# ACTION RESEARCH ON POINT OF USE DRINKING WATER TREATMENT ALTERNATIVES

## AS APPROPRIATE FOR UNDERPRIVILEGED HOUSEHOLDS IN JAKARTA

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**Photo Credit:** ESP Jakarta

A woman is demonstrating Solar Water Disinfection (SODIS) method to obtain drinking water at household level.

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Mindy Weimer
31st August 2006

# ACRONYMS

| | |
|---|---|
| CDC | Center for Diseases Control |
| EPA | (United States) Environmental Protection Agency |
| FC | Fecal Coliform |
| MCL | Maximum Contaminant Level |
| PDAM | Perusahaan Daerah Air Minum |
| RO | Reverse Osmosis |
| SODIS | Solar Water Disinfection |
| UV | Ultra Violet radiation |
| YE | Yayasan Emmanuel |

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# ABSTRACT

This report documents the action research conducted on point-of-use drinking water treatment alternatives appropriate for underprivileged households in Jakarta. An introduction to the scope of work and project summary is first given. Second, technology research is covered, specifically boiling, *isi-ulang*, chlorination, ceramic filtration, and SODIS, which are each discussed with regards to background, technology, perception, and limitations. A preliminary comparison of these disinfection technologies follows. Next reported are results from bench-scale investigations of SODIS and ceramic filtration, which were conducted prior to implementing alternative practices with community members. Pilot-trials with Bintaro Lama, Bintaro Baru, Teluk Gong, and Tanjung Priok slum communities in Jakarta followed. A Water Handling & Hygiene Campaign, and subsequent Point-of-Use Water Treatment Alternatives Campaign, was initially conducted in each of these four communities. Campaign participants ranked their treatment preferences at that time, and thereafter, volunteers to try one of each of the treatment alternatives were assigned in each of the communities. Water quality was monitored and user feedback was documented from the 20 families participating over the following month. A User's Feedback & Water Quality Results Campaign was then conducted in each community, where each user spoke about their findings and water quality results were presented. Campaign participants ranked their treatment preferences again at that time. Conclusions were made based on all the information gathered and analyzed to assess the technology comparison method constructed and implemented and to provide grounded advice for feasible replication.

# 1. INTRODUCTION

## 1.1. SCOPE OF WORK

The purpose of this action research was to present and demonstrate appropriate point-of-use treatments with underprivileged household participants in Jakarta, in order to foster hands-on learning of disinfection alternatives and to gather valuable user feedback for full-scale replication. The range of point-of-use technologies researched include boiling, refill boutiques *isi-ulang*, chlorination, household ceramic filtration, and solar disinfection (SODIS). These specific technologies were chosen because they are each practical, relatively affordable water disinfection alternatives for underprivileged households in Jakarta.

It is important to differentiate that this research focuses on alternative *drinking water treatments*, not alternatives for *access to clean water*. Thus, this research is not based on getting clean water, rather ways to treat clean water for drinking. The objective was to increase the drinking water quality in households by presenting a menu of water disinfection technology options, rather than promoting a specific technology, along with subsequent household monitoring/follow-up visits.

Field-trials with four Jakarta slum communities were conducted to investigate effective treatments and an appropriate implementation method. Technical aspects and community acceptance of the point-of-use technology alternatives were jointly investigated throughout this study. Water quality results and users' feedback were analyzed to report the potential of replicating the technology comparison method constructed.

## 1.2. SUMMARY OF PROJECT

Appropriate disinfection treatment alternatives were determined at the onset of this project. Each of the treatment technologies (boiling, *isi-ulang*, chlorination, ceramic filtration, and SODIS) were then researched in terms of background information, technical aspects, perception and limitations. Bench-scale tests followed to confirm the effectiveness of SODIS in Jakarta's climate under varied conditions, and to confirm the effective removal of total coliform using Plered Ceramic Filters and assess the water quality with respect to inorganics.

Four poor communities in different areas of Jakarta, namely Bintaro Lama, Bintaro Baru, Teluk Gong and Tanjung Priok, were included in the subsequent pilot-scale study. The main focus was putting into practice affordable household water disinfection alternatives while concurrently heightening awareness of hygiene related to drinking water handling & storage. A campaign addressing water handling & storage was conducted in each of the communities, and a later campaign introducing point-of-use water treatment alternatives followed. During the second campaign, attendees were asked to rank their perceived technology preferences. Thereafter, volunteers were elected to try one of each of the five alternatives presented in each of the four communities, for a total of 20 active participants.

Weekly monitoring of water quality and user feedback from the 20 families participating took place for the month following. Discussions with users and data collected provided valuable information, which was used to decipher fuel costs directly related to boiling drinking water for example. After the month of monitoring, a third campaign was conducted in each of the communities to present the water quality results and direct feedback from each user. Community members were invited to drink the differently treated waters, and were again asked to rank their preferences.

Results from monitoring user feedback and water quality were reported and analyzed to assess replication feasibility. Conclusions from the data gathered are discussed in terms of acceptability, practicability, and lessons learned from the implementation and monitoring of boiling, *isi-ulang*[1], chlorination, ceramic filtration, and SODIS. Lastly, suggestions for replication in the wider poor communities in Jakarta are given to provide grounds to progress improved household drinking water quality and more affordable point-of-use treatment alternatives.

