Safe Water Systems for the Developing World: A Handbook for Implementing Household-Based Water Treatment and Safe Storage Projects

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Department of Health & Human Services
Centers for Disease Control and Prevention

Safe Water Systems for the Developing World: A Handbook for Implementing Household-Based Water Treatment and Safe Storage Projects
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ACT International, Atlanta, Ga. USA.

Technical advisor: Robert Quick, MD, MPH
Centers for Disease Control and Prevention
Original graphics: Robert Hobbs
Centers for Disease Control and Prevention
Layout and cover design: Jody Blumberg, Sara Cote
Centers for Disease Control and Prevention

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Centers for Disease Control and Prevention
Eric Mintz, MD, MPH
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Luke Nkinsi, MD, MPH

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Janet Livingstone

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Samantha Gray

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Angelica Thevos, MSW, PhD

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Martin Wegelin
Bruno Gremion

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Foreword

In 2000, just 10 years after the end of the Water and Sanitation Decade, the lack of access to safe water remains a problem for more than a billion people in the developing world. Annually, 2 to 3 million children less than 5 years old die of diarrheal diseases, a large proportion of which are acquired through exposure to contaminated water. In addition, after 39 years, the 7th pandemic of cholera continues unabated, claiming the lives of a high percentage of children and adults who acquire the disease. There are a number of reasons for the persistence of these problems, in spite of the investment of billions of dollars in safe water by donor agencies and governments. Population shifts from rural to urban areas have stressed existing water and sanitary infrastructure and exceeded the capacity of most countries to keep up with demand. Large population dislocations caused by armed conflict and natural disasters have created enormous logistical problems in providing water and sanitation services, as have dispersed populations and poor transportation infrastructure in many rural areas. While larger scale projects, such as the construction of deep wells or piped water systems, remain an important objective of many development agencies, a shortage of time and resources will leave hundreds of millions of people without access to safe water into the foreseeable future.

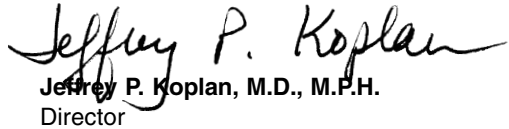
The Centers for Disease Control and Prevention (CDC) and the Pan American Health Organization developed the household-level water quality intervention described in *Safe Water Systems for the Developing World: A Handbook for Implementing Household-Based Water Treatment and Safe Storage Projects* to help bridge the enormous gap in developing countries between populations served by existing water projects and those most in need. This handbook, produced by the CARE/CDC Health Initiative, is a valuable tool for providing inexpensive and feasible appropriate-technology alternatives in situations where resources are not available for improvements in infrastructure.

While we fully support efforts to build the infrastructure necessary to create a healthier living environment for people in developing countries, we also recognize that such efforts will not meet the enormous global need in the near term. Because of that, CARE and CDC have joined together under the CARE/CDC Health Initiative to conduct implementation projects in Kenya and Madagascar that build on the successes of projects in other countries. We have designed this manual for program managers and technical personnel in other parts

of the world who may find this approach helpful in implementing their own projects.

We hope that you find *Safe Water Systems* helpful and invite your comments and suggestions *(www.cdc.gov/safewater)* on making it more useful.

Peter D. Bell
President and CEO
CARE USA



Jeffrey P. Koplan, M.D., M.P.H.
Director
Centers for Disease Control and Prevention

Introduction

There is no question that, for many populations in developing countries, the need for safe water is great. The ultimate solution for the problem is to provide systems of piped, disinfected water, but this approach is expensive, time-consuming, and will take decades to realize. To address immediate needs, other approaches are required while progress is made in improving infrastructure.

In our experience, alternate locally available approaches are few in number and often impractical. Boiling water is expensive, time-consuming, and, in areas where wood is needed for fuel, harmful to the environment. The use of commercial bleach to disinfect water is not always practical or acceptable because the price can be high, the concentration variable, and the product is often marketed for unappealing activities not related to consumption, such as washing clothes or cleaning toilets. A variety of alternative technologies have been developed, but most are unavailable in developing countries, and many are expensive or have not been adequately field-tested.

