contaminated. Also, as the water can only be stored under ground level, it is less convenient to withdraw it for use. In case ground water catchment systems are used for drinking water purpose, it is strongly recommended to treat the water to make it safe to drink. To avoid accidental drowning of children or cattle, underground tanks should be properly covered. To avoid contamination, the catchment area should be fenced off. Depending on the means available, the surface area should be made less pervious to make water catchment more effective.

Malteser international has supported ground catchment systems built by its partner agency UNNATI in India.

Annex 1 shows the working method applied to construct such ground catchment tanks.

Rainwater harvesting in underground tanks, Rajasthan, India
CARMEN WOLF

4.2.4 Storage reservoirs[26]

<u>General</u>

Water storage capacity is required to balance out the differences between rainwater supply and users' demand.

The tank seize is therefore dependent on the rainfall pattern and the number of users. Areas with seasonal rainfall will require larger tanks to cover the water demand in long dry seasons.

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[26] John Gould et al, Rainwater catchment systems for domestic supply, Rugby, 2008, p33

While deciding on the required tank seize, it is important to consider if rainwater is the main source of supply that the users are depending on or a secondary source that can be allowed to be disrupted for some time.

Rainwater storage reservoirs can be subdivided into three categories;

- Surface or above ground tanks:

These are commonly used in combination with roof catchment systems, which have an elevated catchment area. Based on local practices, tanks can be made of ferro-cement, bricks, rubble-stone blocks, plastic or other materials. Water can easily be extracted from a tap placed above the base level of the tank. The main disadvantage of surface tanks is that they are relatively expensive compared to under-ground tanks.

- Sub-surface or underground tanks:

These tanks are normally constructed in combination with ground catchment systems. Several of the techniques mentioned above for surface tanks can also be used for under-ground tanks if constructed in excavations with the soil being back-filled around the outside of the tank after completion. If the soil is firm, the walls of the tank do not be made as strong as is the case for the surface tanks. For ferrocement tanks, the excavated hole can be lined with chicken wire and reinforcement and directly plastered on, which will safe costs. The groundwater level should be taken into consideration to avoid upward pressure when the tank is empty, which might lift the tank out of its position. Main disadvantage of the underground tank is that a pump is needed to extract the water.

Ferrocement tank under construction for school in Myanmar

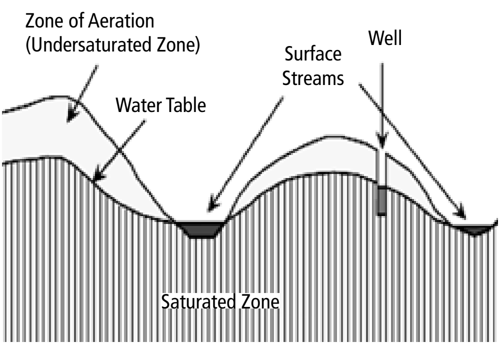
Rain water harvesting sanitary check list (as used by Malteser International program in Sri Lanka)

1.	There is no road or industry nearby?
2.	There are no objects such as tyres, sand bags or nests for animals visible on the roof?
3.	There are no signs of dirt or debris on the roof?
4.	There are no access routes for animals such as overhanging trees or branches?
5.	The guttering that collects water is clear, unblocked and not broken?
6.	Do you operate the 1st flush at the commencement of rain?
7.	The 1st flush does not contain water?
8.	The filter does not overflow when it rains?
9.	The tank walls are not cracked or damaged?
10.	Is the rain water tank closed ?
11.	Are there no entry points for insect or animal?
12.	Is the tank clean inside?
13.	Is the tap is not leaking or damaged?
14.	There is no pooling or stagnating water around the tank collection area?

4.3 Groundwater

4.3.1. General

Some surface water sinks into the ground and then becomes groundwater and can stay for a long time in an aquifer (relatively permeable deposit which contains and transmits groundwater which can be tapped by a well).



Groundwater is sub-surface water that can be found in the saturated zone (see diagrams below).

Groundwater has a number of advantages over surface water for supply[27];

[27] Ken Nelson, Dictionary of Water Engineering, ITDG Publishing, Warwickshire, 2005, p148

- Better bacteriological and chemical quality
- Greater scope for well siting
- Lower cost of schemes

Without clear local evidence from nearby existing wells, good water resource surveys or preliminary test-drilling, there is no assurance that new wells or boreholes will yield the necessary amount of water of the right quality[28].

In case of expensive (deep borehole) drilling work, it is recommended to undertake a hydrogeological survey before starting the work

There is a higher possibility of contaminating ground water from latrines pits, community and industrial waste dumping sites. Therefore it is very important to undertake water testing to assure safety of water according to local and international standards.

Ground water can be extracted in the following ways;

4.3.2 Shallow dug wells

Shallow dug wells are commonly used in Malteser International target areas as a means to extract ground water. They typically are dug manually using simple tools.

Safety is often a concern, as well shafts occasionally collapse while workers are inside. Malteser International should address these safety concerns while engaging local contractors in well digging activities.

Shallow wells should be developed at the end of the dry season, when the ground water level is at its lowest. Bottom of the well should preferably be dug up to three meter below this dry season ground water level to assure year round supply from the well. Seasonal yield fluctuation should be taken into consideration.

A safe way to construct shallow dug wells is to use concrete rings which are sunk down while digging underneath. Once one ring is sunk, the next one is put on top.

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[28] UNHCR Water manual,D. Mora Castro, Geneva, 1992

Wells should be covered and provided with a lifting device, like a handpump. For larger supplies, diesel, petrol, solar, or wind driven pumps could be considered.

Practical guide on measuring yield from wells[29]

Requirements:

- Distance measuring instrument (laser or meter)
- Stopwatches (2)
- Bucket with scale (min. 20 litres)
- Water Pump including power supply

Procedure:

- **Step 1:** Measure difference between water level and soil surface
- **Step 2:** Measure the real water flow of the pump by using the bucket and the stop watch (e.g.20 litres in 5 seconds results in 20/5 equal to 4 l/s). Do not pump the water out of the well you want to test, use another source.
- **Step 3:** Pump out water from the well you want to test by measuring time (e.g. you pump 2 minutes you can calculate 120 seconds time 4 l/s equal 480 litres)
- **Step 4:** Measure the time until the water level is equal to the level before you started pumping e.g. it took 20 minutes to reach the original level and you have pumped out 480 litres. This results in 480 l / 20 min which is 24 l/min or 0.4 l/s. Note: If the water level does not go down while you pump the equipment (pump) is too small.

The well provides:

- 0.4 l/s
- 24 l/min
- 1440 l/h
- 34.560 l/d equal to 34 m^3/d
- This well could provide water for 864 people if you calculate 40 litres per capita per day

[29] Adapted from Powerpoint presentation on Groundwater by Walter Berier, 2013

The depth of shallow wells is typically less than 30m, and water is drawn from the layer above the first impermeable layer. Consequently, water drawn from shallow dug wells also contains (contaminated) surface water that has seeped into the ground or well. For that reason it is essential to keep a radius of 25m[30] around the well free from contamination sources (latrines etc). Wells are typically lined with stone, bricks or concrete. To minimize the contamination, it is essential that the upper part of the well is water tight. It is best to close the top of the well, to avoid dust or other contamination to enter it, and to avoid that UV beams can stimulate algae growth.

In rural Sri Lanka people like to keep the wells open, as the general believe is that sunlight helps to disinfect well water. They often also prefer to have small fish in the well to help it keeping clean. Hygiene awareness activities are required to convince users to adopt safe well users practices.

!

Regular quality checking of water taken from shallow wells should be undertaken to assure the water is safe to drink.

Well digging safety[31]:

Most accidents in a well are caused by:

- Collapse of shaft walls which are not properly lined
- People working alone in a well
- Falling into open well (children!)
- Sudden collapse shaft well due to pressure differences between aquifer and well
- Overnight accumulations of sulfuric or carbonic gas (check with flame, if it dies, gas is present)

!

30 Handpump and sanitation facilities design manual, Oxfam, 2011, p3
31 UNHCR Water manual, D. Mora Castro, Geneva, 1992

Ground water check list

1.	Is there a latrine within the direct vicinity of the water point?
2.	Is there any other source of pollution within the immediate environment? (dumping site, cultivation, roads, industry, breeding)
3.	Is the soil sandy?
4.	Does poor drainage allow pooling of water near the well and apron?
5.	Is the well covered?
6.	Is the well open to direct sunlight?
7.	Are there any cracks in the well head, apron or drainage system?
8.	Does the community use a bucket to collect water from the well?
9.	Is the bucket or rope in contact with the ground?

4.3.3 Boreholes

General

4.3.3.1 Shallow boreholes (tube wells)

Depending on the height of the ground water table, shallow tube wells can be equipped with a suction handpump if the depth is less than 8 meter, and a cylinder handpump in case the depth is between 8 and 30 meter. If the water is tapped from deeper than 30 meter, we consider those wells as deep wells.

The tube well consists of a perforated pipe with diameter of < 100 mm.

Shallow tube wells are prone to contamination as they withdraw water relatively close to the surface level. To reduce the level of contamination, it is essential that the handpump is equipped with a platform and drain.

There are several techniques available to install the shallow tube wells[32];

- Hand-drilled wells[33]: First a 100mm diameter hole is drilled to the water table. A 70mm diameter auger with 90mm diameter temporary casing is then brought to the final depth. The auger

[32] UNHCR Water manual, Mora Castro, Geneva, 1992
[33] J. Davis et al, Engineering in Emergerncies, Warwickshire, 2009, p254

is then withdrawn. Finally, a 63mm PVC casing, screen and gravel packing are installed. The temporary casing is removed and a sanitary seal is installed at the top of the drilled hole and handpump placed. Standard drill sets are available for holes up to 180mm and depths of 25m.

- Driven wells: These wells are constructed by driving a pointed screen (filter intake) with attached pipe directly into the aquifer. As driving proceeds and the well point sinks into the ground, succeeding sections of pipe are screwed on top of the screen, keeping the upper end of the casing above ground level. Although driving can be done by hand in very soft formations (silty sands, fine sands), it is usually better to have a machine capable of hammering down the pipe string. Such wells are only possible in sandy soil and not in rock or heavy clay formations. Typical depth of these wells is not more than 20 - 25 meter.
- Jetted wells: These wells are constructed by employing the erosive action of a stream of water to cut the hole, inside which a well screen and rising pipe can be inserted after completion. The water squirts at high speed against the bottom of the hole, which loosens the material and carries the disintegrated fragments upwards and out of the hole. To prevent the hole from collapsing, temporary casing is commonly sunk as jetting proceeds. This type of wells may only be constructed in places where subsoil formations are soft enough. Well jetting requires large amounts of water, limiting its application in arid regions.
- WEDC posters 27 -29 (Annex 2) on handpump installation give a clear overview on the steps to be taken in shallow borehole development.

4.3.3.2 Deep boreholes (tube wells)

- Deep wells are drilled up to a level of 30 meter depth or more. The top section of about 30 meter is made of a water tight casing to avoid contamination by surface impurities. However, pumping from such depths has a higher risk of extracting “hard” water Deep wells take water from the zone of saturation, most times with centrifugal pumps.

Sophistic drilling techniques by specialized agencies are needed for constructing deep boreholes. Two main techniques are used[34];

- With percussion drilling the cutting action is obtained by alternately raising and dropping the tools in the descending drill hole
- With rotary drilling this is accomplished by the rotation of suitable tools to chip any rock formations into small fragments
- After drilling, test pumping is required to confirm that the well yield and capacity of the pump to be installed are compatible.

4.3.4 Springs

- Provide a safe source for drinking water, provided that they are well protected from contamination. Springs often are located in hill areas, and can then be connected to a piped system to supply water by gravity flow.
- Before considering to use a source for a water supply system, its annual flow should be assessed to assure that the source has the capacity to provide an all year round supply. It should also be assessed if there are any existing ownership or users right to the sources by others that might be affected by extracting water from the source.
- Particular attention is required to protect the spring source during rainy season, as this might lead to high turbidity levels with related additional water treatment needs. Infiltration galleries might be connected to the spring source to serve as an intake to a piped supply system.
- Water provision from springs can be developed relatively cheap provided that the community to be served lives nearby. It is then also relatively cheap and easy to operate and maintain.
- It is essential that the spring water is protected against pollution at the source by creating as simple fenced-in spring catchment intake work. Spring catchments have the following components[35];

The spring collection structure should consist of a permeable structure or filter into which the water enters and a barrage to

[34] UNHCR Water manual, Mora Castro, Geneva, 1992
[35] UNHCR Water Manual, Geneva, 1992

Spring Collection Box, Mongla, Shan Special Region, Myanmar

lead the water into the supply pipe which takes it to the inspection chamber. A water-tight cover (preferably concrete) should be placed on top and surface water should be drained away from the structure. The barrages may be built in stone masonry or concrete and should be as high as the impermeable cover on top of the filter.

Care should be taken of the fact that the supply of water from a spring may vary with the seasons, and will be at the minimum at the end of the dry season.

4.3.5 Recharge

Aquifers (groundwater) can be recharged[36] in two basic ways - naturally and artificially. In natural recharge, the rainwater or surface water get percolated into shallow and deep aquifer by itself through uncovered soil surfaces and fissures on the rock mass. Artificial recharge to the aquifer is the process of draining the rain water or surface water into the aquifer by constructing simple civil structures. With this concept of channelizing surface rainwater into dug wells and recharge (soak) pits is possible to revitalize the wells which are dried up or have reduced water level considerably compared to the past. Groundwater recharge can be an effective activity in drought-prone areas to battle lowering levels of the groundwater table. Groundwater recharge can be considered as a suitable Climate Change Adaptation (CCA) activities in areas with a diminishing groundwater table.

[36] Rainwater Harvesting for recharging shallow groundwater, Water Aid, p 10

Gravity flow drinking water supply systems, Wa Special Region, Myanmar

Limited access to clean drinking water is adversely affecting communities in remote, underserved villages in mountainous areas like in the Wa Special Region of Myanmar. Village communities rely on drinking and domestic water from rivers and unprotected springs. Pathways to water sources are often arduous and a long way off and villagers especially the women have to go up and down the steep hill to fetch the water for their families.

Gravity water systems (through source protection, collection boxes, pipelines down the hill, break pressure tanks and storage reservoirs with multiple tapping points in the village) are a solution to bringing safe water closer to the community. Construction is costly, and typically is implemented with outside support for construction materials and skilled labor and voluntary labor and local materials contributed by the concerned community.

Gravity Flow water system Lai Rai, Wa Region, Myanmar

Section 5: Action planning and project cycle aspects of water supply interventions

Starting point:

Starting point of any water supply intervention is to assess the current context and facilities present in the community.

- Is there a perceived generally felt need for improvement or changes in service level?
- What is the current level of organization in relation to managing the water supply?
- Do all sections of the community have equal access to the water supply services?
- In what quantity and quality is water available?
- Risks that could impact project implementation should be identified at this stage.

Software before hardware:

- Link between safe water and good health should be clearly understood by community for them to be motivated to contribute to the necessary operation and maintenance requirements
- Water User Groups or committees to be set up to manage construction aspects and operation and maintenance, including creating revenue for parts and services that need to be acquired.
- Participation should be inclusive of all groups represented in community, with particular attention to the less influential and marginalized ones

Appropriate designs, plans and implementation:

- Designs and plans should be affordable and within the capacity to manage by the local community and WUG
- Where possible, local materials and other resources should be used

- Designs should be inclusive with attention to the requirements of special needs groups like women, children, elderly, and people with disabilities.
- Designs and plans should be guided by international standards like SPHERE and WHO in particular, and should be in accordance with locally applied rules and regulations

Operations & management (O&M):

In the long run, the effectiveness of any water supply system depends on the correct operation of each of its components and on the efficiency of arrangements for service, repair or replacement of damaged components.

To sustain progress in the water supply sector, it is therefore essential that functionality of systems is assured for the future so that communities can continue benefitting from improved services and do not need to fall back to use of unsafe water sources. Coverage level can only increase steadily if those already served stay served.

To achieve this, maximum involvement is required from the community right from the onset of the project. This will also strenghten the sense of ownership in the community, which facilitates their involvement in longer term care and maintenance activities.

Every water supply system should have a plan to cover the operation and preventive maintenance needs. A Water Users Group (WUG) should be established and trained to fulfil this task. The community members that are organized through the WUG should be able to operate the water supply system and undertake the necessary maintenance work themselves.

The WUG should appoint a caretaker, preferably someone with some technical background and experience in water supply operations, to coordinate and ensure the most effective operation and timely maintenance of the system. The technical project staff concerned with the design or construction of the water supply system should be responsible for instruction and training of the caretaker.

The operation and maintenance requirements should have been considered by the design engineer, who then provides a clear and practical plan to operate and maintain all system components.

The plan should be detailed and specific, but realistic with a time element in the form of work schedules (for preventive maintenance etc)

Necessary funds are tob e raised within the community to operate and maintain the water supply system. Sufficient stock of spare parts is to be mobilized and made available to the WUG.

Transparant organizational management procedures should be in place and are tob e followed by the WUG.

Where possible, the WUG should be linked to a concerned governmental authority for technical support when needed.

Nepal: Creation of O&M funds in Nepal

In Nuwalpur, Bardiya District, Nepal, the women's users group of a raised handpump constructed by Rural Self-relience Development Centre (RSDC) with Malteser International support consists of 80 families. They contribute a few roepees per family per month into a pump maintenance funds, which generates sufficient funds to repair and maintain the pump throughout the year when necessary.

Womens' group in Nuwalpur, Bardiya district, Nepal managing O&M funds for raised handpumps.

Water user groups (WUG) in Myanmar

In Myanmar WASH projects, Malteser International has the following approaches in close collaboration with target communities for the sustainability.

Assessment

- Rapid assessment of the village is carried out before or in the first months (1-3 months depending on the size and length of the project)
- Take all basic community data [water availability in all 3 season; use of latrine, type, coverage; drainage situation & incidence of water borne, water related diseases etc.]
- WASH infrastructure of the schools & health posts
- WASH-IDD
- Once the project is confirmed, conduct one or two days WASH-IDD sessions with the women, men & children of the target communities.
- Community contract or agreement is signed for the implementation
- Implementation is done in close collaboration with beneficiaries.

Formation of WUG

- WUG are formed in a mass community meetings with popular elections
- 30% to 50% of the WUG members are women
- WUG are trained in bookkeeping, basic WASH concept, HH latrine construction & Water Safety Plan
- WUG is also trained for the Operation and Maintenance of the WASH facilities
- WUG is also responsible for the collection, keeping & utilization of maintenance funds (collected from the water users)

- Village Development Committee (VDC)
- In all target villages there are VDC, who are formed also through election and responsible for broad development of the village in health, education, WASH, infrastructure, livelihood in collaboration with external supporters (UN, INGO,NGO & well wishers etc.) , Govt development progtams, etc.
- WUG is normally part of VDC who are the main link with Government programs & outside assistance bodies.

Malteser International staff interacting with water users' group in Myanmar

WUG in Thailand

In the Malteser International project for Karen refugees in Thailand, the followings activities are undertaken with local WASH committees:

Setting up WASH committees.

- Focus group discussion with WASH committee members on current WASH related issues.
- Problem ranking to prioritize main issues.
- Problem –cause –solutions finding tree activities to find the solution (activities to overcome prioritized issues)
- Training WASH committee members on basic proposal writing and budgeting.
- WASH committee to submit proposal by using the outcomes of participatory planning.
- Re- modify proposal and include technical inputs by MI staff.
- Signing the project agreement.
- Training WASH committee members on finance management , preparing bills and other support documents , book keeping.
- Monthly progress review meetings.
- Monitoring of Construction and finance documents by MI staff.
- Handing over facilities to WASH committee.

Meeting with water users' group in local village near Karen refugee camps, Thailand, to discuss water supply interventions supported by Malteser International

Section 6: Selection procedures community water provision facilities

A needs assessment should be at the basis to identify the most pressing water provision intervention for the most needy sections of the target community, and seeking to address those as a priority issue. Cost-effectiveness is an important consideration, which could result in the fact that some sections of a community that are far from any source can not be reached by a community system but individual wells or RWH systems should be considered instead.

For a water source to be suitable for development for community water provision purpose, it should provide sufficient quantity of water with adequate quality for drinking, cooking and domestic needs within a reasonable reach of the community. SPHERE[37] standards and other local guidelines serve as a reference to assess this.

It is important to have a clear idea of those sections of the community that have specific water access needs. Facilities should be developed as such that they are inclusive towards disabled people, women and children, elderly and other identified special needs groups.

It should be checked that the area where the water provision facility will be constructed is not in a hazard prone area, like a flood plain.

The selected option should be technically feasible and sustainable in the long run. This means that operation and maintenance aspects should be well within the capacity of the community.

The source for the community water provision facility should have undisputed access from legal or community users point of view.

[37] The SPHERE Project, 2011 Edition, p 79 - 138

WEDC Technical Note 55 on Water source selection identifies the following areas that are important to consider:

Socio-political and cultural considerations	If the water supply is not culturally appropriate, and causes security difficulties or restricts access to certain groups, the benefits of the new system will be limited.
Approach	It is important to participate with all local authorities and local population from the beginning onward. Planning and implementation should be together with the community to get a sustainable result, specially children and women are often involved in the water collection, therefore it is essential to involve them.
Water committees	Care must be taken to ensure that all groups in the community are represented and can make their concerns and needs heard and understood. Committees are one solution to managing sustainable water distribution systems, to care about financial issues and maintenance.
Yield versus demand	The yield must be adequate. If a more convenient supply is developed, then consideration must be given to the potential increase in demand and the possible migration of outsiders into the community, particularly in areas where water is scarce.
Water quality	The water quality must be acceptable and treatment methods suited to the community concerned. It is important to consider the treatment methods already practiced in the community.
Legal requirements	Current ownership of land and the legal requirements of getting permission to abstract water are also factors to consider while selecting a source.

Handing over of water supply system to community in Abanh 2 village, Trhy commune, Tay Giang District, Quang Nam Province, Vietnam

Section 7: Link of water to health

Both water quality and quantity directly affect health. If the water quality is not according to the recommended standard, there is a high possibility of spreading water-borne diseases. Improvement of drinking water quality can prevent and control water-borne diseases.

There should be sufficient water supply to improve sanitation and personal hygiene. Therefore, if water supply is enough it enhances the health status.

