REQUEST FOR PROPOSALS

Water and Wastewater Treatment Investigations in Nepal
Environment and Public Health Organization
Kathmandu, Nepal

Contact: Susan Murcott

c/o Dr. Eric Adams
MIT Dept. of Civil and Environmental Engineering
Master of Engineering Program 1-143
September 2002

NOTICE TO PROSPECTIVE BIDDERS

The Environment and Public Health Organization (ENPHO), a research institute and laboratory located in Kathmandu, Nepal has obtained funding from the United Nations Development Program (UNDP) and is seeking a research partner. During the summer of 2002, Environment and Public Health Organization (ENPHO) prepared a document describing specific research topic areas and has requested proposals from interested parties to assist in conducting drinking water and wastewater treatment technology design and implementation studies during 2003-2003. The anticipated effort will require up to 3200 hours of technical effort up to 8 M.Eng. students), leading to a draft final report on March 21, 2003. Assuming a one-week review by sponsors, a final report is due on Friday, May 2, 2003. 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, October 4, 2002. 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 11 if they have made the short list, and successful bidders will be asked to submit a full technical plus cost proposal by December 6, 2002. Details of the proposal follow.

BACKGROUND

Although Nepal is a country rich in fresh water resources, these resources are unevenly distributed and water quality is poor. Water supply coverage is officially 70% in Nepal, however, microbial water quality of various supplies – piped, tubewell, stone spouts -- is suspect, based on investigations of ENPHO (2000), the MIT Nepal Water Project and others. Also, for many people, getting water year-round is a problem. There is either too much water in the monsoon season or too little water during the rest of the year.

Nepal has a serious public health problem on account of poor water quality. According to the UNICEF statistics (2000):

- 1 in 10 children in Nepal die before the age of 5. Diarrheal illness causes 44,000 childhood deaths/year in Nepal making waterborne diseases the leading cause of childhood death.
- Infant mortality is 75 per 1,000 live births.
- 54% of children in Nepal are stunted on account of waterborne diseases. Diarrhea and other waterborne diseases mean that children cannot retain nutrients essential to growth.
- Life expectancy is 58 years.
- Water pollution and scarcity have a particularly strong impact on women's lives. On account of their responsibility caring for sick children and carrying water from distant sources, women are prevented from attaining education or economic opportunities.

PROPOSED WORK

1. DRINKING WATER SUPPLY

1.1 Rainwater Harvesting
(Location: Butwal)
Comparison of Rural Water Supply and Sanitation Project (RWSSSP) and IDE rainwater harvesting systems for rainwater sufficiency (relative to supplying minimum needs) and for microbial safety. Consider chlorination or other means of disinfection. (RWSSSP is the NGO working in Butwal and environs. They were an excellent host last year, the first year we worked with them. They do not have a Web site, but a general introduction to RWSSSP can be found in the M.Eng thesis of Yongxuan Gao (2002).) For information on IDE's rainwater harvesting system, see: http://www.ide-international.org/whatsnew/Newsletter/newsletpg2.htm and http://www.ide-international.org/whatsnew/Newsletter/newsletpg4.htm

1.2. Tubewell Protection and Maintenance
(Location: Butwal)
Dye test to assess the disintegration of cow-dung under tubewell platforms. These tests might make use of bacteriophages as hygiene indicators, available from the ENPHO laboratory in Kathmandu, and following procedures developed by the Swedish Institute for Infectious Disease Control. This project would also build on the work of 2001-2002 M.Eng student, Yongxuan Gao (2002), who determined that the use of cow dung as an aid in drilling tubewells was statistically correlated with well contamination. Tubewells are the most common means of accessing groundwater supplies in southern Nepal (and many other parts of the developing world). This project would also deepen our knowledge and the practical application of the best approaches to tubewell protection and maintenance.

