REQUEST FOR PROPOSALS

Research and Implementation of the World Health Organization Strategic Plan for Household Drinking Water Treatment and Safe Storage and Related Parallel Activities in Kenya

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September 30, 2004

1. NOTICE TO PROSPECTIVE BIDDERS

At the United Nations Millennial Summit in New York in 2000 and again at the United Nations Summit on Sustainable Development in Johannesburg in 2003, the international community signed on to the Millennium Development Goals – a recommitment was made to sustainable development and the elimination of poverty. The seventh of the eight Millennium Development Goals is "to halve by 2015 the proportion of people without sustainable access to safe drinking water." [1] The World Health Organization is one of the organizations actively implementing this agenda.

In this capacity, the World Health Organization is seeking proposals from qualified bidders on research, assessment and implementation of household drinking water treatment and safe storage technologies in developing countries. The anticipated effort will require 1600 to 3200 hours of technical effort (4 to 8 MEng students) leading to a draft final report on Friday, April 16, 2005. Assuming a one-week review by sponsors, a final report is due on Friday, May 6, 2005. In addition, the successful team will be expected to make one or more oral presentations to the client and the public.

To be considered, prospective bidders are asked to forward a letter of intent (LOI) with team qualifications to the above address by COB, Friday, October 8, 2004. The LOI should be no longer than 2 pages, exclusive of resumes, and should outline the team's preliminary plans for the project. Bidders will be notified by October 15 if they have made the short list, and successful bidders will be asked to submit a full technical plus cost proposal by December 3, 2004. Details of the proposal follow.

[1] http://www.developmentgoals.org (Goal 7)

2. BACKGROUND

"Why Focus on Household Drinking Water Treatment and Safe Storage"
(excerpt of a letter by Dr. Jamie Bartram, Coordinator, Water, Sanitation and Health Programme, World Health Organization to the International Network to Promote Household Drinking Water Treatment and Safe Storage (HWTS))

> Water is the essence of life and human dignity. As a fundamental human right "sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses" is vital for all. Governments are responsible for ensuring that this human right is progressively fulfilled. As a result of their action with partners, 900 million more people have gained access to an improved water supply during the 1990s. Yet worldwide, 1.1 billion people in rural areas and urban slums still rely on unsafe drinking water from rivers, lakes and open wells. Children in particular suffer a severe toll of illness. While we all agree that ensuring access to clean, piped water supplies to all is the ultimate goal, we also acknowledge that this is not likely to occur soon. Even if the Millennium Development Goal of halving the proportion of people without sustainable access to safe drinking water by 2015 is accomplished, 700 million people will remain unserved. Because these vulnerable populations cannot afford to wait, we must be realistic, and understand that economic and political constraints require that we develop alternatives that can be implemented quickly.
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> There is now conclusive evidence that simple, acceptable, low-cost interventions at the household and community level are capable of dramatically reducing the risks of diarrheal disease and death. These household interventions are cost-effective, with an overall benefit of up to 60 US$ per 1 US $ invested. While efforts are ongoing to provide everyone with access to safe water, treatment techniques at home are simple and cheap measures that can make an immediate difference to the lives of the worst affected.

3. INTERNATIONAL NETWORK TO PROMOTE HOUSEHOLD DRINKING WATER TREATMENT AND SAFE STORAGE

At the June 2004 meeting of the WHO International Network to Promote Household Water Treatment and Safe Storage (the Network), participants worked to create an achievable operations plan for the next 12 months that will help promote simple, low cost initiatives to treat and safely store water at the point of use. Bidders to this project are invited to participate and assist in the Network's activities. The Nairobi meeting included representatives from a diverse group of NGOs, government agencies, research institutions and private companies committed to promoting household water treatment and safe storage (HWTS) initiatives. Participants built on momentum created in previous meetings – February 2003 in Geneva, where these organizations began forming a network to advance shared goals, and June 2003 in Washington, where Network members created

a 5-year strategic plan. Drawing on information presented in background documents, presentations and dialogue, participants in the Nairobi meeting outlined priority actions to begin implementing the strategic plan. Breakout sessions separately addressed advocacy, communications, research and implementation.