The effort put into this study has helped the four communities involved in this project, and has the potential to help many others in Jakarta, or other applicable areas in Indonesia. The following comments were gathered after the completion of this research, during August 2006, from members of Teluk Gong community.

> Ibu Kartini: *"Government and producer never informed us about the alternatives before, we knew it from you."*
>
> Ibu Ncum (*isi-ulang* volunteer): *"Because of the campaigns about healthy drinking water, we were informed about available alternatives. There were no others that helped us about this kind of assistance before."*
>
> Ibu Noor's mother: *"My family really gets benefit from SODIS application. Except for making tea and coffee, we never boil water anymore. We really thankful and appreciate for you works for us."*

1 Isi-ulang treatment was not implemented, rather monitored at point-of-use for this study.

# 2. INITIAL TECHNOLOGY RESEARCH

The following point-of-use treatment technologies are used to *disinfect* water, which is not necessarily inclusive of inorganic contaminant removal. The following disinfection processes are discussed in the context of Jakarta's urban poor with the understanding of this limitation.

## 2.1. BOILING

### 2.1.1. BOILING BACKGROUND

If you asked an Indonesian how to treat drinking water, you would undoubtedly be told by boiling water. Indonesians have long been taught in schools, local clinics, etc. to boil their drinking water to prevent sickness. The majority of households in Jakarta no longer use firewood to boil their water, rather use kerosene stoves.

Considering this customary boiling practice with the resent and nearing fuel price increases, stresses a major burden for the poor. Fortunately, some of the people understand the value of treating their drinking water and so, are paying the price for fuel. Others pay to continue boiling their water because they are "use to it." In any case, there is a definite need for implementing alternative methods to treat drinking water.

### 2.1.2. BOILING TECHNOLOGY

The success of boiling drinking water as a treatment technology is the ready access to boiling appliances in conjunction with a successful promotion campaign. With almost all households having access to a stove, no new supplies are necessary, only additional fuel. And, maintenance pretty much boils down to keeping the stove clean and operational.

### 2.1.3. BOILING PERCEPTION

A critical issue in proposing alternative household drinking water treatments is understanding the users' perception of boiling drinking water. Changing behavior from a customary practice is a challenging endeavor no matter what the case (CDC 2001). Pak Harris, of Tanjung Priok, highlights a common standpoint: "Well, even though isi-ulang water, which has become a new phenomenon in my neighborhood, looks simple, but I rather boil my water. It has already proven that my family does not have any problems with diarrhea."

The cost of boiling water is definite consideration from the users' point of view. It is difficult to quantify the fuel costs directly related to boiling drinking water because the same stove and fuel are also used for cooking. Care International – Indonesia did an unpublished study in

April 2004 that found at a fuel cost of Rp.1.100 /L, the cost for boiling10L of water (average daily family consumption) is approximately Rp.500. The current fuel cost is Rp.3.000 - 2.500 /L, and is likely to increase in the near future. As Ibu Nunung from Tanjung Priok states, "I have ten kids, and we always must have water and it needs a lot of money to cover their living expense."

A further consideration prior to proposing alternative household drinking water treatment methods is the users' perception of the ease and availability of boiling water. Several locals share Ibu Lena's (Teluk Gong resident) viewpoint: "It is easier for me to boil water bought from the cart-vendor than it is for me to fetch isi-ulang water, especially if it is raining. It is cheaper for isi ulang, but I don't have a motorbike so only when I borrow my neighbors sometimes." Hence, alternative treatment options need not only be cheaper, but also convenient. In terms of ease and availability, boiling is advantageous since the majority have stoves in their homes and are accustomed to it.

Additionally, resulting water quality must be maintained or improved to rationalize a behavior change from the long-standing boiling practice. Ibu Sus of Teluk Gong echoes a typical sentiment of many Indonesians: "Even though there are some isi-ulang stations as an alternative to get drinking water, I prefer to boil my water. For years my family treats our drinking water by boiling, and we are healthy so far." Many such users perceive boiled water as suitable quality for their families, thus, alternative methods will likely be held to this measure.

### 2.1.4. BOILING LIMITATIONS

Despite the fact that boiling drinking water is extensively used, there are limitations to this practice. "Boiling water is the best method for making water safe to drink. Boiling water as recommended will kill bacterial, parasitic, and viral causes of diarrhea."(CDC 2005) This is considering that the water is boiled properly[2]. However, there is a common **misperception of the actual time required to properly boil** water. EPA recommends that water be rendered microbiologically safe for drinking by bringing it to a rolling boil for 1 minute (EPA 1994) [3].

Beyond ensuring water is boiled properly, a further concern is **water handling and storage**. As boiled water holds no residual disinfection power, it is susceptible to recontamination, via unclean dishware for example. It is worth noting that the majority of poor Jakarta residents boil water originating from the municipal water supply which, although unreliably, has a chlorine residual. Boiling this water has been shown to actually lower the water quality[4], since boiling increases dissipation of the chlorine residual. This highlights the imperative need for education in regards to water handling and storage.

Another forefront limitation to boiling drinking water is **time and money** costs. Someone must be present in the household to attend to the stove and oversee the boiling.