Diseases associated with water can be categorized[38] depending on the source of the pathogen and the route by which we come into contact with the pathogen. Water-borne diseases are those that are caused by drinking water that is contaminated with pathogens. Water quality testing usually focuses on water-borne pathogens that are caused by fecal contamination.

Diseases associated with water contaminated with pathogens

Possible Diseases	Source	How We Get Sick	How to Stop Getting Sick
Diarrhoea, cholera, typhoid, shigellosis, hepatitis A and E, amoebic dysentery, cryptosporidiosis, giardiasis, guinea worm	Water-borne	Drinking water contaminated with pathogens	Treating water to make it safe to drinks.
Trachoma, scabies	Water-washed	Pathogens touch the skin or eye	Provide enough water needed for basic hygiene. Improve basic hygiene practices.
Schistosomiasis	Water-based	Pathogens go through the skin	Do not bath or swim in water that is known to be contaminated. Improve water quality by removing or killing the source of pathogens.
Malaria, dengue, yellow fever, filariasis, river blindness, sleeping sickness	Water-insect vector	Pathogens are passed on by insects that breed or live in water, such as mosquitos	Prevent insects from breeding in water. Use pesticides to control insects. Prevent insects from biting by using bed nets and wearing long clothes.

[37] CAWS: Introduction to Drinking Water Quality Testing, Calgary, 2013, p7.3

Check list with key measures to reduce water related diseases:

- Adequate and clean water supply.
- Improving the quality of water at source, at tap or in the storage containers.
- Improving the quantity of water availability. This allows better hygiene and prevent disease.
- Improved water treatment and sanitation.
- Enforce good personal and food hygiene.
- Household hygiene (at home, the water should be boiled, filtered or other methods and necessary steps taken to ensure it is free from microorganisms).
- Health and hygiene education and promotion regarding causes of water borne diseases and mode of the disease transmission.

Further reading on water related diseases can also be found in the Malteser International " WASH Guidelines for field practitioners; part 3, Hygiene" under section 3.2.2.a, page 10.

Facts and figures of water related diseases[39]

Diarrhoea

- 1.8 million people die every year from diarrhoeal diseases (including cholera); 90% are children under 5, mostly in developing countries.
- 88% of diarrhoeal disease is attributed to unsafe water supply, inadequate sanitation and hygiene.
- Improved water supply reduces diarrhoea morbidity by 21%.
- Additional improvement of drinking-water quality, such as point of use disinfection, would lead to a reduction of diarrhoea episodes of 45%.

Note: Details on Cholera prevention can be found in the WASH Guidelines for field practitioners, part 3, Hygiene, page 37.

[37] [http://www.who.int/water_sanitation_health/publications/factsfigures04/en/]

Malaria

- 1.2 million people die of malaria each year, 90% of whom are children under 5.
- There are 396 million episodes of malaria every year, most of the disease burden is in Africa south of the Sahara.
- Intensified irrigation, dams and other water related projects contribute importantly to this disease burden.
- Better management of water resources reduces transmission of malaria and other vector-borne diseases.

Schistosomiasis

- An estimated 160 million people are infected with schistosomiasis.
- The disease causes tens of thousands of deaths every year, mainly in sub-Saharan Africa.
- It is strongly related to unsanitary excreta disposal and absence of nearby sources of safe water.
- Man-made reservoirs and poorly designed irrigation schemes are main drivers of schistosomiasis expansion and intensification.

Trachoma

- 500 million people are at risk from trachoma.
- 146 million are threatened by blindness.
- 6 million people are visually impaired by trachoma.
- The disease is strongly related to lack of face washing, often due to absence of nearby sources of safe water.
- Improving access to safe water sources and better hygiene practices can reduce trachoma morbidity by 27%.

Intestinal helminths (Ascariasis, Trichuriasis, Hookworm disease)

- 133 million people suffer from high intensity intestinal helminth infections, which often leads to severe consequences such as cognitive impairment, massive dysentery, or anaemia.
- These diseases cause around 9400 deaths every year.
- Access to safe water and sanitation facilities and better hygiene practice can reduce morbidity from ascariasis by 29% and hookworm by 4%.

Japanese encephalitis

- 20% of clinical cases of Japanese encephalitis die, and 35% suffer permanent brain damage.
- Improved management for irrigation of water resources reduces transmission of disease, in South, South East, and East Asia.

Hepatitis A

- There are 1.5 million cases of clinical hepatitis A every year.

In addition, a high concentrate of chemical dissolved in drinking water has significant effect on health.

- Arsenic contamination of ground water has been found in many countries, including Argentina, Bangladesh, Chile, China, India, Mexico, Thailand and the United States.
- In Bangladesh, between 28 and 35 million people consume drinking-water with elevated levels of arsenic in their drinking-water.
- The number of cases of skin lesions related to arsenic in drinking-water in Bangladesh is estimated at 1.5 million.
- Over 26 million people in China suffer from dental fluorosis due to elevated fluoride in their drinking water.
- In China, over 1 million cases of skeletal fluorosis are thought to be attributable to drinking-water.

(http://www.who.int/water_sanitation_health/publications/factsfigures04/en/)

There is suggestive evidence[40] that increasing water quantity directly reduces the risk of diarrhoea and other WASH related diseases. Few studies have looked at the effect of water, sanitation and hygiene interventions on mortality, and these have not been of good quality. Therefore, there is currently only weak epidemiological evidence that WASH interventions reduce mortality, even if biological plausibility remains high. The effect on health of different WASH interventions is likely to extend to a large variety of infectious diseases such as worm infections, trachoma, acute respiratory infections and most importantly diarrhoea.

[40] Water, Sanitation & Hygiene; Evidence paper, May 2013, DFID, p 49

Section 8: Water quality issues[41]

8.1 General

As the quality of water can vary significantly in a short time and over short distances, it is important to consider the quality of water within the whole water chain and not simply at sources only. Information should be collected frequently, using on-site equipment kits or laboratories, and is a routine activity. Water quality issues depend on the following parameters.

- Microbiological
- Chemical
- Aesthetic
- Physical

Improved public water supply, piped water on private premises, source water treatment and point of use water treatment can reduce diarrhoea morbidity in children under 5 up to 29%[42]. However, continuous monitoring of the quality of water is essential. A "Water Safety Plan" approach was initiated by WHO to ensure drinking water supplies are safe. This method will be further elaborated on in section 7.b.

Microbiological Aspect

The primary concern with health problems caused by water supply is infectious diarrhoeal diseases transmitted by the faecal-oral route. These are caused by disease-causing micro-organisms, or pathogens. Therefore the principal concern in water quality is the microbiological quality of the water that is being consumed. As mentioned above, microbiological quality can change very rapidly over time and short distances and therefore frequent testing is needed.

[41] WEDC: Guy Howard, Water quality surveillance, A practical guide, 2002
WHO: Guidelines for drinking water quality, Fourth edition, 2011

[42] IRC: A. Potter et al, WASH Cost, Working paper 6, The Hague. December 2011

For microbiological water quality[43], verification is likely to be based on the analysis of faecal indicator micro-organisms, with the organism of choice being *Escherichia coli*.

With the Delagua or similar Wachtech water testing kits as described in section 7.d.1, one can do microbiological testing of E Coli.

Chemical Aspect

The chemical quality of water is in fact a lower priority for testing, and the effects on health are more long-term (chronic). Exceptions to this however are contamination by arsenic, nitrate and fluoride, which may all give short-term health effects and these should be included in the water quality regular monitoring program. Other chemicals should be tested during source selection or periodic evaluation. In case presence of certain chemicals, like iron or manganese, leads to rejection of water for drinking and domestic purpose (due to bad taste and staining of clothes while washing them), more frequent analysis may need to be carried out. Arsenic (when present) may require more frequent testing as its concentrations may increase when abstraction of groundwater leads to changes in the sub-surface water chemistry. Arsenic is a highly poisonous metallic element and found in trace quantities in rocks, soil, water and air. In some areas of South Asian and South East Asian countries, arsenic contamination in water supplies mainly from drilled wells is found. Exposure to high level of arsenic in long period can cause cancers of skin, bladder, kidney and diseases of blood vessels of legs and feet.

In fact, a full chemical analysis of the newly developed water supply facility is needed to identify those chemical parameters that could be risky. Then one choses certain chemicals that need to be periodically tested on a regular basis. This can then be different from source to source, depending on those chemicals that pose a risk.

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[43] WHO: Guidelines for Drinking Water Quality, Fourth Edition, 2011, table A 3.3, p 26

Chemical	Mg/l
Arsenic	0.01
Nitrate	50
Fluoride	1.5

The WHO Guidelines for Drinking Water Quality[44] includes a table with guideline values for chemicals that are of health significance in drinking water. Some of the most important chemical parameters for drinking water mentioned in the WHO Guidelines are;

Aesthetic aspect

Parameters of water quality such as colour, odour or taste are also important as these may cause people to reject a water supply of little microbiological risk and consume water from a more contaminated supply. These are called aesthetic parameters. Many of our communities in rural Cambodia reject tube well water that is safe to drink, but does not taste well for them.

Physical aspect

Physical water quality parameters are turbidity, hardness, conductivity, pH which also affect the acceptance of water by the consumers. If the water is turbid we need to treat the water using filtration. The conductivity is an indicator of the high or low content of chemicals in the water. Hardness is the indicator for calcium content and pH is a parameter indicating acidity and alkalinity of the water.

Turbidity is the amount of cloudiness in the water and is usually measured in nephelometric turbidity units (NTU). Turbidity is important because bacteria are often found attached to suspended particles in the water. Also, raised turbidity may reduce the effectiveness of chlorination. In case one chlorinates water supplies with raised turbidity levels increased doses of chlorination are required. The level of turbidity can be easiest checked with a turbidity tube[45]. Advantages are that this is a cheap piece of equipment with a simple design. It is however not so accurate as a turbidity meter.

All the critical parameters as mentioned above require frequent and routine monitoring. On top of that, other tools are required in order to be sure that the water quality is kept as good as possible.

44 WHO: Guidelines for Drinking Water Quality, Fourth Edition, 2011, table A 3.3, p 472
45 WHO Fact sheet 2.33, Turbidity measurement

These are:

1. Sanitary inspection – in which one assesses the hazards and contaminating pathways into the source that could cause microbiological contamination. Such Sanitary inspections look particularly at the water source and immediate surroundings. This is of particular importance for village level water ponds, with all kind of washing and other domestic activities going on nearby. (sanitary inspection example from Sri Lanka rainwater harvesting activities on page no 28)

Sanitary inspections[46] are a simple, inexpensive, and practical method to help communities and households understand and manage the quality of their drinking water. Sanitary inspections combined with water quality testing can be used to identify the most important sources of contamination and appropriate actions to improve the safety of drinking water.

Water quality testing alone does not guarantee safe drinking water. Periodic testing only gives you a snapshot of the water quality. It provides limited information on the source of contamination, and it may not identify important seasonal changes in water quality. Identifying the causes of water contamination and appropriate actions to prevent contamination is only possible if information is available on the sources and pathways of contaminants. This information can be provided by sanitary inspections (UNICEF, 2008).

2. Source protection – the physical measures that are done to protect the source of water from becoming contaminated.
   When we discuss water quality aspects, we always have to consider the link to water quantity as well. Inadequate volumes may lead to poor hygiene standards and subsequently skin and eye diseases. Moreover, poor hygiene due to a lack of adequate water is also a key factor in the transmission of many infectious diarrhoeal diseases.

Therefore, apart from monitoring qualitative aspects of water supply, it is equally important to monitor access to safe water to assure people have a sufficient amount of water at their disposal for health, hygiene and domestic purpose.

[46] CAWST: Introduction to Drinking Water Quality Testing, Calgary, 2013, p3.1

8.2 Water Safety Plan (WSP)

A Water Safety Plan is a plan that ensures the safety of drinking water supply through the use of comprehensive risk assessment and risk management approaches that encompasses all step in water supply from catchment to final consumer (drinking). (WHO 2004).

A Water Safety Plan has 6 steps as mentioned below and the continuous process is designed to get safe drinking water for all consumers.

- Engage the community and assemble a Water Safety Plan team
- Record details of the community water supply system
- Identify and assess hazards, hazardous events, risks and existing control measures
- Develop and implement an incremental improvement plan
- Monitor control measures and verify the effectiveness of the plan.
- Document, review and improve all aspects of Water Safety Plan implementation

Rural Water Safety Plans, Household water safety plans and safe storage interventions can lead to dramatic improvement in drinking water quality and reduction of diarrheal diseases.

The ultimate purpose of a Water Safety Plan is to transform passive users into conscious producers of their own water. The course of action requires owners of the system to understand the process that produces their water , identify the hazards present in each step and implement control measures. It is important that water safety plans do not stop at the collection point, it should continue to the point of use.

Given their specificity, the WSPs must be developed for each technology (dug wells, twells, rainwater harvesting systems, protected springs, etc.)

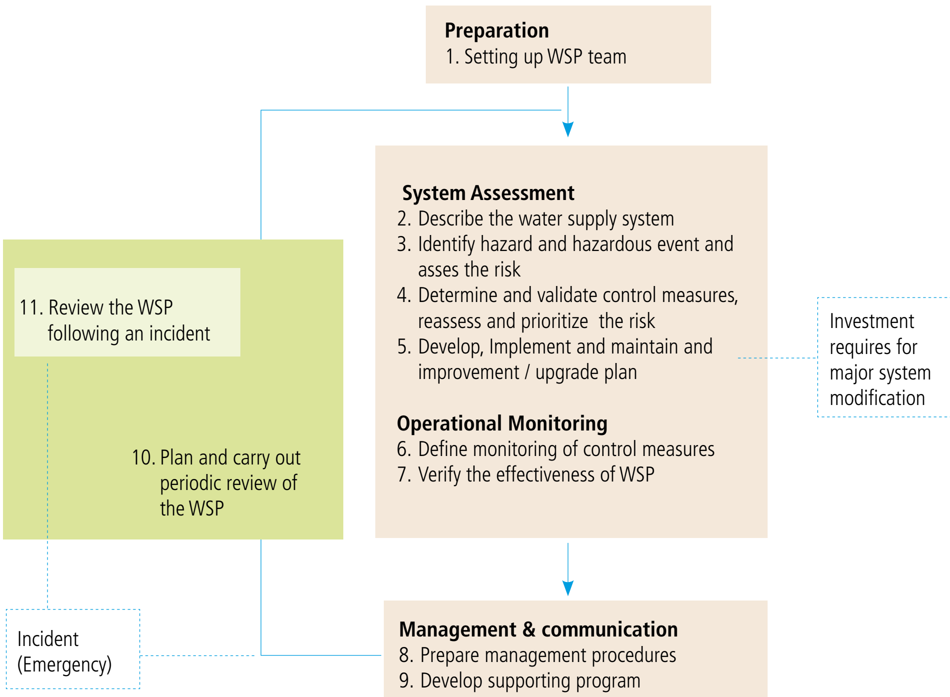
The Water safety plan can be divided in to the following elements

- Description of the systems – The water system divided into individual elements from the catchment to the point use.
- HACCP matrix (Hazard Analytical Critical Control Point) – For each element, the hazards for the quality of the water are identified, control measures and actions are then listed to mitigate the hazard, monitoring tools are defined.

- Verification plan – The plan for the periodical verification of the quality of the final product, to guarantee the correctness of the assumption in the HACCP matrix, and the correct implementation of the control measures.
- Dissemination and implementation plan – IEC materials are produced in support of the practical implementation of the water safety plan. The content is in accordance with the HACCP matrix but translated into simple language that allows rural communities to understand it properly.

Water Safety Plans are a useful basis for hygiene promotion activities. Current practices for collecting and managing water sources should be examined as a basis for action for proposed water handling improvements in the Water Safety Plan.

How to develop and Implement a water safety plan[47]



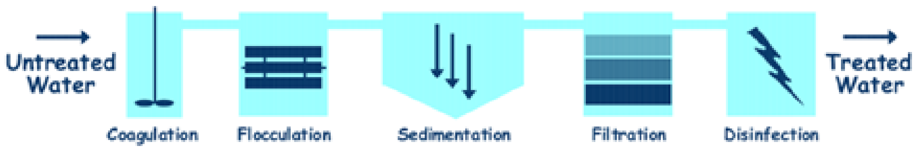
[47] [http://www.wsportal.org/templates/ld_templates/layout_33212.aspx?ObjectId=1374&lang=eng]

8.3 Water treatment

General

The treatment process[48]

Both community and household water treatment systems follow the same water treatment process. The only difference is the scale of the systems that are used by communities and households.



The main objective of water treatment is to ensure that the water consumed will not produce disease.

There are physical, chemical and biological issues.

The most important contaminants to remove from the water are:

- **Physical:** turbidity, solids
- **Chemical:** arsenic, fluoride, iron and manganese, nitrate, chloride and sulphates, pH
- **Biological:** bacteria, viruses, helminthes, protozoa

Step 1 **Sedimentation:** Removes large particles (sand, grit, dirt) and attached bacteria
Step 2 **Filtration:** Eliminates fine particles and most pathogens
Step 3 **Disinfection:** Eliminates pathogens

8.3.1 Multi-barrier Approach to Safe Drinking Water[49]

The best way to reduce the risk of drinking unsafe water is to use the multi-barrier approach.

The five steps of the multi-barrier approach to safe drinking water are:

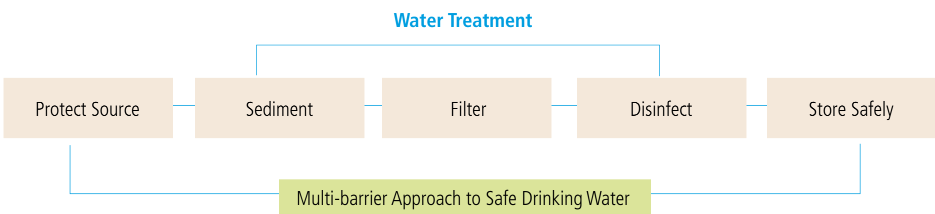
48 [http://www.cawst.org/en/resources/household-water-treatment/ Michigan Environmental Education Curriculum Drinking Water Treatment]
49 Adapted from CAWST: Introduction to Drinking Water Quality Testing, Calgary, 2013, p1.4

1. Protect your water source
2. Sediment your water
3. Filter your water
4. Disinfect your water
5. Store your water safely

Each step in the process, from source protection to water treatment and safe storage, helps reduce health risks. The emphasis should be placed on protecting water sources first, so that they don't need to rely so much on treatment to make the water safe to drink.

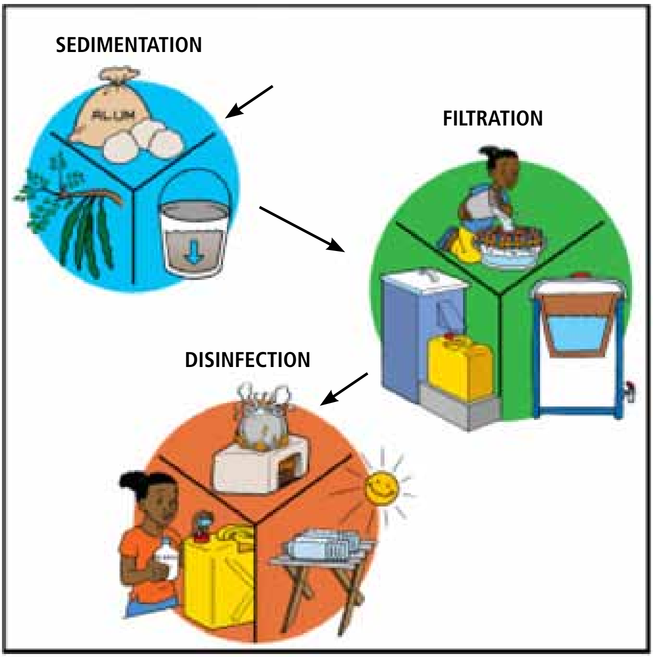
The concept of the multi-barrier approach is also addressed by the WHO as part of the Guidelines for Drinking Water Quality and water safety plans, the principles of which can be applied at both community and household levels. The WHO provides additional information about water safety plans on their website at: www.wsportal.org/ibis/water-safety-portal/eng/home.

Water can be treated at a central location, in large volumes, and then supplied to households through a network of pipes. This is often called centralized or community water treatment. Smaller volumes of water can also be treated at the point of use (POU), such as in institutions (e.g., schools, clinics, religious institutions), and in the home. This is also commonly called household water treatment and safe storage (HWTS) since the family members gather the water, and then treat and store it in their home. Both conventional (community) and household systems follow the same basic water treatment process, which is the middle three steps of the multi-barrier approach: sedimentation, filtration and disinfection. The main difference between conventional and household systems is the scale of the technologies used.



Water Treatment

1. Sedimenting water removes larger particles and often more than 50% of pathogens
   Note[50]: Coagulation and flocculation might be required to assist (speed up) the sedimentation process. Chemical coagulation removes turbidity-producing colloids such as clay particles, bacteria and other organic matter. Most commonly used coagulant is Aluminium Sulphate (Alum)). Flocculation is a process whereby the products of coagulation are made to form "flocs" of sufficient size and weight to allow removal by sedimentation or filtration
2. Filtering water removes smaller particles and often more than 90% of pathogens
3. Disinfecting water deactivates or kills any remaining pathogens



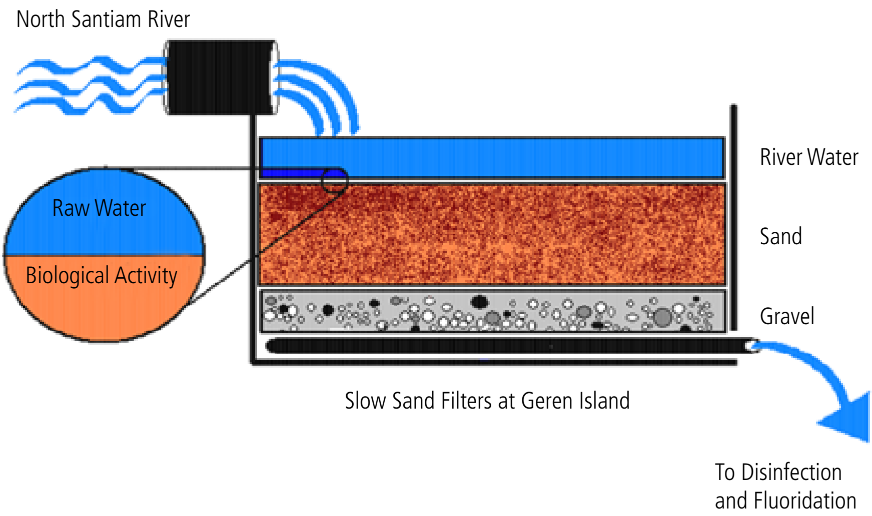
[50] Adapted from UNHCR: Water Manual for Refugee Situations, Geneva, 1992, p85

8.3.2 Treatment options at source (community level)

8.3.2.1 Sand filters

Slow sand filters[51]

These filters are designed to remove contaminated matter from a water supply and form a barrier against bacterial pollution. They are usually made of a rectangular open basin, and are constructed below ground level. The vertical or sloping filter walls may consist of brickwork, masonry or concrete. The floor is usually paved with concrete or brick on which the under-drains are laid. About 0.6 m of successively finer gravel is laid over the drains, followed by 0.6 – 0.9 m of graded sand. The use of slow sand filters is declining, mainly due to its high costs.



