A TOOLKIT FOR MONITORING AND EVALUATING HOUSEHOLD WATER TREATMENT AND SAFE STORAGE PROGRAMMES

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EXECUTIVE SUMMARY

An estimated 780 million people drink water from unimproved sources, and millions more drink contaminated water from improved sources (UNICEF/WHO, 2012). Until safe, reliable, piped-in water is available to every household, interim measures, such as household water treatment and safe storage (HWTS) to prevent contamination during collection, transport and use in the home, are needed to reduce the burden of diarrhoeal disease. While a growing body of evidence demonstrates that the use of HWTS methods improves the microbial quality of household drinking-water and reduces the burden of diarrhoeal disease in users, there is also increasing evidence that inconsistent and/or incorrect use may be a major challenge in realizing the full potential from HWTS. In order to develop effective mechanisms to encourage and sustain correct use of HWTS, there is a need to monitor and evaluate uptake. To date, there has been a lack of harmonized relevant tools and indicators to assist in the monitoring and evaluation (M&E) of HWTS programmes. This document is intended to address this need.

Integrated planning, combined with effective M&E, is critical to achieving programme aims. M&E of HWTS include 1) process monitoring to assess programme implementation and 2) quantitative analysis through surveys, direct observation and water quality monitoring. As part of this document, a set of 20 indicators is recommended (see **Table S-1**). These indicators build upon previous efforts among HWTS stakeholders and are grouped according to the following themes: *reported and observed use*; *correct, consistent use and storage*; *knowledge and behaviour*; *other environmental health interventions*; and *water quality*.

A decision-tree is presented in section 4 to assist in the selection of indicators based on programme aims and resources.

Following the presentation of the core indicators, commonly tested water quality parameters—including turbidity, free and total chlorine residual, *Escherichia coli* and thermotolerant coliforms, and arsenic and fluoride—are discussed. Additionally, step-by-step guidance to conduct M&E is delineated, including descriptions on how to 1) understand the context within which the HWTS programme is operating; 2) develop the M&E question(s); 3) select the appropriate indicator(s) to answer the question(s); 4) develop an M&E plan; 5) develop the M&E tools; 6) select and train the M&E team; 7) conduct the M&E; 8) compile and review the data; and 9) analyse the data and disseminate the results. Real-world examples of M&E in HWTS programmes are included throughout the document to highlight key points, and annexes provide additional resources on the topics presented.

The ultimate aim of collecting M&E data and disseminating M&E results is to achieve the main benefit of HWTS: improved health. The value of HWTS M&E will be realized only to the extent that results are utilized to inform future programmes, policies and investments. The progressive accumulation of M&E data from HWTS programmes will provide an important knowledge resource for guiding implementation and scaling up. This, in turn, will result in decreased incidence of disease and healthier lives for all those who consistently and correctly use HWTS.

Table S-1: Core HWTS indicators

	REPORTED AND OBSERVED USE
1	Self-report treating drinking-water
2	Observation of drinking-water treatment method
3	Self-report safely storing water
4	Observation of safely stored drinking-water
	CORRECT, CONSISTENT USE AND STORAGE
5	Knowledge of correct use
6	Demonstration of correct use
7	Demonstration of safe water extraction
8	Frequency of non-use by most vulnerable
9	Consistently treating drinking-water with HWTS
10	Use of improved drinking-water source
	KNOWLEDGE AND BEHAVIOUR
11	Knowledge of at least one proven HWTS method
12	Received messaging and/or training on HWTS
13	Access to HWTS products
14	Personal norm for drinking treated water
15	Confidence in improving the quality of their drinking-water
16	Community support in treating drinking-water
	OTHER ENVIRONMENTAL HEALTH INTERVENTIONS
17	Knowledge of other environmental health interventions
18	Use of other environmental health interventions
	WATER QUALITY
19	Households effectively using HWTS method to improve quality of household drinking-water ("effective use")
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ACRONYMS

AIDS	acquired immunodeficiency syndrome
CAWST	Centre for Affordable Water and Sanitation Technology
CDC	United States Centers for Disease Control and Prevention
CFU	colony-forming unit
FCR	free chlorine residual
FoQus	Framework for Qualitative Research in Social Marketing
GDWQ	WHO *Guidelines for Drinking-water Quality*
GPS	global positioning system
HIV	human immunodeficiency virus
HWTS	household water treatment and safe storage
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation
M&E	monitoring and evaluation
MDG	Millennium Development Goal
MF	microfiltration
NF	nanofiltration
NGO	nongovernmental organization
NTU	nephelometric turbidity unit
PSI	Population Services International
RO	reverse osmosis
SOHIP	Seeds of Hope International Partnerships
TRaC	Tracking Results Continuously
UF	ultrafiltration
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
UV	ultraviolet
WASH	water, sanitation and hygiene
WHO	World Health Organization

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1. INTRODUCTION

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The burden of diarrhoeal diseases is largely borne by developing countries and continues to drain important resources from already impoverished economies. Each year, an estimated 1.9 million deaths, primarily of children under five years of age, are caused by unsafe drinking-water and inadequate sanitation and hygiene (WHO, 2008a). The accumulated burden of repeated diarrhoeal diseases also results in decreased food intake and nutrient absorption, malnutrition, reduced resistance to infection and impaired physical growth and cognitive development (Baqui et al., 1993; Guerrant et al., 1999). The World Health Organization (WHO) estimates that improving water, sanitation and hygiene (WASH) could prevent approximately 9.1% of the global burden of disease and 6.3% of all deaths (Prüss-Üstün, Bonjour & Corvalán, 2008).

In addition, an immediate link exists between household water storage and breeding of dengue fever vectors. Dengue fever outbreaks have increased fourfold since 1995, with 2.5 billion people at risk today (WHO, 2011a). Tight-fitting water container lids and other environmental vector control measures have been shown to significantly reduce the risk of dengue fever (Phuanukoonnon, Mueller & Bryan, 2005).

An estimated 780 million people drink water from unimproved sources, and millions more drink contaminated water from improved sources (UNICEF/WHO, 2012). Providing safe, reliable, piped-in water to every household is the ultimate goal of WHO and the United Nations Children's Fund (UNICEF) and would yield optimal health gains while contributing to the Millennium Development Goal (MDG) targets for poverty reduction, nutrition, childhood survival, school attendance, gender equity and environmental sustainability. While pursuing this long-term goal, WHO and UNICEF are also committed to incremental improvements in drinking-water supplies and have called for targeted, interim approaches that will accelerate the health gains associated with safe drinking-water (Sobsey, 2002). One such approach is household water treatment and safe storage (HWTS).

A growing body of evidence demonstrates that the use of HWTS methods improves the microbial quality of household water and reduces the burden of diarrhoeal disease in users (Fewtrell et al., 2005; Clasen et al., 2007; Waddington et al., 2009). Based on this evidence, HWTS has been recommended in the WHO *Guidelines for Drinking-water Quality* (GDWQ): "Household water treatment approaches have the potential to have rapid and significant positive health impacts in situations where piped water systems are not possible and where people rely on source water that may be contaminated or where stored water becomes contaminated because of unhygienic handling during transport or in the home" (WHO, 2011b). WHO also recognizes the health contribution that HWTS can make among people living with human immunodeficiency virus (HIV) and recommends the integration of HWTS along with other WASH interventions in prevention and treatment efforts (WHO, 2008b; WHO/USAID, 2010). In addition, in 2009, WHO and UNICEF announced a seven-point strategy for the treatment and prevention of diarrhoea among children that highlights the importance of HWTS alongside other prevention interventions, including handwashing, community-wide sanitation, breast-feeding and measles and rotavirus vaccines (UNICEF/WHO, 2009).

The effectiveness of HWTS as a preventive health intervention requires that individuals, especially vulnerable populations, correctly and consistently use methods that make their water safe for drinking. Evidence indicates that less frequent use of HWTS is associated with an increased incidence of diarrhoeal disease (Arnold & Colford, 2007; Clasen et al., 2007; Waddington et al., 2009). Furthermore, epidemiological models based on quantitative microbial risk assessment have shown that even occasional exposure to untreated drinking-water can largely diminish the potential health benefits from water quality interventions such as HWTS (Hunter, 2009; Brown & Clasen, 2012; Enger et al., 2012). Measuring effective use (the percentage of the population that actually used the intervention to make contaminated source water safe to drink) provides important information for understanding and developing solutions to overcome challenges associated with inconsistent and/or incorrect use.

Although the need for consistent and harmonized monitoring and evaluation (M&E) of HWTS interventions is clear, there is a lack of tools and common HWTS indicators. This document addresses this gap by recommending indicators and providing examples of conducting M&E on HWTS programmes. It builds upon previous HWTS M&E efforts, including indicators developed by the United States Agency for International Development (USAID) Hygiene Improvement Project (USAID, 2010) and a performance monitoring plan created and used by Population Services International (PSI) in their Point-of-Use Water Disinfection and Zinc Treatment Project (PSI, 2008).

This toolkit and associated efforts to improve M&E of HWTS also contribute to a growing movement towards greater accountability, which includes "results-based financing" or "pay-for-performance" (World Bank Group, 2012). This trend focuses on measuring outputs, such as households relying on unsafe sources whose drinking-water has been treated effectively at home, as opposed to inputs, such as the number of filters or chlorine tablets delivered. The information gained through M&E will allow for more reliable and comparable assessments of the value of HWTS; this, in turn, can be used to modify programmes and improve outcomes, which can then be used to justify greater investments and nationwide scaling up of HWTS. Such scaling up—especially within HIV, nutrition and maternal/child health programmes—is critical for achieving the intended health impact of improving drinking-water quality at the point of consumption.

The main audience of this document is public health officers, WASH practitioners, donors and policy-makers. Additional audiences include HWTS manufacturers and regulators, who may find value in understanding how methods are used and how user preferences can be reflected in the design of such methods. Lastly, use of the indicators recommended in this toolkit by academics in experimental trials of HWTS will serve to validate the indicators and promote greater cross-fertilization and communication among the research, implementation and policy communities. The document focuses primarily on longer-term development settings, but many of the concepts and indicators may also apply to emergency situations, for which there is also currently a need for improved M&E. Many of the M&E concepts apply to other public health interventions as well. All of the information and tools presented herein are intended to be flexible, such that they can be adapted to specific M&E needs and existing local and national efforts.

This toolkit is not intended to support evaluation of the *efficacy*, or performance in laboratory settings, of HWTS methods. Such information is detailed in *Evaluating household water treatment options: health-based targets and microbiological performance specifications* (WHO, 2011c), which provides a risk-based framework for assessing the performance of HWTS in regards to the three major pathogen classes of diarrhoeal disease concern (i.e. bacteria, protozoa and viruses).

This introduction is followed by an overview of HWTS (section 2), a description of M&E (section 3), HWTS indicators (section 4), design and implementation of M&E efforts (section 5) and conclusions (section 6). The annexes provide practical tools, including a summary of HWTS methods (Annex A), links to bibliographic resource material (Annex B), a sample evaluation survey (Annex C) and sample sanitary risk assessment forms (Annex D).

2. HOUSEHOLD WATER TREATMENT AND SAFE STORAGE

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Four WASH interventions—increased access to water, improved drinking-water quality, adequate sanitation and handwashing—have been shown to be effective in reducing the incidence of diarrhoeal disease (Fewtrell et al., 2005; Clasen et al., 2007; Waddington et al., 2009). HWTS is an important intervention to improve drinking-water quality and thereby interrupt one major pathway of disease transmission. In this section, we discuss disease prevention and HWTS; the role of M&E in HWTS programmes; the International Network on Household Water Treatment and Safe Storage; and the various HWTS methods.

2.1 HWTS AND DISEASE PREVENTION

Understanding the characteristics of existing drinking-water sources, attitudes and practices in the communities and households that are most in need of HWTS is important for maximizing the benefits of HWTS. Although it is often the poorer households that suffer most from diarrhoeal disease, these households may be the least likely, based on self-reported data, to use HWTS products (Rosa & Clasen, 2010). Targeting vulnerable groups and optimizing the benefits of HWTS interventions require a wider assessment of overall environmental and health conditions.

The use of water safety plans provides a systematic means to address drinking-water safety from catchment to consumer and thus can be a useful instrument to determine when and where HWTS is most appropriate. Water safety plans are the most effective approach to ensure consistent supplies of safe drinking-water by requiring the identification, prioritization and management of risks to drinking-water safety before problems occur (Bartram et al., 2009; WHO, 2012). Regular monitoring of the control measures put in place and periodic review of the water safety plan are also required to ensure that the control measures continue to work and the water safety plan as a whole is effective and remains up to date. Water safety planning draws on the principles and concepts of sanitary inspections, the multiple-barrier approach and hazard assessment and critical control points (as used in the food industry) (WHO/IWA, 2011). Water safety plans can be adapted to all water supply types, from point sources to large piped systems, in existing and new systems and in all socioeconomic settings.

The health benefits associated with water quality improvements resulting from HWTS are likely greatest when HWTS is implemented in tandem with complementary environmental health interventions (Esrey, 1996; Pickering & Davis, 2012). For example, in a World Bank study, it was shown that HWTS combined with interventions to reduce indoor air pollution and insecticide-treated mosquito nets had a notable impact on poverty reduction (Harou & Doumani, 1998; Shyamsudar, 2002). In southern Malawi, the combination of hygiene kits (including a covered water storage container, soap for handwashing, a chlorine disinfectant and education materials) with antenatal care resulted in sustained improvement in water treatment practices as well as an increased uptake of prenatal visits, delivery in clinics and use of antenatal services (CDC/CHAI, 2011; Wood, Foster & Kols, 2012). Furthermore, the United States Centers for Disease Control and Prevention (CDC) demonstrated that using a similar approach of targeting pregnant mothers through integrated packages in western Kenya led to greater uptake of health messages (CDC, 2011). Integration provided incentives for mothers to visit health clinics to access services and capitalized on mothers' motivation to improve hygiene practices just prior to the arrival of new life. Lastly, integration is cost-effective and results in health-care savings, as demonstrated by a recent analysis of a combined campaign targeting HIV and acquired immunodeficiency syndrome (AIDS), malaria and diarrhoea in Kenya (Kahn et al., 2012).

2.2 IMPORTANCE OF M&E IN HWTS

Comprehensive M&E help ensure the effectiveness of HWTS by keeping the focus on the key objective elements of success. M&E are also important for supporting implementation of HWTS, as exhibited by the oft-quoted saying, "what gets measured gets done" (Drucker, 1954). By monitoring the proposed set of indicators in this document, for which there are associations with health outcomes, programme implementers can make reasonable inferences about the potential health benefits of HWTS. For many programmes, measuring outcomes is sufficient to answer the M&E questions. Measuring health impact requires more resources, a sufficient study size and an understanding of epidemiology and statistics. Where resources are invested in assessing health impact, outcome indicators provide an important complement and confirmation of impact data.