2 Directions for Boiling Water: Boil water vigorously for 1 minute and allow it to cool to room temperature (do not add ice). At altitudes greater than 6,562 feet (>2,000 m), boil water for 3 minutes or use chemical disinfection after water has been boiled for 1 minute. (CDC 2005)

3 This will inactivate all major waterborne bacterial pathogens (i.e., Vibrio cholerae, enterotoxigenic Escherichia coli, Salmonella, Shigella sonnei, Campylobacter jejuni, Yersinia enterocolitica, and Legionella pneumophila) and waterborne protozoa (e.g., Cryptosporidium parvum, Giardia lamblia, and Entamoeba histolytica). Although information about thermal inactivation is incomplete for waterborne viral pathogens, hepatitis A virus - considered one of the more heat resistant waterborne viruses - also is rendered noninfectious by boiling for 1 minute. (EPA 1994)

4 This is based on unpublished data gathered by Yayasan Emmanuel Water Program in 2005-6.

(Considering close living quarters of poor communities, unattended stoves have detrimental fire hazard repercussions.) In addition to the time required for boiling, is the direct cost of fuel. This is the prominent expense contributed to boiling water at household level. From a global standpoint, boiling requires fuel consumption that could be avoided by using alternative water treatments.

# 2.2. ISI-ULANG

In Bahasa Indonesian, *isi-ulang* means refill, which refers to refilling empty dispenser jugs with potable water. Although *isi-ulang* is not specifically a household water treatment option, it is an existing local alternative for providing affordable drinking water. *Isi-ulang* is considered in this study because it is a widely used, viable option for obtaining drinking water from a number of small local vending stations.

## 2.2.1. ISI-ULANG BACKGROUND

*Isi-ulang* use to pertain specifically to dispenser jugs refilled by authorized water companies in Indonesia, such as Aqua, 2 Tang, and Vit. Refilled dispenser jugs (which are 19L volume but are commonly called "gallons") were either delivered to the consumer and exchanged with empty ones of the same brand, or consumers brought their empty "gallons" to refill at respective company-authorized *isi-ulang* stations.

In the last five years or so, a different *isi-ulang* retail practice emerged in many urban areas of Indonesia, prominently Jakarta. The new *isi-ulang* practice is not brand-specific, rather independent stations buy clean water in bulk from suppliers (who are said to truck the water from a mountain spring in West Java) and treat the water at their own local stations. Some treat PDAM (piped government) water at their station to sell. The way the water is treated depends on the technology *isi-ulang* station owners bought from distributors.

These new *isi-ulang* stations are small businesses, and it is doubtful that *isi-ulang* station operators have ever been to the water source or that they understand the treatment technology. Nevertheless, they provide relatively convenient and affordable means to drinking water. The small business *isi-ulang* water is approximately a third of the price of the company-branded *isi-ulang* "gallons" such as Aqua. There are hundreds of these *isi-ulang* stations now around the Jakarta area alone that have been started by local entrepreneurs. Locals either bring their empty "gallons" to refill or exchange them with already refilled "gallons." (Some so-called *isi-ulang* stations are simply hubs for "gallon" exchange and do not treat the water there.) At most stations, there is a flushing system for customers to clean their "gallon" prior to refilling.

## 2.2.2. ISI-ULANG TECHNOLOGY

Many of the water vendors are hesitant to disclose details concerning their water treatment technology as they consider such information their secret business strategy. Vendors suggest calling their treatment technology distributor directly for details. Summaries of the different *isi-ulang* small business water treatment technologies existing in most urban areas of Indonesia, like Jakarta, follow. Regardless of the treatment technology, the cost of a "gallon" is normally Rp.3.000.

Reverse Osmosis

Reverse Osmosis (RO) is an energy-intensive process whereby water is forced through a membrane filter to remove impurities. (Local stations refer to there business as "RO" although they are not sophisticated RO treatments.) The capital investment to start an *isi-ulang* RO station depends on the desired capacity. For example, based on information from an *isi-ulang* vendor in Teluk Gong, the retailer offers Rp.2.500.000 for a system to treat 10 "gallons"/day or Rp.4.000.000 for a system treating 20 "gallons"/day. Beyond the capital cost provision, vendors must have a dependable water supply as stipulated by RO retailers. Since the RO process is designed to run continuously, a reliable water supply (typically from a groundwater well or PDAM connection) is necessary. Also, the proposed water supply must meet RO retailer specifications with respect to water quality. If prerequisites are met, retailers then train the vendors on how to conduct RO operation and maintenance. RO technology operation is relatively simple; however, periodic maintenance is relatively complex. Every few months (depending on number of "gallons"/day) the RO membrane must be replaced, which costs around Rp.12.000. Moreover, the electricity demand is a significant operational cost (Rp.350.000-300.000/month), varying at different stations as a function of the capacity and use of the system.

Membrane Filtration

Membrane filtration is the most common *isi-ulang* technology. The principle of this system is also using a membrane to strain impurities from water. The difference between this membrane filtration practice as it is called, and RO is the unrestricted water supply. Membrane filtration vendors do not have to have their own reliable water supply; rather they get the water directly from the retailer who usually delivers untreated water in an 8.000L capacity water tanker truck. Membrane filtration stations thus require water storage facilities which require a higher capital investment than that of RO stations. The capital investment for a membrane filtration system ranges from Rp.12.000.000 to 20.000.000. This investment includes equipment such as a large storage tank for untreated water, another for storing water after treatment, a filtration apparatus, two flushing machines for rinsing "gallon" containers, and two filling machines to fill the "gallon" containers. Despite the higher capital cost, operation and maintenance is said to be simpler than RO.

