Point-of-Use Drinking Water Purification

Behrampada Slum - Bombay, India

Engineers for a Sustainable World- Berkeley

Project Final Report

February 17, 2006

Submitted to

The Ann Campana Judge Foundation

Project: Point-of-use Drinking Water Purification: Behrampada, Bombay
Report Prepared By: Mike Fisher, Ashley Murray, John Dracup (Advisor)
Submitted to: The Ann Campana Judge Foundation

Participants at a community workshop on hygiene and water quality

Amount Requested (USD): $4000
Allocation of Funds:

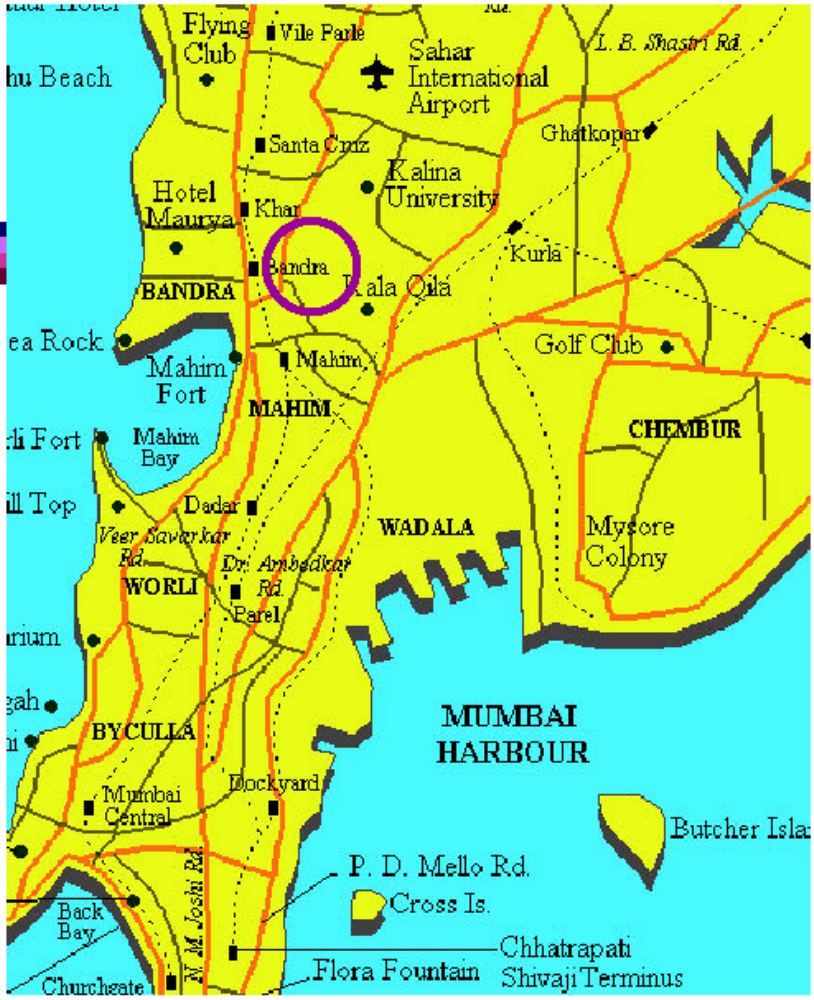
Materials for Filters and prototypes:	1200
Workshops:	400
Local Transportation:	400
RT Airfare to Bombay:	2000

Duration: Ongoing (May 2005-?)
Team Members: Ashley Murray, Erin Inglish, Mike Fisher, Scott Remine, Gabe Harley
Project Advisor: Professor John A. Dracup Ph.D., P.E. Civil and Environmental Engineering, U.C. Berkeley, California
Affiliate Organization: Engineers for a Sustainable World, Berkeley
209 O'Brien Hall UC Berkeley, Berkeley, CA 94720
Partner Organizations in Bombay: Committee for the Right to Housing, Jai Maharashtra Mahila Mandel, Seva Mandel, Mila Mandel

Scope of the Problem:
Behrampada is a slum of 100-150,000 inhabitants in the Bandra district of Bombay, India. It has been estimated that as many as much as 80% of the community suffers from enteric diseases. This disease burden has in part been attributed to contaminated drinking water in the slum. Specifically, because Behrampada only receives water pressure for roughly four hours each day, it is believed that sewage-contaminated water infiltrates the pipes of the slum's distribution system during the remaining 20 hours of the day. This project was designed to address the problem by providing low-cost point-of-use drinking water purification solutions to the inhabitants of the slum.