The harmonized indicators presented in this toolkit are designed to inform estimates of risk reduction and health impact. These indicators also allow for comparability of data across programmes and among countries. In addition to monitoring the harmonized indicators, programmes may also be interested in measuring additional, programme-specific indicators to assess particular operational parameters. It is recognized that those involved in development initiatives, including HWTS, may be tempted to publicize positive outcomes and ignore disappointing evaluations. Lessons learnt from less than ideal results are critical to improving programmes in the future and maximizing the benefits gained from use of HWTS.

2.3 INTERNATIONAL NETWORK ON HWTS

The purpose of the International Network on Household Water Treatment and Safe Storage (hereafter referred to as "the Network") is "to contribute to a significant reduction in water-borne and water-related vector-borne diseases, especially among vulnerable populations, by promoting household water treatment and safe storage as a key component of community-targeted environmental health programmes" (WHO/UNICEF, 2011a). The Network was established in 2003 by WHO, and UNICEF joined WHO as a co-hosting agency in 2011. The Network is composed of over 100 organizations, including international, governmental and nongovernmental, as well as private sector entities and academia, that subscribe to the above mission. The four main areas of Network activity are policy/advocacy, research/knowledge management, implementation/scale-up and M&E. The Network aims to increase effective implementation and achieve scale. This requires more rigorous M&E, and it is hoped that this document will facilitate meeting these goals.

2.4 HWTS METHODS

Several HWTS methods have been proven to significantly improve drinking-water quality in the laboratory and in field trials in developing countries (Clasen et al., 2007; WHO, 2011b). These HWTS methods are illustrated in **Figure 1** and include filtration, chemical disinfection, disinfection with heat (boiling, pasteurization) and flocculants/disinfectants. In addition, a combination of these methods may be used to increase the efficacy of treatment. For more detailed information on the microbial removal performance, advantages and limitations of each method, the reader should refer to **Annex A**.

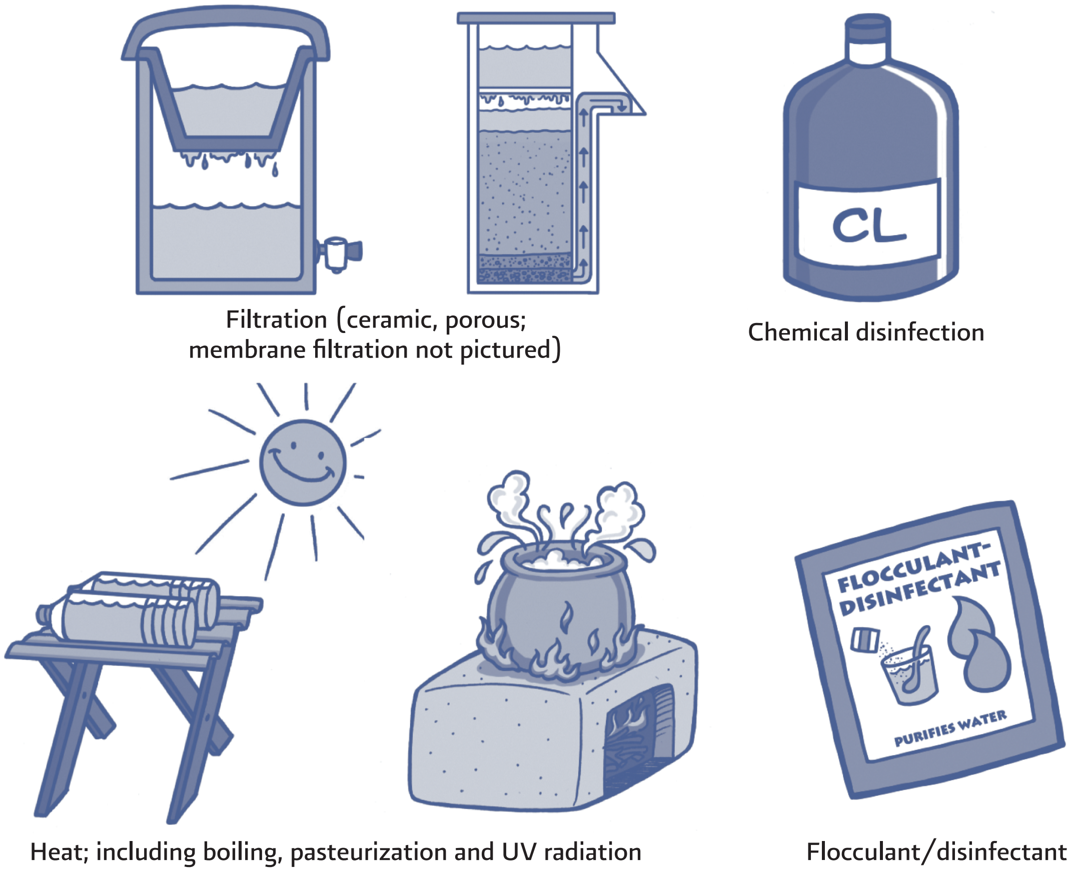

Figure 1: Proven HWTS methods
(images from Centre for Affordable Water and Sanitation Technology [CAWST])

HWTS implementers should promote efficacious HWTS methods (based on WHO performance recommendations) that are culturally appropriate and work with trusted local community educators to encourage healthy practices. The most appropriate HWTS method for a particular location is highly contextual and depends on a number of interconnected factors. These include existing diarrhoeal disease burden and pathogens of concern, water and sanitation conditions, drinking-water source quality, and cultural acceptability, implementation feasibility, financing and availability of HWTS methods. For all methods, it is increasingly being recognized that user education and ongoing support are needed to facilitate the necessary behaviour changes required (Lantagne & Clasen, 2009). Specific actions to improve HWTS effectiveness and scale-up include focusing on users' attitudes and aspirations, targeting those most at risk for diarrhoeal disease, integrating HWTS into other health programmes and utilizing M&E data collection efforts (Clasen, 2009). Given the variability in these factors, there is no "one size fits all" solution. Implementers are increasingly providing a suite of HWTS methods to allow for consumer choice and in turn increase correct and consistent use.

3. MONITORING AND EVALUATION

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An effective HWTS programme requires M&E. In a comprehensive review completed by the United Nations Development Programme, development programmes with strong M&E components were more likely to be successful because they identified problems earlier and were able to address shortcomings (UNDP, 2009). M&E need to be properly planned before programme implementation and then carried out during and after implementation to assess inputs, outputs, outcomes and impacts. Clear criteria should be agreed upon and applied to appraise the quality of programme implementation. This is discussed in further detail below, followed by short examples of how these M&E concepts have been applied in the field.

3.1 M&E COMPONENTS

The aims of both monitoring and evaluation are similar: to provide information to inform decisions, improve outcomes and achieve objectives. *Monitoring* is an ongoing process by which stakeholders obtain regular feedback on progress made towards achieving objectives (UNDP, 2009). *Evaluation* is an objective appraisal of either completed or ongoing activities to determine the extent to which they are achieving the stated objectives (UNDP, 2009).

In rigorous HWTS M&E programmes, the *outputs* and *outcomes* of HWTS programmes are measured. *Outputs* are the more immediate consequences of inputs and relate to tangible consequences of project activities (McAllister, 1999). Examples of output indicators include the number of HWTS methods distributed and/or sold, the number of community HWTS outreach meetings held or the number of community health workers trained. *Outcomes* describe the intermediate effects of outputs. Examples of HWTS programme outcomes include indicators of physical evidence of HWTS use, such as a wet filter, unexpired chlorine, free chlorine residual (FCR) in the water or improved drinking-water quality, as measured by microbial indicators.

Although outputs and outcomes are useful for determining a programme's operational objectives, they do not provide direct information on the effects of a programme on health or economics. *Impacts* are the long-term consequences of delivering outputs. These may include a reduced incidence of diarrhoeal disease, improved school attendance or economic gains. Measuring impacts requires research methods beyond what is practically feasible for many HWTS implementers and is not discussed in this document. However, measuring outputs and outcomes is generally feasible. Outputs provide a direct reflection of the amount of resources that are invested, whereas outcomes provide more detailed information on how these resources were utilized and the *potential* for impact.

An illustration of outputs, outcomes and impacts in the context of HWTS is included in **Figure 2**. Please note that this figure is an example only, and not all HWTS programmes will have these same inputs, outputs, outcomes, impacts and influencing factors.

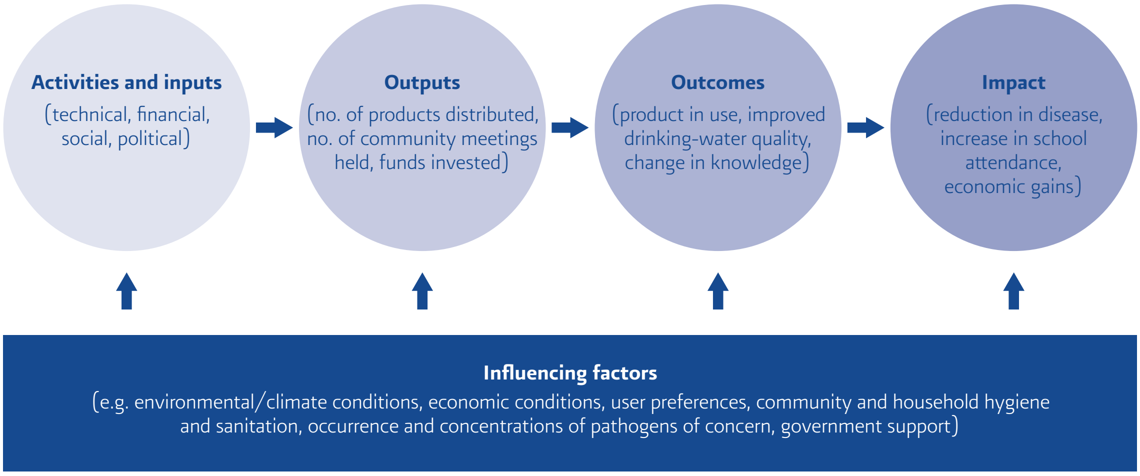

Figure 2: Examples of HWTS-related programme outputs, outcomes and impacts

There are a number of important considerations when developing and implementing an M&E programme. These include the following:

- ***Context of M&E within national efforts.*** Although strengthening and aligning national-level M&E systems are critical needs, addressing this topic is outside the scope of this document. However, it is recommended that M&E programme implementers seek to understand the current regulatory environment, responsible organizations and existing M&E programmes and reporting structures. Such an understanding will provide information on how to link HWTS M&E programmes to existing structures, resources and reporting chains.

- ***Internal and external M&E.*** M&E may be done by an internal team, an external group of individuals or a combination of both. Although internal evaluations can be useful for rapidly assessing programmes and making in-time adjustments, they may also be more subjective and less impartial. External evaluations can be useful for obtaining more objective data. In all cases, efforts should be made to ensure that the M&E clearly address the questions that the programme seeks to answer, that results are shared with all relevant stakeholders and that a standard code of ethics is upheld.

- ***Essential functions.*** Essential functions to be performed for M&E are multifaceted and necessitate a wide range of individuals formulating, collecting and using the data generated. A dedicated M&E coordinator, familiar with managing staff and budgets, should be tasked with the responsibility for implementing M&E activities and disseminating the information from the M&E programme. In addition, programme staff should be aware of the importance of keeping clear records, beneficiaries should understand the importance of M&E and their participation in evaluation efforts, and funders and policy-makers should assist in disseminating and utilizing the results along with those directly involved in HWTS interventions.

- ***Costing.*** The resources necessary to complete the M&E, including sufficient funds for staffing, transportation, equipment, water quality testing (if conducted) and data entry and analysis, should be allocated. M&E budgets should be incorporated into programme budgets to ensure that such funds are available, even if it means reallocating funds from other programme activities. It is likely advantageous to implement HWTS in fewer households, but be assured that those households are correctly and consistently using the HWTS methods.

- ***Capacity building.*** Local universities, research institutions and government ministries are resources that can be used to assist in M&E programmes. Integrating with national data acquisition or census efforts ensures sustainability and reduces the overall costs of data collection, analysis and reporting. These partnerships can lead to capacity building for both the M&E staff of the organization implementing the HWTS methods and national data acquisition programmes.

3.2 PROCESS MONITORING

Process monitoring provides a means to assess the quality of programme planning and implementation. Ideally, process monitoring is conducted during the main phases of a programme—conceptual and planning, implementation and post-implementation—but it may also be conducted after the final phase has been completed.

3.2.1 CONCEPTUAL AND PLANNING PHASE

During the conceptual and planning phase, process monitoring should be completed to assess the proposed goals of the project and whether or not implementation of HWTS will contribute to achieving those goals. If reducing morbidity and mortality associated with diarrhoeal disease is one aim of the programme, it is important to consider the major routes of diarrhoeal disease transmission and the extent to which unsafe drinking-water contributes to the disease burden. In addition to focusing on diarrhoeal disease, it may be worthwhile to address other related diseases that contribute significantly to the overall disease burden. For instance, HWTS and advanced combustion cookstoves are two household environmental health interventions that can, in certain settings, play an important role in preventing childhood diarrhoeal and respiratory diseases. A recent field study in Kenya and Cameroon found that integrated delivery of HWTS and advanced combustion cookstoves enhanced understanding of health benefits and reduced costs of promotion and distribution of products (WHO, 2011d). Other household environmental health considerations include handwashing practices, use of safe sanitation, use of insecticide-treated mosquito nets, general hygiene of surfaces, clothing and utensils, water management for vector control practices (e.g. securely covering and regularly washing large water storage containers to prevent breeding of the *Aedes* vectors of dengue fever) and consumption of safe and nutritionally adequate foods. Together, such interventions and practices provide a multibarrier approach to reduce the risk of diseases, especially in vulnerable populations, such as children and the immunocompromised. An overview of resources that provide recommendations on indicators for measuring the above environmental health interventions is included in **Annex B**.