Exchange Depot

While exchange depots do not function as local water treatment facilities, they are included in this section because they are vendors of *isi-ulang* water. Retailers deliver pre-filled "gallons" to be exchanged with empty ones. As such, the prior water treatment process is not always clear to the vendors or consumers. Such *isi-ulang* stations are simple to manage as they do not require any system operation or maintenance. When Ibu Suriah, an exchange depot *isi-ulang* vendor in Teluk Gong, was asked about the capital for starting her exchange depot she replied *"All I have to do is provide a place to store the "gallons."*

UV

Destruction of microorganisms by ultraviolet (UV) radiation is the principal of this water treatment technology. Most UV *isi-ulang* stations filter the water prior to their UV treatment. Based on information from a vendor in Cilincing, a capital investment for a UV *isi-ulang* station that sells an average of 400 – 500 "gallons" daily is Rp.20.000.000. There are also significant operations and maintenance costs associated with running a UV *isi-ulang* station. In addition to monitoring and cleaning lamp sleeves and filters, they must periodically be replaced. Replacement lamps (from Australia) cost Rp.950.000 and last for approximately 1 year, and the replacement filters cost Rp.12.000 and last for approximately 6 months. Plus, electricity costs, which Pak Sinta from the UV *isi-ulang* station in Bintaro Baru says is about Rp.325.000/month.

### 2.2.3. ISI-ULANG PERCEPTION

Based on surveys of poor communities in Jakarta, users' perception of *isi-ulang* drinking water varies in regards to many aspects. Even within the same community **perceptions vary**.

The following are comments from residents of Bintaro Baru community:

> Ibu Deyen: "*It has been years my family gets drinking water by boiling. Well, I recognize the isi ulang, but I think it is more complicated. As long as my family does not have any problems related to our drinking water, I prefer boiling water.*"
>
> Pak Sukron: "*I have been using isi-ulang drinking water since two years ago. My bore-water sometimes turns to yellow, especially in rainy season. Moreover, since I and my wife have to work* [they are scavengers] *I feel it is more simple to buy isi-ulang drinking water than to boil it.*"

It costs Rp.30.000 for a "gallon" container, which serves as the customers' capital so to speak. Thereafter it costs Rp.3.000 to refill or exchange the "gallon." Since *isi-ulang* stations are widespread, they are relatively easy for customers to get to. No cases were stations reported to have run out of stock, hence, the availability of *isi-ulang* drinking water is not limiting.

Comments from users regarding the **cost and availability** of *isi-ulang* drinking water follow:

> Ibu Kartini (Teluk Gong): "*I know that isi-ulang water is less pricey compared to the cost we spend to boil the same amount of water. However, since I need to spend more money for transportation to buy isi-ulang water, so I prefer to boil my clean water.*"
>
> Ibu Marni (Bintaro Baru): "*Since my family financial condition is very restricted, I cannot buy "gallon" for drinking water. So, I still boil water.*"
>
> Ibu Nur (Teluk Gong): "*I adapted myself and my family not to depend on isi-ulang drinking water. For me, when we use isi-ulang it means I need dispenser, which also needs electricity (to get hot water). Well, it is okay now, since we don't have to pay electricity bill* [Teluk Gong community gets their electricity illegally], *but if someday my family has to move from here, then what are we going to do? It is better for us to get our drinking water by boiling it.*"
>
> Ibu tua (Bintaro Baru): "*It less pricey, easy to get since the station close to my house and they are never out of stock.*"
>
> Ibu Syanne (Tanjung Priok): "*I only have three family members. For me, it less pricey to get our drinking water from isi-ulang station, rather than boiling, but I could not buy it by myself, since the station is quite far. So, when we are out of isi-ulang and my husband is not at home, I boil water. Oh yah, the station is also never out of stock; whenever we want to buy it, it is always available.*"

The lack of company-authorization/labels in the small business *isi-ulang* operations has rightfully raised questions about **water quality**. Some users have strong preferences on the *isi-ulang* technology used, claiming better water quality from certain stations (although this is

often perceived from word of mouth.) For others, they do not question the method applied as long as they do not get diarrhea.
The following are responses from community members with regards to *isi-ulang* water quality:

Ibu Aas (Teluk Gong): "*I use to buy isi-ulang drinking water. But after I heard news from the radio which informed that one of university laboratory had tested isi-ulang water and the results proved that it contained E. Coli., since then my family prefers not to buy drinking water from isi-ulang station*."

Ibu Nuriah (Bintaro Lama): "*I am not sure about isi-ulang drinking water quality. It has been two times my family got diarrhea after drank isi-ulang water, since then, I never use isi-ulang drinking water.*"

Ibu Mar (Teluk Gong): "*I use to buy isi-ulang drinking water, but since I found a worm in my "gallon," I never buy isi-ulang water again*."

