Contents

Executive Summary

The Problem

The Solution

The WAPI
Why Pasteurize?

Is the WAPI a realistic solution to the problem of water quality?

Business Plan

Market and Customers
Partners
Education: Preventing Recontamination
Distribution
Rollout Strategy
Next Step

Conclusion

Team HydroLogic

References

Acknowledgements

We would like to thank our fellow teammates at IIT-Bombay, Anbarasan, Pleasa and Nidhi Kulshrestha for their assistance in gathering information on the ground in India. Also, special thanks to our mentor Shweta Humad Sharma, to Professor John Gulliver, and to the guest lecturers and instructors at the U of M for their advice and assistance.

Cover Image

Uptown, Minneapolis and Dharavi, Mumbai at 1” = ¼ mile (1cm = 400 m).
Executive Summary

India embodies a complicated crossroads of ancient culture, new technology, rich but dwindling natural resources and an ambitious agenda for economic growth. It has the fastest growing middle class in the world, and yet more than a quarter of the population lives below the international poverty line. Of the desperately poor, most live not in remote villages, but in the slums of Chennai, Bangalore, Calcutta, Delhi, and the largest of all, Mumbai.

Not all the urban renewal in the world could fix the slums. Each problem is frustratingly entwined with three or five or fifty other irresolvable issues, creating a tangled web of challenges that seem insurmountable. In this mess, however, one problem stands out as fundamental, with tentacles reaching in all directions to affect the environment, health, the economy and social equity, and that is the problem of water. Finding enough water is a challenge for many, but the cost of drinking contaminated water can be deadly.

This proposal addresses the problem of water quality in Mumbai by introducing the WAPI—a small, inexpensive and reusable device that indicates when water has been purified for human consumption—to the potentially massive consumer market of Mumbai slums.

Making water safe for consumption is an energy intensive process. The WAPI, or Water Pasteurization Indicator, addresses the reality of current conditions—the fact that people who do purify their water, do so by heating it, which burns expensive fuel and contributes significantly to problems of air quality. It also recognizes the costs of living in slums, which necessitate an effective but low-cost solution.

Team HydroLogic believes that this technology, combined with a program of education and distribution through networks of community members, facilitated by a partner NGO in Mumbai, has the potential to reduce contamination in drinking water from the ground up, in each home, one family at a time.
The Problem

Mumbai city proper is the second largest city in the world with nearly **14 million inhabitants** (WG 2009). According to the 2001 census, **54% of all residents of Mumbai live in slums**. Life in the slums is characterized by substandard housing and limited access to basic civil services. The slums are overcrowded, many people do not own the land upon which they live, and some residents of the slums make as little as one dollar per day. One of the most unfortunate circumstances in the slums, however, is the lack of sanitation facilities.

The poor living conditions in the slums ultimately lead to issues with water supply. Families pay too much for water, they do not receive enough water, and they must spend hours every day waiting in long queues to collect water (Bapat 2003). Besides expensive and/or inconvenient, the **water consumed by residents in the slums is often contaminated**.

![Drinking Water Contamination](image)

In slum areas up to **61 percent of water samples are contaminated** with fecal coliform bacteria, and an average of 20 percent of water samples in most wards are contaminated (Times of India, 2003). Contaminated water causes water-related diseases impacting the slums' residents. Every year, up to **600 slum residents per one thousand experience a form of diarrheal disease**. In the same group of one thousand, 50 will contract typhoid, 30 will become ill with cholera, and over 100 will experience intestinal worms (Karn 2002). The prevalence of these diseases indicates water contamination.

Disease rates alone cannot convey impacts of poor water quality. For infants living in the slums, diarrheal illness is the most common cause of death. Studies have shown that **nine out of every one thousand children born in the slums die before the age of one due to these water-related diseases** (Vaid 2007). This statistic applied to the population living in the slums in Mumbai means that over 1,200 infants die each year from diseases that could be prevented if sanitation and clean water were provided.

Poor water quality and water-related diseases also have economic consequences. If a person is sick, they cannot go to work. Similarly, if a child is sick the parent has to stay home to take care of the child. In both cases, the worker will not obtain any income for the days missed due to illness. The inconsistency of work only perpetuates the cycle of poverty responsible for the inadequate living conditions.