Slow Sand Filters at Geren Island

8.3.2.2 Chlorination[52]

Chlorine is the most readily available and widely used chemical disinfectant for water supply. The aim of chlorination is the

[51] K. Nelson: Dictionary of Water Engineering, Warwickshire, 2005, p 292
[52] Davis et al; Engineering in Emergencies, A Practical Guide for Relief Workers, Warwickshire, 2009, p 336

destruction of pathogens and the protection of water supply. To achieve this, a chlorine dose must be sufficient to:

- Meet the chlorine demand of the water (it must oxidize the contaminants)
- Leave a residual, in order to give protection against further contamination. This is achieved by ensuring a free residual of 0.2-0.5 mg/l of chlorine in the disinfected water. Higher residuals may give an unpleasant taste.

Pre-condition of effective chlorination is that the turbidity of the water must be low: less than 5 NTU. At high turbidity levels, large quantities of chlorine are needed to oxidize the water, which leaves a strong taste.

Chlorine may be added to a water supply by:

- Dosing with a continuous flow of one per cent solution of chlorine
- Adding chlorine tablets or powder directly to a tank of water (for emergency chlorination only)

Water treatment unit deployed in Myanmar after Cyclone Nargis

Desalination

Desalination[53] is defined as the reduction in salt content of sea or brackish water to a level acceptable for consumption. It is a relatively expensive process, and most commonly used in countries or areas where there are few alternative sources or if energy is cheaply available.

The German company Moerk[54] has developed a whole range of desalination equipment from small (100 l per hour) and relatively affordable systems for social infrastructure facilities like schools or health posts, or small communities to more comprehensive larger scale (up to 10,000 l per hour) equipment.

8.3.3 Household Water Treatment and safe Storage (HWTS)[55]

i. General (sedimentation, filtration, disinfection)

Household water treatment and safe storage (HWTS) has been recognized by the World Health Organization as an affordable and effective solution for improving water quality. It is a useful approach to empower individual homeowners to make decisions;

Providing access to safe drinking water through centralised systems in developing countries is very challenging[56]. Large distribution systems involve a lot of operation and maintenance and often, drinking water gets contaminated during distribution and during handling in the household. Therefore, treating drinking water at household level by using simple, but effective Household Water Treatment and safe Storage (HWTS) options such as boiling, filtration, chlorination and SODIS could significantly reduce incidences of waterborne diseases.

According to the WHO (WHO 2007b) HWTS dramatically improves microbiological water quality; significantly reduces

53 K. Nelson; Dictionary of Water Engineering, Warwickshire, 2005, p 87
54 [http://moerkwater.com/]
55 Text adapted from SSWM, Bipin Dangol,ENPHO, HWTS, [www.sswm.info]
56 Adapted from CAWST 2009: HWTS Published on SSWM [http://www.sswm.info/] 4/5/13 HWTS [www.sswm.info/print/978?tid=577 2/5 The five steps of the multi-barrier approach of HWTS. Source: CA WST (2009)] Accessed on 25June2014.

diarrhoea; is among the most effective of water, sanitation and health interventions; is highly cost-effective; and can be rapidly deployed and taken up by vulnerable populations.

Applicability

Household Water Treatment and Safe Storage (HWTS) is particularly suitable in places where people are using contaminated drinking water sources and relying on potentially contaminated centralised water supply systems.

HWTS is also suitable for urban poor communities such as slums where households are very likely to use unprotected water sources.

Advantages

- Relatively inexpensive and cost-effective
- Independent from an institutional set-up or centralised systems
- Can be deployed faster than community/centralised drinking water treatment and supply systems
- Improves microbial water quality and reduces contamination risk between treatment and use
- Wide range of simple, low cost technologies are available so people can choose the technologies most appropriate for them

Disadvantages

- Difficult to monitor correct operation and maintenance (O&M) of technologies
- High self-responsibility required from the households
- Each household should be provided with knowledge on O&M of the system
- Treated water may be lower quality than that offered by a well designed, operated and maintained community system

Steps of HWTS

HWTS is a multi-barrier approach, as described on page 49. There are several steps in HWTS which all contribute improving water quality and keeping it safe.

Using the multi-barrier approach is the best way to reduce the risk of drinking unsafe water. A process needs to be followed for this, and one can not just rely on a single technology to improve water quality.

Main steps of household water treatment, following the multi-barrier approach as described on page 50.

Source protection

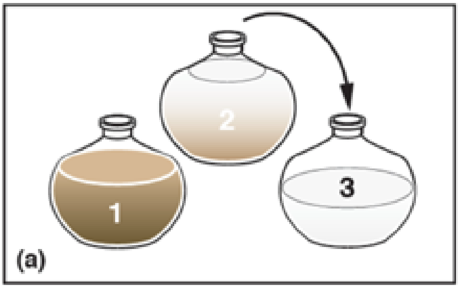
It essential to undertake activities to protect the source of water and keep it as clean as possible.

ii. Sedimentation

Sedimentation is a physical treatment process used to reduce the turbidity of the water. Suspended materials in water, such as particles of sand, clay, and other materials can be substantially removed simply by settling the water. The sedimentation process can be accelerated through the use of coagulants and flocculants. These are natural (e.g. Moringa) and synthetic (e.g. purifier of water, PUR) chemicals that change the electrical charges of the suspended materials. This allows the particles to join together, thereby increasing their mass so that they settle to the bottom of the container. Since bacteria and viruses are often attached to particle surfaces, the removal of particles through sedimentation will produce a marked reduction in bacterial concentrations.

The simplest method of treatment is storage in a covered pot. If the water can be stored for at least two days, schistosomes (small larvae which cause bilharzia) will die. It will also contain considerably fewer bacteria because these slowly die off because the conditions in the pot are not normally suitable for their survival and multiplication. Pathogens (i.e. disease causing organisms including some types of bacteria) attached to suspended solids will settle to the bottom of the tank together with the solids, further purifying the stored water.

[57] WEDC Poster 2; The three-pot water treatment system



The Three Pot System[57] is an effective system to improve the quality of water through a sedimentation process.

Drinking water should always be taken from pot 3. This water has been stored for at least two days, and the quality has improved. Periodically this pot will be washed out and may be sterilized by scalding with boiling water.

Each day when new water is brought to the house:

(a) Slowly pour water stored in Pot 2 into Pot 3, wash out Pot 2.

(b) Slowly pour water stored in Pot 1 into Pot 2, wash out Pot 1.

(c) Pour water collected from the source (Bucket 4) into Pot 1. You may wish to strain it through a clean cloth.

iii. Filtration

Filtration is commonly used after sedimentation to further reduce turbidity and remove pathogens. Filtration is a physical process which involves passing water through filter media. Filters remove pathogens in several ways.

These include straining, where the particles or larger pathogens such as worms become trapped in the small spaces between the grains of filter media; adsorption, where pathogens become attached to the filter media; or biological processes, where pathogens die naturally or the micro-organisms living in the filter consume the pathogens.

There are various types of filters that are used by households around the world including ceramic candle filters, colloidal silver filters, bio-sand filters, cloth straining, biosand filters adapted for arsenic removal, membrane filters (e.g. lifestraw), etc.. Sand and ceramic are the most common filter media, although cloth filters are also often used.

Effective technologies such as Biosand filters and ceramic filters exist.

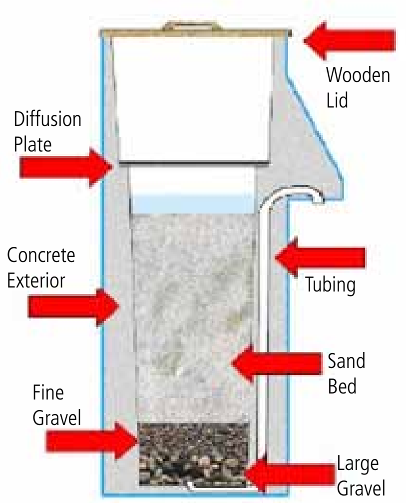
Some effective filtration applications:

Bio-sand filters

A slow sand filter contains biological activity and is therefore often referred to as a bio-sand filter. As micro-organisms such as bacteria, viruses and parasites travel through the sand, they collide with and adsorb onto sand particles. The organisms and particles collect in the greatest density in the top layers of the sand, gradually forming a biological zone. The biological zone is not really a distinct and cohesive layer, but rather a dense population that gradually develops within the top layer of the sand. The population of micro-organisms is part of an active food chain that consumes pathogens as they are trapped in and on the sand surface. The uppermost 1-3cm of this biological zone is sometimes referred to as '*schmutzdecke*' or 'filter cake'. This is defined as a layer of particles deposited on top of the filter bed or biological growth on top of the filter bed. Slow sand filters are usually cleaned by scraping of the bio-film and/or the top sand layer.

(reference /http://www.biosandfilter.org/biosandfilter/index.php/item/229)

Cross Section of the Filter



How does it work?

Water is poured into the top of the filter as needed, where a diffuser plate placed above the sand bed dissipates the initial force of the water. Traveling slowly through the sand bed, the water then passes through a bed of prepared sand media and collects in apipe at the base of the filter. From there, the water passes through plastic piping encased in the concrete exterior and out of the filter for the user to collect in a safe water container. As with all slow sand filters, a combination of biological and mechanical processes removes pathogens in the water. The bio-sand filter has proven to almost entirely remove the disease-causing organisms found in water. Extensive water analysis carried out by the Centre for Affordable Water and Sanitation Technologies (CAWST), Calgary, Alberta, Canada, has proved that bio-sand filters remove:

- More than 96% of fecal coliforms (additional disinfection process might be necessary)
- 100% of protozoa and helminthes
- 50-90% of organic and inorganic toxicants
- Greater than 75% of iron and manganese
- Suspended sediments, in all or part

Moreover, operating the filter is very simple: remove the lid, pour a bucket of water into the filter, and immediately collect the treated water in a container. The filter can produce up to 36 litres/hour. Its effectiveness in treatment of contaminated water and easy maintenance makes it a very effective system for household water treatment.

Bio sand filters produced in Sri Lanka

Clay (ceramic) water filter

Household scale ceramic water filtration technology is the most promising option treating drinking water at household level in developing countries (Lantagne 2001; Sobsey 2002; Roberts 2004). There are several different kinds of ceramic water filters designed and used world-wide for household water treatment. However the most widespread ceramic water filter is the one that is promoted by ‘Potters for peace’, a US and Nicaragua – based NGO and tested in Cambodia. The Cambodian version of it is called as Ceramic purifier, which is used commonly around the world.

Drawing provided by SANITEC, Cuba

How does it work?

There are two ways of removing pathogens in the water.

1. Physical filtration – The pathogens are trapped inside the small pores when water goes through the ceramic layer. 99% removal
2. Chemical - The colloidal silver that impregnated in inner layer kills the pathogen (99.1-99.3% removal)

This is easy to maintain, move and within 2-3 fillings it provides 20 -30 liters of safe drinking water per day.

LifeStraw®[58]

LifeStraw® is a water filter made to be used by one person to filter water so that they may safely drink it. It filters a maximum of 1000 litres of water, enough for one person for one year. It therefore is useful in emergency situations, provided that water in sufficient quantity can be found nearby. Life Straw removes almost all of waterborne bacteria and parasites.

The LifeStraw Family 2.0, is a larger unit designed for family use. It also filters out nearly all microbes.

LifeStraw Family 2.0 filters a maximum of 30,000 litres of water, which means it can provide safe drinking water for a family of five for up to five years.

The LifeStraw Community filter

LifeStraw® Community is a high-volume point-of-use water purifier with built-in safe storage that provides safe drinking water for community, educational and institutional settings. It prevents waterborne disease such as diarrhoea, typhoid, cholera, worms, and cryptosporidiosis.

- Hollow fibre filtration technology converts contaminated water into safe drinking water
- Removes a minimum of 99.9999% of bacteria, 99.999% of viruses and 99.99% of protozoan parasites

[58] [http://www.vestergaard.com/our-products/lifestraw]

- Reduces turbidity (muddiness) by filtering particulate matter larger than 0.02 microns
- Meets the standard for the "highly protective" category of household water treatment options by the World Health Organization and complies with US EPA guidelines for microbiological water purifiers
- Can purify between 70,000 -100,000 litres of water, enough to serve community settings for several years
- Chemical-free
- Made of durable plastic
- Doesn't require electrical power or batteries

iv. Disinfection

The destruction of the organisms' cell walls by oxidation is known as disinfection. Typically, disinfection involves the addition of chemicals such as chlorine. It can also be induced by ultraviolet radiation, such as natural sunlight or artificial UV rays.

The most common method used by households around the world to disinfect drinking water is chlorination.

Heat can also kill microorganisms and this process is called pasteurisation. Pasteurisation has almost the same effect as disinfection. The most common methods to pasteurise water are boiling, solar disinfection or solar pasteurisation.

If water contains high amounts of organic matter (for instance surface water from tropical regions), there is a risk of the formation of toxic disinfection products when chlorine reacts with these organics. Turbid water helps pathogens to "hide" from chemicals and natural or artificial UV radiation. Reducing turbidity and organic matter by sedimentation and filtration before the treatment is therefore necessary to improve the effectiveness of these disinfection methods.

Boiling

Boiling is the oldest and most commonly practiced household water treatment method. Boiling as household water treatment method is widely promoted in developing countries and emergency situations to provide safe drinking water. To make water safe for consumption, the water should reach the boiling point 100 C /212 F. Most of the organizations recommend that water should be brought to "rolling" boil, held there for at least 2-3 minutes to make it safe for human consumption. Safe storage of boiled water is very important to avoid recontamination.

Apart from the high cost for energy needs for boiling, an other disadvantage is the change in taste of water.

It is recommended to use fuel efficient stoves while boiling water for disinfection.

SODIS – Solar disinfection

SODIS (**So**lar water **Dis**infection) is a water treatment methods which uses the sun as a source disinfection process.

How does it work?

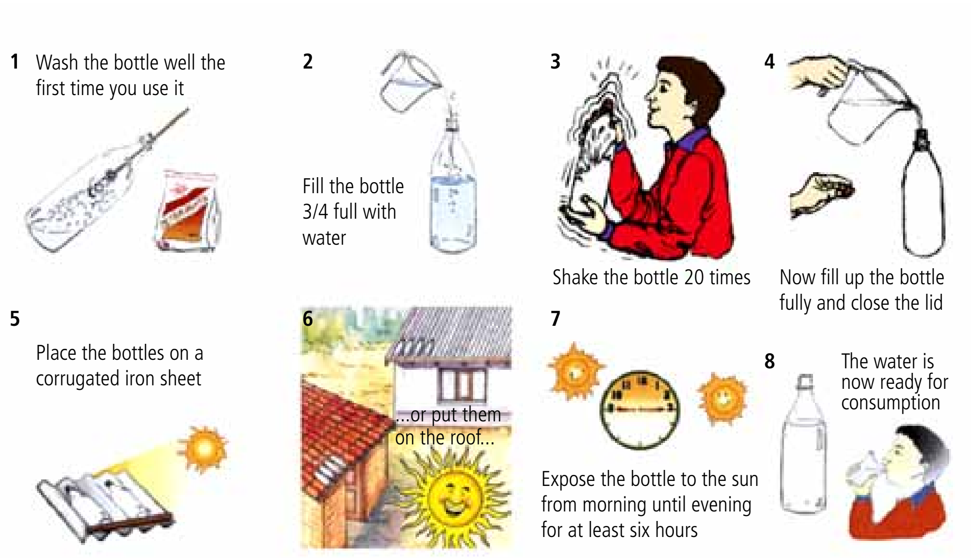
The solar radiation and heat of the sun inactivate the micro-organisms. It is believed that there are 3 ways of inactivating micro-organisms by solar rays.

1. Ultra violet – A rays directly change the metabolism and destroy the cell structure of pathogens.
2. Ultra violet – A rays react with dissolved oxygen in the water and produce hydrogen peroxide, which also damage the pathogens.
3. Solar energy heat the water and increases the temperature. If the temperature is raised up to 50^{o}c , the disinfection process is three times faster.

Selecting the right kind of bottle is very important for the efficiency of solar disinfection. It is advised to use transparent non damaged PEP bottles of maximum 2 liters. Furthermore, bottles with scratches and change of shape reduce the efficiency of SODIS.

The intensity of UV radiation is decreased with the depth of the water. Therefore it is recommended to use bottles with a diameter of less than 10 cm (4 inch). Furthermore, the efficiency of SODIS also depends on the turbidity of water. Water should be filtered through a clean cloth prior to applying it to SODIS in order to reduce the turbidity.

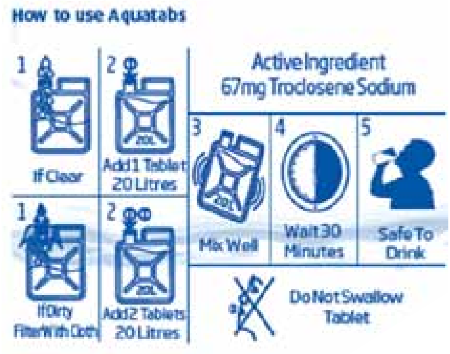
Steps of SODIS



Chlorination

Chlorination tablets are available in a range of sizes. Each tablet size is formulated to treat a specific volume of water – ranging from 1 litre to 2,500 litre. Aquatabs[59] is brand of chlorination tablets which is widely available. They are used both in emergency situations and also for continuous use in households that do not have access to safe drinking water.

[59] [www.aquatabs.com]



Litres	Emergency	Household Water
1 Litre	8.5mg	3.5mg
4-5 Litres	33mg	17mg
10 Litres	67mg	33mg
20-25 Litres	167mg	67mg
200-400 Litres	1.67gm	1.67gm

Based on the quantity of water to be chlorinated, one can choose the appropriate Aquatab tablet. If jerry cans are distributed during an emergency, the Aquatab tablets that are distriuted need to be aligned with the volume of the jerry can.

Need for chlorination

- Many water sources throughout the world, even after filtration, remain contaminated and require some form of disinfection.
- Through the use of Aquatabs or other products in liquid form like WaterGuard, areas without access to water disinfection systems can benefit from the advantages of chlorination without any infrastructure requirements in a speedy and cost effective manner.

While chlorinating water with Aquatab or WaterGuard, the turbidity level of the water to be treated needs to be considered. If this is >5 NTU, a double dose will be required to treat the water safely. Sedimentation and/or filtration should be considered as pre-treatment.

P & G Purifier of water (formerly known as PUR)[60]:

This product combines the sedimentation and disinfection processes for water treatment at household level. It is therefore particularly suitable for flood emergencies, when water sources might have turned more turbid and need disinfection.

[60] CAWST: Introduction to Household Water Treatment and Safe Storage, Calgary, 2011, p153

Purifier of Water is a powder which contains both coagulants and a timed release form of chlorine. Purifier of Water is sold in single packets designed to treat 10 litres of water.

The product uses coagulation and disinfection to remove turbidity and pathogens from water at the same time.

When added to water, the coagulant first helps the suspended particles join together and form larger clumps, making it easier for them to settle to the bottom of the container.

Then chlorine is released over time to kill the remaining pathogens. The treated water contains residual free chlorine to protect against recontamination.

The contents of a Purifier of Water packet is added to 10 litres of water and stirred vigorously for five minutes. The water is then left to settle for 5 minutes.

Once the water becomes clear and the flocs have all settled to the bottom, the water is decanted and filtered through a cotton cloth. The water should then be left for 20 additional minutes before it is consumed. The total of 30 minutes from start of the process is sufficient for the chlorine to disinfect pathogens.

P&G Purifier of Water Packet
(Credit: Procter & Gamble, 2012)

v. Safe storage

Households do a lot of work to collect, transport and treat their drinking water. Now that the water is safe to drink, it should be handled and stored properly to keep it safe. If it is not stored safely, the treated water quality could become worse than the source water and may cause people to get sick.

Safe storage means keeping treated water away from sources of contamination, and using a clean and covered container. It also means drinking water from the container in a way so that people do not make each other sick.

The container should prevent hands, cups and dippers from touching the water, so that the water does not get recontaminated.

There are many designs for water containers around the world.

A safe water storage container should have the following qualities:

- Strong and tightly fitting lid or cover
- Tap or narrow opening
- Stable base so it does not tip over
- Durable and strong
- Should not be transparent
- Easy to clean

Jerry can

For safe collection and storage of water at household level, the jerry has played a huge role worldwide. With this device water can be stored easily and safely compared to open buckets. Plastic sealable containers make water transport also far easier. An other advantage of jerry cans is that they have a known volume, which makes it easier to use them while disinfecting the water with chlorine as this process can be done more accurate. With its narrow neck, water from jerry cans is easier to pour without spillage and there is less risk of in-house contamination.

Jerrycan distribution in combination with hygiene awareness in Rumbek East-cattle camp near Paloc, South Sudan

Creating demand[61]

Creating demand requires awareness and education to convince households of the need and benefits of HWTS so that it is desired and sought after. Demand exists when people need and want HWTS and have the opportunity and ability to bring it into their homes. It is critical that households actually want and value HWTS; this ensures it will be used over the long term.

8.4 Water quality surveillance[62] and testing[63]

8.4.1 General

Safe drinking water should have the following microbiological, chemical, physical and aesthetic parameters (described more in detail on page 43):

- Free of pathogens (a pathogen is any living organism that causes disease). Pathogens commonly found in drinking water include bacteria, viruses, protozoa and helminths
- Low in concentrations of toxic chemicals
- Clear
- Tasteless, odourless and colourless (for aesthetic purposes)

Microbiological testing

By far the most serious public health risk associated with drinking water is micro-biological contamination, which makes it the priority for water quality testing. Pathogens in water bacteria, viruses, protozoa and helminths can cause a wide range of health problems, but the primary concern is infectious diarrhoeal disease transmitted by people drinking water contaminated with feces (UNICEF, 2008).