Participants reviewed mounting evidence demonstrating that HWTS initiatives can dramatically improve the microbial quality of household water, and reduce incidents of childhood diarrheal and other diseases. Participants also learned about new evidence that HWTS interventions have the potential to yield dramatic economic benefits if implemented on a global scale.

An economic evaluation recently commissioned by WHO found that all water and sanitation interventions evaluated by the authors provide benefits greater than the cost of implementation. The report singled out HWTS interventions as particularly promising, resulting in high health improvements with relatively low costs. Point-of-use chlorination and safe storage, in addition to access to improved water and sanitation, would provide benefits ranging from 5 to 60 $US per 1 US$ invested. With this solid evidence base, energized members, and dedicated support within WHO, the Network now possesses the capacity to begin achieving its important mission.

MIT faculty and staff from the Civil and Environmental Engineering Department's Master of Engineering Program have been involved in all three Network meetings in Geneva, Washington DC and Nairobi and are playing a leading role in the activities of the Implementation Working Group in the coming year.

4. PREVIOUS MIT MASTER OF ENGINEERING RESEARCH ON HOUSEHOLD TREATMENT AND SAFE STORAGE

Since 1999, 14 MIT Master of Engineering (M.Eng) student teams have done engineering thesis and related project work on household drinking water treatment and safe storage (HWTS) in five different countries: Nepal, Haiti, Dominican Republic, Nicaragua and Haiti. We have engaged in about ten areas of activity:

(1) Simplified Field-based Laboratory Methods;
(2) Water Quality/Site Investigations (microbial indicators, arsenic, other basic water quality parameters);
(3) Technology Evaluations (existing HWTS options);
(4) Technology Design and Innovation;
(5) Technology Comparisons;
(6) Manufacture, Quality Control, Operation and Maintenance;
(7) Management, Business, Finance;
(8) Pilot Projects;
(9) Implementation and Scale-up;
(10) Project Monitoring, Surveys and Overall Project Assessment.

When we began this work five years ago, there were very few household drinking water treatment options available. Since then, we have located a number of existing systems and programs in various countries, adapted conventional drinking water treatment engineering principles and processes to household systems and/or invented new systems. We have evaluated the following HWTS systems and processes for particle removal, microbial inactivation/removal, disinfection and arsenic removal at the household scale:

1. Safe Storage
2. Filtration:
    * Cloth Filters
    * Ceramic water filters
    * Intermittent slow sand filters
3. Coagulation/Flocculation
    * Ferric chloride
    * Alum
4. Disinfection
    * Chlorine and the Safe Water System
    * SODIS and UV Disinfection Systems
5. Combined (multiple barrier) HWTS Systems
    * Rough filter + granular activated carbon filter + chlorine disinfection
    * Ceramic candle + sand
    * Ferric chloride, charcoal and hypochlorite bleach+ filtration
6. Arsenic Household Treatment Systems

METHODOLOGY

Our methodology is primarily field-based engineering research, with studies generally following this progression:

Background Research - Develop knowledge base of range of options in a given category (e.g. household slow sand filters, ceramic filters, arsenic technologies, etc.);

Phase I Evaluations – Field and laboratory studies in multiple sites/countries using typical water sources and/or evaluating options already in use;

Phase II Evaluations - Pilot studies in a limited set of households evaluating one intervention or comparing different interventions in a given HWTS category in households;

Phase III Evaluations – Implementation and monitoring in a scaled-up set of households.

Our approach is that no one thesis or team report accomplishes the entire set of objectives, but each work builds on prior research, accomplishing our ultimate goal of reaching large numbers of people with safe drinking water. This will be our 6th year working on water/sanitation projects. We suggest that bidders review the reference list of

HWTS projects, organized by topic (available as a hand-out) and/or to visit: http://web.mit.edu/watsan in order to get a sense of the range of project options.

5. KENYA

This year's "Water and Sanitation in Developing Countries" M.Eng. project will be based in Kenya. Kenya is located in East Africa and is bordered on three sides by Somalia, Uganda, Ethiopia and Tanzania with the Indian Ocean to the west. The land area is 580,000 km^2 and the year 2003 population is 31 million. Average annual income per capita is $350.The infant mortality rate and under-five mortality rate has gotten worse in the last decade. The infant mortality rate is 78/1000 live births and the under-five mortality is higher at 122/1000 births (World Bank, 2003).