3.2.2 IMPLEMENTATION PHASE

Process monitoring of the implementation phase should describe how the intervention was actually delivered. This includes the following activities:

- ***Review programme documentation.*** In order to understand the process of how the programme was developed and implemented, a review of programme documentation should occur. Relevant documentation could include logical framework documents, periodic programme reports, previous surveys and staff notes.
- ***Conduct interviews with programme staff.*** In addition to a review of programme documentation, interviews with programme staff should be undertaken to inquire about what did or did not go according to plan in the implementation process.
- ***Understand what happened between the plan and the M&E outputs.*** It may be misleading to evaluate a HWTS programme based on the initial implementation plan if the actual distribution of products did not occur as intended. For example, a flooded road may prevent distribution and/or HWTS outreach to particular communities in a targeted geographic area. This failure to reach certain communities will obviously affect use and thus should be taken into consideration in analyses and reporting.
- ***Ensure that the HWTS technologies distributed and/or methods promoted were effective.*** The performance of HWTS can vary widely. It should be verified that the HWTS methods were actually capable of reducing microbial contamination, as poor quality products will not be effective in the home.

- ***Understand the factors contributing to use.*** In some circumstances, non-use or inconsistent use of HWTS may result from poor or incomplete implementation. For example, users may not have been given enough information on how to operate the technology, or use of the technology may conflict with spiritual or cultural beliefs. Documenting and understanding such factors are important for knowing which programme aspects to modify and for improving future implementation efforts.
- ***Quantity and quality of contact with beneficiaries.*** Both the quantity and quality of contact with beneficiaries provide information on the success of implementation. Quantity of contact includes measures such as number of visits to communities by health workers and number of training sessions conducted, whereas quality reflects time spent on training materials, use of effective behaviour change mechanisms and extent of information retained by beneficiaries. The former may be accessed by examining daily work logs and programme reports, whereas the latter requires more involved measures, such as observing the delivery of training and/or short quizzes that test beneficiary knowledge.

3.2.3 POST-IMPLEMENTATION PHASE

Process monitoring of the post-implementation phase should describe what happened when the programme ended. Monitoring of this phase should focus on the availability of ongoing HWTS user support and supply chains, continued product use and education. Additionally, cost-effectiveness and financial sustainability can be critical indicators for overall success of the programme. In such cases, an economic analysis can be included.

3.3 EXAMPLES OF HWTS M&E EFFORTS

Two examples of the role of M&E in HWTS programmes are provided in this section. The first highlights a national M&E programme in Thailand, where household drinking-water quality data collected by local health workers are used to inform government investments (**Box 1**); and the second describes how M&E of a long-term community HWTS programme in Haiti have informed the expansion and evolution of the programme (**Box 2**).

Box 1: Drinking-water quality surveillance efforts in Thailand (Thailand, 2010)

Monitoring drinking-water quality is an important component of Thailand's "MDG Plus" goal, which is to provide safe drinking-water to all citizens by the end of 2012. The national drinking-water quality surveillance efforts are coordinated by the Ministry of Public Health and are multilevel. Locally, over 1000 village health-care workers, trained by regional health centres, monitor faecal coliforms and residual chlorine levels at community taps and in household-stored drinking-water twice a month. These data are sent to subdistrict health centres and the local administration offices, both of which are under the Ministry of the Interior. Depending on the results, the government may decide to invest in greater protection of source water, improve treatment of community drinking-water supplies and/or subsidize HWTS. The logistical costs of drinking-water quality monitoring are minimized by combining visits with other home-based health consultations, such as those concerning nutrition and child health. In addition, rather than importing expensive water quality test kits, locally manufactured equipment is used to measure the presence or absence of faecal coliforms and total chlorine residual. These indicators provide health-care workers and households with data on the safety of their drinking-water.

At the national level, an evaluation is conducted annually of all drinking-water sources and of stored drinking-water in selected households. These data are sent to the regional health post and to the national government, the latter granting accreditation to communities where drinking-water supplies meet national standards. In addition, the government sponsors research on water quality and is currently assessing rainwater quality and the viability of this source to meet drinking-water needs. One of the challenges of these efforts is obtaining data from rural areas and in real time to facilitate effective action on prevention and treatment options. The programme is currently investigating the use of digital technology (e.g. text messaging through mobile phones) to rapidly and easily share information.

Box 2: Long-term M&E in a HWTS programme

The Jolivert Safe Water for Families programme in rural northern Haiti is an example of a long-term HWTS programme that has incorporated M&E since its inception in 2002. On a monthly basis, programme technicians record the amount of chlorine produced, the number of chlorine bottles sold, the number of household visits and programme income and expenditures. In addition, technicians visit participating households once per year to conduct education and test stored household water for FCR using a presence/absence test kit. The cost of this ongoing monitoring (the technical salaries, transport and FCR testing) is covered by programme income from chlorine sales (equivalent to US$ 0.10 per household per month). The monitoring data are used by the programme technicians to regularly assess programme activity and determine in which areas or households greater support is needed to improve HWTS practices and uptake.

In addition to the ongoing monitoring, a number of external evaluations have been conducted to answer specific programme-related questions. These include the following:

- In 2003, an external survey of 200 households in the pilot project documented high uptake of HWTS. FCR was detected in 68% of households surveyed, and there was a 98.8% to greater than 99.9% reduction in faecal indicator bacteria in treated drinking-water (Brin, 2003). Based on these results, the programme began to expand.
- In 2006, a comparative household survey was conducted to establish the determinants of HWTS use (Ritter, 2007). The determinants varied along the stages of adoption, from purchasing the first bottle of chlorine to becoming a regular user. These determinants of adoption were used to develop targeted behaviour change messages (including radio advertisements and new promotional materials) to increase and sustain adoption.
- Finally, in 2010, a health impact analysis was conducted (Harshfield et al., 2012). In this assessment, 56% of programme households had FCR in their stored drinking-water, and children in participant households had 55% reduced odds of diarrhoea in the previous 48 hours. Respondents had been in the programme an average of 4.0 years.

This combination of internal, ongoing monitoring and external evaluations to investigate specific programme-related questions has allowed for informed expansion of the project. The M&E efforts could be improved, especially in regards to more frequent monitoring to determine triggers of use/non-use and how to best support behaviour change. Monitoring has become especially challenging as the programme has scaled up, and the Jolivert Safe Water for Families programme is currently exploring how to improve its M&E while securing more sustainable resources to fund these important efforts.

4

4. HWTS INDICATORS

4. HWTS INDICATORS

This section presents 20 key indicators for assessing and comparing HWTS outputs and outcomes. The M&E indicators can be used in stand-alone HWTS programmes, in broader, integrated environmental health activities and in efforts to improve drinking-water quality in institutional settings, such as schools and hospitals. The description of the indicators is followed by a decision-tree that highlights considerations in selecting indicators. A sample survey for gaining information on these indicators is provided in **Annex C**.

4.1 CORE HWTS INDICATORS

In 2008, Network researchers and practitioners developed a set of M&E indicators for HWTS, which were later expanded upon by USAID's Hygiene Improvement Project (USAID, 2010). Based upon this initial work, and with more recent input from Network stakeholders, a core set of 20 indicators was developed. The indicators are grouped according to the following themes: *reported and observed use*; *correct, consistent use and storage*; *knowledge and behaviour*; *other environmental health interventions*; and *water quality.* This is not an exhaustive list of indicators, and programmes may choose to select additional indicators specific to their objectives and needs.

4.1.1 REPORTED AND OBSERVED USE INDICATORS

In 2006, as per the harmonization task force of the WHO/UNICEF Joint Monitoring Programme on Water Supply and Sanitation (JMP), a core set of questions was produced for adoption by household surveys. In this set, the question concerning HWTS reads 1) *Do you treat your water in any way to make it safer to drink?* followed by, if answered in the affirmative, 1a) *What do you usually do to the water to make it safer to drink?* Several possible options are listed to answer question 1a), including boil, add bleach/chlorine, strain through a cloth, use a water filter, use solar disinfection, let it stand and settle, other (specify) and do not know.

Demographic and health surveys and multiple indicator cluster surveys included these questions in their post-2006 surveys. An analysis of the HWTS responses from 67 national surveys indicated that although a sizable percentage of households report treating drinking-water at home (33%), practices vary widely by region, are often inadequate and are least likely to occur in households in the lowest wealth quintile (Rosa & Clasen, 2010).

Anecdotal evidence from organizations conducting M&E of HWTS indicates that in some contexts the above question 1) may be biased. For example, the word "treat" may be associated with chlorine rather than with HWTS in general. Thus, for the purposes of this document, we have modified the JMP question to read, "Do you do anything to your water to make it safer to drink?".

In preparation for a new cycle of United Nations MDG targets and monitoring post-2015, JMP staff and partners are examining options for revised water and sanitation questions and indicators. While the current questions and indicators will be used until 2015, programmes intending to use the JMP core questions should consult the JMP web site to find the latest information and recommendations (refer to Annex B for web link).

The limitation of reported use indicators is that they capture *self-reported* water treatment only, and there is no confirmation via observation or water quality. Thus, indicators on observed use and observed safe storage and handling are also included (**Table 1**).

Table 1: Reported and observed use indicators

	INDICATOR	QUESTION/REQUEST	ANSWER/OBSERVATION
1	**Self-report treating drinking-water**	*What do you usually do to the water to make it safer to drink? (more than one answer may be possible)*	Nothing Water is already safe Boil Bleach/chlorine Strain through cloth Filter Solar disinfection Stand and settle Other (specify) Do not know
2	**Observation of drinking-water treatment method**	*Ask to see drinking-water treatment method.*	Observe boiled water, fuel source Observe chlorine bottle/tablets, test FCR Observe cloth, and if it appears intact Observe filter, and if it appears intact (i.e. not broken) Observe if bottles are in house/on roof Observe settling containers or sediment Other (if other option listed) None
3	**Self-report safely storing water**	*How do you store your drinking-water? (more than one answer may be possible)*	Do not store water In container with no lid or cover In container with lid but no spigot/tap In container with lid and spigot In narrow-mouthed container Other (specify) Do not know
4	**Observation of safely stored drinking-water**	*Ask to see stored drinking-water. (more than one answer may be possible)*	Completely covered with lid Open, uncovered Narrow opening Spigot Beyond reach of animals Clean (free of dirt, debris, garbage, faecal matter, etc.) Dirty Other (specify)

4.1.2 CORRECT, CONSISTENT USE AND STORAGE INDICATORS

Households that use HWTS methods correctly and consistently to improve their drinking-water quality and do not drink untreated, contaminated water outside the home have a lower risk of diarrhoeal disease. Indicators to measure correct and consistent use and storage are detailed in **Table 2**. In addition, an indicator on drinking-water source type is included in the table. Although even improved drinking-water sources may be contaminated (WHO/UNICEF, 2011b), households accessing unimproved sources likely access water with greater contamination and thus have greater need for HWTS. Table 2 is followed by an example illustrating the importance of assessing indicator 5, knowledge of correct use, in **Box 3**.

Table 2: Correct, consistent use and storage indicators

	INDICATOR	QUESTION/REQUEST	ANSWER/OBSERVATION
5	**Knowledge of correct use**	*Please describe how to use this method.*	Dependent on method. For examples of correct use questions, refer to sample questionnaire in **Annex C**.
6	**Demonstration of correct use**	*Please show me how you use this method.*	Dependent on method. For examples of demonstration of correct use questions, refer to sample questionnaire in **Annex C**.
7	**Demonstration of safe water extraction**	*Please show me how you usually extract water from your container. (more than one answer may be possible)*	Observe whether hands touch water Observe whether utensil or tap is clean (no visible dirt and debris) Other
8	**Frequency of non-use by most vulnerable**	*How often do children and/or HIV+ in your household drink untreated water?*	Always, usually, sometimes, never
		IF NOT ALWAYS, where do they report drinking untreated water?	At neighbours'/another house, school, work, religious centre, in fields, when travelling, bar/café, other (specify)
9	**Consistently treating drinking-water with HWTS**	*Have you ever used the HWTS method? In last month? In last week? Always?*	Yes No
		When do you not use?	When there is no money, when there is no time, during the rainy season, during the dry season, never not use, other
10	**Use of improved drinking-water source**	*What is the main source of drinking-water for members of your household?*	Piped connection into house, piped connection into yard, public standpipes, boreholes, protected dug wells, protected springs, rainwater collection, surface water, open dug wells, unprotected springs, vendor-provided water, bottled water, tanker

Box 3: Measuring knowledge of correct product use in Kenya

A survey in Turkana, Kenya, where chlorine tablets and flocculant/disinfectant sachets were distributed during an emergency response programme, sought to assess knowledge of correct use of HWTS (Lantagne & Clasen, 2011). Recipients were given one training session on both products during distribution. Three weeks after distribution, a survey of 400 randomly selected beneficiary households was conducted to assess who had received and were correctly using the products. Respondents using chlorine tablets were asked: 1) how many tablets they used; 2) the volume of water they treated; and 3) how long they waited to drink the water after treatment. Respondents were considered to have "correct knowledge" if they reported using 1 tablet for 20 litres **and** waiting 30 minutes before drinking. To assess correct knowledge of the flocculant/disinfectant, the first question was, "Can you describe to me how you use the flocculant/disinfectant product?". Enumerators did not prompt answers, but instead noted whether respondents stated "add sachet", "stir", "wait until settled", "filter through cloth" and "wait to drink". Subsequent questions addressed the time respondents spent stirring the water and waiting until drinking and the order of these operations. The evaluation indicated that knowledge after a single training session was high (>90%) if the product was simple to use (having two steps, like the tablets), but low (<5%) if the product was complicated to use (more than two steps, like the flocculant/disinfectant sachets). As a result, more attention has been given to providing follow-up training and support on more involved HWTS methods to improve knowledge and facilitate correct use.

4.1.3 KNOWLEDGE AND BEHAVIOUR INDICATORS

The adoption of HWTS requires changes in behaviour (Figueroa & Kincaid, 2010; Mosler, 2012; Mosler & Kraemer, 2012). Thus, indicators on knowledge and behaviour (**Table 3**) are important for assessing uptake and for informing efforts to increase and sustain adoption of HWTS. Assessing behaviour is highly contextual, and conducting formative investigations to understand the favouring and hindering conditions for adopting HWTS would greatly assist in determining the relevance of the indicators in Table 3 and the importance of including other behavioural measures.

An illustration of using the indicators in **Table 3** to improve programme implementation is provided in **Box 4** on the following page.

