Technologies Policy

Last revised September 2016

Goal

20 Liters seeks to improve the health of vulnerable people by increasing access to clean water through rainwater harvest systems and improving water quality through filtration. The technology selected must be acceptable to the people and appropriate to the situation.

20 Liters will continue to innovate and redesign on existing solutions to improve the end-user experience and increase reliability and productivity.

20 Liters will further continue to develop new solutions that meet new or existing challenges in ways that increase positive results, lower costs, and have greater impact on the health and prosperity of our recipients.

Background on the World Health Organization Standards

Link to documents: http://www.who.int/water_sanitation_health/en

In 2004, WHO published the third edition of the *Guidelines for Drinking-Water Quality*. Addendums were published in 2006 and 2008. The fourth edition was published in 2011. This document is a framework for safe drinking water utilizing a preventive management approach that establishes health-based targets, water safety planning and independent surveillance.

Prior to 2011 the World Health Organization (WHO) defined an acceptable water treatment intervention as one that reduced diarrhea by 50%.

In 2011 WHO also published *Evaluating Household Water Treatment Options: Health Based Targets and Microbiological Performance Specification*. This standard set removal targets for three classes of pathogens: bacteria, viruses and protozoa. They set target removal goals for household water treatment (HWT) systems and classed them as: "Highly Protective", "Protective" and "Interim". It is important to note that the standard does not speak to the removal of parasites, worm cysts and amoeba. This may be because most types of HWT systems currently used in developing countries already remove these agents.

Discussion

The people 20 Liters interviewed in Rwanda primarily get their water from a swamp or river. Prior to getting their filter they were typically not treating their water before consumption. The most dangerous contaminates are parasites, worm cysts, and amoebas as evidenced by the number of cases of parasitic and amoebic dysentery reported by the local health clinics. While viral presence remains in most of 20 Liters' filtration solution, the local resistance to these viruses significantly lowers negative health impacts.

Locally-available treatment or collection options include:

WATER TREATMENT OPTION	AVAILABILITY	COMMENTS
BOILING	Government regulations on deforestation have greatly increased the cost of firewood and charcoal and stifled local collection of firewood and production of charcoal.	Many areas still see turbidity, odor, taste and discoloration issues post-boiling. Thus boiling is seen as costly and ineffective in producing potable drinking water.
CHLORINATION	Local stores and markets carry sodium hypochlorite solutions, some marketed for cleaning and some for water purification. One locally-manufactured source of sodium hypochlorite, called Sur'Eau was easily purchased in higher population areas (cities and large villages). In 2015, a sharp decline in the availability was noticed in all forms of sodium hypochlorite. The cause is believed to be related to poor sales.	This treatment option does not seem to be culturally preferred by either educated city-dwellers or rural communities. Some will only utilize the product temporarily to combat a known water-related illness. Reasoning ranges from taste and discoloration concerns to pricing and availability.
FILTRATION	At least one manufacturer of ceramic water filters exists in Kigali, though the product was not found to be commercially available. It is believed to be used by an NGO.	The slow filtration speed of ceramic filtration and their fragility are both seen as significant barriers to adoption.
WELL ACCESS POINTS	In some communities, hand-pump or mechanized wells have been installed near water sources. It is believed that 30% to 50% of these wells are operational. In addition, many broken wells have been opened	Water from many of the functioning wells contain high levels of silica, which add a "gritty" texture. Many of the wells are non-functioning and have been abandoned. Some older pit-well heads have been opened to allow for drop-bucket collection. A high water table means that in some areas, locals will climb down into wells to lift water out.

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COMMUNITY TAPS	National government planning seeks to install public taps in village centers across significant parts of the country over the next several decades. Many of the same sectors where 20 Liters works are slotted to receive public taps or have already received taps. In most cases, these taps will be free to the public.	Water from the taps has much lower turbidity than groundwater and in some cases exceeds the quality of rainwater. However, microbial content remains high and the water is still not considered potable.
BOTTLED WATER	Most road-side stores sell brands of bottled water at an average retail of $0.40 each. The bottled water meets or exceeds WHO standards. Those with financial means rely heavily on bottled water as even the piped-on-premises water available in homes in the major cities is not safe for drinking.	The vast majority of the rural population hardly ever consume bottled water due to the cost. While it is viewed as the "safest" method for procuring potable water, it is not affordable to be used as a sustainable solution.

There remains a significant un-met need for potable water across all of Rwanda, with obvious shortfalls in existing available solutions.