Kenya is an ideal country to study point-of-use water treatment systems because of both the variety of systems in place and the varying terrain, geography and implementation mechanisms currently underway. All the major point-of-use water treatment options (ceramic filters, biosand filters, PuR, Safe Water System, SODIS) have projects in Kenya, in addition to other groups promoting water supply, sanitation and hygiene interventions. There are a diverse group of partners, including government (Kenya and international), non-governmental organizations and the private sector. In addition, although Kenya is seen by many in the West as a tourist center, there is incredible need and demand for safe water in Kenya, the people in rural areas drink some of the most turbid and organically contaminated water in the world. The many opportunities to study household treatment systems in Kenya because there are multiple HWTS systems and programs in operation, in the following topical areas:

- Water Supply and quality
  * Groundwater,
  * Surface water (rivers, streams, lakes and ponds)
- Filtration
  * Ceramic filters
  * Intermittent slow sand filters
- Coagulation/Flocculation
  * Alum, ferric chloride, natural polymers
  * Coagulant + disinfectant
- Disinfection
  * Safe water system (household chlorine disinfection)
  * SODIS
- Combined (multiple barrier) systems
- Rainwater Harvesting
- Sanitation Systems

6. NEW RESEARCH OPPORTUNITIES

Broadly speaking, there are three types of research opportunities offered in the 2004-05 "Water and Sanitation in Developing Countries" M.Eng. project(s).

1. WHO Network Implementation Activities

2. HWTS Technical Research

3. HWTS Project or Program Assessments

The first set of activities involves working directly with the International Network for Safe Household Drinking Water Treatment and Safe Storage on their 2004-05 "Priority Activities." The second and third options are activities in parallel with the WHO Network agenda, but not directly a part of the 2004-05 WHO Network "Priority Activities." Selection of any of the projects described in this RFP would involve field visits and work in Nepal and/or Kenya.

6.1 WHO NETWORK IMPLEMENTATION ACTIVITIES

The WHO Network Implementation Working Group has identified "Priority Activities" for 2004-2005. Individual bidders to this RFP may select one of these activities as the focal point of their year's work and/or a team may select a number of these activities as their foci. In doing so, bidders would be committed to collaborating with Network partners who have expressed interest in providing assistance to a given activity. The activities and interested partners are listed in Table 1 (Contact information for interested partners will be provided at a later time).

Table 1: Priority Activities of the Implementation Working Group of the WHO Network and Interested Partners

IMPLEMENTATION ACTIVITY	WHO NETWORK PARTNERS INTERESTED IN PROVIDING ASSISTANCE IN THIS ACTIVITY
1.Create Web-based tool for HWTS technology and program options, organized according to key parameters	CDC, IDE, MIT, Ministry of Local Government-Kenya - City Council of Nairobi (CCN) (need more info Dr. Nynku), SANDEC (need more info), UNICEF, USAID, UNC
2. Create Web-based database of implementation experience of the WHO Network Members	IDE, MIT, Ministry of Local Government-Kenya -City Council of Nairobi (CCN), Medentech (provision of data), P&G, SANDEC (provide data), National Nurses Assoc. of Kenya (NNAK) (provide data), Nursing Council of Kenya (NCK) (need more info for final decision)
3. Create Web-based tool for sharing technology verification methodologies and results	CDC, Emory, IDE, MIT, Ministry of Local Government-Kenya - City Council of Nairobi (consumer of this information), UNICEF, UNC
4. Develop guidance for HWTS technology evaluation/verification, including both impact evaluation/verification for health, water quality, behavior/use as well as program implementation evaluation/verification	Anglican Church, AIT, Bushproof, CDC, CAWST, Emory, IDE, KWAHO, JHU, LSHTM, MIT, MedAir, Ministry of Health-Gov't of India, Ministry of Local Government-Kenya, City Council of Nairobi-Kenya, DOH/MOPH-Thailand, MOH-Kenya, Nursing Council of Kenya (NCK) (behavior/use, program implementation, evaluation), Practica, Rotary, Samitarian's Purse, UNICEF, USAID, UNC, Water Resources Management Authority
5. Develop program and business development checklist	CAWST, IDE, MIT, PSI, Practica, USAID

Activities #1 and #2 could be stand-alone activities which would be selected by one individual bidder or combined into one project. Activity #3 might be linked with #4 and would involve providing assistance and technical support to a WHO expert task force on technology verification. Activity #5 is a comparatively simple activity that could be undertaken in conjunction with some options, either from this list, or as described later in this proposal. All of the activities listed in Table 1 would entail HWTS field site trips in either Nepal or Kenya.