1.3 The Bottled Water Industry and Water Vending in Nepal
(Location: Kathmandu)

One response to polluted and/or scarce water supplies is the development of a bottled water and water vending industry. Whereas bottled water is typically sold in 1-3 ml polyethylene terephthlate (PET) plastic bottles, water vending is the sale and distribution of water by larger containers, ranging from delivery by tank truck to carrying containers by individuals. Bottled water is widely available in Nepal and water vending is present in urban areas. This study would involve one M.Eng student, and possible collaboration with a Sloan School Global Entrepreneurship-lab student team. The M.Eng project would study the bottled water industry/water vending in Nepal. What is the quality of the bottled/vended water? Does it meet World Health Organization guidelines and/or Nepali water standards? How much bottled/vended water is being consumed in Nepal and how much is exported to other countries? How much are people willing to pay for bottled/vended water in Nepal? Who is buying it? (The American Water Works Association (AWWA) says that for the price of one bottle of "boutique" designer water, 1,000 gallons (3,800 L) could be delivered to homes in the U.S. The National Resources Defense Council (NRDC) reports that some people spend up to 10,000 times more per gallon for bottled water in the U.S. then they do for tap water. How does this compare with Nepal?)

There are a number of bottled water companies in Nepal – Bailley, Thirst-Pi, YES, Bisleri. One company we already have contact with is **Himalayan Nara, Natural Spring Water.** Himalayan Nara is a Nepali joint venture with 90% ownership by a Korean company that produces bottled water for export to countries throughout Asia. Nepal provides access to the water in the Himalayas and the employees to operate the manufacturing facility. The Korean company built the manufacturing facility and handles facility operations and engineering. Atul Lal Shrestha indicates that the business is well funded and organized. He continues to search new markets for the water and has extensive cost data to make carefully considered decisions on which markets to enter.
Contact: Atul Lal Shrestha (Director)
Source: Ajaya Ghimire, MIT Alum

1.4 Dug well Improvement Methods and Shock Chlorination
(Location: Butwal and/or Rautahat)
Dug wells are the traditional wells in Nepal (and throughout the world), predating the now widely used tubewells. Use of dug wells has fallen off sharply where tubewells are available. Yet dug wells are being reconsidered as one of the drinking water options for people in the Terai region, especially in arsenic-affected areas. Thus many dug wells have been rehabilitated by various organizations like the Nepal Red Cross Society, the Finnish Aid Organization (FINNIDA) etc. This project would involve water quality testing of dug wells, experiments with shock chlorination, and result in recommendations for future maintenance and use.

2. FILTRATION

2.1 *** Priority Project *** Ceramic Filter Design

A grant has been given by a U.S. family foundation to support the ceramic candle filter industry in Nepal. Building on the work of M.Eng student Jason Low (2002), this project would work with Hari Govinida of Madyapur Clay Crafts and other colleagues in Nepal to come up with an improved ceramic filter design then test that design.

2.2 *** Priority Project *** Biosand Pilot Project
(Location: Lumbini)

In January 2002, a biosand pilot project was initiated by Lee Hersh and Susan Murcott and studied by M.Eng student Heather Lukacs (2002). Currently, about two dozen biosand filters are located in households in villages associated with the International Buddhist Society programs. This project would test these filters and develop a monitoring program. (This project could be linked with topics 2.3 and 2.4)

2.3 Design and Evaluation of a Bench-top Biosand Filter

Using the bench-top filters constructed at a workshop in our M.Eng lab 1-047 in May 2002, this study would first develop a breakthrough curve of start-up time and determine the effect of pause time on filter performance. Subsequently, this project would investigate one of the following topics:

- Variability between filters using different source water (Charles River water vs. other surfaces waters)
- Variety of sand sources;
- Variety of head spaces (2 cm, 5 cm, 10 cm)

2.4 Biosand Filter Performance Testing Protocol and Training Manual

A performance testing protocol is needed for the biosand filters in Lumbini, Nepal. In collaboration with Center for Appropriate Water and Sanitation Technology (CAWST), this project would also develop a training manual presenting "Best Practices for BioSand Filters Use in Nepal." (This project might be linked to other biosand topics listed).
http://www.cawst.org

2.5 Biosand Filter Testing for Cryptosporidium and/or Giardia

A possible project, under the guidance of Prof. H. Hemond, and in collaboration of doctoral student Kristen Jellison, to investigate cryptosporidium and/or giardia in Nepal. Background and Study Objective: Samaritan's Purse, in conjunction with the Canadian International Development Assistance (CIDA) has built and distributed 14,000 biosand filters in 24 countries. In 2001, an internal report, "Biosand Household Water Filter Evaluation 2001," evaluated 100 filters in each of 6 countries (Mozambique, Kenya, Cambodia, Vietnam, Honduras, Nicaragua) in 3 regions – Africa, South Asia, Central

America. This report and others shows consistency in the health benefits reported from the filter users, which is not generally reflected in the consistency of the bacterial removal data. The reason CAWST hypothesizes that this may be the case is that the organisms that are making people sick are primarily the parasites or cysts and not bacteria. Yet, the WHO microbial guidelines are defined in terms of indicator bacteria -- fecal coliform and E.coli. Researching this contradiction would be at the central goal of this study.