Testing for microbiological contamination is usually the priority in most drinking water projects. Escherichia coli (E. coli) and/or thermotolerant coliforms (TTC) are the standard for testing for microbiological contamination.

[61] CAWST: Introduction to Household Water Treatment and Safe Storage, Calgary, 2011, p38
[62] Text adapted from WEDC: Guy Howard, Water quality surveillance - a practical guide -, Leicestershire 2002, p 1
[63] Text adapted from CAWST: Introduction to Household Water Treatment and Safe Storage, Calgary, 2013

Associated risk for fecal contamination in drinking water

E.coil Level (CFU/100mL sample)	Risk[1]	Recommended Action[2]
0-10	Reasonable quality	Water may be consumed as it is
11-100	Polluted	Treat if possible, but may be consumed as it is
101-1000	Dangerous	Must be treated
>1000	Very Dangerous	Rejected or must be treated thoroughly

CFU = Colony forming units

([1]WHO, 1997;[2] Harvey,2007)

Chemical testing

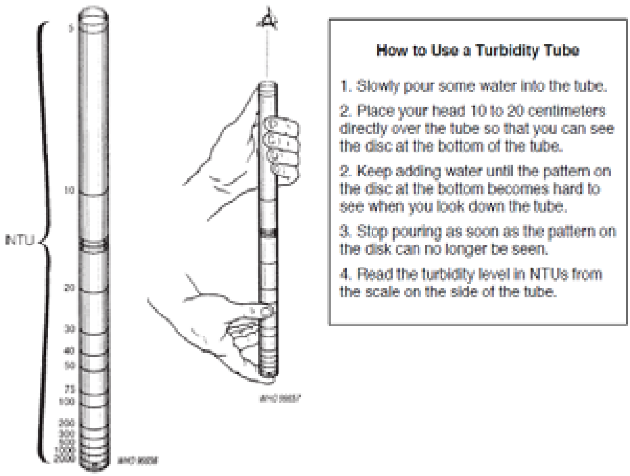
It is not possible to test water for all of the chemicals that could cause health problems, nor is it necessary. Most chemicals are rarely present, and many result from human contamination of a small area, only affecting a few water sources. However, three chemicals have the potential to cause serious health problems and occur over widespread areas. These are arsenic and fluoride, which can occur naturally, and nitrate, which is commonly used in fertilizer for agriculture. When planning new water supply projects, these three contaminants should be prioritized for testing (UNICEF, 2008). A second priority for water quality testing should be for chemical parameters that commonly cause water to be rejected for aesthetic purposes, such as metals (mainly iron and manganese) and total dissolved solids (salinity) (UNICEF, 2008). When water is disinfected with chlorine, it is also important to monitor the drinking water quality for pH and free residual chlorine (FRC) as indicators of appropriate and effective treatment. As well, it may be important to test for chemicals that are known to be present locally, such as copper or lead from industrial pollution.

Physical testing

Most physical parameters can be simply observed, like taste, smell and colour. Turbidity is generally the most important physical parameter to measure, since high levels of turbidity are usually associated with high levels of microbiological contamination. As well, high levels of turbidity can reduce the effectiveness of some water treatment technologies.

WHO recommends the turbidity level to be < 1 NTU and preferably much lower for effective disinfection; <5 NTU for small water supplies.

Turbidity can be easy measured with a turbidity tube:



How to read NTU using a turbidity tube
(Credit: WHO, 1997)

8.4.2 Water Testing options[64]

The three options most commonly used by humanitarian agencies for water quality testing are:

1) observation,
2) testing using portable (field) kits,
3) commercial laboratory testing,

i. Observation

Water quality testing tells you about the quality at the time of sampling, but it cannot give you information on either the causes of pollution or possible future trends. Simple observation is a very useful tool to identify potential risks that could affect the current and future quality of drinking water. If contamination is suspected through observing the local environment, then testing is the next

[64] Several text sections adapted from: CAWST: Introduction to Drinking Water Quality Testing, Calgary, 2013

step to confirm the water quality. Sanitary inspection (as described on page 46) is a useful observational technique. It needs no special equipment and it is quick and cheap. A limitation is of course that this method does not confirm the water quality or specific type of contamination.

ii. Portable (field) kits

Different types of water testing kits are used based on the needs and requirement for the specific results and outcomes. There are water testing kits ranging from stationary laboratory based test kits, portable water test kits which can test physical, chemical and micro-biological parameters and simple test kits which can determine the presence and absence of bacteria. Two main suppliers of portable water testing kits commonly is in use by humanitarian agencies are ‘DelAgua’ and ‘WagTech’. A disadvantage of portable field kits is that it is difficult to process a large number of samples (over 80 per week) without supplementary equipment.

DelAgue

DelAgua Single Incubator model title=”DelAgua Single Incubator (including Consumables x 200 tests)” v:shapes=”_x0000_i1026”> http://www.delagua.org/products/details/10098-DelAgua-Single-Incubator-including-Consumables-x-200-tests

The Single Incubator, designed for microbiological water monitoring via detection of indicator organisms for e coli, cholera, salmonella and other faecal water borne pathogens, is the most popular portable water testing system in the developing world. Built with an internal battery, it is capable of up to 5 incubation cycles between recharges.

The Oxfam-DelAgua Single Incubator Water Testing Kit was developed by scientists at the University of Surrey in collaboration with colleagues at Oxfam. The kit was designed to help provide information about the safety of water supplies in difficult situations or remote areas where laboratory facilities do not exist. Designed to carry out five basic tests to measure the quality of drinking water, (microbiological quality, turbidity, free chlorine, total chlorine and pH), the kit is primarily used in the field, but may also be used in a laboratory or other permanent location.

Wagtech Potakit

http://www.wagtech.co.uk/products/water-and-environmental/water-test-kits/potakit%C2%AE-intermediate-low-budget-testing-kit-physico-chemical-microbiological

Potakit®: Intermediate Low-Budget Testing Kit (Physico-Chemical + Microbiological)

Product code: **WAG-WE10030**

Portable testing laboratory designed to assess the suitability of drinking water on-site, even in remote areas.

Both kits provide field testing capacity for a full range of drinking water quality parameters.

3M™ Petrifilm™ E.coli/Coliform Count Plates

The 3M™ Petrifilm™ E.coli/Coliform Count Plate identifies both E. coli and other coliforms with confirmed results in just 24-48 hours. By eliminating the confirmation steps you increase productivity and reduce overall lab costs. Fast, accurate, results in either 24 or 48 hours with three easy steps:

1) Inoculate - 3M™ Petrifilm™ Plates are easy to inoculate. Lift the top film and add sample

2) Incubate - The space saving design maximizes incubator space

3) Enumerate - Confirmed coliforms are red and blue colonies with associated gas bubbles. Confirmed *E.coli* coliforms are blue colonies with associated gas bubbles. This 3M Petrifilm Plate can also be read in 4 seconds using the 3M™ Petrifilm™ Plate Reader.

http://solutions.3m.com/wps/portal/3M/en_US/Microbiology/FoodSafety/product-information/product-catalog/?PC_Z7_RJH9U523003DC023S7P92O3O87000000_nid=C0WJ62882Vbe29BDXSBJ7Fgl

Catalog #	Product	Description	MSDS
6404	3M™ Petrifilm™ E. coli/Coliform Count Plates 6404	50 plates/box, 3M™ Petrifilm™ E. coli Count Plates (EC) for Escherichia coli and coliform enumeration.	
6414	3M™ Petrifilm™ E. coli/Coliform Count Plates 6414	500 plates/case, 3M™ Petrifilm™ E. coli Count Plates (EC) for Escherichia coli and coliform enumeration.	

Presence/absence testing

H2S Test Kit[65]

Lack of access to laboratories or field analysis kits is an obstacle to the provision of microbiologically safe drinking water to many communities and people worldwide. In an effort to overcome this problem, a number of alternative indicators and tests to detect faecal contamination of drinking water have been proposed and developed. Some of these are simple, low cost and do not require a microbiology laboratory or bacteriological field test kit. Some of

[65] M. Sobsey, F. Pfaender, WHO Geneva, Evaluation of the H2S Method for detection of Fecal Contamination of Drinking Water, p 6

School boys in Sri lanka examining an H2S testing bottle

these simple, low cost fecal indicator tests have come into use in actual drinking water supply practice. Prominent among these is the so-called hydrogen sulfide or H2S test, which is intended to detect or quantify hydrogen sulfide-producing bacteria, considered to be associated with fecal contamination.

H2S testing is a way of presence/absence testing. It can pick up the presence of coliforms in the water, but it can not quantify the contamination. It is therefore apprpropriate for testing sources that should be free of contamination after treatment (like HWTS), to confirm that the water is safe to drink. The method is less appropriate for testing sources that are likely to be contaminated, like shallow open wells, as it can not define the level of contamination. Accuracy of H2S testing method is in the range of 80-84%[66]

iii. Commercial laboratory testing

Water samples can also be sent to a commercial laboratory for testing. These laboratories are usually located in larger cities and have dedicated facilities, trained technicians and specialized equipment. Laboratories use international standards for testing

[66] Chuang et al, IWA, 2011, Comparison and verification of four field-based microbiological tests, p 77

and can provide more consistent, accurate and precise results. UNICEF (2010) also recommends that some chemicals, such as lead, cyanide, chromium, mercury and selenium, be tested at a laboratory in order to achieve a reliable result. Using a commercial laboratory can be useful if you are taking a small number of samples and your project is close to a city where a laboratory is present. However, the relatively high cost of commercial laboratory testing makes it difficult or impossible to use in many developing countries, especially if many tests are needed.

Testing water samples

Sampling should be taken at the source, water collection point, household level storage and drinking cup or other device used, to get a clear picture on where any contamination might occur along the water chain that leads from the source to the consumer. Different Water Test Kits come with detailed instructions on the testing procedures and using the relevant apparatus and the general procedures can be described as follow. Water sampling and analysis can also be found in the link www.who.int/water_sanitation.../2edvol3d.pd.

8.4.3 Water Testing Procedures

CAWST[67] recommends the following sample sizes;

a. Steps in the collection of samples: when colleting the water samples from the source (ponds, hand pump, drinking water containers for a house etc.), it is important to disinfect the spouts of hand pumps, taps, and to use the sterilized sampling bottles or plastic bags. It is important to disinfect the hands of the technician who collects the water sample as well.

b. Amount of the water sample: normally for all physical, chemical and microbiological tests, collection of approximately one litre of water sample is enough.

Project and Sample Sizes

Project Size	Sample Size
500	41-83
1,000	43-91
2,000	43-95
3,000	44-97
4,000-6,000	44-98
7,000-15,000	44-99
>20,000	44-100

67 CAWST: Introduction to Drinking Water Quality Testing, Calgary, 2013, p 2.7

c. Transporting the water samples: to test the E-coli presence, water samples have to be transported within six hours to the place where the microbiological tests are to be made with an incubator. It is important that the battery is fully charged and/or electricity supply is available uninterruptedly to supply to the incubator.
d. Analyzing the water testing results: The results of the water test have to be compared with the specific country "Drinking Water Quality Standard" or WHO standards mentioned in "Guidelines for Drinking Water Quality-Fourth Edition 2011" http://www.who.int/water_sanitation_health/dwq/gdwq3rev/en/
s. Follow up actions: When the water test results are beyond (above or below the standard figures) the remedial actions or control measures to be introduced timely according to the nature of urgency. For instance if a sample has an E-coli level of " too numerous to count", the respective source or household storage has to be immediately checked thoroughly and adequate control measures are to be installed, after which a re-test of a water sample needs to be done again. For high arsenic content, the source has to be abandoned and closed in collaboration with the local authorities. In large water supply schemes chlorination for disinfection is a common practice. In those water supply schemes, residual chlorine level should be checked continuously to ensure the communities or camp residents receive safe water for drinking to avoid diseases. http://www.cdc.gov/safewater/publications_pages/chlorineresidual.pdf

Example of measuring residual chlorine level

In the refugee camp setting in Thailand, the quality of the water is checked regularly by measuring the residual chlorine level.

Water distribution in Darbonne, Haïti

Section 9: Water transport, storage and distribution systems

9.1 Private/commercial water provision initiatives (kiosks)

- Water kiosks mostly have a few taps, operated by a kiosk attendant. They typically receive treated water from utilities through a piped distribution network. Where water supply in the network is disrupted, kiosks sometimes also have a water storage tank. In rural areas, water for kiosks can sometimes come directly from a well, spring, stream or lake after treatment.
- Kiosks can be operated by employees of utilities, by self-employed operators under contract with utilities or water committees consisting of volunteers. Kiosk operators also sell other related goods at the kiosk. A water kiosk can serve between 500 and 3,000 people. Water is typically carried home from the kiosk in buckets or jerry cans of 20 liters. The sale price can be a flat rate per household or, more typically, a price per container which is advertised at the kiosk.
- Making water kiosks commercially viable is more difficult where population density is low and where there are alternative often low-quality, free water sources such as shallow wells, ponds or streams. Low awareness of the health benefits of clean water can make these problems worse. In those conditions, kiosks are at greater risk of failing. Involving communities in deciding about the location of kiosks, their opening hours and the choice of the kiosk operators increases the likelihood of the kiosks being accepted and functioning well. If operators have a contract with the utility, regular supervision is important to ensure that the contract stipulations concerning cleanliness of the premises, prices charged and opening hours are respected.

Water kiosks, Haiti

In Belle Anse, Haiti, Malteser International built an aqueduct and supply line in 2011 and 2012, from a source at a mountain top. This water supply system serves 1,080 families (5,400 people) in Caduc and Bel Air and smaller habitations along the way with the required 15l/day/person. The water quality was tested and proved to be safe for drinking purpose.

The aqueduct and supply lines comprise of 11 km of length. The communities that live along the supply line dug the entire way for the tubes, partially through rocky ground.

Two major concrete tanks comprising 27m³ and 18m³ were built, together with six water kiosks and further public water collection points. For the taps, a model was chosen that closes automatically to limit the loss of water due to incorrect handling.

Water committees were trained for each water kiosk and equipped with small material for repair and also with a handbook. The members of the committees were chosen and assigned by the users and manage the operation of the kiosks. Each committee also includes one skilled laborer from the community in case of necessary repairs.

The distribution of the water and the maintenance are both linked to the water committees. There is a skilled technician available that should be paid from the collected funds in case of repair needs.

Malteser International is developing an Memorandum of Understanding (MoU) with all stakeholders, including the water committees, the municipality, water ministry, and the local agricultural association (the water kiosks benefit small peasants), to assure a sound and sustainable management set up for the water kiosks.

9.2 Water tankering[68]

Water tankering can be a rapid means of transporting water to areas in need during the initial phase of an emergency. However, tankering operations are very expensive and can be time consuming.

Types of tankers

It is best to use tankers that are specifically designed for this purpose as they are safer and more reliable. Temporary tankers made from flat bed trucks with portable storage tanks attached can be dangerous if the tank is not securely fastened. The delivery of bottled water may be a short term option, but it is expensive and inefficient. It also produces a major solid waste problem resulting from empty, discarded water bottles.

While employing tankers, it is important to be assured of a regular supply of fuel, which can be problematic in a crisis situation. In remote locations, it is also important to make the necessary arrangements for maintenance of the tanker fleet.

While hiring tankers, one should be sure that the tanks are made of stainless steel or other material suitable for the storage of drinking water. The tank should have an access point preferable large enough for a person to enter for cleaning purposes, and this access should be lockable with a dust-proof and manhole cover. The tank should also have an air-vent with an outlet that is screened to prevent dust, insects, birds etc, to enter. Most tanks are fitted with water pumps to speed up loading and unloading. Hoses and related couplings should be stored in a sealed container to protect them from contamination.

Water in the tanker should be chlorinated to prevent the build-up of organic matter in the tank and to ensure the water delivered is safe to drink. Chlorination usually takes place as the tank is filled with water.

9.3 Piped water distribution network[69]

Piped water distribution systems should be built to deliver the required quantity of water to the users and under satisfactory pressure. The main system components are the pipelines; other

[68] Adapted from; WEDC: Technical note 12, delivering safe water by tanker

[69] Sections of text adapted from; UNHCR; Water manual for refugee situations, 1992, p 100

basic components are break pressure tanks, valves, service reservoirs and watering points.

Branched networks, in which water is conveyed from a distribution main to different consumption points, following a treelike pattern, are most commonly used.

Pipelines can be classified in accordance with the tasks they should perform:

- Trunk mains convey water from the sources to other points in the distribution system over long or short distances. They may be pumping mains if the water is coming under pressure from a pumping system or gravity mains if gravity is the force used to generate flow. Distribution mains are those to which standposts and other service connections are connected.
- Service pipes connect the mains to a standpost or house connection
- Plumbing pipes form the pipework within stand posts, showers houses, etc.

Pipelines require the use of valves to control flows and pressures as well as for closing or opening a pipeline or a section of it. As the pipeline must always follow the terrain's topography, some valves are used for the release of air that may be trapped at high

Trench Digging for water supply distribution system in Nar Wai Village, Wa special Region, Myanmar

points (air valves) and to facilitate emptying and scouring the pipeline to flush out sediments that may have been deposited at low points (wash out valves). Valve boxes should always be built to protect control valves from undesirable tampering. Whenever it is necessary to reduce hydrostatic pressure in gravity pipelines, break-pressure tanks are used.

The most common water distribution facility is the public distribution tapstand. The SPHERE[70] standards of 2011 recommend that the maximum distance from a house to a tapstand does not exceed 500 m and a maximum of 250 people per tap, based on a flow of 7.5 litres per minute.

A review by the John Hopkins University[71] outlined a number of typical deficiencies in distribution systems in developing countries;

- the failure to disinfect water or maintain a proper disinfection residual;
- low pipeline water pressure;
- intermittent service;
- excessive network leakages;
- corrosion of parts;
- inequitable pricing and usage of water.

9.4 Storage

Reservoirs

Reservoirs are often needed to collect water from the source for future use and prior to treatment. Tanks, basins, cisterns, or any place in which water has accumulated can be used for this purpose.

Tanks can be above or below ground. Factors such as soil, outside temperature ranges, and cost should be considered to determine whether a tank is placed above or below ground. Some tanks can be used both above and below ground (i.e. polyethylene).

[70] The SPHERE Project, 2011 edition, p 97-99

[71] John Hopkins University, Deficiencies in drinking water distribution systems in developing countries Ellen J. Lee and Kellogg J. Schwab, 2005

A few common tank options:

Polyethylene tanks

Polyethylene tank in use in Illeret, Kenya

Polyethylene tanks are probably the most common type of tank being sold today. They vary greatly in size, shape, and color, and can be used above or below ground.

Most of the tanks are usually for above-ground installations. For under-ground installation, specially designed and reinforced tanks are necessary to withstand soil expansion and contraction. Polyethylene tanks are comparatively inexpensive, lightweight, and long-lasting and are available in capacities from small 200 liters to large 40,000 liters tanks. They are lighter in weight than other types of tanks, and consequently, are cheaper and easier to transport.

Black and dark colored tanks will absorb heat and thus, should be shaded or buried. The fittings of these tanks are according rmarket modifications and are easy to plumb. However, the fittings are not always tight, and should be checked for leakage occasionally.

Metal tanks

Galvanized sheet metal tanks are available in sizes that range from small tanks of 500 liters to medium-sized 10,000 liters tanks, and are lightweight and easy to relocate if required. Most tanks are corrugated galvanized steel dipped in hot zinc to improve corrosion resistance. These tanks should be lined with a food-grade liner, usually polyethylene or PVC, or coated on the inside with epoxy paint. The paint or liner will extend the life of the metal and should be non-toxic for potability.

These tanks are for above-ground use. Additionally, care should be taken when cleaning these tanks, as a film develops naturally on the inside of the tank, which coats the tank and contains corrosion which should be avoided.

Concrete

Concrete tanks can either be poured in place or prefabricated. They can be constructed above or below ground. Poured-in-place tanks can be very attractive and easily integrated into new construction. Concrete tanks, once poured, are considered permanent.

One unique advantage of poured concrete is that the concrete will over time decrease the corrosiveness of rainwater by leaching into the water. This advantage of concrete tanks results in a desirable taste added to the water by calcium in the concrete being dissolved in locations where there is slightly acidic rainwater. For potable systems, it is essential that the interior of the tank be plastered with a high-quality material approved for potable use.

Underground concrete tanks are prone to cracking and leaking, especially when in clay soil. Leaks can be easily repaired, although the tank may need to be drained to make the repair. A manhole should be provided to facilitate operation and maintenance.

Ferrocement

Ferrocement is the term used to describe a steel and mortar composite material. These tanks can be above or below ground. They are relatively low-cost and durable.

Ferrocement tanks are typically built with concrete, but have multiple layers of wire mesh - typically chicken wire-wrapped around a light framework of rebar, embedded in the concrete. Walls can be as thin as 2.5cm and still be strong. Consequently, it can cost less to build than a concrete-only tank.

Ferro cement tank under construction for a school by Malteser Interrnational in Cambodia

Ferrocement, like concrete, will need maintenance and repair as cracks appear. It is important to ensure that the ferrocement mix does not contain any toxic components. Some sources recommend painting above-ground tanks white to reflect the sun's rays, reduce evaporation, and keep the water cool.

Stone masonry

Hand made stone masonry have higher labor costs.

The mass of the stone gives these tanks two distinct advantages: it keeps the water cool in hot climates and they can be very attractive. As with ferrocement tanks, care should be taken to make sure the mix does not contain toxic materials.

These tanks are custom-built, so they can be as large as designed. Most tanks are designed to be circular, since this shape is more structurally sound. These tanks, if properly constructed and maintained, will last for decades.

Section 10: Pumping equipment

10.1 Handpumps

Before making a choice on the type of handpump to use, it will be good to check if the intervention country has a handpump Standardization Policy, in which case one has to choose the pump type from the standardized options. Availability spare parts should also be accessed.