ABBREVIATIONS OF ORGANIZATIONS OF INTERESTED PATNERS:
AIT – Asia Institute of Technology
CAWST – Centre for Affordable Water and Sanitation Technology
CDC – Centers for Disease Control
DOH-MOPH-Thailand: Department of Health/Ministry of Public Health-Thailand
IDE – International Development Enterprises
JHU – Johns Hopkins University
KWAHO – Kenya Water for Health Organization
LSHTM- London School of Hygiene and Tropical Medicine
NCK – Nursing Council of Kenya
MIT – Massachusetts Institute of Technology
NNAK – Nurses Association of Kenya
PSI – Population Services International
P&G - Proctor and Gamble
SANDEC = EAWAG/SANDEC - Swiss Technical Institute – Water and Sanitation in Developing Countries Program
UNC – University of North Carolina
UNICEF- United Nations International Children's Emergency Fund
US AID – United States Agency for International Development

6.2 TECHNICAL RESEARCH

Below are some suggested project ideas. Bidders may select from this list or suggest ideas that could be tailored to meet individual interests.

6.2.1 Engineering Safe Water Containers

"Safe storage" is an essential component of household drinking water treatment, because even pristine water stored improperly can cause illness. There are several safe water storage options currently use in Kenya – the "modified clay pot," widely available "jerry cans", and the Centers for Disease Control-designed safe storage vessel. There are issues associated with each of these options.

The modified clay pot is locally produced at the Oriang Women's Pottery Group. It is low cost (450 – 500 shillings), creates local jobs, is culturally appropriate and well-received insofar as the ceramic keeps water temperature cool. However, there are design issues associated with standardization of the vessel capacity, with the mixture of clay and sand that appears to cause leakage, and with the attachment of the tap, which leaks. All these issues need to be addressed and could form a single project.

Jerry cans are also locally available and inexpensive. They are typically used for transporting water and/or for storage of oils, paints, gasoline, and other compounds. It is the opinion of local water professionals that it is not appropriate to have the multiple purpose jerry can mixed up in people's minds with a dedicated safe water storage container.

The Centers for Disease Control (CDC) Safe Water System container is currently imported from South Africa and because it is not locally produced and is subject to high import taxes, it is very expensive – about $80 [check this number]. Moreover, it is difficult to transport. A newly designed CDC safe water system (SWS) container is stackable and transportable. One option is to explore local plastic manufacturing. We have some contacts to help get this process underway, and support from Sloan Business School students is possible, but creative initiative would also be essential to move this project forward. Another aspect of this topic could be the design a plastic tap or recommendations for improvement of the existing tap.
potential.

6.2.2 Study of coagulation/flocculation and disinfection

[1-2 person study]
This study could involve testing:

- Natural polymers, including Moringa seeds, chitosan, other;
- Alum or ferric chloride;
- Weighting agents (ash, charcoal);
- Inclusion of disinfectant(s) with coagulant;
- Comparison of a locally available solution to Proctor & Gamble's "PuR" project, which has been rigorously tested in households in Kenya and which is in the early stages of being marketed.
- Water quality testing that would take place as part of this project and would likely include some or all of the following parameters: turbidity, chlorine demand, total organic carbon, trihalomethane (THM) formation
- A customer survey could be undertaken;
- A business plan could be developed.