Ibu tua (Bintaro Baru): "*I use to buy Aqua isi-ulang "gallon" but since there are some unlabeled isi-ulang station exists, I was curious to try it. Then when I tried this isi-ulang UV station, I found it has the same taste as my previous drinking water. So I never buy Aqua "gallon" any longer and have it from this station. Oh yah, my family also do not have any problem with diarrhea, etc.*"

### 2.2.4. ISI-ULANG LIMITATIONS

There is a constant supply of *isi-ulang* water from **reasonably accessible stations**. Costs for *isi-ulang* water are comparable with that of boiling; however, transport costs must also be accounted for. For very poor families however, covering the initial "gallon" **cost** (Rp.30.000) is limiting.

It is common for households in Jakarta to buy *isi-ulang* water sometimes and to boil water other times. This is usually a function of **convenience** as well as of what the water is used for. For example, for making tea/coffee, boiled water is almost always used. *Isi-ulang* water is used for other purposes since it is generally more time-efficient to buy *isi-ulang* rather than spend time boiling water.

Reports have been published that reveal negative *isi-ulang* water quality results. It is common for new stations to produce quality water at the start of the business but over time, quality often decreases because vendors cut corners on membrane replacements for example. Publications of skeptics are compounded by the lack of understanding of, for the most part, the undisclosed *isi-ulang* technology processes, which have led the public to **question *isi-ulang* water quality**.

## 2.3. CHLORINATION

### 2.3.1. CHLORINATION BACKGROUND

Chlorine is a chemical disinfectant used to combat waterborne diseases such as cholera, diarrhea and typhoid. Chlorination also removes soluble iron, manganese and hydrogen sulfide from water (NDSU 1992). According to the World Health Organization (WHO, Sobsey 2005), chlorine's use in water treatment has been one of the most significant advances in public health protection. This is evidenced by the virtual absence of waterborne diseases in developed countries where chlorination is employed (World Chlorine Council 2002).

Chlorination is widely used in different parts of the world because of low cost and high efficiency in killing just about everything hazardous in the water except for effective removal of cysts. Chlorine is available in different forms and for different applications but has not yet effectively been marketed in Jakarta for household water treatment. Although Jakarta's Municipal Water Department chlorinates their water, point-of-use applications have yet to be firmly established.

USAID-Safe Water Systems launched Air RahMat (100mL bottles of 1.25% sodium hypochlorite) in Indonesia in February 2006, and is working to develop the availability and acceptance of the chlorine additive as an alternative household water treatment. Prior to awareness campaigns and distribution efforts for Air RahMat, using chlorine to treat drinking water at the household level was rarely practiced in Indonesia.

## 2.3.2. CHLORINATION TECHNOLOGY

The chlorination technology discussed in this report deals with household drinking water treatment as available in poor communities of Jakarta. At present, a user-friendly chlorine additive for water disinfection (i.e. Air RahMat) still is not readily accessible. However, USAID-Safe Water Systems is currently working to disseminate information about advantages of chlorination, while functioning to establish local vendor stations throughout Jakarta, as well as other areas of Indonesia.

Establishing a local vendor station requires minimal investment, namely, the cost of the stock. One bottle of Air RahMat retails at Rp.4.000 (which is enough to treat 600L of water), and will be sold to vendors by the box (24 bottles/box) at a cost of Rp.79.200/box (Rp.3.300/bottle). The bottle-cap is designed for measuring the chlorine dose for specific 5, 10, and 20L volumes, providing a simple and affordable water treatment alternative.

Prior to chlorinating, the freshwater used should have a low turbidity and organic content. In practice, families who normally pre-treat their water by settling it overnight or filtering it through a cloth for example, would do the same before adding the chlorine. The appropriate dose of chlorine is measured according to the volume of water being treated, then added to the water and mixed thoroughly. After at least half an hour contact time, chlorine will have sufficiently disinfected the water (WHO 2005).

The benefit of residual disinfection power is unique to the chlorination alternative. Residual chlorine combats re-contamination which is a valuable attribute. Yet, despite its' extensive benefits, concentrated chlorine can be harmful to health, such that contact with skin and inhalation of fumes should be avoided. Chlorine additives should be stored in a cool, dark, dry place in a sealed container out of the reach of children.

### 2.3.3. CHLORINATION PERCEPTION

Jakarta's poor communities recognize the use of chlorine in the municipal drinking water supply, although **most do not understand the purpose of chlorine** in water treatment. This is evident by the families who boil PDAM-chlorinated water, thinking they are making the water better by getting rid of the chlorine smell/taste, when in actuality they are removing the disinfectant power of the residual chlorine. Such is the case with Pak Harris, from Tanjung Priok, who said *"I only know the application of chlorine by municipal drinking water distribution. And, sometimes the odor is strong, so that I evaporate it before use."*

Many people were taught that clean water does not have smell. Although this is an important criterion, it is primarily an aesthetic property of the water. Nonetheless, some people object to the **smell/taste** of chlorine and deem it unpalatable, while others adjust. *"I settle my water overnight since the water I bought from vendor smells chlorine,"* says Ibu Ita of Bintaro Baru. Ibu Nur, of Teluk Gong, claims *"The only water that I know contains of chlorine is water from PDAM. At first, I did not like the odor, but then I get used to it. I prefer to put the boiled chlorinated water at refrigerator before we drink it, it is fresher."*

The majority of local population is **unaware** of chlorination as a point-of-use water treatment option, since products such as Air RahMat are **not yet extensively available**. "I never know that there is a product of water chlorination we can individually use in household scale," said Pak Harris of Tanjung Priok. Ibu Ita, from Bintaro Baru, tells "I just know that there is chlorine product sachet to disinfect our water, I thought it only applied by PDAM." Thus, both product distribution and related community awareness & education remain underdeveloped in Jakarta.