Table 3: Knowledge and behaviour indicators

	INDICATOR	QUESTION/REQUEST	ANSWER/OBSERVATION
11	**Knowledge of at least one proven HWTS method**	*Can you tell me all the ways you know to make your water safer to drink?*	Boiling Chlorination Ceramic filter Slow-sand filter Membrane filter Solar disinfection Coagulant/flocculant Other
12	**Received messaging and/or training on HWTS**	*From what sources did you receive messaging and/or training on your HWTS method?*	Household visit Group training Media (radio, television, newspaper) Mobile phone text messaging From child through school Religious centre None Other
13	**Access to HWTS products**	*Do you know where to buy new parts (or replace broken parts) for your HWTS method?*	Yes, no, don't know
14	**Personal norm for drinking treated water**	*Do you feel a strong personal obligation to consume treated water?*	Yes, somewhat, no, don't know
15	**Confidence in improving the quality of their drinking-water**	*I feel confident that I can correctly improve the quality of my drinking-water.*	Agree, disagree, don't know
16	**Community support in treating drinking-water**	*My friends/community leaders/ health-care workers encourage me to make my water safer to drink.*	Agree, disagree, don't know

Box 4: Improving programme implementation by understanding practices and perceptions in Zambia

Seeds of Hope International Partnerships (SoHIP) is a Zambian nongovernmental organization (NGO) that started implementing HWTS with support from CAWST in 2005. Since that time, SoHIP has installed more than 6500 biosand filters in 10 communities in periurban areas of Lusaka and Ndola. In 2010, with training from CAWST, the SoHIP team developed two evaluations, piloted the questionnaire, and collected and analysed the data. The evaluations used three main data collection methods: household survey, observation and water quality analysis. The household survey included questions concerning user practices, such as uses of the filtered water, safe storage and maintenance; as well as user perceptions, such as likes and dislikes and ease of use. To assess correct use, the team assessed the filter flow rate, general condition of the filter and height of the water above the sand. Finally, testing of turbidity and *Escherichia coli* was completed at 12% of the households surveyed. For every filter tested for *E. coli*, four samples were analysed: source water, water poured into the filter, filtered water and stored water.

The results provided important information that influenced improvements in programme implementation. For example, water quality results from filtered water indicated, on average, 94% removal of *E. coli*, but recontamination of the filtered water in the storage container was common. The household survey found that users were performing filter maintenance more often than was necessary, and some users lacked knowledge about how to correctly use their filter. As a result, SoHIP improved education and training on filter use, filter maintenance and safe water storage. To reinforce the education messages, CAWST and SoHIP developed introductory seminars on WASH for community groups and schools as well as training workshops for community health promoters. After each training session, follow-up meetings were held to check progress and assist users in overcoming problems. Each community health promoter now visits an average of three households every week to reinforce messages about filter use and maintenance, hygiene and sanitation. Ongoing monitoring by the community health promoters includes collecting information about filter use and safe water storage practices. The community health promoters also monitor the households' hygiene and sanitation practices and knowledge of disease transmission. SoHIP's monitoring has shown that there has been an increased demand for the biosand filters, more willingness by the community to contribute to the cost of the filters and improved correct use of the filters.

4.1.4 OTHER ENVIRONMENTAL HEALTH INTERVENTION INDICATORS

As described in section 2, interventions delivered as a package may result in greater uptake and additional health benefits at a lower overall cost compared with interventions delivered individually. The indicators in **Table 4** assess the knowledge and use of other environmental health interventions.

Table 4: Other environmental health intervention indicators

	INDICATOR	QUESTION/REQUEST	ANSWER/OBSERVATION
17	**Knowledge of other environmental health interventions**	*Besides HWTS, what are other ways that you know of to improve the health of your household?*	• Insecticide-treated bednets • Improved sanitation • Wash hands at critical moments/handwashing station • Advanced combustion cookstoves • Covering open water sources to prevent vector-borne disease • Exclusive breastfeeding for first 6 months • Consuming nutritionally adequate foods • Hygienic handling of foods
18	**Use of other environmental health interventions**	*Do you use any of these interventions?* *If yes, ask to see intervention.*	Yes No

4.1.5 WATER QUALITY INDICATORS

Water quality indicators provide a means to assess the correct use of HWTS methods and are presented in **Table 5**. When combined with a sanitary risk assessment (**Annex D**), they also provide a means by which to prioritize risks and take action. Following the indicators (see Section 4.2), there is a discussion of commonly tested water quality parameters, including turbidity, free and total chlorine residual, *E. coli* and faecal/thermotolerant coliforms, and arsenic and fluoride. Additional resources for water quality testing are included in **Annex B**.

Table 5: Water quality indicators

	INDICATOR	QUESTION/REQUEST	ANSWER/OBSERVATION
19	**Households effectively using HWTS method to improve quality of household drinking-water ("effective use")**	*Can you please provide me a cup of water as you would give to a child? If treated, also collect paired untreated sample.*	Test stored untreated and treated drinking-water pairs for indicator bacteria, report reduction of bacteria.
20	**Households with FCR in drinking-water [*only with chlorine-based methods*]**	*Can you please provide me a cup of water as you would give to a child?*	Test stored drinking-water for FCR, report amount or presence/absence of FCR.

Unlike the other indicators, water quality testing requires equipment and consumables, which can be costly. The testing itself also requires time to conduct, and data analysis requires specialized training. Therefore, it may be neither feasible nor, in many cases, necessary to sample water quality parameters in all households. Household water quality testing needs will vary by programme. When determining how much water quality testing to conduct, the following factors may be considered: 1) budget; 2) capacity of the staff to conduct testing; 3) logistics involved in sample collection and processing; and 4) seasonality and variance of contamination in sources. These criteria will assist programmes in determining the proportion of households (from 10% to 100%) for which water quality sampling should be conducted and the intervals at which to survey.

4.2 WATER QUALITY TESTING CONSIDERATIONS

There are a number of considerations in assessing water quality and understanding how the concentration of constituents in water may impact health. The following briefly summarizes some of the major water quality testing considerations most often encountered in HWTS efforts.

4.2.1 TURBIDITY

Turbidity is a measurement of suspended particles that obstruct light transmission through water. It is measured by nephelometric turbidity units (NTU). The turbidity value increases with increasing numbers of particles. Turbidity is an important water quality parameter when evaluating HWTS methods, for three reasons: 1) the efficacy of disinfection-only methods is decreased in waters with higher turbidity; 2) acceptability of water by the user decreases with increasing turbidity of the water; and 3) for HWTS methods that remove turbidity using flocculation or filtration mechanisms, turbidity reduction is an indicator of treatment effectiveness. Turbidity can be measured with a portable electronic device, which provides accurate quantitative data but is more expensive, or a turbidity tube, which is not accurate in low-turbidity waters. In resource-limited settings, WHO recommends that water should have a turbidity of less than 5 NTU and, if possible, less than 1 NTU (WHO, 2011b). Programmes should check with manufacturers of the product(s) that they promote to determine the turbidity requirements and what, if any, pretreatment measures may be needed to ensure the effectiveness of the selected product.

4.2.2 FREE AND TOTAL CHLORINE RESIDUAL

When chlorine is added to water, some of the chlorine reacts first with organic materials and metals in the water and is not available for disinfection. This is called the chlorine demand of the water. The remaining chlorine concentration after the chlorine demand is accounted for is called *total chlorine* (CDC, 2012). Total chlorine is further divided into combined and free chlorine. *Combined chlorine* is the amount of chlorine that has reacted with nitrates and is unavailable for disinfection, whereas *free chlorine* is the chlorine available to inactivate disease-causing organisms. The presence of FCR in drinking-water suggests the absence of pathogens. Thus, for water treated with chlorine products, FCR is one measure of drinking-water safety.

There are five main field methods to test for free and total chlorine residual in drinking-water. They are: 1) pool test kits; 2) paper strips; 3) colour-change test tubes; 4) colour-wheel test kits; and 5) digital colorimeters. Selecting the most appropriate method is dependent on a number of factors, including 1) need for accuracy, 2) cost, 3) number of samples to be tested and 4) how the data will be used. The most expensive methods (digital colorimeters and colour-wheel test kits) are more complicated to use, but provide more accurate quantitative information. The least expensive method (pool test kits) is simple to use, but does not provide accurate quantitative results. Depending on the needs of the programme, a simple presence/absence test may be sufficient, whereas in other contexts, quantitative data are required.

4.2.3 *E. COLI* AND THERMOTOLERANT COLIFORM BACTERIA

Microbial contamination contributes to the largest share of the diarrhoeal disease burden associated with unsafe drinking-water (Prüss-Üstün et al., 2008). Thus, absence of microbial contamination is one important indicator that water is safe to drink. Microbial indicators are bacteria that have been shown to be associated with disease-causing organisms, but do not cause disease themselves. The recommended microbial indicator is *E. coli* (WHO, 2011b). Alternatively, thermotolerant coliform bacteria, which are total coliform bacteria that are able to ferment lactose at 44–45 °C and include *E. coli* as the predominant species, may be measured. A third indicator, production of hydrogen sulfide, may also be used. The 4th edition of the GDWQ does not recommend using total coliforms as an indicator for verification of water safety in the home (WHO, 2011b). The GDWQ state that *E. coli* and thermotolerant coliform bacteria "must not be detectable in any 100 ml sample" of water intended for drinking. While the GDWQ also note that "immediate investigative action must be taken if *E. coli* are detected", the Guidelines also recognize that the majority of rural water supplies in developing countries are contaminated and therefore recommend that "medium-term targets for the progressive improvement of water supplies should be set".

A summary of commonly performed types of microbial indicator testing is presented in **Table 6**. Qualitative (presence/absence) tests provide information on whether or not indicator bacteria are present in the drinking-water, but not their quantity. Semiquantitative and quantitative tests provide more precise information on the concentrations of faecal indicator bacteria in water samples.

Table 6: Summary of types of microbial indicator testing

TYPE	ADVANTAGES	DISADVANTAGES	COST[a]
Qualitative (presence/absence)	• Simple testing and analysis • Minimal equipment • Incubation not required	• Not appropriate for known contaminated waters • Can report false negative at low concentration	US$ 1–5/test
Semiquantitative	• Simple testing and analysis • Simple incubation or incubation not required	• Not all are commercially available	US$ <1–10/test
Quantitative			
• Tray methods	• Simple testing and analysis • Reliable quantitative results	• Electricity required • Large volume of equipment	US$ 4000 + US$ 5/test
• Kit methods	• Easy to transport • Reliable quantitative results	• Risk of sample contamination • Minimal incubator space	US$ 2000 + US$ 1/test
• Laboratory methods	• Can test many samples • Reliable quantitative results	• Requires trained personnel • Medium volume of equipment	US$ 1000 + US$ 4/test

[a] All costs are approximate.

Increasingly, low-cost quantitative tests are becoming available. A recent review of 44 different microbial drinking-water tests for low- and medium-resource settings found that 26 provide enumeration of bacterial concentration (Bain et al., 2012). The review noted that although the costs for the tests are relatively low, considerable logistical resources are needed to conduct sampling in remote, difficult to reach communities.

One of the key issues in M&E is the determination of effective use, which is the percentage of the targeted population using a HWTS product that results in improved drinking-water quality (Lantagne & Clasen, 2011, 2012). The effective use metric clearly identifies whether the people using the HWTS method were at risk of waterborne disease; and whether use was effective in reducing exposure to microbial contaminants. In addition, where relevant, effective use may assess chemical contaminants. In order to have effective use of a HWTS method, 1) the method must be used by a household that needs it (i.e. a household with contaminated water); 2) the method must effectively remove pathogens; and 3) households must use the method correctly to reduce the contamination to internationally accepted levels. **Box 5** provides an example from Haiti where measuring water quality and determining effective use provided insights into the impacts associated with HWTS.

Box 5: Example of determining effective use in Haiti after the 2010 earthquake

Following the 2010 earthquake, a number of HWTS methods were promoted to minimize health risks. These methods were promoted without first determining whether households were at risk from unsafe water. After distribution of biosand filters, ceramic filters and chlorine tablets, drinking-water samples were taken from households receiving HWTS. Results revealed that some households (primarily those that received ceramic filters) did not need HWTS, as their untreated drinking-water quality already met WHO standards (<1 colony-forming unit [CFU] of *E. coli* per 100 ml). These households would have benefited from behavioural interventions aimed at safe handling and storage. Other households (those that received biosand filters or chlorine tablets) did have untreated water, largely from surface water sources, that was contaminated. However, those households that received biosand filters failed to improve their water quality, because the filters were installed incorrectly and thus did not reduce microbial contamination. As a result, these households were still at risk for waterborne disease. In contrast, those households supplied with chlorine tablets were familiar with water purification tablets before the emergency and received community health worker training after the emergency. Thus, they were able to reduce microbial contamination to WHO guideline values. Overall, the effective use of these three methods varied widely: 16% for biosand filters, 28% for ceramic filters and 72% for chlorine tablets. These results illustrate the importance of targeting households with poor water quality and ensuring that they have the proper tools to effectively use and maintain HWTS.

Finally, water quality information should be considered in tandem with a sanitary survey in order to comprehensively understand and address contamination risks and set interim targets. Sanitary surveys consider faecal risks posed to water sources and allow calculation of a sanitary risk score in the range from 0 to 10 (**Annex D**). Water quality risks (based on detection of *E. coli* or thermotolerant coliform bacteria) range from A to E, where A is less than 1 colony-forming unit (CFU) per 100 ml, B is 1–10 CFU per 100 ml, C is 11–100 CFU per 100 ml, D is 101–1000 CFU per 100 ml and E is greater than 1000 CFU per 100 ml (WHO, 1997).

4.2.4 ARSENIC AND FLUORIDE

Two other water quality parameters for which it may be necessary to test in HWTS M&E programmes are arsenic and fluoride. Arsenic and fluoride can be tested on site using portable kits, or samples can be collected, acidified and transported to a laboratory for more detailed analyses.

Arsenic is an odourless and tasteless semimetal that enters water supplies via natural deposits in the earth or from agricultural and industrial practices. The effects of excessive arsenic consumption include discoloration of the skin, stomach pain, nausea, vomiting, diarrhoea, numbness in hands and feet, partial paralysis and blindness. Arsenic has also been linked to cancer of the bladder, lungs, skin, kidney, nasal passages, liver and prostate (WHO, 2010). Levels of arsenic in natural waters range from 1–2 µg/l up to 12 mg/l (WHO, 2011b). WHO recommends a provisional guideline value for arsenic in drinking-water of 10 µg/l, based on treatment performance and analytical achievability (WHO, 2011b).

Fluorine is a common element in Earth's crust and exists as fluorides in a number of minerals. In groundwater, concentrations of fluoride vary with the type of rock and usually do not exceed 10 mg/l (WHO, 2011b). While low levels (0.5–1.0 mg/l) of fluoride in drinking-water may reduce dental caries, higher levels of naturally occurring fluoride found in some groundwater supplies cause skeletal fluorosis. In skeletal fluorosis, the bone is hardened, resulting in an increased frequency of fractures, thickening of the bone structure and accumulation of bone tissue, which impairs joint mobility. The WHO guideline value for fluoride in drinking-water is 1.5 mg/l (WHO, 2011b).