In 1992, in response to the Latin American cholera epidemic, the Centers for Disease Control and Prevention (CDC) and the Pan American Health Organization (PAHO) developed a household-based intervention to meet the immediate need for improved water quality, which is called the Safe Water System[1]. The Safe Water System is inexpensive, easily disseminated, and has the potential for recovering some of the costs of implementation. The Safe Water System has been extensively field-tested and several non-governmental organizations are implementing large-scale projects. We feel that the Safe Water System adds a useful, practical, flexible approach to interventions for water quality and hygiene.

The Safe Water System: What is it?

The Safe Water System is a water quality intervention that employs simple, inexpensive and robust technologies appropriate for the developing world. The strategy is to make water safe through disinfection and safe storage at the point of use. The basis of the intervention is:

- point-of-use treatment of contaminated water using sodium hypochlorite solution purchased locally and produced in the community from water and salt using an electrolytic cell;

- safe water storage in plastic containers with a narrow mouth, lid, and a spigot to prevent recontamination;
- behavior change techniques, including social marketing, community mobilization, motivational interviewing, communication, and education, to increase awareness of the link between contaminated water and disease and the benefits of safe water, and to influence hygiene behaviors including the purchase and proper use of the water storage vessel and disinfectant.

Potential target populations for the Safe Water System

The Safe Water System was designed for populations that must obtain their water from the following sources:

- surface water sources such as rivers or lakes;
- shallow groundwater that is potentially contaminated, particularly open shallow wells;
- piped systems in which the water is inadequately treated or flow is intermittent, allowing contamination through leaks where pipes are connected;
- piped water systems in which intermittent flow requires households to store water;
- water tankers;
- water vendors whose source of water is not safe or whose tanker or storage tank is not likely to be clean.

Other potential target populations are those that exhibit poor hygienic behaviors in the collection and storage of water. Such behaviors would include not cleaning containers before filling them with water and using wide-mouthed containers to collect and store water. Disinfection is not always necessary in these cases (e.g., if the source water is safe) but the practice of disinfection ensures safe water and supports the essential improvements in behavior including the use of a safe storage container.

Field trials

Field trials of the point-of-use water disinfection and safe water storage system conducted by CDC in South America, Africa, and Asia have demonstrated that it is practical, acceptable, effective, inexpensive, and a potentially sustainable means to improve water quality and prevent waterborne diseases:

Acceptability and microbiological effectiveness

- Families in rural and in peri-urban communities in Bolivia, Ecuador, Nicaragua, Peru, Pakistan, and Zambia used the Safe Water System to dramatically improve household drinking water. [2, 3, 4, 5, 6, 7]
- Street vendors in Bolivia and Guatemala used the Safe Water System to dramatically improve the quality of the beverages they sell and of the water they use to prepare beverages, and wash hands and utensils. [8] (Quick, unpublished data)
- Health care workers in Guinea-Bissau used the intervention to dramatically improve the quality of oral rehydration solution prepared, stored, and dispensed to patients on a cholera ward.[9]

Prevention of waterborne diseases

- Families in Bolivia and Zambia who used the Safe Water System had between 44% to 54% fewer episodes of diarrheal diseases when compared with control families who did not use the intervention. The largest protective effect was among infants and young children.[3, 10] (Quick, unpublished data)

Potential sustainability

- Large scale social marketing projects in partnership with Population Services International (PSI) in Bolivia, Zambia, and Madagascar have demonstrated the potential for sustainable Safe Water System projects through partial cost recovery.
- In Madagascar, a partnership between CARE, PSI, and CDC has enabled the Safe Water System to be implemented as part of a community mobilization project and serve as a tool to facilitate the mobilization process.[11]
- Safe Water System projects in Bolivia, Zambia, and Madagascar have mobilized their programs rapidly to respond to cholera epidemics and natural disasters.[12]
- Field trials in Zambia conducted by the Medical University of South Carolina (MUSC) have demonstrated increased rates of utilization of water disinfection and safe storage practices of up to 70% in target populations through the use of motivational interviewing, a novel behavior change method.[13]

The Safe Water System vs. other technologies

Results of the above field trials and implementation projects show how the Safe Water System has been successfully applied in rural and peri-urban settings in Latin America and Africa for populations of up to 200,000 people. The results have been carefully documented, and this manual reflects the extensive experience gained. We believe that the Safe Water System is appropriate in many situations. Before you decide to design a project around the system, however, two important questions must be answered:

- Is household treatment an appropriate priority for the target population?
- What type of household treatment should be selected?