3. CHLORINATION / SOLAR DISINFECTION

3.1 *** Priority Project*** Chlorine Solution Decay Study

(Location: Kathmandu)

Last year M.Eng student, Luca Morganti, in collaboration with colleagues from ENPHO, installed and evaluated a SANILEC-6 sodium hypochloride generator (Morganti 2002). The new sodium hypochlorite ("Piyush") product manufactured by ENPHO with this generator is decaying at a more rapid rate than the old calcium hypochlorite ("Piyush") product manufactured from imported bleaching powder. We have isolated certain causes (e.g. iron spigot, use of municipal piped water supply instead of distilled water) but the rate of chlorine decay rate is still unacceptable. Therefore, it is essential that we know why this is occurring. (This study might be combined with another chlorination study, such as 3.2)

3.2 *** Priority Project*** Chlorine(Piyush) Demand Study of Various Source Waters

(Location: Kathmandu, one site in the Terai and possibly the Annapurna Circuit)

Currently, 3 drops of 0.5% chlorine solution per liter of water is the generalized method for chlorination of water recommended by ENPHO for different water sources in Nepal The chlorine solution available in Nepal is marketed under the brand name, "Piyush," and may be either the old formulation from bleaching powder or the new formulation of from the chlorine generator. In her thesis study, MIT Nepal Water Project team member Hannah Sullivan (2002) found that 29% of households in Lumbini maintained proper chlorine residual levels between 0.2 mg/l and 1.0 mg/l. She performed limited chlorine dosage testing and found "the low measured chlorine residuals in stored household water do not appear to be the result of improper dosage instructions… it may be possible to increase the dosage recommendation to 4 drops per liter without exceeding proper free chlorine residual levels" (page 80). Whether the 3 drops per liter dosing regime is appropriate for all types of water sources in Nepal is an important question for ENPHO, the manufacturer of Piyush and for the MIT Nepal Water Project team. This research project would focus on dosing of Piyush in different water sources including the piped water supply in Kathmandu, tube wells, stone spouts, dug wells etc. to determine chlorine demand. If appropriate, a part of this chlorine demand survey could include chlorine testing along the Annapurna circuit during the winter (dry) season. This would fill out the data set of the chlorine demand survey conducted by Luca Morganti in July 2002 during the monsoon season.

3.3 Expansion of SWS Program in Nepal

(Location: Kathmandu, one or two sites in the Terai, such as Lumbini or Butwal).

This project would be a collaborative effort with the Center for Disease Control/Safe Water System and potentially with PSI, an NGO that is working in several countries to socially market the chlorine disinfectant solution. It could be combined with the Chlorine Demand study (2.2 above) and might involve 2 people: 1 M.Eng student, who would work with CDC to develop a countrywide program for disseminating the Safe Water System program and 1 Sloan School student who would investigate willingness-to-pay/marketing/promotion of chlorination for widespread adoption. If several students were interested in willingness-to-pay, this study could expand to include all the household treatment options now available in Nepal. The M.Eng student would prepare the country –wide plan and participate in developing a funding proposal for this program.

3.4 UV Disinfection

WaterHealth International has designed and is marketing a community-scale UV disinfection unit appropriate for developing countries. However, it is somewhat costly. Searching for a cheaper solutioin, M.Eng. students at the University of California, Berkeley have designed a prototype UV tube. This project would investigate these and possible other UV drinking water disinfection options. http://www.waterhealth.com

4. ARSENIC

4.1 *** Priority Project *** ENPHO Arsenic Removal Filter – Technical Performance and Social Acceptability Evaluation

(Location: Rautahat)

As a preliminary pilot project, ENPHO and the Nepal Red Cross Society have distributed more than 120 household arsenic removal filters in Rautahat district in arsenic affected areas. A preliminary study of the performance of these filters has been performed by Jeff Hwang (2002). However, the filter element has been modified since Jeff Hwang's study, and his study occurred in only one site. This new work would evaluate the success of the pilot study where the new filter is being deployed in arsenic-affected households. This project could involve 1-2 researchers to conduct 1) technical and 2) social evaluation of a subset of the ENPHO arsenic removal filters distributed in these arsenic affected areas of Rautahat .