The HWTS methods presented in this document that have been shown to improve the microbial quality of water and reduce diarrhoeal disease are largely ineffective at removing arsenic and fluoride. In areas with arsenic and fluoride concentrations exceeding WHO guideline values, implementers and evaluators will have to carefully weigh the risks from microbial and chemical contaminants. There are numerous filters that are specially designed to reduce arsenic, and there are promising results from using filtration through bone char to remove fluoride at the household level.

4.3 OTHER POTENTIAL INDICATORS

Depending on the implementation strategy and the goals of the M&E programme, a number of other important indicators could be monitored. Some modifications or additions that might be applicable are given below:

- ***Behaviour change.*** Effective HWTS interventions usually require users to change their behaviours. Many approaches have been shown to influence behaviour, including a status aspiration approach or focusing on the benefits of treatment, such as improved taste, physical appearance and economics (Figueroa & Kincaid, 2010). To understand determinants of behaviour change, indicators focusing on user perceptions, preferences and experience can be informative. To assess behavioural determinants of adoption, Likert-scale questions are often used in surveys. Likert-scale questions utilize a psychometric scale assessing whether or not a user agrees or disagrees with a statement, such as "I like using the HWTS method to treat my water".
- ***Economic.*** Cost-effectiveness and financial sustainability can be critical indicators for overall success of the programme. Thus, it may be important to also conduct an economic analysis.
- ***Enabling environment.*** The enabling environment may also influence the success of the HWTS programme. In such cases, it may be appropriate to add commitment from governments, community leaders, the private sector and donors to support HWTS as an indicator.
- ***Quality of implementation.*** Quality of implementation can be assessed by the frequency of interactions with recipients, time spent during each meeting or household visit, content covered and information understood and retained by recipients. Although some of these data can be collected by reviewing project record logs or monthly or quarterly reports, other aspects, such as information retained, require other methods. For example, mobile phones can be used to assess knowledge and attitudes towards HWTS. Correct answers can be rewarded with, for example, mobile phone credits, whereas incorrect responses may trigger an appropriate follow-up response.

In addition, qualitative information obtained through key informant interviews, focus groups and structured observation can provide important insights into HWTS use and behaviour. A full discussion on qualitative data collection is outside the scope of this document, but resources concerning qualitative data collection and analyses can be found in **Annex B**. An example from Liberia of using qualitative and quantitative methods to improve HWTS messaging and user support is provided in **Box 6**.

Box 6: Using quantitative and qualitative methods to improve HWTS uptake in Liberia

To inform HWTS programme design and assess progress, PSI uses both quantitative and qualitative research. PSI's methodology for quantitative population-based surveys, known as Tracking Results Continuously (TRaC), involves multiround cross-sectional surveys. TRaC surveys identify key behavioural determinants (i.e. opportunity, ability and motivation to adopt a behaviour), monitor changes in those determinants and evaluate whether exposure to the project results in behaviour change. In addition, the surveys allow PSI to segment the target population by socioeconomic class to measure equity in access to products and differences regarding the HWTS practices (PSI, 2012a). PSI also conducts qualitative research using the Framework for Qualitative Research in Social Marketing (FoQus) to answer the "why" behind adoption of health behaviours. FoQus emphasizes audience-centred methods such as photo-narratives, collage-making and theatre presentations, as well as in-depth interviews and small-group discussions. These methods provide insights into how to target vulnerable populations and on effective behaviour change messages (PSI, 2012b).

In Liberia, PSI is implementing a five-year improved WASH programme along with partner CHF International (Buszin, 2011). In 2010, PSI conducted a quantitative and qualitative study using TraC and FoQus to measure the success of the project and identify action items to improve the project. WASH practices of 1995 caregivers of children under the age of five in six target counties were assessed. Quantitative research showed that although the majority of respondents used water from unimproved sources, only 13% used any HWTS method. The key motivation to use HWTS was social norms, whereas barriers were a lack of knowledge that clear water can be contaminated and the belief that 30 minutes is a long time to wait for safe water. In response, the programme developed a positioning statement as a basis for its social marketing campaign: "For primary caregivers, WaterGuard is the best water treatment that makes her water taste clean for a whole day and keeps her family happy and healthy." A marketing strategy that outlined a plan for the placement, price, product and promotion of HWTS was developed, keeping this insight in mind. The project will continue to use qualitative methodologies and regular programme reporting to monitor the retention of messages, as well as an endline TRaC to evaluate the overall success of the project in influencing the key determinants to behaviour.

4.4 DECISION-TREE FOR SELECTING INDICATORS

In many settings, there may not be the time or resources to measure all the indicators presented. Furthermore, depending on the programme aims, it may not be necessary to measure all indicators, and/or there may be other indicators that are important to include. To guide decision-making in selecting indicators, a decision-tree is presented in **Figure 3**. This decision-tree is not meant to be prescriptive; rather, it is intended to help those involved in M&E efforts to make sound decisions on indicator selection. Please note that under the heading *Indicators*, each indicator is identified by the same number presented previously in this section and in the executive summary.

Programmes with sufficient personnel, time and finances may decide to select all 20 indicators, whereas other efforts with limited resources may select only 5 or 10 indicators. Effective use, defined as improving drinking-water quality to meet national and/or international standards, requires testing of both untreated and treated water and use of microbial indicators. At a minimum, it is suggested that all HWTS M&E efforts aiming to know if households use HWTS select indicators 1–4, which concern self-reported use and observations.

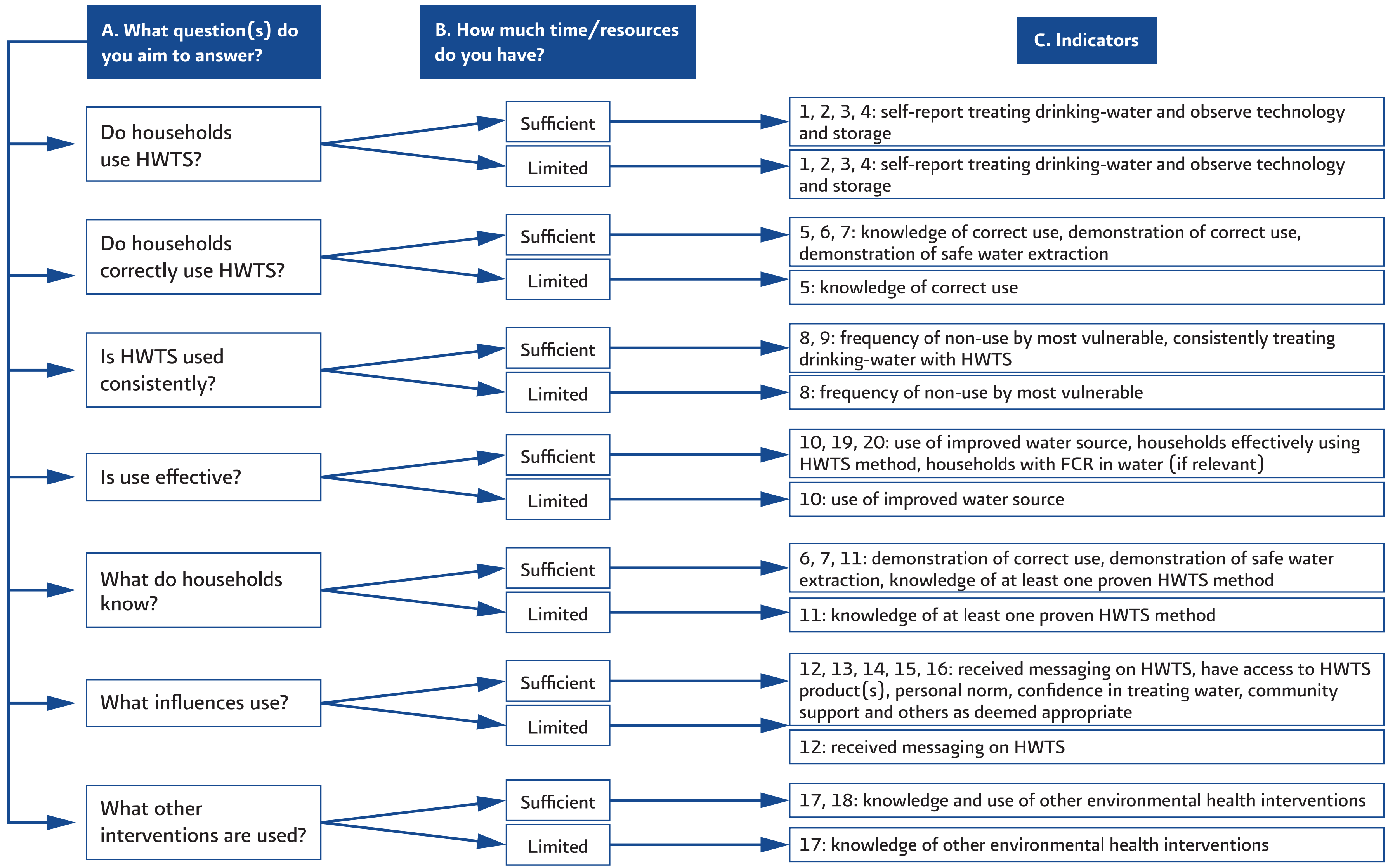

Figure 3: Decision-tree for indicator selection

5

5. CONDUCTING MONITORING AND EVALUATION

5. CONDUCTING MONITORING AND EVALUATION

In order to conduct M&E, the following steps, each of which is described in the following subsections, are suggested:

1. Understand the context
2. Develop the M&E questions
3. Select the appropriate indicators
4. Develop an M&E plan
5. Develop the M&E tools
6. Select and train the M&E team
7. Conduct the M&E
8. Enter and review the data
9. Analyse the data and disseminate the results

5.1 UNDERSTANDING THE CONTEXT

Where drinking-water has minimal contamination, the incremental improvement in water safety through using HWTS methods is likely to be small. Hence, promoting HWTS in such communities may not result in appreciable health benefits. However, in other areas, such as those served by inconsistently treated piped water supplies or surface water sources, HWTS may play an important role in significantly reducing and preventing disease. HWTS may also be important in providing a temporary, short-term solution to improving the quality of water supplies after flooding or other emergencies.

In addition to the water quality context, there are a number of other contextual factors to consider. In some efforts, HWTS products are distributed for free, and in other instances, they are sold to households. HWTS products are distributed in both easy to access urban areas and difficult to access rural areas. Some populations dislike the taste and smell of chemically treated water, the taste of boiled water or the time it takes to filter water.

Each of these factors will affect which M&E questions are important. For example, if a HWTS technology is distributed for free as part of an emergency response programme, it will not be relevant to interview households about willingness to pay or sustained use. Instead, the M&E would focus on confirming distribution and whether households received the training and have correct knowledge of use. Cost-effectiveness may also be analysed. In a situation where the goal of the programme is to encourage sustained use of a product within a longer term in a cost-recovery programme, questions about access to products or replacement parts, willingness to pay and confirmed, consistent use over time become more important.

Thus, at the outset of conducting M&E, the designers of the M&E programme should answer the following questions:

- What are the overall goals of the programme?
- What are the likely outcomes that the HWTS could achieve?
- What is the context in which HWTS is implemented?
    - Urban/semiurban/rural
    - Access restricted due to transportation difficulties or conflict
    - Cultural considerations around appropriate ways to conduct the M&E
        - Sex of respondents and those recording the data
        - Access to the household and drinking-water

With an understanding of the goals, likely impacts and context of the HWTS programme, the next steps in developing HWTS M&E can be undertaken.

5.2 DEVELOPING THE M&E QUESTIONS

The next step in developing the M&E programme is to define the questions that your M&E programme will be designed to answer. A key and basic question is: How is the product being used? This is important for subsequent analysis of how the product is affecting the lives of users. Other key questions may be: Who is using the product? Are the targeted beneficiaries being reached? Other M&E questions will be developed based on specific programme goals and outputs and outcomes to be measured. As stated previously, open-ended questions are important for explaining how and why. However, these should be linked to more quantitative indicators to inform analyses.

5.3 SELECTING THE APPROPRIATE INDICATORS

Once the M&E questions have been determined, the next step is to develop the indicators that will be used to answer the questions. An M&E question can be answered by more than one indicator. The indicators in the previous section are a starting point for HWTS M&E programmes, but other indicators may need to be developed.

5.4 DEVELOPING AN M&E PLAN

In developing an M&E plan, it is necessary to understand the basis for the M&E programme, including, most importantly, how the data will be used. The procedures to ensure that information moves from the collection phase to the phase of informing programme activities and policies should be well defined at the outset of the M&E programme. Once the basis for the M&E programme is understood, there are four milestones, including 1) informing officials to obtain informal support and formal approvals, 2) determining the number of households that will be monitored or evaluated, 3) determining where M&E will take place and 4) determining how often to conduct M&E.

5.4.1 OBTAINING NECESSARY APPROVALS

Before initiating an M&E programme, the necessary approvals for conducting the programme should be obtained. These approvals might include, but are not limited to:

- ***Formal ethics approvals.*** All human subject research should be conducted in an ethical and respectful manner that does not violate the rights of, or cause harm to, those involved in the research. While many non-research-based M&E programmes do not require formal ethics committee or internal review board approval, all surveys involving human subjects should be conducted in accordance with ethical human subject research practices. More information on ethics research considerations can be found in **Annex B**.
- ***Local government approval.*** In addition to the more formal ethics approval processes described above, local government approval for conducting surveys is necessary before any M&E activities can be initiated.
- ***Local approvals.*** Local approvals are important, whether data collection takes place in a health centre or in households. Community leaders, health and water officials and other important local members of the public should be consulted, as they not only are critical for facilitating the logistics but also can provide informative feedback on the survey questions and interpretation of the results.

Finally, it is important to consider confidentiality of the data collected. If the M&E programme is based on a research design, any data that are identifiable (e.g. names, addresses, global positioning system [GPS] points) should be blinded to prevent the linking of respondents to their responses. If the M&E effort is part of ongoing monitoring, it may be important to link the location to the responses in order to provide appropriate, targeted follow-up (i.e. additional education on use or motivators to change behaviour). In all situations, personal information should be treated with sensitivity and care and not used for any other purpose.

5.4.2 SAMPLE SIZE

One important aspect when planning an M&E programme is determining how many households or respondents to sample. One approach for determining the sample size is to assess a minimum number or proportion of households per unit, such as 10% or 50% of households that received the intervention per community. The minimum proportion will depend on many factors, including available resources for monitoring and analysing data, the total number of households involved in implementation and logistical constraints in reaching households, especially those in rural, remote areas. Statistical calculations of sample size for more rigorous research efforts are outside the scope of this document. However, resources for calculating sample size can be found in **Annex B**.