10.1.1 Reciprocating pumps[72]

These types of pumps have a piston which moves up and down within a cylinder to produce positive displacement of water. On the upward stroke the piston forces water out through an outlet valve, and at the same time water is drawn into the cylinder through the inlet valve; the downward stroke brings the piston back to its starting position, and a new operating cycle can begin. These pumps can be operated by hand, wind or engine power. There are several types of reciprocating pumps;

i. Suction pumps, where the piston and cylinder are located above the water level, usually within the pump itself. It can operate up to a level of 7 meters below ground level. The pump sucks the water from the aquifer. The suction pipe needs to be at least 3 meter below static dry season water level. A 2-4 meter uncased borehole is needed at the bottom section to allow water entering the well.

ii. Deep well (lift) pumps, in which pumps, piston and cylinder sets are located below the water level. Water may be lifted with these pumps up to 180 metres or more. The pump is immersed in the aquifer and pushes water up. Cylinder pumps fit in 2inch GI

[72] UNHCR, Water manual for refugee situations, Geneva, 1992, p 64

casings, the water flows up through the casing. The pump should be at least 3 meter below static water dry season level and 4 meter above the bottom of the borehole.

iii. Force pumps: These pumps are able to pump water from a source and to deliver it to a higher elevation. They may be used in deep or shallow wells, and operate according the same principle for reciprocating piston pumps, with the difference that, for force pumps, pistons are located at the top and, therefore can be used to force water to elevations higher than the pump site.

iv. Shallow well rope and washer pump: This pump consists of a knotted rope that holds rubber washers guided through a plastic or bamboo or PVC pipe. The pump is rotated by a pulley on an axle. Depending on the type of rope pump, it can lift water from 0 – 30 meters.

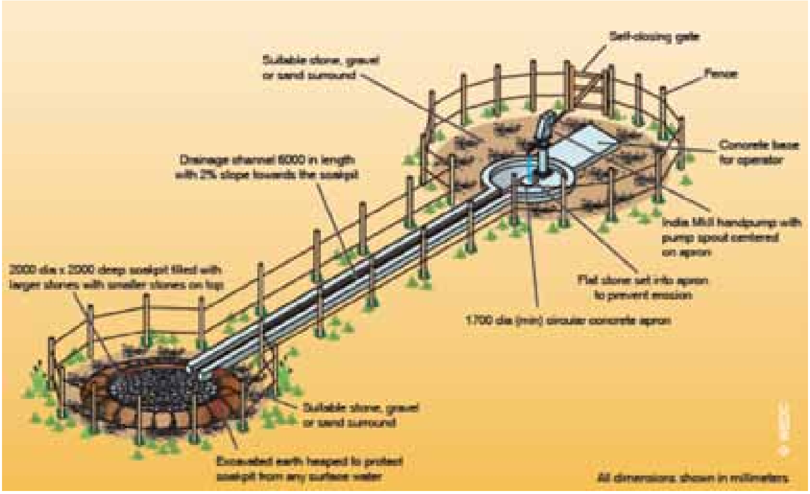
Generally, this type of pump is recommended to be used by one to five families only, due to the more careful handling that is needed.

The pump has been very successfully applied by Malteser International in its Cambodia program.

Rovai pumps are successfully implemented by Malteser International in Cambodia

Pump aprons

Around the wells, the area should be kept clean of stagnant water.



Adapted from WEDC poster number 7 on "Drainage from water points"

10.2 Centrifugal pumps

Motorized submersible pumps[73] are usually electrical centrifugal pumps which can operate when wholly submerged in water. The motor is totally enclosed and fully protected , and its position can be lowered in a shaft, well or borehole as the water is withdrawn. Corrosion-resistant bronze and stainless steel materials are used with sealed motor stator windings. Control of pump can be automatic and remote. Submersible pumps have capacities up to 450 m^3/h and heads up to 300 meters.

Borehole with submersible pump (Grundfos) installed at Rhino Camp, a settlement for refugees from South Sudan in northern Uganda.

[73] K. Nelson; Dictionary of Water Engineering, Warwickshire, 2005, p 316

10.3 Hydraulic ramp pump

Hydraulic ramp pumps are self-acting pumps which use the momentum of a fall of water in a stream to force a small quantity of water to an elevation considerably higher than the initial stream fall. If correctly installed, it will operate for many years without maintenance.

10.4 Energy sources[74]

10.4.1 Solar

The photovoltaic cells convert solar energy into electricity. Electric motors with pumps that run on solar energy are particularly feasible in remote areas where it is difficult to guarantee a steady supply of fuel. For relatively shallow pumping requirements, submersible centrifugal pumps can be used with solar power.

A typical sun-powered pumping system has an array of photovoltaic cells to convert light to electricity, a set of batteries to store the energy, and the electric pump and other components to control and conduct the system.

Solar panel installed to power water lifting pump, implemented by Malteser International in Cambodia

[74] Text partly adapted from: UNHCR; Water manual for refugee situations, 1992, p72

Solar panels are quite costly and prone to theft. The necessary measures should be take to avoid this. Location of the panels, and an ownership feeling for the panels by the beneficiaries are important aspects in this regard.

10.4.2 Wind

The feasibility to use wind mills to pump water for water supply depends on a large variety of factors:

- Winds are required to have a velocity of at least 2.3 m/sec during 60% of the time.
- The water source's yield should be at least equal to the pump's output
- Enough storage should be there (3 days minimum), to overcome times of low wind

10.4.3 Fuel

For humanitarian aid a pump with fuel (gasoline/diesel) is a temporary alternative. For sustainable systems the running costs are a factor to avoid. Due to their comparatively lower running costs, diesel engines are the most widely used fuel driven engines in water supply systems. Fuel consumption varies between 0.15 and 0.25 litres per hour per horsepower. Diesel engines may drive any type of pump.

10.4.4 Electricity

These type of motors should be preferred as a source of power for pumping if a reliable supply of electricity is available, as they have a better performance than diesel engines and require less maintenance.

Promotion of handwashing and tooth brushing habits by Malteser International in Cambodia

Section 11: School/health & social infrastructure water supply

Water supply at social infrastructure assets has in the past not received the attention it deserves in global development frameworks. All WASH-related MDG targets have focused on the household level whereas other facilities in sectors such as education and health where people crucially need access to WASH services have more or less been neglected[75]. As outlined in chapter 3, the current Post-2015 discussions dedicate the second of the four preliminary WASH-related targets: *All schools and health care facilities provide all users with basic drinking water supply and adequate sanitation, hand washing facilities and menstrual hygiene facilities* exclusively to social infrastructure. As indicated here and also most prominently in Malteser International's interventions, the specific focus is laid on schools and health care facilities. Hence, ensuring access to clean and regular water supply should always be considered as a cross-cutting issue in Malteser International's efforts in health, e.g. in constructing a new health facility, or rehabilitation relief, e.g. when rebuilding a school etc. The following chapter intends to give an overview of why the provision of water supply is crucial at schools and health centers as well as to provide practitioners with indicators and a subsequent checklist in order to facilitate access to water supply at social infrastructure assets.

Schools

Many schools in developing countries, particularly in rural areas, lack access to (drinking) water, sanitation and hand washing facilities. This leads to school children's poor health situation and children suffer from helminth infections and water-borne diseases such as diarrhoea and malaria as well as are exposed to chemical

[75] SDC Health Network 2012: Summary of the E-Discussion on WASH in Health Facilities.

contaminants in water (e.g. lead and arsenic). As unhealthy children are often absent from school, this furthermore impacts on children's education levels and ultimately diminishes their future opportunities[76]. Hence, for projects aiming to improve the WASH situation in target communities, schools are a key environment to provide clean and sufficient water since children usually spend most of the day at school. Moreover, children are a key target group as behavior learned at an early age is likely to be applied for the rest of their lives. In this regard, children can also function as messengers and multipliers disseminating good practices within their community and extended family[77]. For these reasons, it is essential to provide clean and sufficient water throughout the school day, and to encourage children to drink it, because even minor dehydration reduces children's ability to concentrate, and may damage their growth and healthy development in the long term[78].

Health centers/health posts

Similar to the situation in schools, also health facilities in developing country are usually ill-equipped with water supply infrastructure. In some circumstances people even do not seek medical care because they know that treatment is uncertain due to shortages of water.

However, ensuring good water quality and sufficient quantity is essential in health facilities due to the following reasons:

- Health centres are highly frequented by people that are potentially exposed to hospital-associated infections[79]
- Many patients have disabilities or are limited in their mobility and need WASH facilities that are easy to access
- Staff, patients and visitors need to be protected, epidemics need to be prevented and the health facility should act as a role model for the whole community

[76] World Health Organization (WHO) 2009: Water, Sanitation and Hygiene Standards for Schools in Low-cost Settings.
[77] [http://www.wsp.org/Hygiene-Sanitation-Water-Toolkit/BasicPrinciples/Facility.html]
[78] World Health Organization (WHO) 2009: Water, Sanitation and Hygiene Standards for Schools in Low-cost Settings.
[79] [http://www.who.int/water_sanitation_health/mdg3/en/]

- Water in health centers is used for essential activities such as cleaning of wards and patients, food preparation, hand washing of personnel, surgical processes etc.

The WHO[80] gives guidance notes and indicators on WASH that have been applied to the school and health facility context. The first three out of eight directly deal with water supply and give practitioners advice on what basic water-related needs should be fulfilled in social infrastructure assets.

Guideline 1 Water quality: Water for drinking, cooking, personal hygiene, cleaning and laundry is safe for the purpose intended

Indicators:

- Microbiological quality of drinking-water: Escherichia coli or thermotolerant coliform bacteria are not detectable in any 100 ml sample
- Treatment of drinking-water: Drinking-water from unprotected sources is treated to ensure microbiological safety
- Chemical and radiological quality of drinking-water: Water meets WHO guidelines for drinking-water quality or national standards concerning chemical and radiological parameters
- Acceptability of drinking-water: There are no tastes, odors or colors that would discourage consumption of the water (especially important for children)
- Water for other purposes: Water that is not of drinking-water quality is used only for cleaning, laundry and sanitation

Guideline 2 Water quantity: Sufficient water is available at all times for drinking, personal hygiene, food preparation, cleaning and laundry.

[80] World Health Organization (WHO) 2009: Water, Sanitation and Hygiene Standards for Schools in Low-cost Settings.

Indicators

Basic quantities of water

Table 1: Basic quantities of water needed in schools

Type of school	Basic quantities of water
Day schools	5 litres per person per day for all school children and staff
Boarding schools	20 litres per person per day for all residential school children and staff

Table 2: Basic quantities of water needed in health facilities[81]

Type of department	Basic quantities of water
Outpatients	5 liters/consultation
Inpatients	40–60 liters/patient/day
Operating theatre/maternity	100 liters/intervention
Dry supplementary feeding center (depending on waiting time)	0.5–5 liters/consultation
Wet supplementary feeding center	15 liters/consultation
Inpatient therapeutic feeding center	30 liters/patient/day

These figures are guidelines, however actual quantities of water required will depend on other factors as well, such as climate, availability and type of water-use facilities, and local water-use practices.

Additional quantities of water required

The following should be added to the basic quantities as necessary. Figures given are for day schools and should be doubled for boarding schools.

[81] WHO 2008: Operations Manual for Delivery of HIV Prevention, Care and Treatment at Primary Health Centres in High-Prevalence, Resource-Constrained Settings.

Table 3: Additional quantities required

Water used for	Quantities needed
Flushing toilets	10–20 litres per person per day for conventional flushing toilets
Pour-flush toilets	1.5–3.0 litres per person per day
Anal washing	1–2 litres per person per day

Guideline 3 Water facilities and access to water: Sufficient water-collection points and water-use facilities are available in the school to allow convenient access to, and use of, water for drinking, personal hygiene, food preparation, cleaning and laundry

Indicators:

1. A reliable water point, with soap or a suitable alternative, is available at all the critical points within the facility, particularly in toilets and kitchens
   - Hand washing points can be constructed in a simple and low-cost way such as tippy taps or just a pitcher of water and a basin (more details can be found in the Malteser International hygiene guidelines)
   - These points should always be equipped with soap, and in health centers with disinfection materials
   - If possible, functioning hand washing points should be in or within close proximity to classrooms and every hospital section where health care is provided (wards, consulting rooms, delivery rooms, operating theatres, etc.) as well as service areas (kitchen, laundry, sterilization, laboratory, waste zone and mortuary)

2. A reliable drinking-water point is accessible for staff and school children and patients, including those with disabilities, at all times
   - Drinking-water should be provided at clearly marked points, separately from water provided for hand washing and other purposes
   - Drinking-water may be provided from a piped water system or via a covered container with a tap where there is no piped supply

Additionally, showers and laundry facilities can be constructed if applicable.

In order to fulfill these needs, the following checklist[82] provides practitioners with a step-by-step approach on how to plan, implement and maintain activities related to ensuring water supply infrastructure at schools and health care facilities.

1. Assess water supply demand at the School/Health Center and set targets and indicators
   - Assessment includes observing current water use, examining the condition of existing facilities, and interviewing stakeholders (teachers, caretakers, children, hospital staff etc.) on current water use and desired water use.
   - Detailed tools for assessments can for example be found in UNICEF's manual "WASH in schools monitoring package" or in WHO's guidelines "Sanitation and Hygiene Standards for Schools in Low-cost Settings" for schools and "WASH in health facilities in emergencies" for health care facilities

2. Choose a suitable location for the water supply infrastructure
   - Easily accessible, even during rainy season, and for people with disabilities
   - Secure within hearing and visual distance from school/health facility or inside the compound
   - Decided upon in a participatory planning activity
   - Allowing supervision to avoid vandalism and monitoring on use, e.g. near the classroom door for the teacher to see
   - For health centers, the handbook "Design and Construction manual for water supply and sanitary facilities in health institutions" designed by Ethiopia's Ministry of Health, Water and Energy together with UNICEF gives clear guidelines on locations including health center floor plans

82 Checklist has been prepared with following resources: World Health Organization (WHO) 2009: Water, Sanitation and Hygiene Standards for Schools in Low-cost Settings; UNICEF 2012: Water, Sanitation and Hygiene (WASH) in Schools; WHO 2008: Operations Manual for Delivery of HIV Prevention, Care and Treatment at Primary Health Centres in High-Prevalence, Resource-Constrained Settings; USAID 2010: WASH-Friendly Schools. Basic Guide for School Directors, Teachers, Students, Parents and Administrators; [http://www.wsp.org/Hygiene-Sanitation-Water-Toolkit/BasicPrinciples/Facility.html]

3. Involve all stakeholders in the design, implementation and maintenance to facilitate use, understanding and acceptance
   - Actors to be involved include: Children, teachers, parents, hospital staff, directors, people with disabilites and patients, etc.
   - If water points or toilets are provided in schools or health care facilities, the community should usually also have access to safe water to avoid conflicts and ensure access for all

4. Design the most appropriate technical solution
   - Use locally already established technologies considering costs and finance options
   - Best are those facilities that are affordable, durable, encourage proper and simple use, and are easy to maintain and keep clean
   - Facilities should be child-friendly and inclusive (see section 15): Right size (e.g. height of taps) and age-appropriate (e.g. hand pumps that require less physical strength), adequate for size of school population and health facilities—no waiting!, safe, not scary or smelly, weatherproof, gender-friendly (separate facilities for boys and girls, male and female teachers)
   - Technology should be chosen taking account of local capacities for maintenance and repair

Most commonly used water technologies in schools and health centers are:

- Piped water including water storage containers
- Shallow covered wells with rope and bucket
- Deep boreholes
- Rainwater harvesting as roofs of school and hospital buildings normally provide a large catchment area and minimal maintenance is involved so that health staff and teachers can focus on their duties.
- Surface water collection (if no other source are available, water needs to be treated)
- Direct-action hand pumps
- Water standposts (on extensions of piped water schemes)
- For more details on the individual technologies see the relevant sections in these guidelines

5. Identify an appropriate water treatment technology
   - Recommended options for microbiological water treatment are boiling or filtering of the water, solar disinfection, and chemical disinfection (also these systems have been explained in previous chapters)
   - In schools: If no feasible solutions for water treatment can be found, asking children to bring their own drinking water in closed bottles can be an alternative

6. Incorporate a software component
   - Provide appropriate training and information to teachers, health center staff and extension agents in operation and maintenance of water supply infrastructure
   - Provide information materials appropriate to the context
   - More details on education and training can be found in the hygiene guidelines, e.g. in the chapter on the “Fit for School” approach

7. Ensure sustainability
   - In schools, children should play an active role in the cleaning and maintenance of facilities (e.g. through school health clubs)
   - Local or district education and health authorities can provide resources and direction for setting, achieving and maintaining, monitoring the implementation of water, sanitation and hygiene guidelines in schools and health centers as part of the routine monitoring and inspection process
   - Operation and maintenance plan to identify who is responsible for cleaning and maintaining the facility and what costs are involved; the operation and maintenance should become part of the daily routine in health centers and schools
   - Identify who takes over costs after project end; for example, authorities may finance spare parts, while the school or health center provide labour and cleaning materials

- WSSCC's handbook "Strengthening Water, Sanitation and Hygiene in Schools. A WASH guidance manual with a focus on South Asia" gives an excellent overview of what maintenance tasks have to be done by whom

8. Monitor the project
   - Conduct a baseline study before program implementation including the establishment of relevant indicators to compare the situations
   - Monitoring during implementation
   - Evaluation after implementation

WASH related drawing competition in Belle Anse (COTEDO), Haiti

Villagers trained to do repairs and maintenance for water supply system, Vietnam


Distribution of equipment during hand pump mechanic training in Rumbek, South Sudan

Section 12: Cross-cutting issues

As outlined in section 3, water is a human right and needs to be made affordable and available for all. This is also crucially indicated in the Post-2015 consultations. However, in developing countries there are huge discrepancies in terms of access to water for different population groups. In order to achieve greater equality, it is therefore essential that the needs of vulnerable and marginalized groups are considered. This is mainly a key issue for persons with disabilities, elderly and women – three population groups that suffer from discrimination as a result of the often inaccessible and gender-neglecting design of water-related buildings, services and infrastructure.

12.1 Gender

Gender inequality in the water supply sector means that women's and girls' full potential is not realized, and sustainability is diminished by women's lack of voice to ensure e.g. maintenance and repair of water facilities[83]. In most developing countries women and girls are responsible for collecting, treating and using water for household purposes while mainly men make decisions about water resources management and development at both local and national levels. Where water is scarce, women are the ones forced to fetch it – often traveling long distances on foot with heavy head loads, sometimes two or three times a day[84].

As women are generally the primary users of water and generally know the locations of existing water sources, their quality and reliability, and any restrictions on their use, it is crucial for project success to involve women at all levels. Benefits of involving

[83] World Bank 2010: Making Water Supply and Sanitation Work for Women and Men – Tools for Task Teams.
[84] [http://www.smartglobalhealth.org/blog/entry/women-and-safe-water-the-ripple-effect/]

women and ensuring easy access to nearby-located water supply sources for both men and women include amongst others[85]:

- Increased health of women who are released of the burden of carrying heavy loads
- Empowerment in community decision-making processes of women through the promotion of change in traditional gender roles
- Reduced workload gives women more time for other (income-generating) activities
- Girls can go to school more regularly if they are freed from collecting water at a source located far away
- Sufficient water available at school to maintain girls' toilet

To achieve these benefits and ensure equal access to water supply for both men and women, the following gender checklist[86] intends to give practitioners a few crucial considerations of how gender concerns can be addressed in WASH project interventions.

1. Conduct a gender analysis with regards to water supply

Detailed information on how to conduct a gender analysis can be found in the "Gender Checklist Water[87]" as well as in the "Gender Mainstreaming Field Manual[88]". A gender analysis should be conducted at the start of each project as it will help you to understand:

- The local context of the project area
- The specific needs of both men and women
- Men and women's different knowledge, attitudes and practices (KAP) as well as the different roles and responsibilities such as who carries water and how etc.
- The constraints of equal participation of both men and women

[85] Water Supply and Sanitation Collaborative Council (WSSCC) 2006: For her it's the big issue. Putting women at the centre of water supply, sanitation and hygiene.

[86] Checklist adapted from the following sources: IASC 2006: Gender and Water, Sanitation and Hygiene in Emergencies; AusAID 2005: Gender guidelines: water supply and sanitation; World Bank 2010: Making Water Supply and Sanitation Work for Women and Men – Tools for Task Teams; Asian Development Bank 2006: Gender Checklist: Water Supply and Sanitation; WEDC 2007: Infrastructure for All)

[87] Asian Development Bank 2006: Gender Checklist: Water Supply and Sanitation

[88] Ministry of Water Resources Women's Affairs Department Ethiopia 2005: Gender Mainstreaming Field Manual For Water Supply & Sanitation Projects

2. Establish gender-sensitive targets and indicators and disaggregate all relevant indicators and data by sex
   - Indicators might be e.g. male/female ratio in community water management committees, number of males and females using improved water sources, time saved in collecting and carrying water for women and men etc. (more indicators can be found in the World Bank's Manual "Making Water Supply and Sanitation Work for Women and Men – Tools for Task Teams")
   - Collect, analyze and routinely report on sex, age and disability disaggregated data on program coverage

3. Involve men and women equally in project design, implementation and monitoring
   - Consult with both men and women stakeholders in the community on what specific needs should be addressed by the project
   - Ensure equal participation of men and women in WASH committees and water-related meetings
   - Involvement does not end after the planning stage: Both men and women should e.g. be involved in construction, operation and maintenance of water supply sources and facilities
   - Monitor women's and men's involvement closely in order to address inequalities during the project period, e.g. access to and control over resources for collecting/carrying water, containers and storage facilities

4. Build water supply facilities gender-sensitively
   - Seek approval from men and women for sites where facilities should be constructed, e.g. near residents' houses and in a safe and easily accessible location to reduce women's burden of carrying water and gender-based violence (especially important in conflict situations)
   - Install separate areas for men and women e.g. in communal washing and laundry areas offering privacy
   - Technology must suit both men and women's needs: Women generally prefer simpler technologies that can be maintained

by themselves rather than high-tech installations that need to be operated with the help of outsiders.
- Physical requirements, e.g. in operating a hand pump, need to be taken into account in deciding on what type of wells, water pumps, taps, etc. should be used in the project

5. Build capacity among both men and women

- Train both women and men in the use and maintenance of facilities as well as in water treatment, storage etc.
- Specific training can be provided for women in technical issues (e.g. maintain and operate water pumps, wells and other water sources) and water management to overcome possible unequal knowledge levels

12.2 Inclusive WASH

The importance of inclusive WASH has already been discussed in the sanitation and hygiene guidelines providing a checklist of what inclusive WASH interventions need to consider (Annex 6 in the hygiene guidelines) and a latrine accessibility audit (Annex 3 in the sanitation guidelines). This chapter complements the given information with regard to access to water supply facilities for persons with disabilities.