### 2.3.4. CHLORINATION LIMITATIONS

Chlorine controls disease-causing bacteria, parasites and other organisms, although unable to completely remove cysts. Scientific studies have linked chlorine and **chlorination bi-products** to cancer of the bladder, liver, stomach, rectum and colon as well heart disease, anemia, high blood pressure, and allergic reaction (EPA 2006, Morris 2004, Dunnick & Melnick 1993, etc.) That said, these considerations are hardly significant relative to the more pressing dangers of unsafe drinking water.

Of relevant concern to the users is that the presence of chlorine in water contributes to the formation of chloramines which can cause **taste and odor issues**. This is the main reason why many Indonesians have an aversion to using chlorine, or if they use chlorinated water, prefer to let the chlorine gas dissipate first. The local population absolutely does not associate the chlorine smell with safe drinking water yet.

Hence, a further limitation for this technology is **information transfer/education and community mobilization** to entice the use of this unfamiliar water treatment. Many Indonesians are already using water that has been chlorinated from the government supply, which they typically boil to get rid of the chlorine smell. Nonetheless, even if locals have heard of household-level chlorination products like Air RahMat, they are **limited by availability** of such products as the market is still developing.

# 2.4. CERAMIC FILTRATION

## 2.4.1. CERAMIC FILTRATION BACKGROUND

Ceramic filtration refers to a process of disinfecting water both physically and chemically, by straining microbes through a ceramic filter element pretreated with colloidal silver. There are many different variations of ceramic filter units produced in many regions of the world. Potters for Peace is a distinguished NGO working to introduce and facilitate the production of ceramic water filtration in developing countries, such as Nicaragua, Thailand, Bangladesh, Mexico, etc.

Impoverished Indonesian communities are not familiar with this drinking water technology, as they have only just begun to be produced locally and the marketing of which has yet to be successfully developed. Potters for Peace supervised the groundwork of the manufacturing process of Bacteria Free Drinking Water, which was built in Bali in 2004. This ceramic filtration factory is still refining their production, and has not begun to sell ceramic filters.

There are low-cost ceramic filters currently being made and sold in Indonesia by Plered Ceramic Water Filters. Husein Wirahadikusumah individually funded the set-up of this company in 2002 in West Java, and as of last year is working in collaboration with the Indonesian government department Badan Pengelolaan Lingkungan Hidup Daerah (BPLHD). Plered produces four different filter models that differ with respect to the filtering elements, receptacles, and price, however, there is definite room for improvements on these filters.

Despite the fact that suitable ceramic water filters for poor households in Indonesia remain to be produced and disseminated, as default, Plered filters were used in this study. Ceramic water filtration is an appropriate point-of-use water treatment worth investigating for use in Jakarta. Thus, using Plered Filters for this study will help to ensure future consideration of this technology as well as highlight constructive feedback for improving Plered Filters. The next best alternative was purchasing filters from Sri Lanka, which is more costly and increases the chance of filters cracking during transport.

## 2.4.2. CERAMIC FILTRATION TECHNOLOGY

The beauty of ceramic filtration is the simplicity of this technology. Several different versions of ceramic water filter systems exist around the world operating under the same principal treatment technique. Freshwater is put into an upper receptacle where it gradually (1-2.5L/hour) filters through to a holding receptacle that duals as a dispenser for the treated water. The porosity of ceramic filters is 0.6 to 3.0 microns, hence, removing a significant fraction of total and fecal coliform (i.e. E. coli) due to pore size alone. Filters are also coated with a germicide, colloidal silver, for additional protection. Silver concentration in the finished water does not pose a human health risk (Alethia Environmental 2001, Owen 1983).

Potters for Peace colloidal silver-impregnated ceramic filter design produces a filter capable of removing 100% of bacteria and bacterial indicators of disease-causing organisms (Lantagne 2002). Ceramic filters produced in Cambodia for example, have been tested in Bangladesh, Cambodia, India, and Vietnam labs to confirm 100% elimination of total and fecal coliform possible from contaminated water (IDE 2002). All studies conclude with an emphasis on the need for effective filter-use training and education on safe storage, cleaning and maintenance when implementing this technology.

Periodic cleaning of the filter and receptacle is necessary to regenerate the flow rate and prevent recontamination. Depending on the filter used, starting water quality, and filter usage, all outer filter surfaces should be scrubbed with a soft-bristle brush every 2 to 30 days (usually specified by the distributor) or when visual build-up of solids is identified. The water receptacle must also be cleaned regularly, with chlorinated water or with soap and dried completely. Careful handling of the filters is important to avoid cracking as well as for hygienic purposes. Potters for Peace has extensively implemented ceramic filtration practices that have now set precedence for others to follow. Plered Ceramic Filters referenced Potters for Peace specifications to create their filters (PATP 2006), although Plered filters lack the same integrity. The lowest cost Plered Ceramic Filter ranges from Rp.200.000 to 150.000 (depending on who is buying the filter).