6.2.3 Ceramic Water Filters

[1-2 person project]
While a tradition of ceramic production has been part of Kenyan culture for centuries, ceramic water filters are just beginning to become available in a few markets in Nairobi and in certain development project areas. An upscale shop in Nairobi sells a variety of ceramic candle filters (Katadyne, Dalton) and mid-grade filters (Stefani-Brazil, Star-China), but not a low-cost filter. A low-cost filter, Kissi, is available in Western Kenya. Ron Rivera of Potters for Peace in Nicargua has investigated starting a ceramic water filter production workshop in Kenya. Ron's colleague in Ghana, Peter Tamakloe, has started a very successful ceramic water filter workshop in Accra. This project would involve a feasibility study of local ceramic water filter production. Included in this could be a survey of the types of ceramic water filters currently in Kenya, performance tests of those filters, and recommendations for next steps. Performance tests could include testing microbial parameters that have not previously been tested in the M.Eng water/sanitation projects.such as clostridium perfringens (some evidence suggests these mimic cysts) and

somatic male-specific coliphages (viral indicators). In areas where ceramic filters are already in use, user surveys could be conducted.

6.2.4 SODIS

SODIS (disinfection of water using solar and thermal processes) is conducted in PET plastic soda/water bottles and leaving them in the sun for 1-2 days, depending on local conditions. In Kenya there are SODIS project both in the slums of Kibera in Nairobi and in a town in Western Kenya, El Dorant, on the Masai Plains (check this location). Numerous studies by EAWAG/SANDEC in Switzerland and four studies by MIT M.Eng students have shown SODIS is a feasible and inexpensive option to remove microbial contamination. Various SODIS studies are possible. M.Eng student Xanat Flores developed a semi-continuous SODIS design that won a prize in the 2003 MIT IDEAS Competition. This design could be applied and refined in Kenya. There has been concern about the degradation of the PET plastic with long term use and the effect of plasticizers on water quality. This research could investigate the components of the PET plastic bottle, the potential for the leaching of toxic material into water, as well as chemical reactions that may take place inside the bottle. Field research and chemical laboratory analysis of organic compounds would be conducted.

6.2.5 Fluoride Contamination

Fluoride, like arsenic, is high on the list of naturally occurring toxic chemicals that potentially cause serious disability, illness and death. Fluoride is a problem in certain regions of Kenya. This would be our first study of this chemical. The focus of this project could be on site investigations, GIS mapping and/or remediation options.

6.2.6 Well Chlorinators/Well Pump Investigation

Afridev Hand Pump Program and Groundwater Supplies in Eastern Kenya
[2 person project]

The Afridev hand pump is designed for rural communities and is gender sensitive. Women are trained as hand pump mechanics. They can fix this pump readily and spare parts are locally available. This successful program of hand pump innovation and dissemination could be one from which to draw lessons to apply to the more "early-stage" household drinking water treatment initiatives.

This project would also be concerned with safe groundwater supplies.

- 50% of wells installed in developing countries fail within 2 years;
- Numerous mechanisms are needed to:
  - Develop more stable well mechanics;
  - Develop low tech well chlorinators;
- Literature review of existing designs;

- Design comparison;
- Testing design that has been provided to Centers for Disease Control and Prevention in Atlanta;
- Assessment of Rotary Club implementation in Eastern Kenya
  - Surveys;
  - Water quality testing;
- Recommendations to Rotary on what to fund.

6.2.7 Biosand Filters

The biosand filter has been promoted in 2 different districts of Kenya. Ngangami is a village in Machakos District which is the focal point of biosand filter production and distribution. Machakos is about 3 hours east of Nairobi along the main highway to Mombasa on the coast. There are 1,000s of biosand filters in this district. Tenwek is in Western Kenya and the Tenwek Hospital is the site of a biosand filter program targeted to HIV/AIDS patients. There are some 100s of biosand filters at this site. Hydraulic studies are needed as are studies of biosand performance in terms of heterotrophic bacteria, viral and parasite removal.

6.2.8 Rainwater Harvesting

There is the possibility of doing a rainwater harvesting study in Kenya. Further details can be provided if there is interest.

6.2.9 Sanitation

In addition to a potential wastewater project being arranged by Professor Harleman with the World Bank, two other possible sanitation projects for the 2004-05 academic year are:

(i) Feasibility study of wastewater/sanitation options for Kisumu. The city of Kisumu on Lake Victoria has a population of about 500,000(?). Wastewater collection and treatment is said to serve about 30% of the population via poorly maintained oxidation ponds. Some homes have septic tanks while others have public or private latrines. People lacking access to any of these options defecate out of doors in fields or alleys. There are 4 slums where the sanitation problem is particularly acute, while at the same time being indicative of the sanitation problem in low income country urban slums worldwide. This project would develop a plan for addressing the sanitation problem of Kisumu and would develop a proposal for funding a solution.