HydroLogic recognizes the wide array of water issues in the slums of Mumbai. After extensive research, we have determined **water quality** is the most pressing and important issue to be addressed.
The Solution

The WAPI
To address the water quality issue, HydroLogic plans to introduce the Water Pasteurization Indicator to the slums of Mumbai. The WAPI is a simple, reusable device created by NorthStar Devices of St. Paul, Minnesota. The sealed plastic tube is placed in a container of heated water, and when the specially formulated wax melts and flows to the bottom of the capsule, it indicates that the water has been heated to a high enough temperature for a long enough time to be safe for human consumption.

Pasteurization is a simple and effective way to purify water for human consumption. Once the water is treated, the WAPI is removed from the water, the wax cools and solidifies, and the WAPI can be reused. A WAPI can be reused hundreds of times as long as it remains sealed.

Use of the WAPI

The wax in the WAPI melts when the water reaches pasteurization temperature. Pasteurization is an effective way to purify water for human consumption by heating water to a temperature of at least 65°C. When water reaches this temperature, numerous pathogens are inactivated. Pathogens treated include Giardia, cryptosporidium, endameba, worm eggs, cholera, Shigella, salmonella bacteria and those that cause typhoid, enterotoxigenic E. Coli, Hepatitis A, and rotavirus (Sponheim 2009). Some bacteria may survive the pasteurization process; however, these bacteria are not capable of causing disease in humans.

Why Pasteurize?
Water is pasteurized when any organisms that can cause harm to humans have been killed. Water boils at 100°C, but it is pasteurized when reaching temperature of 65°C—a full 35°C below boiling. People do
not currently pasteurize water because they have is no visual signal that pathogens have been killed—a rolling boil offers visual confirmation that water is safe to drink. With pasteurization, what can provide this visual confirmation? A thermometer or indicator is required. The WAPI is a simple, dependable indicator.

The amount of energy required to make up the difference between pasteurization and boiling temperatures is substantial. Pasteurizing water instead of boiling water saves money through fuel reductions because it requires almost three times less fuel to pasteurize water than it takes to boil water. In the slums of Mumbai, cooking fuel is very expensive and its supply is limited. In some cases, cooking fuel costs may constitute 30% of a family’s income. For some this is a financial burden, but for others the cost of fuel may mean the difference between boiling and not treating their drinking water at all.

![Amount of Fuel Required for 1 Liter of Water](image)

Amount of Fuel Required for 1 Liter of Water

Pasteurization also provides indirect health benefits by reducing burning time, and thus the volume of pollutants released into the air. A World Health Organization study estimated the amount of carcinogens inhaled by Indian women while cooking is equivalent to smoking 20 packs of cigarettes a day. As a result, the major cause of chronic morbidity among people in the slums is respiratory illness (Karn 2003). If the WAPI were used correctly, the decreased amount of fuel burned would ultimately provide a measurable benefit to respiratory health in the community.

Finally, pasteurization has great potential to provide benefit to people who do not already boil their water due to the high cost of fuel. If pasteurizing water provides an affordable method of treatment, more people will have access to higher quality drinking water which would decrease the spread of waterborne illness and reducing infant mortality (Karn 2002).
Is the WAPI a realistic solution to the problem of water quality?

Slum residents throughout the world can utilize the WAPI. Although the ultimate target market includes every person living in the slums of Mumbai, HydroLogic will initially market the WAPI to the 15% of slum residents who already boil their drinking water. These people are already familiar with the importance of heating water to improve the water quality, and method of water treatment must compete against boiling. The WAPI provides this benefit through fuel savings, and it does not require a drastic change of behavior.
Business Plan

Market and Customers
Residents of the slums generally recognize the quality of their water is poor (Bapat 2003). Despite this admission, the only method of treatment being widely used is filtering the water through a muslin cloth (IIT-Bombay, 2009). The filtering does not effectively remove the pathogens that cause illness. Boiling is the only other form of treatment being used in the slums, and only 5 – 15% boil their water.