Several ministries within the Rwandan Government have been tasked with addressing water quality access and water-borne disease prevention.

Multiple community-based and WASH-sector agencies have also taken a role in creating access to clean water.

20 Liters has selected World Relief Rwanda to serve as our implementing partner through defined MOUs. World Relief Rwanda is uniquely positioned to empower our work because of their church empowerment strategy. World Relief is able to organize and empower local leadership to serve as the implementation and advisory council for every sector where we work. These councils provide the local access, leadership, and oversight that give our program feasibility and sustainability.

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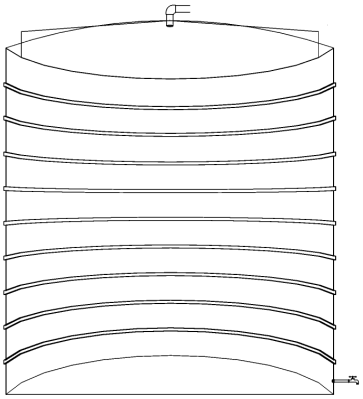
Rainwater Harvesting



The *Guidelines for Drinking-Water Quality* specifically addresses rainwater harvesting systems and promotes "simple good practice[s]" that "can offer drinking-water with very low health risk":

- Well-designed systems
- Clean catchments
- Covered cisterns and storage tanks
- Treatment, as appropriate
- Supported by good hygiene at point of use

While rainwater is "initially relatively free from impurities" the document further points out several potential hazards that can negatively impact the health risk:

- The presence of unsanitary materials in the catchment areas (dirt, leaves, fecal droppings, insects, etc.)
- Materials used in the catchment and storage not approved for use in contact with drinking water, or materials that can leach contaminants or cause taste, odor or discoloration when exposed to slightly acidic water
- Systems that do not divert the contaminated "first flow" of rainwater (which contains higher microbial concentrations)
- Cisterns and storage tanks that expose water to sunlight, mosquitoes, or potential fecal contamination
- Post-catchment contamination where the spout, spigot, or collection container are contaminated.

The system currently in use by 20 Liters utilize metal roofs for catchment, plastic gutters, PVC piping and food-safe tanks varying in size from 10,000 to 5,000 Liters. These systems provide easier access to a higher quality of water during the 4-month rainy season.

Strengths of the current rainwater harvesting model:

- Materials are durable
- Cistern is completely enclosed, eliminating sunlight and mosquito exposure.

Weaknesses of the current rainwater harvesting model:

- Catchment areas can contain unsanitary materials
- System doesn't divert "first flow"
- Spouts and spigots can be contaminated through environmental exposure

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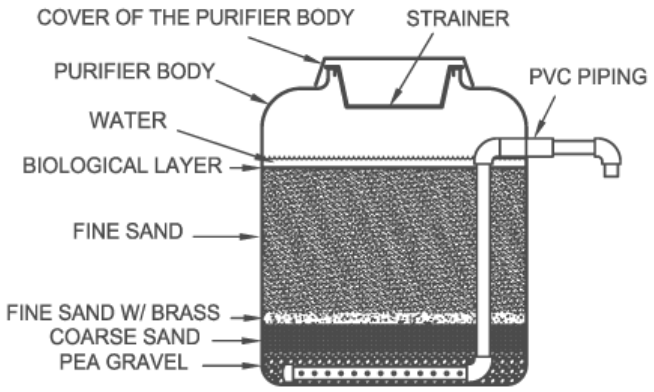
Bio-sand Filtration Solutions

Between 2008 and 2013, 20 Liters created and distributed bio-sand filters in the Maska Sector of Rwanda. Utilizing common practices, these filters were generally composed of a strainer, 4 types of filtration materials (including brass shavings), and a spout. The Initial design utilized concrete tanks and galvanized piping. 20 Liters quickly switched to 300-liter food-safe plastic tanks and PVC piping for greater portability and lower cost. Recipients were instructed on how to culture and maintain the biological layer.



Bio-sand filters working alone will not meet the 2011 WHO Interim Standard. Two installers of bio-sand filters, CAWST and Hydraid, have chosen to add chlorine disinfection or boiling, as a required secondary treatment, after water is filtered to reach the Interim Standard of treatment.

It is the recommendation of 20 Liters to boil or treat water with a chlorine treatment such as Sur'Eau, after it has been poured through the Slow Sand Filter.

