FIELD INSIGHTS SERIES MARCH 2014

Safe WATER NETWORK

MODULAR SLOW SAND FILTRATION

A Low-Cost Surface Water Treatment Solution for Lake Volta Communities

Preliminary results from Safe Water Network's first two Modular Slow Sand Filtration Stations indicate that the technology has the potential to reliably cover operating costs while charging affordable prices for safe water. Its low costs and ease of operation make it an appropriate solution for low-income rural communities relying on certain types of microbially contaminated surface water.

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PROGRAM SUMMARY

- **Objective:** Test the potential of locally operated Modular Slow Sand Filtration (MSSF) systems to provide reliable, WHO-quality water to low-income rural communities on a financially viable basis.
- **Intervention:** Two Safe Water Stations in the Lake Volta communities of Aveme and Akateng, with ongoing monitoring of operational, financial, and water quality results.

KEY INSIGHTS

- Stations were constructed at a capital cost of $16-18 per person.
- In the last half of 2013, both Stations' revenues reliably covered operating expenses.
- Lower operating costs, as compared with our earlier UV systems, have enabled a 66% reduction in water prices.
- Surpluses have enabled the accumulation of reserves for equipment replacement, with Akateng well on its way toward our total reserve target.
- Ease of operation has been dramatically improved, with only five days of operator training required for MSSF, versus a month for our previous multi-stage UV treatment systems.
- Other key metrics, such as water quality and downtime, have been comparable to other treatment technologies.

Background: Evaluating Lower-Cost Technologies

Safe Water Network has been active in Ghana since 2009, when we established four Safe Water Stations in peri-urban Accra and one in the Volta region. These Stations are intended to operate reliably far into the future, which requires that they achieve financial viability—at a minimum, covering operating costs while generating reserves for maintenance. It also requires that operations can be managed locally, with access to affordable external support as needed.

Modular Slow Sand Filtration Safe Water Station in Aveme

Safe Water Network develops innovative solutions that provide safe water to communities in need. Our goal is to achieve sustainable service delivery and locally independent operations through the application of local ownership and market principles.

In *Field Insights*, we provide a focused analysis of how we've approached a particular challenge and what insights have been gained.

For more information, contact info@safewaternetwork.org.

The original five Safe Water Stations in Ghana purify water using a combination of filtering, chlorination, and ultraviolet light. Consumers pay a fee ranging from 10 to 15 pesewas (4-6 US cents) for 20L of water to cover costs and build reserves.

In 2012, Safe Water Network developed plans for an ambitious expansion in Ghana. One of our priorities was to adapt our model to meet the needs of a wider range of communities—particularly smaller, poorer, more rural communities, where the need for safe water is greatest.

The treatment systems used in the original five Stations were too expensive and complex to be appropriate for many communities in need. Our 2013 *Ghana Market Assessment*[1] therefore evaluated a set of alternative treatment technologies. One that emerged as having particular promise was a new, modular variant of a well-established technology: slow-sand filtration (SSF). Originally developed in the 19th century, traditional slow-sand filtration systems have proven to be a reliable solution in many parts of the world, including in Ghana. In SSF systems, water filters by gravity through a tank of sand including a layer of naturally occurring biological film, which removes microbial contaminants. The technology is highly effective and simple to operate.

SSF is not appropriate for all water sources. Unable to remove salinity or mineral contaminants, SSF requires a perennial freshwater source with low, stable turbidity levels. Lake Volta represents an ideal candidate. Formed by the construction of the Akosombo Dam in 1965, Lake Volta is the world's largest reservoir and represents an important, albeit increasingly contaminated, source of drinking water for the hundreds of communities located along its shores.

A second limitation is that SSF traditionally requires a significant capital investment in the form of large concrete tanks. Expansion of an existing system is likewise costly, and as such implementers of SSF systems have tended to overbuild in order to accommodate anticipated growth in demand without requiring incremental capital. Often, this growth does not materialize, and much of the original investment is wasted.

Our Market Assessment identified Modular Slow Sand Filtration (MSSF) as a variation of SSF[2] with the potential to eliminate this second limitation. MSSF makes use of prefabricated plastic tanks to greatly reduce costs and increase flexibility. Systems can be constructed to meet a basic level of demand; if and when demand increases, the system can be expanded simply through the installation of additional plastic tanks and a small amount of piping.