## 2.4.3. CERAMIC FILTRATION PERCEPTION

Ceramic filtration is uncommon to impoverished Indonesian communities. There is a traditional relation between of ceramics and drinking water, albeit for water storage in what is called a *kendi*. Those few who have heard of ceramic water filters assume they are expensive and do not know where they could buy one anyway. Therefore, not much can be reported on the perception of ceramic filtration in Indonesia since no one surveyed had ever tried the technology.

General feedback from users in different areas of the world suggests promise for expansion in Indonesia (Rivera 2006). Ceramic filters are well liked by the majority of families because of **ease-of-use** and **taste** of the water. However, for large families, the flow rate is regarded as “too slow” to meet basic requirements. Past implementers highly recommend including an educational component addressing safe storage, cleaning procedures, and follow-up visits to ensure effectiveness (HIP 2006).

## 2.4.4. CERAMIC FILTRATION LIMITATIONS

While water quality results show effective removal and inactivation of bacteria and bacterial indicators of disease-causing organisms, further research on the removal rates of protozoa, viruses and contaminants, and the resistance of the colloidal silver to scrubbing, is needed (Lantagne 2002). There are on-going studies investigating the effectiveness and field performance of filters in rural homes, as well as investigating the relationship between filtration rate, colloidal silver application, and bacterial inactivation (HIP 2006).

Ceramic filters have a limited lifetime, which mainly depends on starting water quality, total usage, and cleaning maintenance. Distributors typically specify 2 years to account for exhaustion of germicidal properties and the chance of any cracks that may limit filter effectiveness over time. The capital cost of a new ceramic filter system is a high expense for very low income households and, despite cost savings over time, presents a financial limitation. Additionally, the slow flow rate is not time efficient for treating large quantities of water.

Specific limitations to the Plered Ceramic Filters were evident prior to independent bench-scale testing. There was an inconsistent availability and quality of the systems. It was difficult to contact the distributor, and 4 of the 6 systems bought had leaky taps. The systems do not come with clear operation & maintenance instructions, nor is there any educational component to foster proper filter practice, nor user follow-up. Furthermore, their internal bench-scale tests found manganese concentrations above the minimum limit of drinking water and that filtration rate increases with use. Moreover, product quality control monitoring measures are not followed.

# 2.5. SODIS (SOLAR DISINFECTION)

## 2.5.1. SODIS BACKGROUND

SODIS is the process of disinfecting water using solar energy. EAWAG-SANDEC, a Swiss research institution, began comprehensive laboratory and field tests in 1991. Since then, they have engaged in providing information, technical support and advice to local institutions in developing countries for the promotion and dissemination of SODIS in more than 20 countries. SODIS is well documented on the website www.sodis.ch.

SODIS implementation in Indonesia was initiated by Yayasan Dian Desa (a NGO based in Yogyakarta) with support from EAWAG-SANDEC. Unfortunately, the application of this energy and cost effective technology has not yet been well established in Indonesia. Nonetheless, disseminating SODIS practice remains a worthwhile endeavor, particularly for Jakarta scavenger communities.

## 2.5.2. SODIS TECHNOLOGY

SODIS uses solar energy to disinfect water in 0.3 – 3.0L UV-A transparent bottles. The UV-A light is the most important component for the inaction of pathogens causing diarrhea. The water temperature plays a secondary role and becomes effective only at temperatures above 42°C. Painting bottles half-black will raise water temperatures by about 5°C; thus, painting bottles is only worthwhile if the water temperature in non-painted bottles is around 37°C. If transparent bottles are used, UV-A radiation is optimized even if the water temperature does not exceed 40°C because the main disinfecting effect from the sun is the **UV-A radiation** (Meierhofer 2006).

Transparent PET-bottles may be used provided they are not scratched or damaged, which would inhibit UV-A radiation from effectively treating the water. (Turbidity also inhibits effectiveness, so water with turbidity <5 NTU is required.[5]) The **transparency of plastic bottles** will decrease with ware, which determines the life of the bottle. Hence, users must judge the life of their bottles, which may be anywhere from one to five months. Users must

5 It is not necessary for users to test the turbidity of their water since water >5 NTU looks unclear and users inherently know to filter their water through a cloth prior to treating it. In no cases during this research did pre-treatment waters have >5 NTU.

also know how to adjust the recommended exposure time (five to six hours of strong sunshine) for cloudy weather. These somewhat subjective judgments add complexity to this simple technology.

Since the treated water is stored in the bottle it is treated in, the risk of recontamination is reduced. The bottles used must be cleaned thoroughly between each treatment, and then filled completely full to minimize air pockets/bubbles. Bottles should be placed in **direct sunshine** away from wind and shade, and as learned in practice, out of reach of playful children. Roofs, sand, metal sheeting, or other open surfaces that get hot are appropriate. Note that SODIS cannot be practiced on days of continuous rainfall.

Using water stored in used PET-bottles exposed to extreme conditions has raised concerns about possible carcinogenic risks due to chemical migration (Lilya 2001). Eawag/Sandec in collaboration with the Swiss Federal Laboratories for Materials Testing and Research, studied the migration of organic components DEHA and DEHP from new and used bottles in Honduras, Nepal and Switzerland, which were subject to the extreme conditions of SODIS. Levels of DEHA and DEHP plasticizers detected were in the range of background levels detected in pure water stored in glass bottles. Such low concentrations of DEHA and DEHP are distinctly below the WHO guidelines for drinking water quality (Kohler 2003).