4.2 *** Priority Project *** Arsenic-contaminated Sludge

This project would involve study of the sludge characteristics and disposal issues of 2-3 promising arsenic remediation technologies already investigated by the MIT Nepal Project team to date. It would build on the work of Cambridge University engineering graduate, Reuben Mann (2002), and might involve collaboration with a new student at Cambridge University.

4.3 Arsenic Bio-sand Filter

(Location: Nawalparasi)

Tommy Ngai, of the 2001-2002 MIT Nepal Water Project team, has come up with several innovations to the biosand filter, adapting it to remove arsenic. In April, 2002, he was awarded a $10,000 prize by the Lemelson Foundation for this work. He is currently in Nepal until October 15 to test these ideas, and will then return to MIT to assist with the 2002-2003 M.Eng program. This work requires follow-up in a new M.Eng project -- tracking the pilot study Ngai has established and further development of the technology. This project might link up with 4.1 or 4.2. Moreover, it might involve a team of Sloan School students who would concurrently be determining the marketing possibilities for this technology.

4.4 Arsenic Contamination and Treatment in Salem New Hampshire

2001-2002 M.Eng Nepal team members found and tested a household in Salem, New Hampshire supplied with groundwater from a well contaminated with > 1,000 ug/L arsenic. We hypothesize that other households in the same neighborhood, also supplied by well water, might also be affected. This project would entail a study comparing arsenic contamination and treatment in Salem New Hampshire with arsenic in Nepal. This work could be linked with one or several of the other arsenic projects.

4.5 Evaluation of International Development Enterprise's Shapla Filter

The Shapla filter is being promoted in Nepal and throughout south Asia by UNICEF and International Development Enterprises (IDE), Nepal. IDE performs the marketing function for appropriate, low-cost, rural technologies it believes are solid bets for eradication of poverty. IDE's most popular product is a foot-operated treadle water pump for village tubewells. These pumps are capable of pumping enough water to irrigate one acre of land per day. So far, more than 40,000 pumps have been sold and installed in Nepal and millions throughout the developing world. The Shapla filter is IDE's best bet on a viable, low-cost arsenic remediation filter. Contact: Radhe Shyam Bista (Nepal Country Director)

5. WASTEWATER

5.1 Monitoring of Wetland System (Reed Bed System) at ENPHO

(Location: Kathmandu)

ENPHO is pioneering the introduction of wastewater treatment through a reed bed system in Nepal. ENPHO has constructed several such systems in Kathmandu. With the increasing demand and curiosity of the people, ENPHO has built a wastewater treatment system on its premises. As this system treats water coming from ENPHO's daily activities which also includes waste water from its Laboratory, it is important to monitor the system and to gain information on the capacity of the system while dosing with different types of waste water.

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).

The majority of these research topics have been prepared by ENPHO. Additional topics have been proposed by the MIT Nepal Water Project 2002-2003 team and project supervisor, Susan Murcott.

ENPHO is a private research laboratory in Kathmandu, Nepal that conducts chemical analysis, laboratory and field studies and consulting services for environmental pollution control in Nepal. Because of their skilled laboratory staff and facilities, ENPHO works with the Department of Water and Sanitation and Sewerage (DWSS), the lead government water agency to conduct some of their water quality and treatment studies. In addition, ENPHO is the coordinator of the NGO Water Coalition Group, which brings together the entire NGO water sector in Nepal (including the Nepal Red Cross, UNICEF-Nepal, NEWAH-Water Aid, and others) for regular meetings and collaboration.

NOTE #1 Priority Projects**:** This year's MIT Nepal Water Project includes a number of new projects as well as follow-up work related to 2002-2003 projects. In terms of our responsibility to our hosts in Nepal and to the villagers who lack access to clean water, we would urge you to strongly consider those projects highlighted identified as: *** Priority Project***.

NOTE #2: We are seeking a maximum of 8 individuals for this overall Nepal project If appropriate, we might break into 2 smaller teams.

NOTE #3: All MIT Nepal Water Project team members will be expected to participate in weekly meetings and/or lab work at MIT, as well as field work in Nepal in January, 2002.

NOTE #4: 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 a poor and unstable country. Applicants should also be aware that there is political instability in the country and should inform themselves about the political climate. If you have questions about signing up for this project, please contact Susan Murcott.