5.4.3 SAMPLING PLAN

If conducting household surveys, it is important to sample a random, non-biased selection and clearly document the methodology for selection. Some selection processes that have been used in other M&E programmes include:

- ***Community mapping.*** If the HWTS was distributed throughout a community, it may be useful to first map the community households and then randomly select those that will be sampled, taking into consideration geographic diversity, if necessary.
- ***Spin the bottle.*** If the population is evenly distributed in a community, data collectors may stand in the community centre, spin a bottle and walk in the direction the bottle points, sampling every other (or every third or fifth, depending on population density) household.
- ***Satellite imagery.*** If satellite imagery of the geographical area of the intervention exists, then a map of the area can be printed on a grid overlaid on the map. After random intersections are selected, households near those random intersections can be found using GPS points and surveyed.
- ***Randomizing a line-list.*** If a list of programme participants or HWTS users exists, that list can be entered into a spreadsheet and a random number assigned to each row. The list can be sorted by random number, and the first *n* households (where *n* is the sample size of the evaluation) can be selected for monitoring or evaluation.

Each of these methods has benefits and drawbacks, but the most important aspect in collecting a random sample is to develop a sampling plan, consistently implement the plan and describe in detail why that sampling plan was selected. In addition, documentation of what happened in each community/setting and how replacements were made if households or respondents could not be contacted will assist in understanding the randomness of the sample selection.

5.4.4 DETERMINING HOW OFTEN TO SAMPLE

M&E programmes tend to conduct three types of sampling: 1) comparing baseline with post-intervention populations; 2) conducting periodic monitoring; and 3) completing a one-time evaluation. Although there is no specific rule for the frequency of periodic monitoring, measuring use at intervals (4–6 months) over several years (2–5 years) is preferable to collecting data over shorter periods or only in one instance. Longitudinal (over time) data help determine trigger points that lead to increased or decreased use. For example, households may treat water only during the rainy season, when there is a real or perceived risk of microbial contamination and diarrhoeal disease, or households may treat water only for the few weeks or months following the harvest, when they are more likely to have expendable income and/or time to engage in water treatment activities.

5.5 DEVELOPING THE M&E TOOLS

One commonly used M&E tool is a household survey. Depending on the aims of the M&E programme and the resources available, the survey will vary in both breadth and depth. A more comprehensive survey includes information or questions on the following:

- ***Informed consent script.*** This is the first part of the survey, which explains why the survey is being conducted and any risks to the participant and obtains the consent of the respondent before proceeding.
- ***Demographics.*** Questions regarding sex, age and schooling can be included.
- ***Economics and income.*** Areas to include concern household assets, spending income and employment.
- ***Health data.*** Health data could involve self-reported diarrhoeal disease, anthropometric measurements, such as weight, height and upper arm circumference, and perception of disease.
- ***Water and sanitation knowledge, attitudes and practices.*** These include the perception of water safety, knowledge of treatment practices and actual practices.
- ***Knowledge on HWTS.*** As described, this includes knowledge of HWTS methods and demonstration of correct use.
- ***HWTS use.*** HWTS use can be measured through reported use and confirmation of use.
- ***Behavioural indicators.*** These include, but are not limited to, self-efficacy (belief that one can effectively treat water), social norms and perception of water treatment in the community, and exposure to training and messaging on HWTS.
- ***Water quality testing.*** This may involve testing of FCR, chemical indicators or microbial indicators.

When developing survey questions, several items should be carefully considered. The way in which questions are asked can influence responses. For example, leading questions, such as "Do you use a water filter?" or "Did the water filter you were given improve your health?", encourage the respondents to respond "yes", because they believe that this is the *correct* answer. Households may also feel compelled to state that HWTS has resulted in fewer episodes of diarrhoea so as not to offend or discredit the programme that provided them with the product. A more neutral way to ask these questions is, "Do you do anything to your water to make it safer to drink?" or "Has any member of your family had diarrhoea today? Yesterday? The day before yesterday?" and, if yes, "Who?". Diarrhoeal disease recall beyond seven days has been shown to be unreliable, and therefore it is suggested that recall be limited to two or three days (Schmidt et al., 2011). More frequent surveying has also been shown to lead to a lower reported incidence of child diarrhoea, indicating that the surveying itself affects either HWTS usage or reported health impacts

(Zwane et al., 2011). The order of questions can also influence responses. If the respondents are aware that they are being questioned on water treatment, they may overstate their use of HWTS methods. Verifying responses with objective and observable indicators can assist in minimizing these courtesy and social desirability biases.

Additionally, in developing questions, data entry and analysis should be considered. Closed questions are simpler to analyse than open-ended questions. The appropriate mix of closed and open-ended questions will depend on the goals of the M&E programme. Lastly, surveys should be translated into the local language(s) and then back-translated to verify accuracy before being put into practice. Even if those conducting the survey speak the local language(s), there are variations in language that should be accounted for to ensure that survey questions are clear.

Surveys should be pretested in settings similar to the ones that will be studied in order to assess the understanding and relevance of the questions. In the case of household sampling, pretesting also provides the study team with an opportunity to practise the logistics of finding and approaching households. Pretesting can reveal important cultural norms that may not be apparent. For example, in a WASH study in the United Republic of Tanzania, which asked questions using a Likert scale (strongly agree, agree, no opinion, disagree, strongly disagree), it became evident that respondents did not differentiate between strongly disagree and disagree. Both answers meant the same to them, and thus the questions were changed to include only three levels of response (agree, no opinion/ neutral, disagree).

5.6 SELECTING AND TRAINING THE M&E TEAM

The selection of the individuals who will conduct M&E is particularly important. These individuals can heavily influence the participation of and responses from the survey participants. Thus, it is important that those asking the questions operate objectively and do not bias the survey responses. If hiring external enumerators, it is preferable to select individuals from the specific area where the HWTS implementation occurred, as they are more likely to know the local languages and customs and can provide insights in interpreting the results. In addition, enumerators should be of a sex that will allow them to speak with the key beneficiaries, who are often women.

After identifying the team to conduct the M&E, some training will be needed. Training for national-level multiple indicator surveys can last weeks, whereas less involved training for conducting community M&E may be done in a few days. For large surveys, external enumerators may need to be hired, whereas for ongoing monitoring, local health and/or WASH officers may collect the data. In either situation, it is important that all individuals involved in data collection understand the correct procedures, keep diligent records and can troubleshoot issues in the field. Although the specific format of training is beyond the scope of this document, the main areas to cover include goals of the M&E programme, working conditions and expectations, correct use of HWTS technologies/methods, obtaining informed consent and a comprehensive review of all questions.

5.7 CONDUCTING THE M&E

When conducting the surveys, it is important to develop a schedule that maximizes efficiency. For example, if mothers are the main respondents and they are busy early in the morning with household chores or agricultural work, it is preferable to come later in the morning. In addition, consideration should be given to seasonal factors that may delay data collection. During the rainy season, roads may become impassable, or during the planting and harvest seasons or political elections, many adults may not be available to participate in the survey. If data are collected in health-care settings, attention should be given to when maternal or HIV clinics are held, the existing burden of data collection and the timing of national holidays or celebrations. The actual period of data collection deserves important attention, as often unforeseen events occur in the field. These can be mitigated through proper preparation, coordination and leadership.

During surveying, each data collector will need to be prepared with the equipment necessary to complete the data collection for the day, such as survey forms (paper or electronic), GPS meters and/or water quality testing supplies. Completed surveys should be reviewed regularly with those collecting the data to note any errors and, if justified, to amend problems with the survey or revisit the households.

5.8 ENTERING AND REVIEWING THE DATA

Once the surveys have been completed, the collected data should be collated into one database. Increasingly, data are collected electronically through mobile phones and personal digital assistants (Hutchings et al., 2012). In areas where it is possible, electronic data collection saves time and resources and reduces error in transferring responses from paper surveys to computer databases. Once the data are entered, they should be reviewed ("cleaned") to ensure that entry and outlying data points are identified. Once a clean and complete dataset is obtained, analysis can begin.

5.9 ANALYSING THE DATA AND DISSEMINATING THE RESULTS

One of the tasks that is most often neglected in an M&E programme is that of analysing, understanding and, most vitally, using the data to improve programme activities and/or investment of resources. Shortly after data collection, preliminary results should be provided to local communities and decision-makers, for a number of reasons. First, this is one means by which to give back in exchange for the time and effort from participants. Second, information on both outputs (number of HWTS products distributed or sold) as well as outcomes (types of HWTS methods used and period of use) can empower citizens to hold leaders accountable, provide information to entrepreneurs and vendors on user preferences and increase overall awareness of HWTS in the community. In addition, such dissemination, which often takes the form of a structured community meeting and summary of results in the local language, can allow for community members to clarify unclear results and explain unexpected results.

A variety of methods exist for analysing results, including:

- ***Calculating frequencies.*** One of the most straightforward and simple analyses is to calculate frequencies, such as the percentage of households that received the HWTS method, report currently using the method and/or know how to correctly use the method. Such analyses can effectively summarize outputs and outcomes and graphically provide a description of the programme.

- ***Meeting a standard or guideline value.*** Water quality data can be reported as the percentage of households meeting a certain standard or range—for example, the percentage of households with FCR between 0.2 and 2.0 mg/l, or the percentage of households with less than 1 or less than 10 CFU of *E. coli* per 100 ml of drinking-water. These outcomes compare the household water quality with international standards.

- ***Statistical methods.*** Statistical analyses can be completed to compare populations—for example, comparing the baseline results with post-intervention results or the group that received the HWTS method with non-recipients or segmented groups of HWTS method users. This requires a skilled researcher or statistician and is outside the scope of this document.

Particular attention should be given in the analyses to questions in series. As the example on correct product use in Box 3 in section 4.1.2 illustrates, users may know some, but not all, of the correct steps for using a HWTS method. Such questions should be analysed in sets to ensure that the correct, overall conclusions are made.

After analysis has been completed, a formal dissemination of results is important, not only to inform the specific HWTS programme, but also to increase the information available to government officials and policy-makers, other HWTS implementers and funders in regards to both the successes and challenges of specific HWTS efforts. In addition, a formal report should be provided to the communities, districts and regions where the evaluation took place to assist in local planning and resource allocation efforts. Lastly, sharing the results with other implementers can also be particularly valuable in order to share lessons, build off one another's work and avoid duplication.

5.10 EXAMPLES OF M&E PROGRAMMES AND RESULTS

In the following pages, two M&E examples are presented, using the nine steps described for conducting M&E. The first example evaluates the extent of sustained use of biosand filters distributed in Zimbabwe following an emergency (see **Box 7**).

Box 7: Evaluation of sustained use in Zimbabwe

During a recent cholera epidemic in Zimbabwe, an NGO distributed biosand filters to approximately 900 families. After the emergency response effort was completed, the NGO commissioned an external evaluation to determine the extent of filter use in the post-emergency development context. The nine steps were conducted as follows:

1. *Understand the context.* A list of the approximately 900 households to which filters were distributed was provided by the NGO. Households were in a rural area, with access to mostly unprotected sources of water, and were located some distance (~20 minutes of driving) apart from one another over a large geographical area. There were no social considerations around sex of enumerators to consider in this context.
2. *Develop the questions.* The main question in this M&E project was: What percentage of households that received a filter in the emergency are effectively using it in the post-emergency period?
3. *Select the indicator.* To answer the M&E question, the main indicators used were the percentage of households a) with a wet filter on the day of the survey, b) reporting correct knowledge of maintenance of the filter, c) reporting filter-treated water on the day of the survey and d) with "effective" use of the filter.
4. *Develop an M&E plan.* As a line-list of recipient households was available, the sampling plan was to randomly select 100 (~10%) of the households for surveying and water quality analysis.
5. *Develop the M&E tools.* The tools used in the evaluation were a household survey and key informant interviews. During the survey, enumerators collected paired untreated and treated household water samples.

6. *Select and train the M&E team.* The local NGO identified five enumerators, who were trained and managed by an external team leader.
7. *Conduct the M&E.* Because of the distance between households, surveys were conducted by driving enumerators in two vehicles to conduct the interviews. During the survey, there were difficulties with a) impassable roads, b) rain and other weather conditions, c) households where no one was home because they were working in the fields and d) having enough time to complete the survey, as obtaining local approval took longer than expected. In total, 61 of the 100 randomly selected households were interviewed. At the end of each survey day, the external evaluator reviewed the surveys and conducted membrane filtration testing for *E. coli* on the collected water samples.
8. *Enter and review the data.* Data were entered into Microsoft Excel by the external evaluator and reviewed. Percentages were calculated for most of the analysis, and additional statistical analyses were conducted to determine differences between groups using different filter casings.
9. *Analyse the data and disseminate the results.* A report on the data was provided to the NGO, which used the data in cooperation with its partners. A report was also provided to the government, to determine how to improve efforts in future emergencies, as the results were less positive than expected.

The major findings from the evaluation included the following:

- The majority (at least 75%) of respondents reported using in the past or currently using their biosand filter.
- Self-reported data were confirmed by the finding of a total of 91% of biosand filters that were wet on observation.
- The majority of households (84%) self-reported cleaning their filter, although when further questioned, only 41% knew how to clean it correctly, indicating some problems with knowledge retention following training.
- A majority (74%) of households covered their household drinking-water storage container, which indicates that safe storage practices could be improved.
- Only 54% of households could provide biosand-filtered water at the time of the household survey.

A total of 19 households had treated and untreated water available for collection. The samples were tested for *E. coli.* As shown in **Figure 4**, three households already had water meeting the WHO guideline value before treatment. Thus, 9/19 (47%) of households using the biosand filter were effectively using it to improve the microbial quality of stored household water. To calculate the final “effective use” indicator, the percentage of households with treated water available at the time of the unannounced household survey (54%) is multiplied by the percentage of households using the biosand filter to improve the microbial quality of stored household water to meet the WHO guideline value for *E. coli* (47%), giving 25.4%. Thus, *after* the emergency project ended, a quarter of the sampled population was still using the biosand filter to effectively treat their water in the post-emergency context. It is important to note that these data are limited by small sample size and may not accurately reflect use among all 900 households that received filters.