Behrampada Slum, Bombay, India

- **Population:** 100-150,000
- **Problem:** Contaminated drinking water
- **Impacts:** ~80% of the community has enteric dysentery
- **Proposed Solution:** Point-of-use water filters



Project Objectives

1. Increase access of Behrampada's residents to safe, affordable drinking water
2. Increase awareness of hand washing and hygiene practices among slum residents
3. Promote safe water storage within the home
4. Empower women of Behrampada's Mahila Mandels (local women's groups) to promote safe water and hand washing

Progress to Date—Deliverables:

June-August 2005

1. 10 hands-on community workshops on topics including
    a. Hand washing and hygiene
    b. Drinking water treatment
    c. Safe water storage
    d. Germ theory and microorganisms
    e. Oral rehydration therapy
2. 8 water quality sampling events to better assess current water quality and customize filter and workshop design
3. Independent testing of filters for effective removal of bacteria and protozoan cysts
4. Installation of 10 trial filters in homes within Behrampada
5. Distribution of chlorine for interim water treatment to 100 families
6. Identification of key contacts and leaders within the Behrampada community
7. Partnership with local university students for ongoing work in Behrampada
8. Production and distribution of bilingual manual for hand washing, water treatment, and safe water storage.

December 2005-January 2006

1. Distribution of 30 filters to homes in Behrampada
2. Distribution of updated bilingual manuals
3. Development of partnership with PSI (Population Services International), producer and supplier of SafWat, a high-quality chlorine solution for drinking water treatment
4. Two additional community workshops

Project Activities:

The work of the ESW-Berkeley team in Bombay to date consisted of three key components: Filter production, education, and networking. Filter production activities included translating the filter design created at UC Berkeley to the most affordable and appropriate locally available materials. The final result is a 1 micron filter capable of removing helminth eggs and protozoan cysts used in combination with chlorine, which inactivates bacteria and viruses, all at a price affordable to Behrampada's residents. The filter also integrates a safe water storage system, which prevents recontamination, and provides for adequate chlorine contact time to ensure adequate disinfection. The filters were installed in 10 homes throughout the slum on a trial basis to assess their suitability to the conditions and needs of the community. After several weeks of home visits and testing, modifications were made to improve the effectiveness and suitability of the filters. Currently, the team is installing 30 filters and coordinating the production of high quality chlorine solution.

Education activities included a coordinated series of workshops designed to create awareness about issues of water quality and health in the slum, as well as provide simple tools that the community's women leaders can utilize to protect the health of their families and themselves. Topics included explanations and demonstrations of how water

in the community becomes contaminated, both through sewage infiltration into pipelines, and through unsafe water storage in the home. Other workshops dealt with germ theory, with which most of the women were unfamiliar, and the importance of hand washing with soap. Women were taught to store water safely in suitable containers, disinfect through filtration and chlorination, and how to prepare oral rehydration solution to treat children with severe diarrhea. These lessons were compiled in a booklet prepared in English and Hindi, and distributed among the workshop participants.

Finally, the team sought to make contacts within the community, with representatives of local NGOs and universities, and with suppliers and manufacturers capable of assisting in filter production. These interactions proved extremely fruitful, as they gave rise not only to a great deal of useful information, but also to a partnership with students at Bombay's Sophia and Somaya colleges interested in volunteering with the project.

All of these activities helped to further the projects' ultimate goal of providing safe water by building support and acceptance of the filters and chlorine, and trust and rapport within the community, as well as improving the team's capacity to obtain affordable materials and partner with local volunteers.