Handicap International points out that "an accessible infrastructure will not only benefit people with disability but a wide range of people such as elders who have difficulties to move, pregnant women and young mothers, people with cardiac problems, persons carrying heavy burdens, people with a broken leg. Anyone can be part of one of these categories sooner or later in his life. Accessibility thus concerns a much larger public than only people living with disability, and must be considered when building a new infrastructure"[89].

[89] Handicap International 2008: How to build an accessible environment in developing countries. Manual #1 - Introduction & Accessibility standards.

However, persons with disabilities as well as elderly persons often face constraints in their daily life with regard to accessing water supply sources – especially in developing countries due to a lack of inclusive water infrastructure. Generally, Persons with disabilities have difficulties with their balance and coordination, squatting or lifting as well as experience weak grip and limited flexibility[90]. This makes performing simple tasks such as fetching water and washing clothes all the more challenging and impact on their well-being for several reasons[91].

If people with disabilities cannot access the main water points and have to use unclean alternative water sources this has a direct consequence on their health and hygiene situation.

Inaccessible or distant water sources force persons with disabilities to depend on others for water collection, taking a bath, doing laundry etc.

Access to water for everyone creates not only great benefits for persons with disabilities but also for the entire community:

- Increasing accessible WASH facilities near households, in community settings and schools will improve self-reliance and dignity of persons with disabilities as well as reduce work load of their families in terms of care-giving tasks[92]
- The time spent to have access to facilities (by persons with disabilities and their families) is potentially some time that can be used to participate in social or economic life[93]

Planning for and including people with various disabilities in the design of water services is a necessary first step to inclusive coverage. Similarly, if they are present in your project area, Disabled People's Organizations (DPOs) should be approached and asked for advice or cooperation. Moreover, when implementing inclusive solutions in access to water supply, the complete domestic water cycle – drawing water, transporting and storing water and household use of water – needs to be considered.

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90 WEDC 2005: Water and Sanitation for Disabled People and Other Vulnerable Groups: Designing Services to Improve Accessibility.

91 [http://www.wsscc.org/topics/crosscutting-themes/disabilities-and-wash]

92 CBM 2012: Inclusion made easy. A quick program guide to disability in development.

93 Handicap International 2008: How to build an accessible environment in developing countries. Manual #1 - Introduction & Accessibility standards.

CBM has developed a checklist (Annex on p ...) for practitioners of what other steps need to be considered in order to take inclusiveness into account and, which should be the aim of every WASH intervention, to mainstream inclusiveness. Another source giving guidance on planning and implementing inclusive WASH projects is chapter 8 of WEDC's manual "Water and Sanitation for Disabled People and Other Vulnerable Groups: Designing Services to Improve Accessibility".

There are actually already a lot of studies, literature etc. published but practice lacks behind and has mostly focused on sanitation but less on accessibility to water supply. Hence, the examples below give a few practical examples of how inclusive water supply interventions can look like. These examples show that usually with only minor adjustments and a little extra thought, huge impacts with great benefits for persons with disabilities can be reached. For more details, Handicap International's manual "How to build an accessible environment in developing countries" as well as Water Aid's "Technical manual on community water supply, hygiene and sanitation facilities" are excellent sources for practitioners on how water sources are built inclusively. Furthermore, Water Aid Australia provides through its website http://www.inclusivewash.org.au an extensive list of resources, including various videos and webinars. Another resource on equity and inclusion in WASH can be found on WEDC on link: https://wedc-knowledge.lboro.ac.uk/collection/equity-inclusion/

A simple dipper can enable persons with disabilities to easily draw water from a container or jerry can[94]

Household solutions

Simple approaches such as the dipper shown in the photo to the left, or tippy taps for hand washing can be used to improve the accessibility of water within the household for persons with disabilities. Installing the necessary infrastructure such as taps, pipes etc. at household level is a preferred option that enables persons with disabilities to access clean water sources from inside the household and therefore reduces the burden of fetching water from a communally located water source.

[94] Norman, Ray 2010: Water, Sanitation and Disability in West Africa: A summary report of the Mali water and disabilities study.

Inclusive access to water point[95]

Communal water points

Above figure gives an example of an inclusively built water point offering an improved access for wheelchair users. Important features besides the indicated points in the figure are:

- Plenty of circulation space around the water tap
- Seating block in front of the water tap
- Flat rest area at the end of the ramp so persons with disabilities can open the door easily

Moreover, also taps and tapstands should be installed inclusively. These are usually easy to operate and can be installed at a height that is convenient for all users and allowing to fill any size of container with water.

Design of technology/hardware

The hardware used in water supply infrastructure needs to be adapted for the needs of persons with disabilities. An example are modifications to hand pumps used at water points. For persons with disabilities there are two main difficulties. Firstly, hand pumps are generally designed to accommodate the size and muscular capacity of healthy, able-bodied adults and, secondly, the pumps are installed within an apron that is often slippery and therefore a challenging environment for persons with disabilities to keep the balance. To tackle these shortcomings and accommodate the needs of persons

[95] Water Aid Madagascar: Technical manual on community water supply, hygiene and sanitation facilities.

Person with disability using pump installed at the edge of the apron[96]

Woman using lengthened handle of water pump[97]

with disabilities, the hand pump can for example be installed at the edge of the apron enabling the persons with disabilities to operate the hand pump from outside (see photo above). Another solution is a lengthened hand pump handle as illustrated in photo above. The lengthened handle provides more leverage and less strength has to be used. In both examples a permanent pump seat is provided.

Laundry area with raised laundry slab[98]

Laundry/washing areas

Laundry or washing areas in communities can be made more user-friendly through laundry slabs and seating arrangements for persons that have difficulties or are not able to stand while washing.

Rural roads leading to facilities

Not only the water sources themselves but also the paths and roads to these points have to be constructed in an inclusive way. The water source should not be located too far away from the houses and there should be no obstacles in the way for persons

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96 WEDC 2011: WASH and people with disabilities. Improving access for all.

97 Norman, Ray 2010: Water, Sanitation and Disability in West Africa: A summary report of the Mali water and disabilities study.

98 Water Aid UK 2013: Mainstreaming disability and ageing in water, sanitation and hygiene programmes.

with disabilities. It is obvious that the path in the photo to the right is not feasible for wheelchair users however, since the majority of standards concentrate on the needs of people with mobility impairments, this example should raise awareness that access should also be ensured for people with sensory impairments. Therefore, contrasting signs, Braille signs and tactile paving could be applied[100].

Tactile path leading to water source[99]

Open waters

Although these water points do not usually provide drinking water, open water sources such as lakes, rivers, reservoirs etc. are still very important in some communities for tasks of the everyday life like washing clothes or dishes, or bathing. Open water sources can be made accessible through specific docks with handrails that can be constructed near the banks of a lake or a river[101].

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[99] Water Aid UK 2013: Mainstreaming disability and ageing in water, sanitation and hygiene programmes.
[100] Water Aid 2011: What the global report on disability means for the WASH sector.
[101] Handicap International 2008: How to build an accessible environment in developing countries. Manual #2 - Access to water and sanitation facilities.

Annex: Checklist for disability inclusion in WASH programs[102]

- Is data being collected regarding the needs and priorities of people with a disability during planning and throughout the entire program cycle?
- Are consultations held in physically accessible venues?
- Are disability related objectives and indicators identified in the planning stage?
- Have local DPOs been used in the consultation and planning process?
- Have a diverse range of people with a disability and DPOs been engaged to maximise their contribution and input into all phases of the program?
- Is there budget allocation to cover participation expenses and attendance time for consultations with people with a disability and DPOs?
- Has someone with a disability been employed in the project?
- Have privacy, hygiene, security and protection needs of all people with a disability, especially women and girls, been considered? Have WASH programs, including accessible infrastructure, been embedded in schools? (A lack of accessible or appropriate WASH facilities is a common reason for low participation in education, especially for teenage girls with a disability.)
- Is WASH information and education material accessible to people with a disability using large print, Braille, plain language, pictorial or audio formats?
- Are budgets reflective of disability-specific requirements and universal design principles?
- Are women, men and children with a disability directly involved in monitoring and evaluation activities?
- Are program outcomes and impacts for people with a disability being measured?
- Have existing disability-inclusive WASH programs and facilities been promoted and modelled?
- Are international agreements and local laws and guidelines used in advocacy to promote rights to disability-inclusive WASH?
- Have people with a disability been employed in the program?

[102] CBM 2012: Inclusion made easy. A quick program guide to disability in development.

Section 13: Mapping tool

Mapping is a useful tool for monitoring the distribution and status of water supplies. Data are collected and shown about different aspects related to the water availability and other public services in a community. The process is helpful to visualize the spatial distribution of water supply coverage and can thereby be used to highlight equity issues. CHHRA (Cambodia Health and Human Rights Alliance) a partner agency of Malteser International has developed village maps like the one below for its intervention areas.

Use of steel mold for concrete tanks

Steel cylinder molds are used for constructing concrete water tanks in and nearby the Karen refugee camps in Thailand. Use of this type of molds and tank design was found safe time, costs and materials compared to rectangular tanks made with wooden molding. WASH committees participated in every step for the design and implementation of this technique.

Section 14: New water related concepts

14.1 Multiple use services

People need water for multiple uses; drinking, cooking, washing, sanitation, crops, livestock, fisheries, gardens and small-scale enterprises. Such multiple needs are particularly relevant for people living in a rural or peri-urban context. However, in most communities the systems have only been designed for one type of use; domestic or irrigation/agriculture.

When people are faced with a single use service, they often use it in a way to meet their multiple needs. Consequently, they make illegal pipe connections, destroy or alter canal or pump access, drink unsafe water or exceed the limits of a system.

In a multiple use water services (MUS) approach, the services of the water sector are designed to provide for both the domestic and productive uses of water required at the homestead level.

MUS focuses on specific needs of water users and aims to improve well being and socio-economic status, which makes it a good poverty alleviation tool. (www.irc.nl "climbing the ladder: Multiple-use Water Services for Poverty Reduction).

The MUS group has developed a toolkit that can be used to practice this method. It can be found at www.musgroup.net . The MUS approach is also promoted in the discussion paper "No Food and Nutrition Security without Water, Sanitation and Hygiene" which the German WASH Network presented at the Bonn 2011 Nexus Conference.

14.2 Self supply concept

Small and remote communities, relying mostly on traditional sources of water such as unprotected family wells, are often not considered within the subsidized communal supply infrastructure[103].

[103] Mario Gelhard, Welthungerhilfe & WaterAid, WASH Self-Supply in Sierra Leone: Perspectives and Options, p 2

Self Supply[104] is the improvement to household or community water supply largely through user investment. It is based on incremental improvements, which are easily replicable, with technologies which are affordable to users. The improvements are led and financed by the water users themselves, from individuals to women's self help groups. Household water treatment, supply construction or up-grading, or rainwater harvesting are typical self supply technologies.

Self supply is a widespread current practice, but tends to be ignored by governments and funding agencies. Such a self-help approach is complementary to conventional communal supply, which refers to heavily subsidised water supply services which are implemented by governments and others, and then managed by communities.

Local self supply initiative in Cambodia, with simple rainwater catchment system linked to water storage jar.

[104] Adapted from [http://www.rural-water-supply.net/en/self-supply]

Section 15: Re-use of water[105]

Why should we consider to re-use of water? The following are some of the reasons why used water should be recycled and utilized again.

- Scarcity of fresh water in the world
- Climate changes
- Population growth
- Over utilization of fresh water by industries, agriculture etc.
- So many causes affected by man-made contamination to fresh water sources around the world

Domestic water use represents a growing proportion of global water use. Water use optimisation means resistance to chronic and short-term water scarcity and cost and energy savings for water supply and wastewater treatment as less water is required and less polluted water produced. Besides installing water saving appliances, source separation and reuse of different types of wastewater is a way to optimise water use at home. Depending on the type, quality and quantity of water, wastewater can either be reused directly, or treated and reused (recycled).

Benefits of reducing domestic water consumption in a developing country context include lower water bills or less time spent collecting water, reduced pressure on local water resources, and increased availability of potable water available for appropriate purposes such as drinking, cooking, and hygiene.

One effective way of reducing water consumption is to reuse the wastewater produced at the household level. The reuse of wastewater presents an opportunity to not only save water and financial resources by reducing water consumption, but to simultaneously increase food production or create livelihood. In developing countries, optimising wastewater reuse can therefore be a significant window for development.

[105] Adapted from: SSWM, Andrea Pain, Waste water reuse at home

A critical aspect for wastewater reuse is that the quality of wastewater must be appropriate for its reuse. There are different types of wastewater produced at the household level that have very different levels of contaminants (i.e. nutrients, pathogens) and reuse potential, including rainwater, greywater (all household wastewater except toilet flushing water), urine, blackwater, and faeces. Separating these streams of wastewater reduces the amount of wastewater contaminated by pathogens (i.e. blackwater, faeces, urine) by preventing it from coming into contact with less contaminated water (i.e. greywater, rainwater), thereby allowing greywater and rainwater to be used for a wider range of purposes.

By separating these waste streams at the source, it is possible to retain high volumes of relatively safe water (i.e.greywater, rainwater) that can be directly reused, whilst reducing the volume of wastewater (i.e. blackwater) that must be treated before reuse. Particularly in developing countries where water and wastewater systems are nonexistent or incomplete, implementing source separation is key in developing sustainable systems that will benefit users over the long term. Depending on the contaminants present in wastewater and its future reuse, wastewater can either be directly reused, or treated and reused (recycled). Similarly, organic waste (such as kitchen waste or toilet waste) can also be reused at the household level to reduce the quantity of waste produced and to gain the benefits of nutrients or energy.

How Does it Work?

Direct Reuse

Water that is of a relatively high quality with few contaminants, such as rainwater or greywater, can be directly reused. Numerous technologies exist for household rainwater harvesting, while greywater can be collected by refitting pipes to divert wastewater from appliances like showers, washing machines, and sinks.

Even though water for direct reuse may be relatively free of contaminants, the future reuse of rainwater and greywater must be appropriate for the level of contaminants present.

In this regard, rainwater from roof collection systems in particular represent available source of drinking water, often with minimum need for treatment.

Appropriate purposes for direct reuse can include:

- Washing (cars, etc.)
- Flushing toilets
- Gardening and food production

Treat and Reuse Wastewater (Recycling)

If wastewater is not suitable for direct reuse, household wastewater treatment options may be employed to reduce the level of contaminants to a level that is safe for reuse. Some possibilities for household wastewater treatment systems include:

- Constructed wetlands
- Biogas settlers
- Septic tanks
- Leach fields
- Evapo-transpiration beds
- Surface or subsurface groundwater recharge

Once treated sufficiently, wastewater can be used similar as rainwater or greywater.

Watering school gardens in Cambodia

Residual chlorine test

To assure safe water supply at Mae Ra Ma Luang and Mae La Oon in northern Thailand, supplies are chlorinated and camp based staff and WASH committee members trained to check the residual chlorine level. This is the simple indirect way to monitor the presence of coliforms. Staff and WASH committee members have acquired the necessary skills on chlorine demand, pH values, and chlorine minimum contact time with water. If the residual chlorine levels are too low, it exposes the users to contamination risks, if it is too high they are likely to refuse the water for drinking purpose.

Section 16: Emergency water supply

Provision of safe drinking water is the first priority in an emergency situation after a disaster has occurred, as people do not survive long without drinking water.

Need for expert advice on provision of emergency water supply facilities:
Access to safe drinking water is a life saving priority assistance activity, and mistakes or short comings can be potentially life threatening for the target population. Expert advice should therefore always be sought when setting up and maintaining emergency water supply facilities.

16.1 Intervention context

- The disaster context determines the required intervention needs for emergency water supply.
- In a flood situation, the main issue is to protect the water supplies from contamination and physical damage, and to assure accessibility during the flood. A successful approach to flood-resilient water supply facilities has been applied by Malteser International and its partners in northern India and Nepal, where raised platforms with hand pumps where installed, like shown on the front cover of these guidelines, to assure access to safe drinking water during flooding.
- WEDC/WHO[106] have developed series of technical notes specifying how to rehabilitate wells and boreholes that have been contaminated by flood water.
- In case of earthquakes, emergency water supply interventions mainly relate to repair of damaged systems, and provision of

[106] WEDC/WHO: Technical notes no 1,2 & 3 on cleaning and disinfecting wells and boreholes, 2005

temporary emergency water supply with tankers or other means. Tankering can be very costly in the long term, particularly in places where the rainy season damages the roads.

- Following are some preparedness actions to prevent or limit damages to water supply systems due to earthquakes:
  - Use flexible joints in pipe connections
  - Storage reservoirs should be as low as possible
  - Boreholes: stronger casings and wider than usual gravel pack with slightly larger diameter gravels
- For a displaced population in camps, water supply standards and directions and mentioned in the SPHERE and WHO references mentioned below could be applied.

!

In each emergency context mentioned above it should be strongly considered to chlorinate emergency water supplies. During emergencies, many households will have difficulties to keep their water supplies safe from contamination. An adequate residual chlorine level of the water supply will keep water kept at household level safe from contamination.

16.2 SPHERE Standards

The water supply chapter in the SPHERE standards 2011 (p 97) outlines standards and minimum supply requirements of water:

Water supply standard 1: Access and water quantity

'All people have safe and equitable access to a sufficient quantity of water for drinking, cooking and personal and domestic hygiene. Public water points are sufficiently close to households to enable use of the minimum water requirements.'

Key indicators for water:

- Average water use for drinking, cooking and personal hygiene in any household is at least 15 liters per person per day
- The maximum distance from any household to the nearest water point is 500 meters
- Queuing time at water source is no more than 30 minutes

Basic survival needs

Survival needs: water intake (drinking and food	2.5-3 liters per day	Depends on the climate and individual physiology
Basic hygiene practices	2-6 liters per day	Depends on social and cultural norms
Basic cooking needs	3-6 liters per day	Depends on food type and social and cultural norms
Total basic water needs	7.5 – 15 liters per day	

Focus on the response interventions in the early stage of an emergency should be on assuring the above mentioned basic survival needs.

Standards for maximum numbers of people per water source

250 people per tap	Based on flow of 7.5 liters/minute
500 people per hand pump	Based on flow of 17 liters/minute
400 people per single-user open well	Based on flow of 12.5 liters/minute

In case the above mentioned standards can not be followed, it is important to document this with appropriate reasoning, and indicate any measures to be taken to bring the access to water up to the desired SPHERE standards level over time, if this is not feasible in the early stage of an emergency. Also it is important to consider locally applied water provision standards and water supply services available with non-affected communities living in areas nearby the intervention area.

Water supply standard 2:

'Water is palatable and of sufficient quality to be drunk and used for cooking and personal and domestic hygiene without causing risk to health.'

Important water quality related key actions mentioned in the SPHERE 2011 handbook (p 100) are to undertake a rapid sanitary survey and, when time and situation allows, implement a water safety plan for the source.

Some water quality related key indicators:

- There are no faecal coliforms per 100 ml of water at the point of delivery and use.

- All affected people drink water from a protected or treated source in preference to other readily available water sources.

Water supply standard 3:

'People have adequate facilities to collect, store and use sufficient quantities for drinking, cooking and personal hygiene, and to assure that drinking water remains safe until it is consumed.'

An important key action to achieve this is to provide the affected population with appropriate water collection and storage facilities. Generally, each household should have at least two clean water collecting containers of 10-20 liters, one for storage and one for transportation. Water collection and storage containers should have narrow necks and/or covers for buckets or other safe means of storage.

16.3 LRRD (Linking Relief, Rehabilitation and Development) considerations

- To the extend possible, longer-term development perspectives and considerations should be taken on board while planning and implementing emergency interventions. The choice of water supply technologies is particularly important for this. Preference should be given to technologies for which local expertise and experience already exists. Any household water treatment methods that will be promoted should have the scope for continued use and replacement after the emergency intervention is over.

Preparedness:

- In areas that are regularly prone to certain disasters, it is essential to keep an emergency stock at head for the necessary materials and equipment to respond to water supply emergencies. Jerry cans, storage tanks, Water Treatment Units (WTU), water testing equipment, fuel reserves and Chlorine disinfection tablets are some of the items that need to be considered to raise the preparedness level to be able to respond to an emergency effectively.
- Staff of Malteser International and its partners in such disaster prone areas should e trained in doing water supply related emergency assessments and first response.

Coordination:

- Coordination with concerned governmental agencies and participation in WASH clusters and meetings that might be organized in the aftermath of a major disaster is essential to support effective and efficient delivery of emergency water supply support . Expert technical advice should also be sought from specialized agencies present on the ground, and partnerships are to be encouraged for technical tasks like water testing, borehole drilling with those agencies that already have the capacity present on the ground.

Local host community support:

- In case of water supply services provided to displaced people in a camp setting, it is essential to consider water supply conditions and requirements of the local population living adjacent to the camps as well. Big differences in service level between these two communities can lead to conflict. Including host communities is key for successful camp operations. They should be involved in search and selection of wells, addressing land ownership issues and matters that impacts cultural aspects and future sustainaibility of interventions.
- "Do No Harm" principle should be adopted while supporting local host communities.

Provision of safe water supply in Karen refugee camps, Thailand

Water supply initial needs assessment[107]:

- What is the current water supply source, and who are the present users?
- How much water is available per person per day?
- What is the daily/weekly frequency of the water supply availability?
- Is the water availability at the source sufficient for short-term and longer-term needs of all groups in the population?
- Are water collection points close enough to where people live? Are they safe?
- Is the current water supply reliable? How long will it last?
- Do people have enough water containers of the appropriate size and type?
- Is the water source contaminated or at risk of contamination (microbiological or chemical/radiological)?
- Is there a water treatment system in place? Is treatment necessary? Is treatment possible? What treatment is necessary?
- Is disinfection necessary, even if the supply is not contaminated?
- Are there alternative sources of water nearby?
- What traditional beliefs and practices relate to the collection, storage and use of water?
- Are there any obstacles to using available water supply sources?
- Is it possible to move the population if water sources are inadequate?
- Is it possible to tanker water if water sources are inadequate?
- What are the key hygiene issues related to water supply?
- Do people have the means to use water hygienically?
- In the event of rural displacement, what is the usual source of water for livestock?
- Will there be any environmental effects due to possible water supply intervention, abstraction and use of water sources?
- What other users are currently using the water sources? Is there a risk of conflict if the sources are utilized for the new populations?