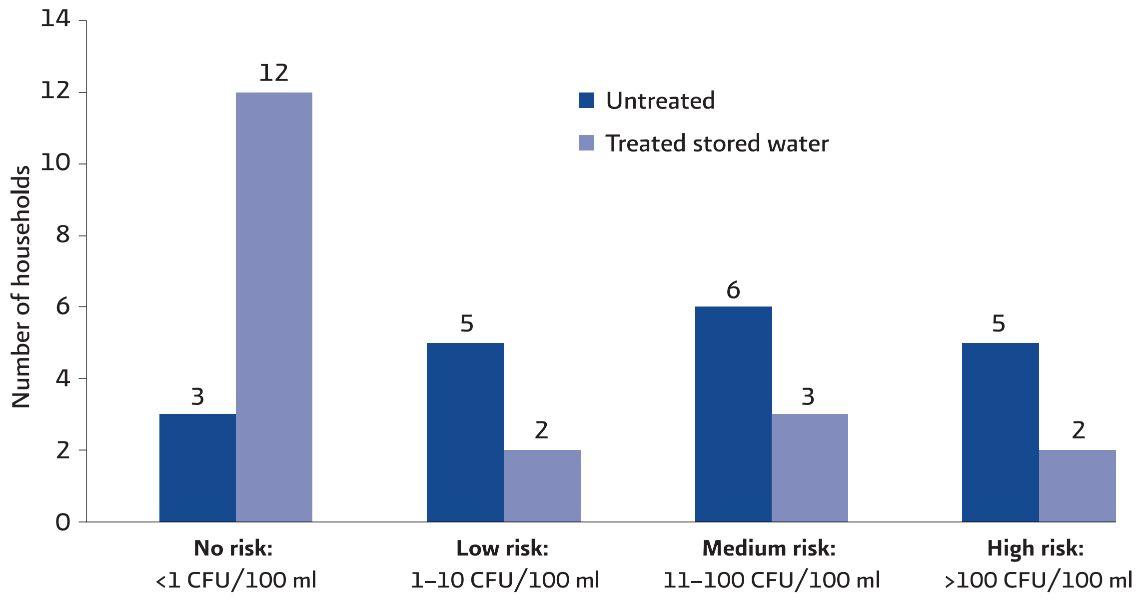

Figure 4: Concentration of *E. coli* in untreated and treated stored water

Most importantly, these data were used by the NGO to inform its other programmes. The NGO determined that in this situation, biosand filters were not an effective HWTS technology for cholera response, as it took too long to implement the project and users were not sensitized to the filters beforehand. However, there was some sustained use of the biosand filters in the post-emergency context, which is promising for future projects.

The second example describes a government-supported M&E programme that took place following the distribution of ceramic filters to approximately 5000 families in Ghana (**Box 8**). The filters were distributed in response to a flooding event with the aim of targeting the most affected communities.

Box 8: M&E of a HWTS programme in Ghana

After a major flooding event in Ghana in 2007, the NGO Pure Home Water, with support from UNICEF and in collaboration with the local government, distributed ceramic filters to approximately 5000 families most affected by the flooding. Monitoring was planned to be conducted on an ongoing basis by the government, and an independent evaluation was conducted one year after distribution (Pure Home Water, 2008). The nine steps of completing an M&E programme were conducted as follows:

1. *Understand the context.* Local government determined which households were most affected by the flooding and thus should be targeted to receive a filter. In all areas where the filters were distributed, community education sessions were provided on how to use the filter. Community health workers were trained on how to conduct monitoring and if necessary re-educate households.
2. *Develop the M&E questions.* Pure Home Water was interested in assessing programme success in five categories: distribution; training; treatment using the filters, and maintenance of the filters; monitoring and re-education; and appreciation of the filters. The overall question to address these categories was: Did the households affected by the flooding receive and effectively use HWTS during the period when water quality was compromised?

3. *Select the indicators.* To assess this overall question and in regards to the five categories, Pure Home Water developed a "five-drop" scale, with one drop considered unsatisfactory and five drops considered excellent. For example, for distribution, the question was: "Did the project reach the targeted beneficiaries?".
4. *Develop an M&E plan.* Based on available resources and the total number of filters distributed, the evaluation plan was to visit about 1000 households in 23 communities that had received the filter.
5. *Develop the M&E tools.* Household interview forms were developed. Water quality testing was not conducted.
6. *Select and train the M&E team.* As discussed previously, community health workers were trained on how to conduct monitoring.
7. *Conduct the M&E.* Government officials and household water providers were interviewed. The interview was script-based and focused on establishing a rapport with respondents in conversation to fill in a survey form, rather than directly asking and receiving answers to questions. An indicator of filter use was developed based on conversation with the respondent.
8. *Enter and review the data.* Data were entered and reviewed in Microsoft Excel.
9. *Analyse the data and disseminate the results.* Data were analysed, and a report was disseminated to UNICEF, the European Commission and the Government of Ghana.

The results of the monitoring found that the majority of respondents appreciated their filters, and 64% (range 41–85% by district) of households met the criteria for "filter in use". Breakage and access to safe drinking-water sources were the main reasons for discontinuing filter use. Concerns noted included the following: 1) while the intention was to distribute to families most in need, due to logistical and other constraints, these families were not always targeted; 2) the initial training sessions were large and did not provide sufficient engagement with the beneficiaries; and 3) the monitoring component was often abandoned, due to lack of financial, material and human resources. Although monitoring was a key planned element of the project, 70% of the 23 communities reported having no continued monitoring and re-education. It was recommended that, in the future, funding be provided to the organization conducting the monitoring (in this case, the local government) in order to cover M&E costs. As no water quality testing or observed filter use (e.g. a wet filter) was recorded, it is not known how effective the filters were at treating water. This example highlights the importance of allocating sufficient resources for monitoring as well as resources to mitigate challenges, such as broken filters. In addition, given that the HWTS technology was distributed in response to an emergency (flooding), identifying whether filters are also needed in the post-emergency context is necessary.

6. CONCLUSIONS

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The ultimate aim of collecting M&E data and disseminating M&E results is to achieve the main benefit of HWTS: improved health. The value of HWTS M&E will be realized only to the extent that results are utilized to inform future programmes, policies and investments. Effective M&E require honest reflection of the successes and failures of HWTS programmes and a willingness to share these results with the wider water, health and development sectors.

The progressive accumulation of M&E data from HWTS programmes will provide an important knowledge resource for guiding implementation, scaling up and improving sustainability. In addition, disseminating lessons learnt from programmes that do not achieve their objectives is as important as highlighting successes. Understanding what does and does not work across geographic regions, income groups and methods is essential for the iterative improvement of implementation strategies. In turn, this will greatly increase the likelihood of achieving the health goals of HWTS and ensuring that this important intervention is included in efforts to prevent and treat HIV, reduce malnutrition and improve child and maternal health.

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ANNEX A: SUMMARY OF HWTS METHODS[1]

METHOD	REMOVAL PERFORMANCE (LOG REMOVAL)[a]	ADVANTAGES	LIMITATIONS
Filtration (ceramic)	Bacteria: 2–6 Protozoa: 4–6 Viruses: 1–4	• Simple to use • Visual improvement in treated water • Possibility of local production benefits economy • One-time capital cost	• Lack of residual protection presents potential for recontamination (although products increasingly address this through attached safe storage containers) • Variability in quality of locally produced filters • Filter breakage requires reliable supply chain • Need to regularly clean filters and receptacles • Low flow rate of 1–3 litres per hour (slower in turbid waters) • Potential user taste objections
Filtration (slow sand filtration, i.e. biosand)	Bacteria: 1–3 Protozoa: 2–4 Viruses: 0.5–2	• High flow rate (~20 litres per hour) • Simple to use • Visual improvement in treated water • Production from locally available materials • Longer life • One-time capital cost	• Lack of residual protection presents potential for recontamination • Difficulty in producing and transporting heavy concrete and plastic (45–160 kg) filter housing and sand • Need for periodic cleaning and difficulty in assessing when cleaning is needed
Filtration (microfiltration [MF], ultrafiltration [UF], nanofiltration [NF], reverse osmosis [RO])	Bacteria: 2 MF; 3 UF, NF or RO – 4 MF; 6 UF, NF or RO Protozoa: 2 MF; 3 UF, NF or RO – 6 MF, UF, NF or RO Viruses: 0 MF; 3 UF, NF or RO – 4 MF; 6 UF, NF or RO	• Visual improvement in treated water • Potential longer life if spare parts are accessible • One-time capital cost	• Lack of residual protection presents potential for recontamination (although methods increasingly address this through attached safe storage containers) • Need for multiple steps to use the product, requires additional user support • Requires reliable supply chain for spare parts
Combined flocculant/ disinfectant powders	Bacteria: 7–9 Protozoa: 3–5 Viruses: 4.5–6	• Reduction of some heavy metals (e.g. arsenic) and pesticides • Residual protection against recontamination • Visual improvement in treated water • Small sachets are easily transported due to size, non-hazardous classification, long shelf life	• Need for multiple steps to use the product, requires additional user support • Requires reliable supply chain • Most appropriate in areas with high turbidity • Higher relative cost per litre treated

1 Adapted from Lantagne & Clasen (2009); WHO (2011c).

METHOD	REMOVAL PERFORMANCE (LOG REMOVAL)[a]	ADVANTAGES	LIMITATIONS
Thermal (boiling and pasteurization)	Bacteria: 6–9+ Protozoa: 6–9+ Viruses: 6–9+	• Existing presence in many households of materials needed to boil water • Sociocultural acceptance of boiling for water treatment in many cultures	• Lack of residual protection presents potential for recontamination • Potential for burn injuries and increased risk of respiratory infections from indoor stoves or fires • Potentially high cost of carbon-based fuel source (with concurrent deforestation risk) and the opportunity cost of collecting fuel • Potential user taste objections
Solar disinfection (solar disinfection + thermal effect)	Bacteria: 3–5+ Protozoa: 2–4+ Viruses: 2–4+	• Simple to use • No cost to the user after obtaining the plastic bottles • Minimal change in taste of the water • Minimal likelihood of recontamination because of safe storage	• Need for pretreatment (filtration or flocculation) of waters of higher turbidity • Volume to treat dependent on availability of clean, intact plastic bottles • Lack of visual improvement in water aesthetics to reinforce benefits of treatment • Relatively longer time to treat water and variability depending on sun intensity (12–48 hours)
Chlorination	Bacteria: 3–6 Protozoa: 3–5 (non-*Cryptosporidium*) Protozoa: 0–1 (*Cryptosporidium*) Viruses: 3–6	• Residual protection against recontamination • Simple to use • Possibility of local production benefits economy • Low cost	• Lower removals in turbid waters • Potential user taste and odour objections • Requires reliable supply chain • Necessity of ensuring quality control of product • Misunderstanding about the effects of chlorination by-products

[a] The range of removals represents baseline (i.e. in the field by a relatively unskilled operator) to maximum documented removals. Removal may also be expressed in terms of per cent reduction: 90% = 1 log, 99% = 2 log, 99.9% = 3 log, 99.99% = 4 log, 99.999% = 5 log, 99.9999% = 6 log, etc.

ANNEX B: RESOURCE MATERIAL

In this annex, resource material on the following topics is presented:

- Water safety plans
- Water quality, access and health
- HWTS methods
- Research ethics
- M&E methods and programming
    - Strengthening M&E systems
    - Sample size calculation
    - Training
    - Sampling plans
    - Data collection, sampling and analyses
    - Impact evaluations
- Behaviour change
- Water quality testing
- Monitoring indicators
    - Related environmental health interventions
    - Market-based solutions

WATER SAFETY PLANS

Bartram J et al. *Water safety plan manual: step-by-step risk management for drinking-water suppliers.* Geneva, Switzerland, World Health Organization, 2009. http://whqlibdoc.who.int/publications/2009/9789241562638_eng_print.pdf

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WATER QUALITY, ACCESS AND HEALTH

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HWTS METHODS

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United States National Institutes of Health. Online training on research ethics. http://phrp.nihtraining.com/users/login.php

World Health Organization. *Standards and operational guidance for ethics review of health-related research with human participants.* Geneva, Switzerland, WHO, 2011. http://www.who.int/ethics/research/en/

M&E METHODS AND PROGRAMMING

STRENGTHENING M&E SYSTEMS

Presidents' Emergency Plan for AIDS Relief. *Monitoring and evaluation systems strengthening tool.* 2007. http://www.pepfar.gov/documents/organization/79624.pdf

World Health Organization. *Monitoring and evaluation systems strengthening tool (MESST).* http://www.rbm.who.int/toolbox/tool_MESST.html

SAMPLE SIZE CALCULATION

Sample size calculator: http://www.surveysystem.com/sscalc.htm

Sample size determination: http://en.wikipedia.org/wiki/Sample_size_determination

Sample size table: http://research-advisors.com/tools/SampleSize.htm

TRAINING

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SAMPLING PLANS

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BEHAVIOUR CHANGE

Figueroa ME, Kincaid DL. *Social, cultural, and behavioral correlates of household water treatment and safe storage.* Baltimore, MD, USA, Johns Hopkins Bloomberg School of Public Health, Center for Communication Programs (Center Publication HCI 2010-1: Health Communication Insights). http://www.jhuccp.org/resource_center/publications/center_publications/social-cultural-and-behavioral-correlates-household

POUZN Project. *Best practices in social marketing safe water solution for household water treatment: lessons learned from Population Services International field programs.* Bethesda, MD, USA, Abt Associates Inc., Social Marketing Plus for Diarrheal Disease Control: Point-of-Use Water Disinfection and Zinc Treatment (POUZN) Project, 2007. http://www.psi.org/resources/research-metrics/publications/diarrheal-disease/best-practices-social-marketing-safe-water

WATER QUALITY TESTING

APHA/AWWA/WEF. *Standard methods for the examination of water and wastewater*, 22nd ed. Washington, DC, USA, American Public Health Association, American Water Works Association and Water Environment Federation. http://www.standardmethods.org

Bain R et al. A summary catalogue of microbial drinking water tests for low and medium resource settings. *International Journal of Environmental Research and Public Health*, 2012, 9:1609–1625. http://www.mdpi.com/1660-4601/9/5/1609

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MONITORING INDICATORS

RELATED ENVIRONMENTAL HEALTH INTERVENTIONS

United Nations Children's Fund. WASH in Schools monitoring package. New York, NY, USA, UNICEF, 2011. http://www.unicef.org/wash/schools/files/wash_in_schools_monitoringpackage_.pdf

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World Health Organization. *Essential nutrition actions: improving maternal–newborn–infant and young child health and nutrition* [draft]. Geneva, Switzerland, WHO, 2011. http://www.who.int/nutrition/EB128_18_backgroundpaper2_A_reviewofhealthinterventionswithaneffectonnutrition.pdf

World Health Organization. *Indicators to monitor the implementation of the comprehensive implementation plan.* http://www.who.int/nutrition/EB128_18_backgroundpaper4_nutrition_indicators.pdf

World Health Organization/United Nations Children's Fund Joint Monitoring Programme for Water Supply and Sanitation web site. http://www.wssinfo.org/

MARKET-BASED SOLUTIONS

Program for Appropriate Technology in Health. *PATH Safe Water Project's monitoring and evaluation framework: testing market-based solutions in four countries.* Seattle, WA, USA, PATH, 2011. http://www.path.org/publications/files/TS_swp_me_frame_br.pdf

ANNEX C: SAMPLE EVALUATION SURVEY (FOR MODIFICATION TO SPECIFIC CONTEXT)

Good morning / good afternoon. My name is _______________ . I am part of a team of people who are assessing water practices in your community. Our team will interview approximately 100 households in this area. Your local leaders have granted us permission to conduct this study, and your house has been randomly selected to participate. If you participate, I will ask you questions about your drinking-water and collect a sample of your water. The interview will take approximately 30 minutes. No one except me will know that it was you who answered these questions. Would you like to participate?