Resident of Aveme collecting water from Lake Volta

We set out to test the MSSF technology in two communities along Lake Volta. Our objective was to test the potential of locally operated MSSF systems to provide reliable, WHO-quality water to low-income rural communities on a financially viable basis. We also sought to understand what additional challenges needed to be addressed in order to enable wide replication.

Bringing MSSF to Aveme and Akateng

With funding from the Conrad N. Hilton Foundation and Newman's Own Foundation, Safe Water Network developed Ghana's first MSSF water systems in the communities of Aveme and Akateng. Both are poor, rural communities with populations of 4,200 and 4,500, respectively. The majority of residents are farmers, fishers, and traders. At the time of Safe Water Network's initial assessments, most residents collected water (free of charge) from the lake or from boreholes. Both were found to be microbially contaminated. No other water sources were in common use. Our assessments identified a high prevalence of water-related diseases including diarrhea, dysentery, worm infestation, skin infections, and schistosomiasis. The two Stations were launched in March (Aveme) and June (Akateng).

[1] Executive summary available at http://safewaternetwork.org/pdf/Hilton%20Ghana%20Market%20Assessment.pdf
[2] Developed by Blue Future Filters of Bellingham, Washington.

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Figure 1: Total Capital Costs

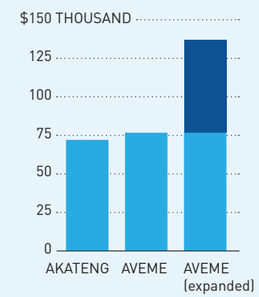


Figure 2: Capital Cost per Capita

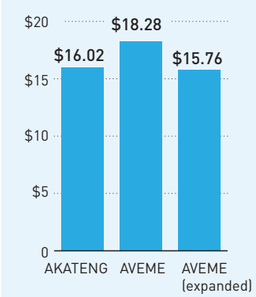


Figure 3: Monthly Volume (Liters), 2013

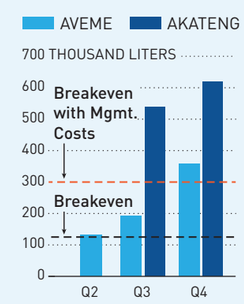


Figure 4: Operating Cost per 20 Liters, 2013

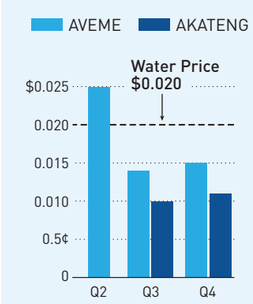
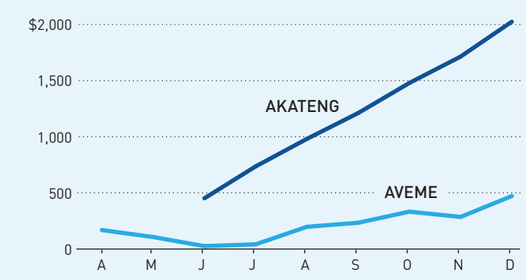


Figure 5: Cumulative Reserves



Promising Financial and Operational Results

Capital Expenses

Both systems have a monthly designed capacity of 1.2 million liters. As shown in Figure 1, total capital costs were initially similar: $72,100 for Akateng and $76,800 for Aveme[3], including hardware costs and some programmatic start-up costs such as assessment and demand generation. Figure 2 shows that this represented a per-capita cost of $16.02 and $18.28, respectively.

In September 2013, we expanded the Aveme system to include three pipeline-connected "subsystems"[4] in the adjacent communities of Tsoyome Sabadu (500m away), Aveme Beme (2.5km), and Aveme Dzeme (3.5km). This expansion required an incremental capital investment of $60,300, but more than doubled the population with access to 8,700. The result was a 14% reduction in per-capita costs to $15.76, lower than for either of the initial stations alone.

Sales Volumes and Operating Expenses

As shown in Figure 3, both Stations show an upward trend in volumes. Each has reliably sold above the volume threshold needed to cover direct, community-level operating costs. These costs do not, however, include the cost required to provide technical and programmatic support to the Stations. As we expand, it becomes increasingly necessary to enable the reliable provision of these support services locally with less need for external intervention.