Is household water treatment an appropriate priority?

The effectiveness of different interventions in preventing the transmission of diarrhea is well documented. Safe excreta disposal, improved hygienic behavior, and use of an adequate quantity of water all typically result in greater reductions in diarrhea than improved water quality.[14] This hierarchy of effect is counterbalanced, however, by a number of factors relating to household-level water quality interventions in general, and the Safe Water System in particular:

- In many communities, the demand for an improved water system both in terms of quantity and quality is greater than that for improved excreta disposal.
- In many communities, there is a lack of awareness of the effect of improved sanitation and hygiene.
- A household-based intervention, like the Safe Water System, can be a low-cost method of improving water quality.
- The Safe Water System offers the possibility of at least partial cost recovery.
- A household-level water quality intervention can be implemented as a stand-alone activity or as a low-cost component of an environmental health program.
- When social marketing and participatory processes are used effectively for promotion and education on water quality, there is potential additional benefit of increasing the general awareness of hygienic behavior.

Each of the above factors should be taken into account when deciding on an intervention for a community. This manual will help you decide if the Safe Water System is appropriate for your community. Other interventions for household water treatment are briefly discussed in the section of this handbook, entitled Alternative Water Treatment Technologies, beginning on page 137. Information about sanitation, water supply, and hygienic interventions will need to be obtained locally from NGOs, Ministries, and other agencies.

What type of household treatment should be selected?

A number of methods for water disinfection at the household level have been developed. In deciding which methods would be most appropriate for a given population, a program manager must consider a variety of factors:

- Is water quality improvement a priority for the target population?
- Do representatives of the population believe that a particular method is appropriate for them?
- Is that method affordable to the target population?
- Is the target population willing to pay for it?
- What is the potential for cost recovery?
- How complex is the process of implementation?
- What is the complexity of behavior change required?
- How difficult will it be to monitor key processes and evaluate impact?
- Do potential donors feel that this approach is justified?

This manual focuses on the Safe Water System because, in a variety of field trials and implementation projects, we have found it to be relatively inexpensive, easy to implement, easy for target populations to accept, adaptable to a variety of conditions, and effective in improving water quality and preventing diarrhea. We recognize that other appropriate technologies are available and that some of them might be more appropriate in some settings than the Safe Water System. In a final section, we provide information about a variety of other appropriate technologies for household water treatment, including a brief description, advantages and disadvantages, and cost. We do not pretend that the list of technologies is complete, or that the information is comprehensive. We hope that it is enough to provide interested

people the basis for beginning to investigate technologies that might be appropriate for the populations they serve.

Purpose of this manual

This manual was developed for program managers, technical staff, and other organization personnel who would be involved in implementing a project to improve water quality. The manual is designed to take people through the necessary steps to initiate the planning process, assemble a team, decide between various water treatment and storage options, and devise strategies for distribution, cost recovery, promotion, behavior change, and monitoring and evaluation. We hope that the manual is thorough enough to provide local program people with information and tools to plan and implement their own projects, but we have included contact information for people with experience in similar projects who may provide technical assistance.

We also hope that the manual in future revisions can become a clearinghouse for new approaches and technologies for the improvement of water quality as knowledge and experience are gained in the laboratory and the field. This manual is available in hard copy and also on the Safe Water web page, which can be accessed through the CDC Home Page (www.cdc.gov). We invite anyone with questions, comments, criticisms, suggestions for improvement, or information on different technologies to contact us through the website. We plan to update the website on a regular basis so that it can become an evolving resource to the community of people who are working to create a safer environment for people around the globe.

How to use this manual

This manual is organized into 14 sections plus annexes. Following the introduction, 12 sections take program personnel through 12 steps to plan and implement a project using the Safe Water System. Because many of the steps take place concurrently, the responsibility for tasks described in different sections can be assigned to different people. Nine annexes provide additional detail for some steps, model forms, worksheets, example brochures, and monitoring instruments. The final section describes other water treatment technologies that some projects may want to consider.

We hope that this manual will be a useful resource. We welcome your comments and questions and look forward to working together toward the goal of providing safe water for all.