____ Household number [   ]

Person obtaining consent

GPS: ______________________________ ______________________________

A	Interviewer	
B	Date	
C	Time	
D	Location	

Household demographics, including education and socioeconomic status

Q1.	Sex of respondent	Male	1	Female	0		
Q2.	How old are you?		years				
Q3.	Did you go to school?	Yes	1	No **[GO TO Q5]**	0		
Q4.	How many years did you go to school?		years				
Q5.	Can the male head of household read?	Yes	1	No	0		
		No male head of household	99				
Q6.	Can the female head of household read?	Yes	1	No	0		
		No female head of household	99				
Q7.	OBSERVE: *type of walls*	Concrete	1	Tarp/cloth	2	Wood	3
		Dirt	4	Metal	5	Other:	
Q8.	OBSERVE: *type of floor*	Concrete	1	Tarp/cloth	2	Wood	3
		Dirt	4	Metal	5	Other:	

Q9. OBSERVE: *type of roof*

Concrete	1	Tarp/cloth	2	Wood	3
Dirt/grass	4	Metal	5	Other:	

Q10. How many ______does the household own?

				Bed		Bicycle		Motorcycle	
Chicken		Donkey, horse		Car/truck		Radio		Television	
Cattle, bull		Goat, sheep		Telephone		Refrigerator		Solar panels	

Q11. Can you tell me all the ways you know to make water safer to drink in your home?
[Multiple answer, ask "Any others?"] *Indicator #11*

Boiling	1	Liquid chlorine	2	Chlorine tablets	3	Coagulant/flocculant	4
Solar disinfection	5	Ceramic filter	6	Biosand filter	7	Membrane filter	8
Cloth filter	9	Settling	10	None	11	Other:	

Q12. May I observe you giving me a cup of your current drinking-water for children from this household?

Yes **[COLLECT SAMPLE]** *Indicators #19, #20*	1	No **[GO TO Q27]**	0	Do not have **[GO TO Q27]**	99

Q13. OBSERVE: Was sample collected safely (not touching water with hands)? *Indicator #7*

Yes	1	No	0

Q14. What source did this water come from? *Indicator #10*

Piped connection to yard or in household	1	Public standpipe	2	Borehole	3	Protected dug well	4
Protected spring	5	Rainwater	6	Unprotected dug well	7	Unprotected spring	8
Vendor water	9	Bottled water	10	Tanker	11	Other:	

Indicator #4

Q15. OBSERVE: Is the container covered/closed?	Yes	1	No	0
Q16. OBSERVE: Is the container clean?	Yes	1	No	0
Q17. OBSERVE: Is the container out of reach of animals?	Yes	1	No	0

Q18. OBSERVE: What container is used for drinking-water? *Indicator #3*

Bucket	1	Jerry can	2	Collapsible bucket	3	Gallon jug	4
Bucket with tap	5	Ceramic pot	6	Large drum	7	Other:	

Q19. Did you do anything to make the water safer to drink? *Indicator #1*

Yes	1	No **[GO TO Q27]**	0	Don't know **[GO TO Q27]**	99

Q20. How did you make this water safer to drink? *Indicator #1*

Boiling	1	Liquid chlorine	2	Chlorine tablets	3	Coagulant/flocculant	4
Solar disinfection	5	Ceramic filter	6	Biosand filter	7	Membrane filter	8
Cloth filter	9	Settling	10	Other:			

Q21. How many hours ago was it treated?

	hours

Indicators #2, #20

Q22. If chlorine, **TEST** for free chlorine residual:

Chlorine level		mg/l

Indicator #2

Q23.	**If filter**, OBSERVE: Is the filter assembled correctly?	Yes	1	No	0
Q24.	**If filter**, OBSERVE: Is the filter wet?	Yes	1	No	0
Q25.	**If filter**, OBSERVE: Is the filter clean?	Yes	1	No	0

Q26.	Can you give me untreated water from the same source?	Yes **[COLLECT SAMPLE]** *Indicator #19*	1	No	0

How often do: *Indicator #8*

Q27.	- adult men drink untreated water?	Always	2	Sometimes	1	Never **[SKIP Q31]**	0
Q28.	- adult women drink untreated water?	Always	2	Sometimes	1	Never **[SKIP Q32]**	0
Q29.	- children drink untreated water?	Always	2	Sometimes	1	Never **[SKIP Q33]**	0
Q30.	- sick/elderly drink untreated water?	Always	2	Sometimes	1	Never **[SKIP Q34]**	0

When do: *Indicator #8*

Q31.	- adult men drink untreated water?	In fields/work	1	Away from home	2	Other:
Q32.	- adult women drink untreated water?	In fields/work	1	Away from home	2	Other:
Q33.	- children drink untreated water?	At school, in fields	1	Away from home	2	Other:
Q34.	- sick/elderly drink untreated water?	When treated water is not available	1	Away from home	2	Other:

Q35.	Have you ever used the HWTS method/technology? *Indicator #9*	Yes	1	No **[GO TO Q44]**	0	Don't know	99
Q36.	Have you used in the past month?	Yes	1	No **[GO TO Q39]**	0	Don't know	99
Q37.	Have you used in the past week?	Yes	1	No **[GO TO Q39]**	0	Don't know	99
Q38.	Do you always use HWTS?	Yes **[GO TO Q41]**	1	No **[GO TO Q39]**	0	Don't know	99

Q39. When do you not use the HWTS method/technology? **[Multiple answer, ask "Any others?"]**

Dry season	1	Rainy season	2	When no money	3
When no time	4	I always use	5	Other:	

Q40. Why do you not use the HWTS method/technology? **[Multiple answer, ask "Any others?"]**

Bad taste	1	Bad smell	2	Do not know how	3
Forgot	4	Takes too much time	5	Broken	6
Requires too much money	7	Do not have HWTS	8	Other:	

Q41. Why do you use the HWTS method/technology? **[Multiple answer, ask "Any others?"]**

Makes water safe	1	Free	2	Prevents disease	3
Someone told me to	4	Other:			

Q42. **If chlorine**, do you know where to buy more chlorine? *Indicator #13*

Yes	1	No	0	Don't know	99

Q43. **If filter**, do you know where to find replacement parts for the filter? *Indicator #13*

Yes	1	No	0	Don't know	99

Q44. Did you receive messaging or training on how to use the HWTS technology? *Indicator #12*

Yes	1	No [GO TO Q47]	0	Don't know [GO TO Q47]	99

Q45. What types of training did you receive? **[Multiple answer, ask "Any others?"]** *Indicator #12*

Community meeting	1	Household visit	2	Radio advertisement or programme	3	Cellular phone quiz/ messaging	
Pamphlet/poster	4	Skit or theatre	5	Messaging	6	Other:	

Q46. Who gave the training? **[Multiple answer, ask "Any others?"]** *Indicator #12*

Promoter	1	Community health worker	2	NGO worker	3
Community and/or religious leader	4	Friend, neighbour, relative	5	Other:	

If chlorine, Can you describe how you use the chlorine? *Indicators #5, #6*
[Circle number next to what respondent states only, prompt if respondent states action]

Q47.	Add tablet/cap	1 →	Prompt: Number tablets/caps: ___________
Q48.	To water in container	2 →	Prompt: Volume water added to: ____________
Q49.	Wait to drink	3 →	Prompt: Time wait: ___________

If filter, Can you describe how you use the filter? *Indicators #5, #6*

Q50.	Add water to filter	1	
Q51.	Store safely	2	
Q52.	Clean filter when dirty	3 →	Prompt: How many times per month? ___________

Can you state if you strongly agree, agree, disagree or strongly disagree with the following statements?

Q53.	Others I know also treat their water at home *Indicator #14*	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
Q54.	I am confident I can treat my water at home *Indicator #15*	Strongly agree	Agree	Disagree	Strongly disagree	Don't know
Q55.	My friends encourage me to treat water *Indicator #16*	Strongly agree	Agree	Disagree	Strongly disagree	Don't know

Do you have the following items in your household? *Indicator #18*

Q56.	Mosquito bednet	Yes No	**If yes, observe:**	Installed	Not installed
Q57.	Soap for washing hands	Yes No	**If yes, observe:**	Present	Not present
Q58.	Latrine	Yes No	**If yes, observe:**	Improved	Not improved
Q59.	Cookstove	Yes No	**If yes, observe:** Traditional stove	Advanced combustion No stove (open fire)	

ANNEX D: EXAMPLE SANITARY RISK FORM AND RISK ASSESSMENT MATRIX[2]

TYPE OF FACILITY: RAINWATER COLLECTION AND STORAGE

1. General information: Zone ______________________ Location __________________________

2. Code number: ____________________________

3. Date of visit: ____________________________

4. Water sample taken: Y / N Sample number: _____________ CFU/100 ml: _____________

SPECIFIC DIAGNOSTIC INFORMATION FOR ASSESSMENT

1.	Is rainwater collected in an open container?	Y / N
2.	Are there visible signs of contamination on the roof catchment?	Y / N
3.	Is guttering that collects water dirty or blocked?	Y / N
4.	Is the top or walls of the tank cracked or damaged?	Y / N
5.	Is water collected directly from the tank (no tap on the tank)?	Y / N
6.	Is there a bucket in use, and is this left where it can become contaminated?	Y / N
7.	Is the tap leaking or damaged?	Y / N
8.	Is the concrete floor under the tap defective or dirty?	Y / N
9.	Is there any source of pollution around the tank or water collection area?	Y / N
10.	Is the tank dirty inside?	Y / N

Total score of risks (sum all the "Y" answers): _______ / 10

RESULTS AND RECOMMENDATIONS

The following important points of risk were noted:

Comments:

Signature of health inspector/assistant:__________________________

[2] From WHO (1997).

Using the above sanitary score worksheet, in combination with results from microbial indicator testing, a risk classification—from "no action required" to "very high risk: urgent action"—can be determined using **Figure A-1**.

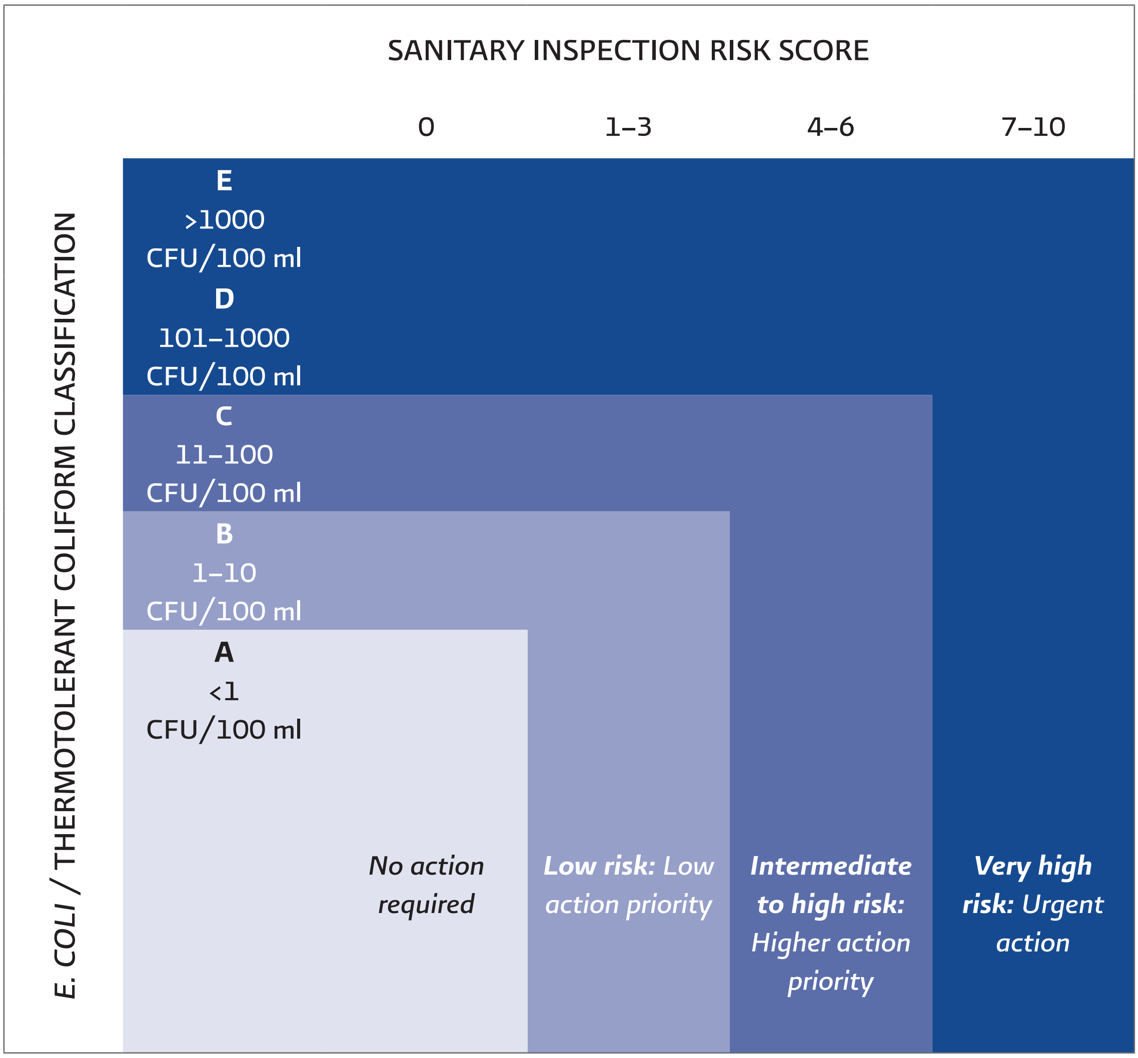

Figure A-1: Risk classification

An example of a situation in which a high-risk sanitary score leads to a low-risk *E. coli* classification might be if the household took the stored rainwater and effectively treated it using a HWTS technology before drinking. The household would have a high sanitary risk but a low microbial indicator risk, and the recommendation would need to be to continue using HWTS until the sanitation conditions of the rainwater storage tank were improved.

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