Over the coming 2-3 years, we are therefore testing a model for such services to be provided through "Water Services Entities" each of which will support a cluster of some 10-20 Safe Water Stations in exchange for a monthly fee[5]. When this fee is introduced in 2018, Stations will need to consistently sell an estimated 300,000 L/month. This threshold was reached by Akateng in both Q3 and Q4, and by Aveme in Q4 (thanks in part to the system's expansion).

These trends in costs and revenues can also be understood on a unit basis. Consumers purchase water from the MSSF Stations at a price of 5 pesewas (just under 2 US cents) per 20L container. Therefore, in order for the Station to cover its operating costs—a bare minimum condition without which financial sustainability cannot be achieved—these costs must be less than $0.02 per 20L. As shown in Figure 4, both Stations were well below this threshold in Q3 and Q4[6]. Aveme's unit operating costs in Q2 suffered from low sales volumes due to equipment-related downtime. A submersible pump had to be replaced in June; since the replacement, downtime has fallen to less than 5%, in line with our targets.

[3] Figures converted at a rate of 1 Ghana cedi = 39.3 US cents (February 2014).
[4] A "subsystem" is a storage facility with additional points of sale, connected by pipeline to a main treatment location.
[5] The Water Services Entity model will be discussed in greater depth in a future *Field Insight*.
[6] Note that as Akateng launched late in Q2, no results are shown until Q3.

The ability of both Stations to cover their operating costs is particularly notable given the reduction in price when compared to our original multi-stage UV Stations, which have struggled to reliably cover their costs even while charging three times the price for water. This result helps underscore the potential for MSSF to enable expansion into certain lower-income communities unserved by conventional water supplies.

Reserves

As described above, volumes at the two Stations have generally exceeded the threshold needed to cover operating costs, which has resulted in a surplus in most months. Figure 5 presents this surplus in cumulative terms, including repair costs as well as direct operating costs presented above. Although there were months in which reserves reduced, their balance remained positive for both Stations in each month.

We estimate a need for each MSSF Station to accumulate reserves of ~$5,000 per year. With just over $2,000 accumulated in six months of operation, the Akateng Station is nearly on track. However, the Aveme Station is considerably below its reserve target; a combination of further revenue growth and cost savings will be required to ensure the Station's sustainability over the long term.

Ease of Operation

In addition to favorable economics, we chose MSSF due to its lower operating complexity, making it simpler to roll out and manage in remote, resource-poor settings. As one early indication, the amount of training required for the Station operators has been far lower than at our earlier Ghana sites—just five days, down from roughly a month.

FIELD STORY

"With the launch of the Station, I spend more time with my family and my business." –Priscilla Gifty Addai
Age: 26

Before the establishment of the MSSF station in Aveme, Priscilla used to walk almost two hours each day to fetch water to meet the needs of herself and her family. Now she has access to higher quality water at a more convenient distance from her home.

What's Next?

In October, we established a third MSSF treatment system in the community of Tongor in the Volta Region. Drawing on lessons learned through the expansion of the Aveme Station, the Station at Tongor is intended to connect to substations in some 10 additional communities, providing access to a total of 11,200 people. Over the coming two years, we are refining a model to operate the Tongor water station as a fully functioning "micro-utility."

MSSF is not a viable option everywhere; it requires source water with stable turbidity and a lack of mineral contaminants. However, given the vast surface water potential of Lake Volta, we believe the technology can be rolled out to hundreds of communities around the Lake, serving hundreds of thousands of people. As a next step, we will launch an additional five MSSF systems over the next year.

As we scale up, we are evaluating options to increase standardization and more effectively leverage African supply chains. Our objective is to develop an "MSSF kit": a nearly turnkey solution, which can be rapidly deployed with minimal need for customization. We believe that this and other efficiencies will enable us to reduce capital costs by up to 30%. We will present further analysis on the results of our expansion in future *Field Insights*.

The content of this document is based on work conducted in honor of Mr. John Whitehead for his many years of service to help improve the lives of others. Funding generously provided by:

NEWMAN'S OWN® FOUNDATION

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