By June of 2013, 20 Liters had phased out Bio-sand filters for several reasons:

- The weight and cost of materials were prohibitive to expansion
- The biological layer required a constant supply of "dirty" water to survive. If improved water were introduced, the filter became inversely effective and actually produced higher microbial content than the initial improved water

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SAND AND MEMBRANE (SAM) SOLUTIONS

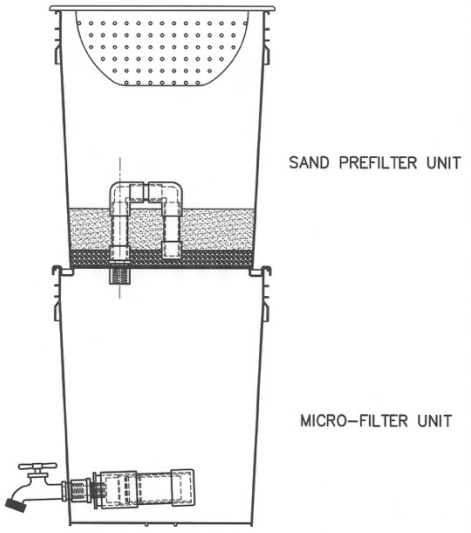
In June of 2013, 20 Liters introduced a three-phase filter with both 20-liter and 300-liter capacity models.

This model utilized a strainer / diffuser, a small slow-sand bed, and a micro-filter cartridge.

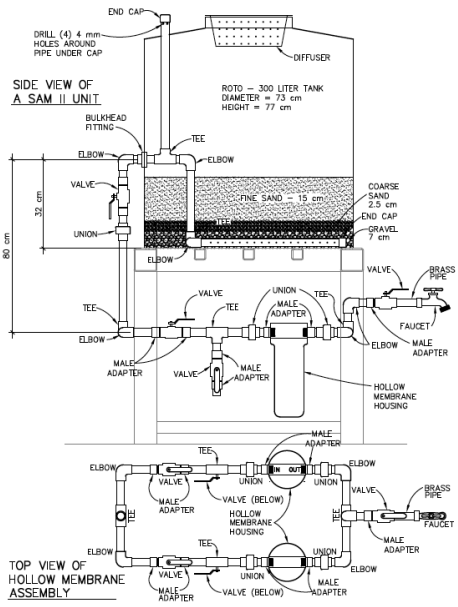
The 300-liter model (SAM II) utilizes a 24.5cm deep sand filter and a 0.1-micron hollow membrane filter.

The 20-liter model (SAM III) utilizes a 8.25cm deep sand filter and a 0.1-micron hollow membrane filter.

The WHO's *Guidelines for Drinking-Water Quality* specify an effective size range of 0.15-0.3mm for the sand and an effective depth of 0.5-1.5m.



While the sand meets the size-range, 20 Liters has shown through water quality testing that the utilized depth ranges are effective when accompanied by the presence of the micro-filter.



Strengths of the SAM solutions:

- The three-phase filtration model eliminates biological contaminates down to the 0.1-micron level, removing all of the primary disease causing agents that 20 Liters focuses on.
- Portable and easily assembled locally
- Cost-effective and allow for a greater population reach
- Durable materials and no moving parts provide a long lifespan and a low risk of breaking
- Using heavily contaminated water or improved water doesn't negatively affect filter's performance

Weaknesses of the SAM solutions:

- Systems require regular backwashing to work effectively, this backwashing is performed by the recipients who are not particularly knowledgeable of the operating mechanics
- Systems are at risk of contamination if backwashed with dirty water
- Systems do not collect and store filtered water internally, it is filtered through the membrane cartridge as the tap is opened.
- Post-filtered water can be re-contaminated by collection containers also used to gather contaminated water

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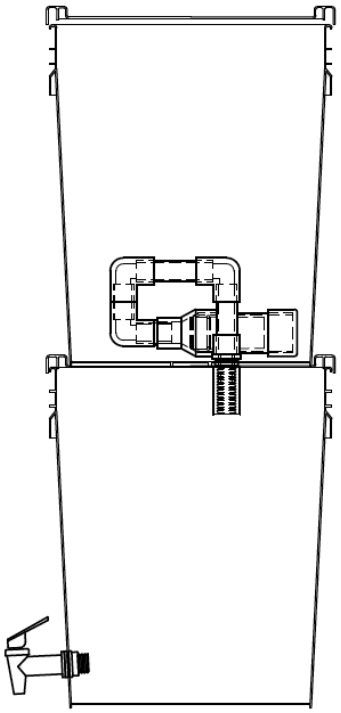
MEMBRANE-ONLY SOLUTIONS



In 2015, 20 Liters tested a modified version of the 20-liter SAM filter that removed the strainer/diffuser and sand components entirely. The 0.1-micron hollow membrane remained the same, though it was re-located to the upper container.