Erin Inglish demonstrates proper chlorine dosage and safe water storage

Scott Remine helps workshop participants to spot the parasite *Entamoeba histolytica*

Observations

- Behrampada tapwater showed substantial bacterial contamination
- Contamination of water storage containers proved much more severe
- Community members had some awareness of waterborne disease, but were only aware of two methods of treating water, boiling and ceramic filters, both of which were too expensive and time consuming for all but one or two households
- Boiling is prohibitively expensive because it would greatly increase the cost of cooking fuel (kerosene or LPG), which is already a major expense for households
- Of commercial filters available, some appeared totally ineffective, while others have the potential to remove protozoans, helminths, and possibly bacteria. None were capable of removing viruses, and most had extremely slow flow rates
- Community members expressed a great deal of interest in acquiring chlorine and filters for water treatment
- Tests showed that some of the homes using filters applied chlorine regularly according to instructions, but roughly half did not.
- Some community members also expressed interest in an aesthetically attractive filter resembling the ceramic models sold in local shops (tall, narrow, metal housing, etc.)
- Community members said 20L would be an ideal capacity for a filter. However, most families appeared to store and use significantly less drinking water than this.
- Hand washing with soap appeared to be nearly nonexistent in the community

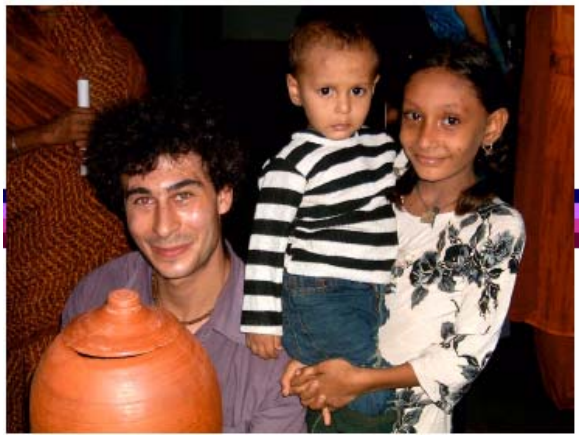
- Sanitation is a major problem in Behrampada: public facilities are overburdened beyond belief (500 or more users per toilet per day might be a conservative estimate), and hand-washing facilities are not available nearby. Very few residents have private facilities.

Lessons Learned

- Interest in filters and point-of-use technology was generally high, however proper use of the filter-chlorine combination will require further education so that users understand the limitations of each process when used alone.
- Clarifying and reinforcing that the filter will not work without chlorine may be important. To this end, the team has developed an interactive workshop that specifically focuses on the strengths and weaknesses of different treatment processes including boiling, chlorination, filtration, and UV disinfection.
- Locally available chlorine (sodium hypochlorite) solutions are completely unreliable. At best a solution labeled 6% might measure 1% free chlorine, and it is difficult to verify that these solutions are free from harmful additives and byproducts.
- Thus, to ensure proper and reliable dosage, it may be necessary to specially contract the production of a high quality chlorine solution, as is done by the CDC's Safewater program in many countries (http://www.cdc.gov/safewater).
- Work in the Behrampada slum would be next to impossible without the generous assistance of volunteer translators and the support of the women in the community's mahila mandels.

Conclusion

Work in the Behrampada community is ongoing. Our group is becoming increasingly confident as the project progresses that the filter we are designing effectively combines safe water storage, point-of-use chlorination, adequate contact time to inactivate bacteria and viruses, and microfiltration to remove protozoan cysts and helminth eggs. Major challenges facing this project include continuing to reduce to cost of the unit from nearly US $10 to our goal of less than $5 and developing an education and maintenance framework to help promote proper use of the filters and chlorine, and to ensure that as filters become worn or damaged, they can be repaired. Our response from the community and our contacts throughout Bombay has been overwhelmingly positive, and we are exceedingly grateful both to the students, doctors, and others who have so generously shared their time and energy to make our goals possible, to Sophia College for allowing us the use of their laboratories free of charge, and to the wonderful ladies of the mahila mandels for opening their homes to us and helping us navigate Behrampada's labyrinthine lanes. And we are especially grateful to the Ann Campana Judge Foundation for helping to get this enterprise off the ground. As our project continues, we will publish periodic updates at http://kettle.cs.berkeley.edu/eswprojects/13.




SCOTT