(ii) Pathogen die-off rate in ECOSAN toilets. ECOSAN toilet design is believed to be a more environmental-friendly, sustainable, and cost-effective solution than the conventional flush or pour-flush toilets. Research is needed to investigate the pathogen die-off rate in ECOSAN and to better understand the potential health risk

6.3 HWTS PROJECT/PROGRAM ASSESSMENTS

Teams of MIT M.Eng students have done considerable work over the past 5 years on individual HWTS systems. We are now at the point where we are interested also in project or program assessments. We have preliminary experience with project and program assessment (referred to earlier as "Phase III Evaluations"), but much more work is needed. Before assessments can occur, we must first develop agreed upon assessment tools and an evaluation/verification framework. Selection of topics in this area will involve collaboration with the WHO Network Implementation Working Group, especially the task force charged with developing evaluation/verification frameworks.

6.3.1 Micro-finance Project Assessment

In many cases, even the most inexpensive and sustainable water treatment devices are not affordable for the rural poor in the Nepal or Kenya. Measures to provide funds to help pay for these water interventions are needed. This may be in the form of filter donation, direct subsidy, user contribution in materials and labor, as well as micro-finance options. The micro-finance option can be a sustainable long-term solution if managed correctly. Examples of micro-finance include:

- The Centers for Disease Control, in conjunction with SWAK (the Society of Women with AIDS in Kenya) has a program where rural HIV+ women sell health products (Safe Water System, PuR) to community members, as a mechanism to promote health and health products and income generation in a rural communities.
- Local small NGOs providing rotating loans to local villagers to buy health products and water treatment devices

Students may want to explore the feasibility of the above options as a project focus and to make recommendations.

6.3.2 Comparison of Different HWTS Interventions in a Given Region

A variety of HWTS interventions available in one region could be compared side by side on the basis of a set of evaluation criteria. Systems could include:

- Biosand Filters
- SODIS
- Ceramic Filters
- Safe Water System
- PuR

6.3.3 Health Impact Analysis

This project would involve the application of the WHO health impact epidemiological survey and analysis method in a given project area.

6.3.4 Hospital-based Project Assessment

The Centers for Disease Control, working in conjunction with the Nursing Council of Kenya, has implemented a program. Nurses train patients and their families sick with diarrhea on the use of the Safe Water System (SWS). Initial studies indicate over a 60% adoption rate among individuals who have received the training. This project would involve working with these nurses and their patients. [This project depends on funding, confirmation for which is expected to occur by December 2004]

7. MANAGEMENT, PERSONNEL, SCHEDULE AND BUDGET

The full proposal should include a breakdown of responsibilities by staff member, including the name of a project manager; schedule for completion including project milestones and progress reports; and details regarding cost, expressed in terms of hours of effort by job classification (staff engineer, project manager).

BASIS FOR SELECTION

Proposals will be evaluated on a competitive basis using the following criteria:

- Does the proposal address the client's needs?
- Originality;
- Likelihood of success;
- Cost (expressed in terms of people-hours).

NOTE #1: All M.Eng team members will be expected to participate in weekly meetings and/or lab work at MIT, as well as field work in Kenya for 3-4 weeks in January, 2003.

NOTE #2: Bidders should be aware that this project is for those who anticipate that they will be able to accept the challenge of living and conducting research in developing countries. Language ability in Swahili is not a requirement (English is the official language in both Kenya and translators will be available). Applicants should also be aware that there is political instability in Kenya, but that we are in close contact with local colleagues and we will not be working in areas considered dangerous.

REFERENCES

World Health Organization and UNICEF. "Global Water Supply and Sanitation Assessment 2000 Report." WHO. Geneva. Switzerland. 2000

World Bank. "The Little Data Book 2003" International Bank for Reconstruction and Development/The World Bank. Washington D.C. April 2003.