Filters were distributed among the staff of World Relief living in Kigali and having access to water piped-on-premises. This system

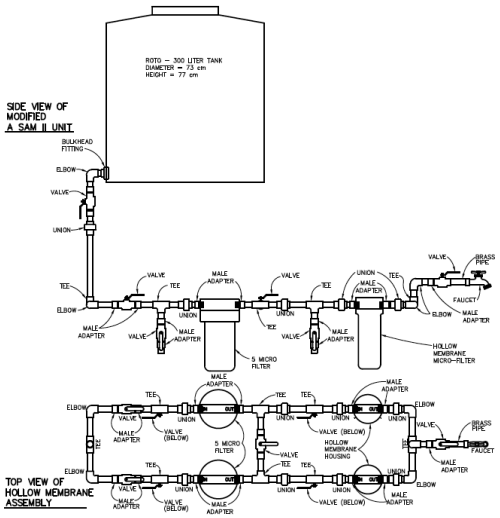
The purpose of the strainer and sand is to filter out larger components that the piped water does not contain, thus making them irrelevant in piped scenarios.

Water testing and feedback indicated this as the preferred solution for this environment for several reasons stated below.

The success of the 20-liter membrane-only solution led to the development of a 300-liter membrane-only solution.

The 300-liter model relied upon two 1-micron membrane tube cartridges and two 0.1-micron hollow membrane cartridges running in series.

These filters were tested with Water Aid Rwanda in a school system in the city of Kigali. Water testing and feedback results were similar to the 20-liter model.



Strengths of the Membrane-only solutions:

- Recipients report greater ease of use, faster flow rates, and greater production
- The 20-liter model collects and stores filtered water internally, lowering the risk of post-contamination
- The 300-liter model's in-series filtration design allows for the filter to backwash itself, almost eliminating the risk of post-contamination
- The 20-liter model is easier to backwash than the SAM version

Weaknesses of the Membrane-only solutions:

- Membrane filters will quickly clog if turbid water is used
- The 300-liter model's backwashing procedure is more complex, requiring additional training

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CHLORINE-PRODUCTION SOLUTION

In 2015, 20 Liters began to explore options for enabling locally production of sodium hypochlorite. This initiative, due in part to the decline of commercially available products, seeks to:

- Provide an affordable post-treatment product
- Create local entrepreneurship opportunities

In basic principle, a mixture of salt and water can be exposed to an electric current to produce sodium hypochlorite, a type of chlorine with a shorter shelf-life than calcium hypochlorite.

Two products were reviewed and tested by 20 Liters:

- A pour-through solution developed by Safe Water International Ministries (S.W.I.M)
- The SE200™ Community Chlorine Maker produced by Cascade Designs' Mountain Safety Research division.

The S.W.I.M solution was found to be too unreliable based upon voltage from the power source. The SE200 was designed for personal use and produced too small a quantity for a viable community solution.

20 Liters developed a 5.6-liter boil-in-place solution ("the Chlorinator") that can be partnered with an 80 amp-hour battery, solar array and charger to make 5 liters of sodium hypochlorite (at 0.2-2 ppm) in approximately 5 minutes.

The Chlorinator is undergoing initial field testing in Masaka and Ghanga Sectors.

20 Liters will consult with knowledgeable agencies to develop an entrepreneurship strategy for future application.

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20 LITER TECHNOLOGY STANDARDS

- Prior to working in a community, 20 Liters will do an assessment to find the best-fit water technology to improve access to clean water for the community.
- Water improvement systems will be designed for easy use and maintenance.
- Where ever possible local products will be used to construct water improvement systems.
- Local technicians, from local churches, will be trained to install and maintain water improvement systems.
- Local technicians will be trained to teach recipients how to use the water improvement systems.
- Follow-up home visits will be performed by the local technicians and program staff.
- Surveys will be performed regularly and at various time intervals to measure the impact and performance of filtration solutions and program delivery methods
- Sufficient water testing will occur on solution models to ensure that each model meets desired quality standards.
- 20 Liters will keep abreast of current World Health Organization Standards.
- 20 Liters will develop and maintain relationships with government, private and not-for-profit organizations to keep up to date on current water technology developments, sector best-practices, and current policies.
- 20 Liters will seek to avoid duplication of efforts by planning with government, private and not-for-profit organizations with a vested interest in the areas where we work.

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