A typical slum dweller works 6-7 days a week as a housemaid earning $11/month, a leatherworker earning $70/month, a small business owner earning $250/month, or an engineering mechanic earning $260/month (BBC, 2006). Average household income is between $50-$300/month. Many slums have become centers for local entrepreneurs and have seen large volumes of food and goods exported.

Slum dwellers often are victims to a ‘poverty penalty,’ paying proportionally more for goods and services than those in higher income brackets (Prahalad 2002). The discrepancy is usually a result of local monopolies and “community leaders” controlling the flow of goods. The cost of water for those in the slums is between of 50-500 rupees ($1-11 per month), which is between 2 and 30 times more than what is paid by the upper class in Mumbai (Bapat 2003).

Along with these other issues, slum dwellers are viewed by the government as illegal squatters and are often reminded of their impermanent living conditions through forced relocation. Spending habits reflect this reality. Purchases are more often for the short-term, and pay-offs need to be quick (Prahalad 2002). Finally, literacy and education levels in the slums are low, so products need to be easily understood.

Partners
HydroLogic realizes we will not be able to distribute the WAPI ourselves, and we need to address our gaps. The first gap to be addressed is the technical. We are not going to attempt to reinvent the wheel, so we have found the people who invented wheel. This explains our partnership with North Star Devices, inventor of the WAPI, and the Solar Oven Society (SOS). They have the production facilities to produce the WAPI cheaply and the testing procedures to ensure quality control. NorthStar Devices and SOS need assistance with marketing and distributing in India, which is HydroLogic’s role. They have observed that the most successful distributions of WAPIs and solar ovens always have a local connection, and this is our second gap: a partner in India.

In looking for a partner, HydroLogic has established criteria. In India, women’s organizations work to provide resources such as medicine, school fees or more intangibles like job training, financial planning or health education. We are seeking a women’s organization, since women are the primary purchaser and food preparer in Indian families. This organization should be well established enough to have some powers of distribution through their close connection to their community. In partnering with a women’s organizations, HydroLogic is not asking them to change anything about what they already are doing—all we are doing is providing them with another resource: the WAPI.
Education: Preventing Recontamination

The biggest barrier in achieving a reduction of waterborne disease is the battle against ignorance of basic hygienic practices regarding water supply. No potential water solution can succeed without implementing a strong educational and awareness raising campaign focused at the individual level which provides a good understanding of the dangers associated with drinking bacterially contaminated water.

Aside from combating unsanitary water habits, the second greatest challenge is breaking the cycle of recontamination after water has been purified. A World Health study in Malawi showed that the simple act of covering drinking water containers with a clearly marked lid can reduce the instance of diarrhea in children in a village by 31% (Roberts 2001).

Example of graphics provided with WAPI education

The education campaign will focus on:

1. The importance of purifying water, and how to use the WAPI
2. Avoiding recontamination, through use of a lid
3. Fuel savings through pasteurization
The mechanics of this campaign will be based on the structure of our partnering organization, but Solar Oven Society has seen success in the past using ‘Town Hall’ style educational seminars. What will also be crucial is educating our partners since India is such a socially structured culture that relies on word of mouth.

Distribution
Provided with a kit of parts, our partner organization in Mumbai will be able to assemble and sell a WAPI for about $1. We will aim for a 30-50% profit margin, increasing the cost to $1.50. The profits will be used to sustain the women’s organization and to expand the business by purchasing more WAPIs. For the customers using the WAPI, this price results in a return on investment through savings in fuel costs in less than 3 weeks. The profit margin may change as we obtain on-the-ground research, but the general strategy is low margin, high volume. This strategy has been proven as the best method to reach the bottom of the pyramid (Prahald, 2003). Again, over 1 million people in Mumbai alone already boil. At $1.50 per piece, even one-tenth of this market has a profit of $50,000.

Expansion, as we have seen, has to come through word of mouth and reputation. Paired with every WAPI is the Clean Water Cover, at a cost of $.20 each. Initially we will distribute these for free as our first form of advertising: every time someone finishes pasteurizing water they will keep the water clean using a lid with the words HydroLogic. We will be associating our name with clean water—name recognition is a crucial part of entering a market that is based on trust.
Rollout Strategy
A great idea or product will not be successful if it is not introduced into the appropriate markets at the right time.