[107] SPHERE Project 2011, p 125

Section 17: Urban water supply context

General

So far, Malteser International interventions typically focus on rural settings since these are “underserved” as compared to urban ones. However, as the world is urbanizing in rapid pace, it is important to get a better understanding on sector needs like water supply interventions in urban settings as well.

Some key data and statements on WASH facilities and services in urban slum areas[108]:

- Between 2000 and 2010, more than 200 million slum dwellers gained access to improved water, sanitation or durable and less crowded housing, thereby achieving twice-over the MDG target of improving the lives of 100 million slum dwellers.
- Although the MDG slum target has been reached, the number of slum dwellers, in absolute terms, continues to grow, due in part to the fast pace of urbanization.
- The number of urban residents in the developing world living in slum conditions was estimated at 863 million in 2012, compared to 650 million in 1990 and 760 million in 2000. Stronger, more focused efforts are needed to improve the lives of the urban poor in cities and metropolises across the developing world.

108 [http://www.un.org/millenniumgoals/pdf/Goal_7_fs.pdf]

The urbanization process[109]

Globally, we have already reached the point at which half of the population lives in towns and cities. In the developing world, urban populations are growing rapidly, and most of these additional people are living in 'unplanned urban settlements' – often referred to simply as shanty towns or slums.

Different challenges are posed in urban areas, due to factors such as:

- High population densities
- Transient populations
- Differing laws and legal status of slum dwellers
- Poor infrastructure (water pipes, electricity, sewers, roads, paving)
- Poor-quality housing built on the land no-one else wants, such as steep slopes

Getting clean water and toilet facilities to these people, who are usually very poor and often have no ownership of their land and few if any legal rights, is therefore a complex challenge, but a vital one.

Because of the complexity, agencies like WaterAid who are already intervening more in urban settings realize that there is no 'one size fits all' approach. However, there is a distinct urban approach that differs from work in rural areas.

WaterAid identified the following key issues related to their WASH activities in urban areas:

1. Strive to ensure services are delivered in an inclusive way.

In urban areas it can be very easy to 'miss' people – the poorest of the poor, the vulnerable, those with no rights, and the most excluded and invisible of all, such as the 'manual scavengers' who have to empty latrines for a living.

2. Be fit for the context.

In practice, this means, for example, recognizing that basic water and sanitation services are often already provided, and the challenge is more around bringing down prices or raising the quality and ensuring everyone is allowed to use them.

[109] Text adapted from: [http://www.wateraid.org/uk/what-we-do/the-crisis/urban]

3. Focus on building relationships.

Urban areas, especially the huge mega-cities are complex and multi-faceted. WASH agencies' role is to encourage collaboration and co-operation, for example between citizens action groups, local government partners and the local utility company in negotiations over supplying water to a slum area at a fair price.

4. Give high priority to sanitation and hygiene.

In urban areas, this has to be the focus. The reality on the ground in most urban settlements is that water is available, even if at a high price from water kiosks. But sanitation remains neglected, and open defecation presents the greatest risk to health in urban areas. Again, local government has a key role to play here.

5. Closely integrate influencing and service-delivery work.

WASH agencies should demonstrate how they can change things for the better through practical work on the ground, and use this as powerful evidence to demand that governments provide these services on a national scale.

Inequalities within urban areas[110]

Urban populations tend to have better access to improved water supply and sanitation compared to rural populations. However, there are also often striking intra-urban disparities in access. Those living in low-income, informal or illegal settlements tend to have lower levels of access to an improved water supply. Improving coverage in informal urban settlements may require innovative approaches, such as pay-as-you-go services offered at water kiosks or public water points as an intermediate step towards a higher level of service. There is a much higher reliance on water kiosks in the informal settlements and less access to piped supplies on premises.

[110] WHO/UNICEF: Joint Monitoring Program (JMP) , Progress on Drinking Water and Sanitation,2014 update

Facility with triple functions

In response to cyclone Nargis recovery efforts, Malteser International started its DRR projects in May 2008 in Ayeyarwaddy Division particularly in 49 villages of Labutta Township. One of the essential needs after every disaster is to access safe drinking water. Traditional drinking water ponds are deemed useless with its level of salinity after sea water intrusion. Other drinking water sources such as dug wells were damaged. Communities identify rain water collection as the most viable option to access drinking water.

Based on consultations with the community, Malteser International has constructed multi-purpose rain water collection tanks (RWCT) with a triple purpose. The RWCT aims to address the safe drinking water supply concerns, to serve as a venue for community meetings and also to work as a common flood shelter.

The RWCTs are made of concrete rectangular tanks with a proper foundation to serve as a refuge for about 50 people when a disaster occurs. The height of the tank is three metres, which can be accessed by a stair. The RWCT is designed with a roof to serve as a catchment for rain water. The RWCT's water capacity is around 36,000 liters and it is sufficient for 100 people for up to four months with at least three litres per capita per day.

Section 18: Linkages of water to disaster risk reduction and resilience

Disaster risk reduction (DRR) link to water supply

Scope for DRR related activities linked to water supply can predominantly be found in the field of disaster preparedness and mitigation.

Preparedness before disaster

- Disaster preparedness activities can be related to the development and strengthening of the emergency response capacity. Aim is that communities and public institutions are better organized and prepared to respond to a disaster, including provision of specialized equipment and development of contingency plans.
- Awareness sessions on how to keep water clean, and how to prepare safe water after a disaster http://www.kingcounty.gov/healthservices/health/preparedness/disaster/SafeWater.aspx
- Collection and stock piling of water purifying materials (Aqua-Tab, water guard, chlorine, alum etc.)
- Human resources development (formation for village DRR committee)
- Protection of water sources
- To store adequate safe drinking water at household, school, community centers for several days
- Disaster preparedness interventions must be hazard specific and feasible for local (community-based) operation and maintenance

Support to community WASH committees and local organizations which can be mobilized in the event of a disaster is also an effective disaster preparedness activity :

- Train committee members in needs assessment, disease control, water safety, etc
- Provision/ repair of material/equipment (e.g water trucks, central water supply points, etc)

Distribution of water supply items to households:
- Examples: water containers/packs, chlorine solutions, ORS, water filters,

Development of water facilities in refuge areas:
- Water supply facilities in so-called safe havens may need to be developed, e.g. hand pumps on easily accessible high grounds in flood prone areas

Certain hazards - such as flooding and cyclones – occur at fairly predictable times of the year, therefore disaster preparedness and contingency planning for continued functioning of water facilities during and after the occurrence of disasters should become a routine event prior to the disaster season wherever possible.

Mitigation

Mitigation activities focus on physical measures to protect water supply facilities against the impact of disasters. Examples of mitigation include protection, strengthening and/or re-location of water supply infrastructure.

General

Carefully locate water supply infrastructure in less disaster-prone areas and away from potential hazards (trees, utility poles which have the potential to fall, steep slopes, weak embankments, etc)

Measures specific for cyclone prone areas:
- Protect watersheds: prevent deforestation, reforest
- Reinforce above ground water supply infrastructure (tanks, etc)
- Raise infrastructure that can be flooded due to heavy (cyclone related) rains (good practice example on p 138)
- Strong roofs for pump houses etc
- Reduce the height of water supply related structures where possible. In case of high tanks, fill them with water and close valves during periods of high winds.

- In Samar province, Philippines storm surges where sea water rise had affected significantly the sources of water for drinking. Mitigation activities are required to avoid that the drinking water systems will be affected by future cyclones.

Measures specific for earthquake prone areas:

- Protect watersheds: prevent deforestation and promote reforestation (to avoid landslides)
- Use flexible joints in pipe connections
- Storage reservoirs should be as low as possible
- Boreholes: stronger casings and wider than usual gravel pack with slightly larger diameter gravels
- Ensure that foundations of water supply structures are well-tied together, and the walls securely fixed to the foundations and roof

Immediately after disaster

- The first goal of emergency response is to prevent outbreaks of waterborne diseases, caused by malfunctioning water supply. Provision of sufficient (survival) quantities of safe water is essential for this.
- Rapid assessment of affected population, conditions of water sources [damaged or still good]

During recovery and rehabilitation from disaster

- Water quality testing of good water sources
- Estimate daily water requirement (should access to 15 liters per day per person according to SPHERE stadards)
- If water sources are contaminated, dewatering, chlorination, installed treatment plant
- Drilling of new borehole
- Arrangement and utilization from existing good water sources
- Additional distribution of minimum drinking and food preparation water requirement if available good water sources are not sufficient

- Distribution of proper size water containers
- Distribution of water treatment materials [Aqua-Tab, water guard, chlorine, alum etc.]
- Planning of projects to build adequate, flood proof water supply systems with community.
- The Building Back Better" principle for WASH represents a DRR approach appropriate immediately after an disaster.
- Adequate understanding of the specific risk factors, particularly of the areas of vulnerability, and its causes, is needed
- Mitigation works may include raising boreholes, or deepening of boreholes;

Well constructed in Darbonne, Haiti

Section 19: References

The following links include many resources compiled by IRC and WASHplus and provide comprehensive information on water supply technologies, mainly in a rural settings.

Water supply overview documents / websites:

- Guidelines and Tools for Rural Water Supplies, 2012. S Smith, Rural Water Supply Network. http://www.rural-water-supply.net/en/resources/details/398 |
  This directory consists of 42 sets of guidelines, manuals, and toolkits about the delivery of rural water supply services.
- Rural Water Supply Design Manual, Volume 1, 2012. The World Bank. http://documents.worldbank.org/curated/en/2012/02/16187144/rural-water-supply-vol-1-3-design-manual . The purpose of this manual is to introduce readers to the key design concepts of waterworks facilities. Geared toward nontechnical readers—managers and operators of small water supply systems rather than designers/builders—the text of Volume I will provide users with the background they need to engage in decision making and discussions with technical consultants and contractors in the field.
- WASHtech. IRC International Water & Sanitation Centre. http://www.ircwash.org/projects/washtech
  The overall development objective of this new project is to strengthen sector capacity to make effective investments in new technologies through research and development of a framework, which assesses the potential of new technologies introduced into innovative decentralized systems.
- Water Supply: Sustainable Technologies. WaterAid. http://www.wateraid.org/what-we-do/our-approach/delivering-services

- This web page highlights WaterAid approaches that promote the use of technologies that are low cost and within the technical capacity of the benefitting community to operate and maintain. It also promotes the use of locally sourced materials and spare parts that can be easily purchased and transported.

Water Compass

http://www.watercompass.info/dst/sanitation/

Water Compass is a novel (drinking) water technology selection tool. This decision-support software contains almost seventy water management methods applicable in asset-poor, developing region contexts. Grouped from source protection to household water treatment and storage, these methods comprise the current best practice in the developing water sector. This tool will support you to make a better decision on which water technology to choose in your case. A better selection will lead to more sustainability of the water supply.

Hand washing stations

- Enabling Technologies for Handwashing with Soap Database. Water and Sanitation Program. http://www2.wsp.org/scalinguphandwashing/enablingtechnologies/index.cfm?Page=Home
  Searching this database using the terms "handwashing stations" retrieves photos and descriptions of 16 different examples of hand washing stations and tippy taps.

Household water treatment

- Dispensers for Safe Water Making Huge Strides in Kenya. WASHfunders Blog, June 2012. http://washfunders.org/Blog/Dispensers-for-Safe-Water-Making-Huge-Strides-in-Kenya
  Information on the benefits of a Chlorine Dispenser System
- WASHplus Household Drinking Water Quality Updates. http://blogs.washplus.org/drinkingwaterupdates/

This blog contains links to manuals, peer-review studies, videos, etc. about household water treatment technologies such as SODIS, Biosand filters, etc.

Rainwater catchments

- Rainwater Harvesting Technical Brief, n.d. WaterAid. http://www.wateraid.org/~/media/Publications/rainwater-harvesting.pdf
- Small Household Ferro-Cement Tanks and other water related tachnologies. Akvopedia, Aug 2012. http://akvopedia.org/wiki/Water_Portal

Rope pumps

http://akvopedia.org/wiki/Rope_pump

Water storage

- Safe Storage of Drinking Water in Developing Countries. Centers for Disease Control & Prevention. http://www.cdc.gov/ncezid/dfwed/PDFs/SafeStorage_2011-final-508c.pdf
  This technical note gives brief descriptions of jerry cans, the Oxfam Bucket, and other methods for storing water in a hygienic manner.

Wells

- Supervising Water Well Drilling: A Guide for Supervisors, 2012. D Adekile, Rural Water Supply Network. http://www.rural-water-supply.net/en/resources/details/392
  This guidance note assists geologists and engineers in charge of the supervision of borehole construction as well as project managers.

Disaster Risk Reduction (DRR) in WASH, good practice example from Malteser International supported projects in flood-prone areas, implemented in India by Sahbhagi Shikshan Kendra and Rural Self Reliance Development Centre in Nepal

Uttar Pradesh (UP) tops the list of flood prone states of India, with Bahraich (North East of Lucknow) being the most flood affected district in UP.

Every year during the monsoons, when the Ghaghara river brims over, the villagers end up drinking turbid flood water. The floods inundate all the wells, tube wells and hand pumps. So there is no drinking water, resulting into widespread illness and even some deaths.

The Intervention

New models of hand pumps suitable for such an area needed to be developed. With the idea of ensuring access of communities to safe sources of drinking water during floods, the concept of raised hand pumps (hand pump mounted on a raised platform) came into being. The hand pumps are mounted on raised platforms rather than at the ground level so they wouldn't be submerged during floods. 40 such devices were installed in the first year over a total of 32 hamlets.

The idea of fixing hand pumps on a raised platform was appreciated by the local government officials. They came forward and adapted this technique with little modifications and supported the construction of 800 raised platforms with hand pumps in 200 flood affected villages of Bahraich District.

Raised handpump, Rajapur, Bardia district, Nepal

Uttar Pradesh's State relief commissioner has now asked other flood affected districts in the state to adopt the model as well. In 2012 the concept was introduced across the border in Nepal, where the population faces similar constraints in accessing safe water during the flood season.

Annex 1: Rajasthan tanks

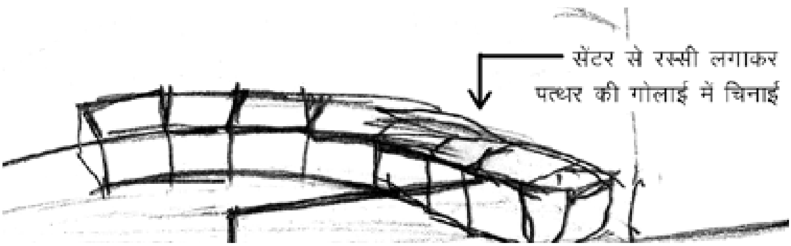
Construction of rain water harvesting tank (text from UNNATI tank construction manual developed for partnership project with Malteser International)

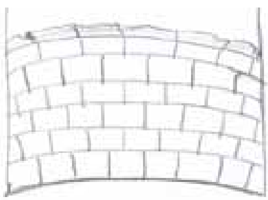
Rain water harvesting tanks are constructed in two dimensions. Tank of 24,000 l water capacity has a diameter of 10 feet and depth of 11 feet. Tank of 6,000 l capacity has diameter of 6 feet and depth of 8 feet. Both use covers of 21 sq. inches.

Some aspects that are taken care of in construction are as below:

Avoid presence of a tree within a radius of 10 to 12 feet

The tank is circular in shape. In stone masonry tank care has to be taken to maintain the joints of stone in line.

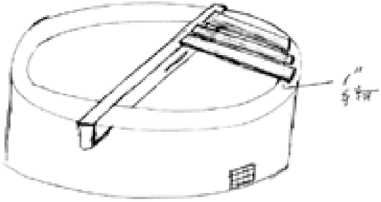




After setting of each layer of stone gap between the wall of digging and the stone has to be filled with sand.

The height should not be constructed more than 4 feet in one day.

For concrete construction, a cast has to be used. Base of the structure is 4 inches. Before making the base of concrete, it has to be sprinkled with water and leveled. The ratio of cement, concrete and sand is 1:2:4. Ratio for plastering is 1:5 (cement:sand). Water proof has to be included in the plaster mixture. Two coats of plaster are required.

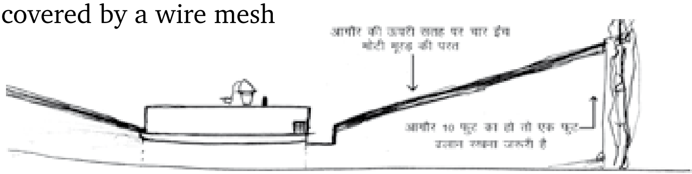


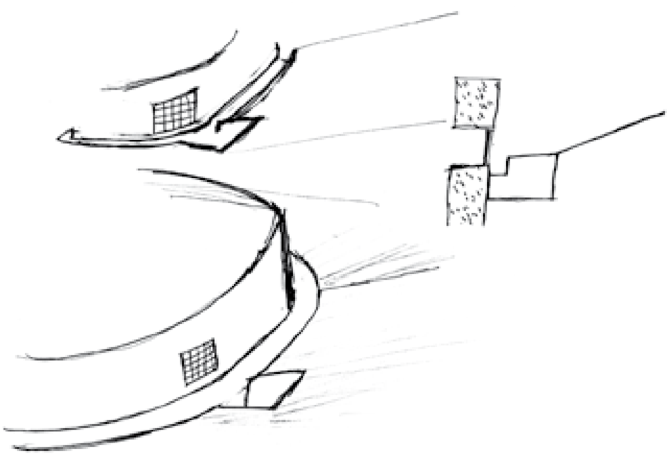
The tops of tanks are constructed of stone slabs. The slabs need to be fixed at least six inches over the sides. Gap between two slabs should not exceed 1.5 inches and should be joined together with cement mixture. The tank cover needs to be fitted properly before plastering the top.

The structure constantly needs to be sprinkled with water five times a day for 21 days. The tanks have to be fully filled with water after plastering.

Care has to be taken in the slope of the catchment. It should be in the ratio of 10:1 feet for tanks of 6,000 l capacity and 20:1 for tanks of 24,000 l. The catchment has to be covered with 4 inches of rubble.

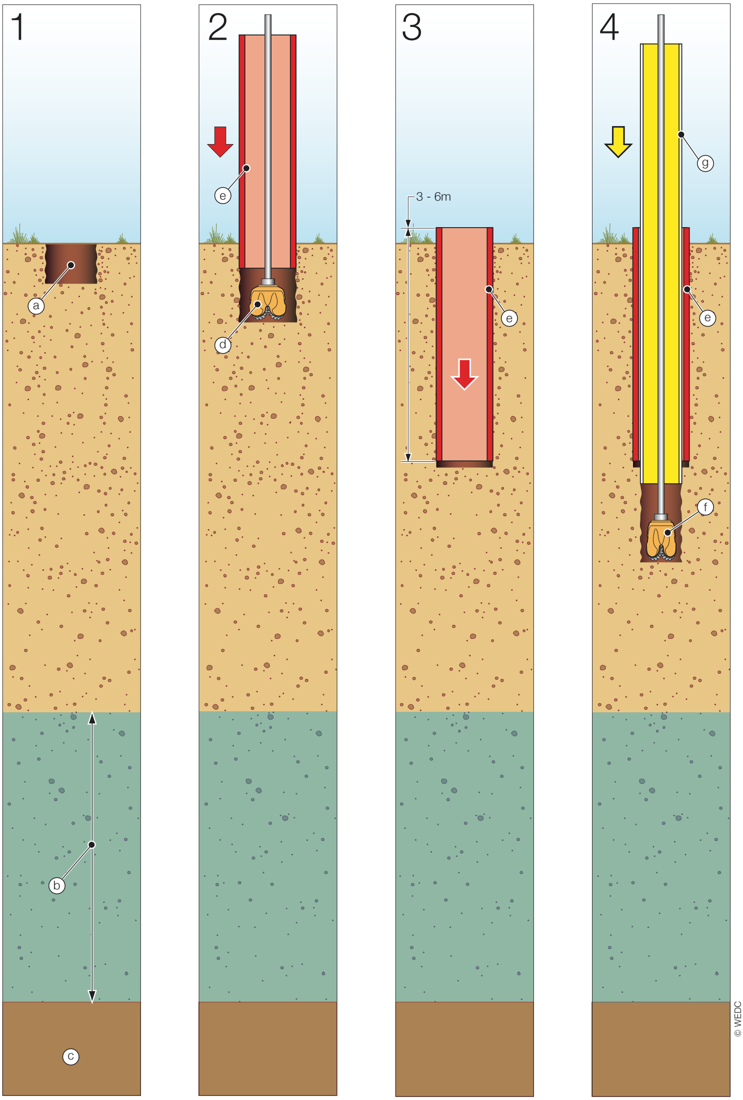
The tank is surrounded by a channel that takes the water to a vessel for sedimentation. After sedimentation the clean water passes through an opening that is covered by a wire mesh





Annex 2: Handpump installation

Part 1 of 3 **Poster 27**

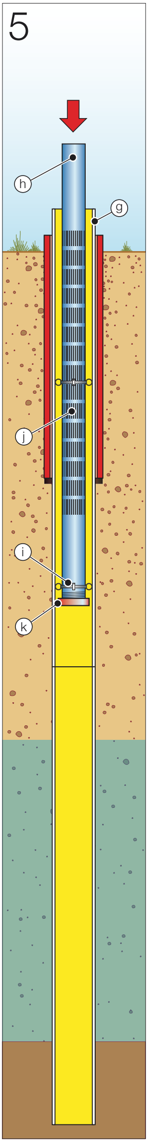


Preliminary hand dug hole (a) aquifer level (b) saturated sand (c)

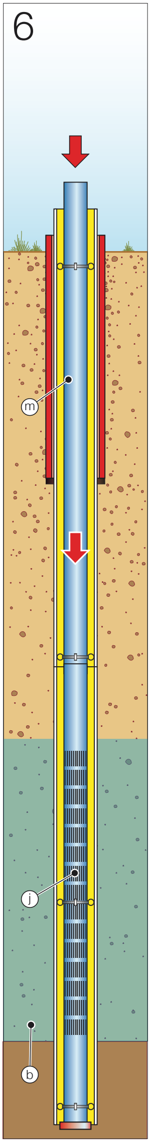
Drilling (d) and installing a temporary surface casing pipe (e)

Temporary surface casing pipe (e) installed to depth of 3 to 6m

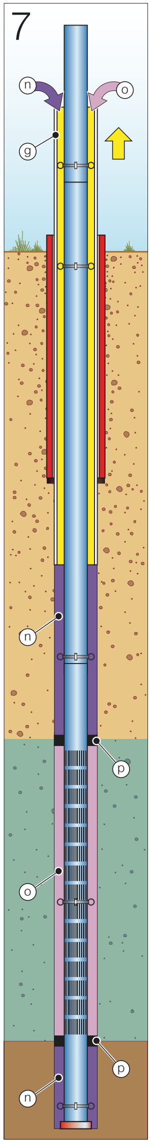
Drilling (f) and installing a second temporary casing pipe (g) inserted inside the surface casing pipe (e)



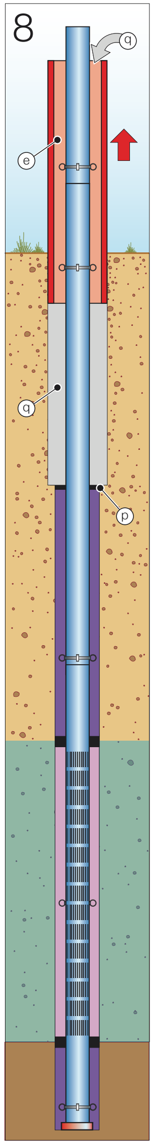
Installing permanent casing pipe (h) with centralisers fitted (i), built-in filter screen (j) and end cap (k), inside second temporary surface pipe (g)



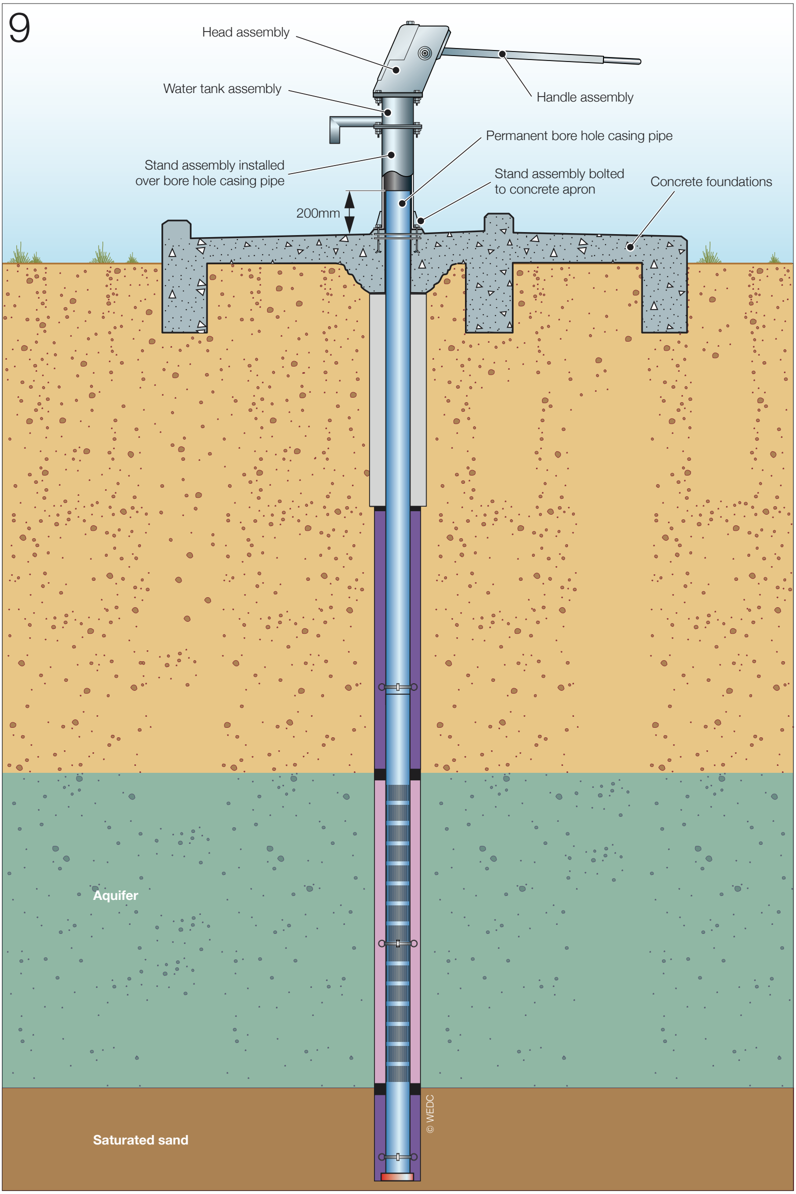
Pipes with screen (j) installed at aquifier level (b),with further plain pipe sections (m) added as required and screwed into previous permanent pipe



Withdrawing second temporary casing pipe (g) and filling gaps with foundation stabilizer (n), fine gravel (o) all separated by clay seals (p)



Withdrawing first stage temporary surface casing pipe (e) and filling gap left with either cement grout or expanding clay pellets (q)


9
Head assembly
Water tank assembly
Handle assembly
Permanent bore hole casing pipe
Stand assembly installed over bore hole casing pipe
Stand assembly bolted to concrete apron
Concrete foundations
200mm
Aquifer
Saturated sand
© WEDC


Hand dug well
under construction
in Darbonne, Haiti

Annex 3: WASH software and assessment techniques

1. Participatory Learning and Action (PLA)[111]

In PLA the process of the participatory method is in the centre and perceived as part of the solution process, i.e. the people take already action in deciding etc. Detailed information on PLA is available on: http://www.iied.org/natural-resources/key-issues/empowerment-and-land-rights/participatory-learning-and-action.

PLA is an approach for learning about and engaging with communities. It combines an ever-growing toolkit of participatory and visual methods with natural interviewing techniques and is intended to facilitate a process of collective analysis and learning.

The approach can be used in identifying needs, planning, monitoring or evaluating projects and programmes. Whilst a powerful consultation tool, it offers the opportunity to go beyond mere consultation and promote the active participation of communities in the issues and interventions that shape their lives. The approach has been used, traditionally, with rural communities in

Sanitation committee meeting, Vietnam

[111] Text of this chapter adapted from "What is Participatory Learning and Action (PLA): An Introduction, Sarah Thomas", University of Wolverhampton, Centre for International Development and Training

the developing world. There it has been found extremely effective in tapping into the unique perspectives of the rural poor, helping to unlock their ideas not only on the nature and causes of the issues that affect them, but also on realistic solutions. It enables local people to share their perceptions and identify, prioritise and appraise issues from their knowledge of local conditions. More traditional, extractive research tends to 'consult' communities and then take away the findings for analysis, with no assurance that they will be acted on. In contrast, PLA tools combine the sharing of insights with analysis and, as such, provide a catalyst for the community themselves to act on what is uncovered.

By utilising visual methods and analytical tools, PLA enables all community members to participate, regardless of their age, ethnicity or literacy capabilities.

How is it Conducted?

The repertoire of PLA tools is large and ever-growing and practitioners of the approach are constantly adapting and adding to the toolkit to meet their needs. What follows therefore are merely descriptions and examples of some of the more commonly used tools intended to give a flavour of the approach.

Mapping

Mapping activities are often used as introductory activities. They allow the community to show and talk about how they see the area where they live, the resources/facilities available and what is important to them in their environment. They enable 'outsiders' to begin to see a community through the eyes of the local people.

Time lines

Time lines are a type of diagram that help to record changes in a community/household/life of a community member over time. They are a way of noting the important historical markers and milestones of a community or individual, giving a wider historical context to issues being discussed. They can also enable participants to draw out trends.

Transect walks

Transect Walks are a type of mapping activity, but they involve actually walking across an area with a community member/group of community members, observing, asking questions and listening as you go. This information is then represented visually in a transect sketch/diagram. Usually, a transect walk follows the gradient/slope.

Problem trees

A ‘problem tree’ or ‘issue tree’ is a type of diagram which enables community members to analyse the causes and effects of a particular problem, and how they relate to one another.

Constructed around a focal problem/issue, the causes of that problem are traced down below, and the effects above.

Ranking/scoring activities

Ranking/scoring activities provide a way for community members to weigh up/rate/ prioritise items or issues either relative to one another or according to criteria.

Venn/chapati diagrams

These are two similar types of diagrams that can be used to explore the roles and relationships of groups and individuals and the links between them.

These are just some of the tools that are used as part of the PLA approach. The approach itself is dynamic and flexible but is underpinned by some key principles:

Roles are reversed such that local people are seen as the ‘experts’

Village consulation meeting, Myanmar

‘Handing over the pen’ – the community members themselves do the drawing, mapping, modelling, diagramming; the facilitators build rapport, listen, ask and learn.

KAP[112]

The Knowledge, Attitude and Practice (KAP) approach has its roots in human health and management sciences. Especially in the health sector, KAP has been used with patients on various long-term therapies where a long-term interaction is needed.

The approach is used in many Malteser International programmes to get information on the knowledge base of the community one wishes to work with, so that appropriate intervention strategies can be worked out that address identified issues.

Within the KAP approach, and particularly when used for WASH interventions, survey is the primary method used to collect data and information about beliefs, practices and perceptions, by asking a structured and predetermined set of questions which produces quantitative information and analysis from a large number (sample) of randomly selected individuals. Survey data is generally collected by trained enumerators who speak the local language and use a standardised questionnaire to collect information from respondents at the household level.

In planned WASH projects which are to be delivered over several years, these surveys are carried out at various stages of the project, to ultimately understand the final impact of the interaction. The key differences between using KAP as an approach versus KAP surveys

Participatory planning session in Vietnam

[112] Adapted from "KAP surveys in the context of WASH projects", DFID

as in WASH projects are in the process of interaction with the respondents, the duration of that interaction, the use of feedbacks, the nature of the intervention and the purpose of the analysis. Although KAP surveys are often packaged together with water, sanitation and hygiene interventions, their application is far more relevant in hygiene education as we can "measure" behavioral change over time, as compared to operation and maintenance of centralised physical infrastructure.

Project Planning, Sri Lanka

The MdM Guide[113] onKAP surveys is a very useful document to guide the use of this survey method in the field.

Surveys, evaluations and assessments

Baseline surveys, intermediate evaluations and final impact assessment studies are necessary parts of all WASH programmes. The purpose of baseline surveys is to establish a baseline figure on various indicators, which will be addressed and changed with the WASH project interventions. If we undertake impact assessments at the final stages of the project, these indicators could be monitored and verified.

If the project only has a small set of indicators, it is possible to accurately measure the changes between the baseline surveys and the final impact assessment. Structured surveys that use questionnaires are also criticised for not promoting enough interaction, being professionally controlled and not a good tool to promote true consultation between different groups.

2. WASH specific software

"WASH-IDD"

The WASH-IDD[114] approach was developed prior to the Malteser International community based disaster risk reduction project in

[113] MdM Guide on KAP surveys, 2011
[114] Malteser International, Annual report 2010, p 21

Sittwe and Rathidaung townships in Myanmar in 2006 and had been designed using several PLA tools and approaches. However, it is more than data gathering. WASH-IDD's final aim is to have a concrete agreement between the community and the project, by signing the deal. Therefore it is more practical and action oriented and once both parties keep their promise, the sanitation project can be successful and possibly sustainable. WASH-IDD also emphasises the community ownership of the project package or input strongly. Community contribution is also an essential part of it and therefore thorough discussion and identification of their felt needs is very crucial to make the project successful. The PHAST method, that is described later, is relatively more time-consuming.

Analysing weaknesses, planning improvements

Drawing on a collective analysis of the situation, and after intensive health and hygiene campaigns, the teams design concrete action plans with the villages and come up with solutions for problems related to drinking water, sewage, sanitation and hygiene in the area. One aim of this work is to guarantee a basic supply for everyday needs as part of the WASH initiative, and a second aim is to guarantee a basic supply for use the next time a disaster occurs. The measures cover a variety of areas: securing the water sources in the village and

Latrine construction, Myanmar

the access to these, transporting drinking water safely, treating it and storing it suitably for use by households, building latrines for families and at public buildings such as schools and health care facilities.

Setting priorities, seeing results

Once the problem is analysed in full, the villagers choose specific measures which are most important to them and prioritise them ahead of the collective implementation process. Finally, the villagers and Malteser International staff sign an agreement identifying the tasks required of the local community and the services Malteser International needs to deliver. This means that, from the very beginning, the success of the measures and the continuous follow-up after implementation will be based on close cooperation between the partners. This will help the villagers identify with the improvement process and increase motivation for the long-term transfer of the responsibility for the activities.

Participation and personal responsibility

While the community's sense of ownership of the project ensures that it will be maintained long-term, the participation of the population will be key to finding suitable solutions and to improving the living conditions on a sustainable basis – the population knows its own needs better than anyone else. The women, usually responsible for managing the home and the health of the family, now have more of a say thanks to the WASH-IDD methodology.

Their participation may help to avoid mistakes in the planning process and reveal what is still missing. Greater personal responsibility and involvement of the population are vital to secure a sustainable and decentralised supply of water and sanitation for all.

Malteser International developed a WASH-IDD implementation manual[115] that clearly explains the use of this method.

The implementation manual is structured in three parts. The first part contains advice on facilitation skills, ways to staff the implementation and also presents an overview of the approach. The second section provides step by step lesson plans for implementing

[115] WASH IDD Manual, Malteser International, Myanmar team, Yangon (internal document)

“Before we started building the latrines, we asked all the families in the village what they needed most urgently. Every family had a say. As it turned out, every family wanted their own latrine”, explains village chief Tha Yet Chaung.

“There were only five latrines for 128 families before. Now there is one for every family.”

the approach while the third and final section contains all the IEC materials and assessment forms.

The WASH-IDD approach was successfully field tested in Malteser International’s WASH intervention areas in Myanmar.

With guidance from the Malteser International staff, the village residents build latrines for their families as well as for schools and other public facilities.

PHAST[116]

PHAST is a participatory technique that develops people’s understanding of the linkages between sanitation, hygiene and health. The aim is to encourage the community to plan their own sanitation and hygiene initiatives, both at household and community level. The technique uses a number of graphical tools such as the sanitation ladder showing different type of defecation eg. from open defecation, open pit, to fly proof, ventilated improved pit, four-flush latrines.

PHAST is primarily a decision-support tool that uses a ‘seven step’ participatory approach to facilitate community planning and action. The seven steps are:

- problem identification
- problem analysis
- planning for solutions
- selecting options
- planning for new facilities and behaviour change

[116] Adapted from “Hygiene and Sanitation Software: A Overview of Approaches”, WSSCC, Eawag, 2008, Elizabeth Tilley, p 46-49

- planning for monitoring and evaluation and
- participatory evaluation.

PHAST works on the basis that as communities gain awareness of their WASH situation through participatory activities, they are empowered to develop and carry out their own plans to improve this situation. The planning method uses specifically designed tools, consisting of a series of pictures showing local situations. Community groups are then asked to say how these relate to the local situation and what they would need to do to solve the problems that they have identified.

When individual knowledge is required a process called pocket chart voting is used which allows the participants to vote in secret. The findings are then discussed by the group as a whole, but an individual never has to reveal their choice.

Strengths:

The WASH IDD process is extremely rewarding for both the community members and community workers, by involving the communities in their project planning and implementation through participatory techniques. Communities gain confidence and responsibility for their own projects and have a clear say in what they want and do not want.

Effective involvement of the community in monitoring and evaluation ensures that the services put in place respond to the needs of the community and that essential direct feedback provided can serve to change activities as necessary.

Community workers trained in participatory techniques, with proper guidance and management, can become a lasting asset to the programme and the community (World Bank, 2008).

The use of pictures and working in the third person enables communities to share information and plan in a manner which does not disadvantage illiterate people and allows people to express their feelings without exposing themselves.

The participatory planning, implementing and monitoring is creating strong feeling of ownership and responsibility to take care of their facilities by their own.

Weaknesses:

Requires in-depth training of community workers in participatory techniques. On average two weeks are needed for this training to be completed, to be followed up by regular refresher courses.

The identification and selection of the community workers is crucial. It is generally necessary to select experienced community workers to take part in the training. This however, may lead to several potential problems, since experienced community workers may not easily adapt to participatory approaches.

The PHAST approach requires that community workers have certain character traits: e.g. they must be outgoing, with a good sense of how the community responds to the participatory tools so that immediate adaptations can be made during implementation.

Requires an intensive management structure. Feasible in smaller "grass-roots" projects but problematic when going to scale.

PHAST tools are relatively time intensive in their use, requiring that the beneficiary communities are available to go through the participatory exercises; this may be seen as a burden if not properly discussed with the community beforehand. (World Bank, 2008).

These weaknesses can lead to PHAST being used incorrectly and so being largely ineffective. Moreover, evidence suggest that the scope for scaling up the use of the PHAST approach is limited.

WHO has developed a step-by-step guide[117] for the use of PHAST.

Red Point Method

Red Point is an innovative tool created to increase self-help capacities in communities. The tool was initially developed by Malteser International staff of Cambodia in March 2004. It was recognised as a new way of doing community based health promotion and as a way of initiation of self help activities among the rural villages.

The design highlights that many people have knowledge, beliefs, and motivation but with no supportive environment, their behaviors do not change.

Red Point works with people who are motivated and links them to a supportive environment and supportive people by making

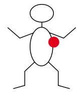
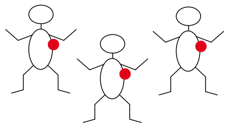
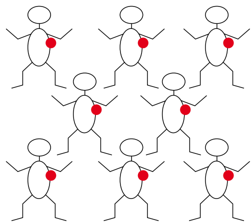
[117] WHO guide, step-by-step, PHAST

action plans. The design assumes that people have the motivation to address the health outcomes that are important to them as individuals, family, and /or community. The design highlights to the community that health education tries to prevent health problems by changing health behaviors with the supportive environment.

It results into ownership, empowerment, behavior change and sustainability by developing the self-help potential of communities. Motivation can be described as a source of energy or their particular RED POINT.

Red Point activities are facilitated by Health Promoters. The method involves 6 different steps as shown in the table below:

The method is described in detail in the Red Point Handbook[118]

An Individual with a Red Point 	Example An individual woman who has two children with tuberculosis.
Group of people with the same Red Point 	Example A group of families living side by side with lots of solid waste collecting in the ditch at the front of their houses.
Entire village with the same Red Point 	Example Many village members are concerned about the quality of the services at their local health centre.

Step	Objectives	Method
1. Introduction to the community	Build good relationships Explain the purpose	Group discussions Individual family visits
2. Identify Red Points	Find people that are motivated about specific health issues	Group discussions Individual family visits
3. Bring together people with the same Red Points	Link people with red points to people with the same red points	Set meeting times and locations
4. Identify root causes of the health problems	Understand all of the reasons why the problem happens Make it easier to make an action plan	Group and individual brainstorming Writing problem trees
5. Make health action plans	Write health action plans	Group and individual brain-storming Write health action plan
6. Follow up action plans	Make sure people follow the plans Identify new problems and make new plans	Visit people who wrote the action plan Evaluate impact of action plan

[118] Red Point Handbook, CHHRA and Malteser International, 2005

Abbreviations

CCA	Climate Change Adaptation
CHHRA	Cambodian Health and Human Rights Alliance
Cr	Runoff Coefficient
GI	Galvanized Iron
HACCP	Hazard Analytical Critical Point
HWTS	Household Water Treatment and (safe) Storage
JMP	Joint Monitoring Programme
LRRD	Linking Relief Rehabiliation and Development
MDG	Millennium Development Goals
MUS	Multi-use Service
NTU	Nephelometric Turbidity Unit
O&M	Operations and Maintenance
POU	Point of Use
RWH	Rainwater Harvesting
SODIS	Solar Water Disinfection
UN	United Nations
UNICEF	United Nations International Children's Emergency Fund
UV	Ultraviolet
WASH	Water, Sanitation Hygiene
WEDC	Water, Engineering and Development Centre
WHO	World Health Organization
WSP	Water Safety Plan
WUG	Water Users Group

Glossary

Aquifer

A geologic underground formation that will yield water to a well in sufficient quantities to make the production of water from this formation feasible for beneficial use; permeable layers of underground rock or sand that hold or transmit groundwater below the water table.

Backwashing

Reversing the flow of water through a home treatment device filter or membrane to clean and remove deposits.

Coliform bacteria

Non-pathogenic microorganisms used in testing water to indicate the presence of pathogenic bacteria.

Discharge

The volume of water that passes a given point within a given period of time. It is an all-inclusive outflow term, describing a variety of flows such as from a pipe to a stream, or from a stream to a lake or ocean.

Faecal coliform

The portion of the coliform bacteria group which is present in the intestinal tracts and feces of warm-blooded animals. A common pollutant in water.

Greywater

Wastewater from clothes washing machines, showers, bathtubs, handwashing, lavatories and sinks that are not used for disposal of chemical or chemical-biological ingredients.

Impermeable

Material that does not permit fluids to pass through.

Pathogen

Microorganisms which can cause disease.

pH

Numeric value that describes the intensity of the acid or basic (alkaline) conditions of a solution. The pH scale is from 0 to 14, with the neutral point at 7.0. Values lower than 7 indicate the presence of acids and greater than 7.0 the presence of alkalis (bases).

Recharge

Refers to water entering an underground aquifer through faults, fractures, or direct absorption.

Residual chlorine

The available chlorine which remains in solution after the demand has been satisfied.

Suspended solids

The small solid particles in water that cause turbidity. Particles of suspended sediment tend to settle at the channel bottom, but upward currents in turbulent flow counteract gravitational settling.

Turbidity

A cloudy condition in water due to suspended silt or organic matter.

Yield

The quantity of water expressed either as a continuous rate of flow (cubic feet per second, etc.) or as a volume per unit of time. It can be collected for a given use, or uses, from surface or groundwater sources on a watershed.

Zone of saturation

The space below the water table in which all the interstices (pore spaces) are filled with water. Water in the zone of saturation is called groundwater.

The human right to water and sanitation

On 28 July 2010, through Resolution 64/292, the United Nations General Assembly explicitly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realisation of all human rights. The Resolution calls upon states and international organisations to provide financial resources, help capacity-building and technology transfer to help countries, in particular developing countries, to provide safe, clean, accessible and affordable drinking water and sanitation for all.

Source: Resolution A/RES/64/292. United Nations General Assembly, July 2010

Malteser International is member of the German WASH Network, which was established in June 2011, and actively participates in activities undertaken by this network. We are also member of the Household Water Treatment and Safe Storage (HWTS) and sustainable sanitation SuSanA Networks