At first, HydroLogic and its small management team will focus on a slum community that already boils water for water treatment. The first step, as we mentioned above, is to make a connection with a local women’s NGO that is already concerned with issues of health and water safety.

Next, we will arrange meetings with community members to discuss health and sanitation, their concerns, and explain how and why water pasteurization works using demonstrations, graphics and discussion to convey the message of clean water. The main purpose of this initial rollout is to establish relationships and develop trust, and to test the viability of the product on a larger scale.

Eventually, WAPI manufacturing might spread to other nearby slums, or perhaps the product would merely be sold there. The process in the new markets would be similar as the initial rollout. Once HydroLogic has developed a positive reputation in the slums, they will have the opportunity to expand into more sophisticated water treatment devices or water supply mechanisms.

Next Step
What is next? Concurrently with our initial rollout, we will be investigating our next step much in the same way we have developed the first, more crucial step. Our counterparts at IIT-Bombay have begun this process and pointed us in the direction of treating for taste and odor. From their research, they have found a significant portion of complaints regarding taste and odor. Though not life-threatening, the market for this issue may speak for itself. We would also like to foster our partners’ efforts in the direction of sanitation as we have seen it is a serious issue. The issues are complex, and this direction will involve more research and well-established relationships.
Conclusion

The residents in the slums of Mumbai face numerous challenges. Of all the challenges, poor water quality presents the most serious risk to community health and wellness. HydroLogic aims to introduce a cheap, simple solution to help reduce the incidence of water-related diseases that cause much morbidity and mortality. This solution is the WAPI. The WAPI will not only provide a better method to disinfect water, but it will also provide fuel savings for the slum residents who are already boiling.

The success of the WAPI depends on the partnerships HydroLogic has established with North Star Devices and Solar Oven Society and will develop with a women’s organization in Mumbai. The women’s organization provides the vital link in distribution and education. The WAPI ultimately provides HydroLogic an entry point into the water market in the slums. If the device is successful, HydroLogic will have the brand recognition and reputation required to expand their scope to include more complex problems and products.
Team HydroLogic

Adam F. Both, EIT
- University of Minnesota  Master of Science in Civil Engineering  May ‘10
- University of Wisconsin-Madison  Bachelor of Science in Civil Engineering May ’05

Adam has experience in design and construction in North America, East Africa, the Middle East and India. His current research is focused on environmental health in the developing world, focused around Bangalore, India. Adam has a passion for people and relationships and the social impact that engineering can have.

Simona M. Fischer
- University of Minnesota  Master of Architecture  May ‘10
  Master of Science in Sustainable Design  May ‘11
- University of Iowa  Bachelor of Arts in Philosophy  May ’03

Simona spent a semester abroad in Mysore and Delhi, India. She is currently studying to become an architect, and her focus is on sustainable renewal and reuse of existing homes and buildings. She believes that change happens individually, and only the results are collective. She taught English in Japan for two years.

Eric N. Hettler, EIT
- University of Minnesota  Master of Science in Civil Engineering  May ‘10
- Colorado State University  Bachelor of Science in Civil Engineering  May ‘08
- Engineers Without Borders  Volunteer  August 2005 – Present

Eric has experience working on water supply and water treatment projects in the United States, Latin America, and East Africa. He is currently working to develop simple methods to improve the quality of stormwater runoff in urban areas. Eric believes engineering professionals can work together with other disciplines at a community level to address the needs of underrepresented populations throughout the world.

Katheryn Hope
- University of Minnesota  Bachelor of Science in Civil Engineering  Dec ’09
- UMN Facilities Management  Student Engineer  November 2006 – May 2008
- Imago Dei Village, Clintonville, WI  Counselor  May 2006 – August 2006
- Queen of Institute of Technology  2009

Katheryn is interested in the bacterial communities of inland lakes and sewer treatment sludge. She is currently researching the existence of antibiotic resistant pathogenic organisms in wastewater treatment plants. Katheryn worked at a Hydroelectric Dam in Prairie du Sac Wisconsin on a $6 million capital project installing federally mandated fish protection. Next semester she will study at the Hong Kong University of Science and Technology.
References