### 2.5.3. SODIS PERCEPTION

Solar disinfection of water is a new concept for Jakarta's poor communities. For that reason, locals were unable to offer their perception of SODIS. However, SODIS has been implemented through Yayasan Dian Desa in Yogyakarta, Java. This work was not as successful as hoped since users drink primarily tea and coffee, which they boil their water to make anyway.

Nevertheless, Helena Susana learned of SODIS through Yayasan Dian Desa's work, and founded Yayasan Masyarakat Peduli, in Selong, Lombok. SODIS has been somewhat successful in several villages and schools around east Lombok. Some of the locals living in the villages where SODIS has succeeded believe it is healthier not to boil their water because it is better to drink *"living water."* (SODIS-treated water is, under that logic, considered "living water.")

### 2.5.4. SODIS LIMITATIONS

Major limiting factors to SODIS are the **climate** and the user training. During the rainy season in Jakarta, more attention must be taken to ensure bottles are exposed to the sun for the proper amount of time. Training users how to judge proper exposure time is crucial when, for example, users must decide how much longer to leave their bottles out during cloudy weather. Ensuring bottles are placed away from shade and wind is another fundamental decision **well trained users** will be better prepared to make.

Furthermore, judging the life of the bottles is also a somewhat **subjective decision** users must be trained to make. Specifications on bottle-life are not defined since that is a function of the bottle used, its' original condition, and ware over time. The effectiveness of SODIS treatment decreases as bottles are worn and scratched; hence, it is important users are well trained to make such judgment calls.

Finding suitable bottles for SODIS and the regular cleaning of them is **time consuming**. Users may have 10 bottles to clean and refill everyday, depending on the size of their family. The time needed to manage the bottles may also limit the acceptability of SODIS in practice.

# 3. COMPARISONS OF TECHNOLOGIES

Each of the technologies discussed has different advantages, no one technology is best for everyone, rather the most appropriate technology for the user depends on a number of factors. The user might live next door to an *isi-ulang* station so transport costs are not incurred. Saving time may be more of a priority than added cost of fuel to some users. In any case, it is useful to compare these household water treatment alternatives with respect to cost, availability, acceptability, simplicity, and recontamination concerns. Table 3.1 summarizes a general comparison of these concerns, which are discussed in detail in the following sections.

**Table 3-1 General Comparison of Point-of-Use Water Technology Concerns for Jakarta.**

| | Cost | Availability | Acceptability | Simplicity | Recontamination |
|---|---|---|---|---|---|
| **Boiling** | -- | ++ | ++ | - | -- |
| **Isi Ulang** | -- | + | -/+ | ++ | + |
| **Chlorination** | + | - | - | + | -/+ |
| **Ceramic Filter** | -/+ | -- | + | ++ | + |
| **SODIS** | ++ | + | -/+ | -- | + |

## 3.1. COST COMPARISON

Cost is a major determining factor in the users' choice of water treatment alternatives, and is the reason only low-cost treatments were considered for this study. Breakdowns of cost estimates for the different low-cost treatments discussed follow and are summarized in Table 3.2. Note that the costs of the water *treatments* are calculated independent of the cost of buying the water, containers/dispensers, and cleaning materials.

**Table 3-2 Household Water Treatment Alternatives: Cost Comparison.**

| Treatment | Cost (Rp./L) |
|---|---|
| Boiling | 128 |
| *Isi Ulang* | 108† |
| Chlorination | 7 |
| Ceramic Filtration | 16‡ |
| SODIS | 0 |

† This price does not include the fixed cost of Rp.50/L for the water treated.
‡ Despite the low normalized cost, the capital cost remains a concern for users.

To estimate a preliminary value for the current cost of **boiling** water, calculations were based on Care International – Indonesia's 2004 study. Fuel costs were said to amount to Rp.500 to boil 10L water at a rate of Rp.1.100/L fuel. Assuming Care International's ratio is correct, at the current fuel rate of Rp.2.800/L families are currently paying about Rp.128 to boil 1L of water. More comprehensive data with regards to fuel used explicitly for boiling water was collected in this field study to confirm the validity of this calculation.

***Isi-ulang*** water is sold by the "gallon" (19L) for Rp.3.000, and untreated water is typically sold by the "jerry" (20L) for Rp.1.000. So, 1L of *isi-ulang* water costs Rp.158, and 1L of untreated water costs Rp.50. The difference between the two, Rp.108/L, gives the value estimated for *isi-ulang* treatment cost. Note however, that some get there water for free (i.e. from a local well or stolen from PDAM distribution system) so the incurred price of the water is an added cost. Also, the initial "gallon" container cost is Rp.30.000, though refundable upon return.

Assuming Air RahMat is used to for point-of-use water **chlorination**, users pay Rp.4.000/bottle to treat 600L. Thus, the cost of treating 1L of water with Air RahMat is approximately Rp.7. Note that in many cases, an initial purchase of a proper storage container/dispenser must also be considered.

The Plered **ceramic filter** cost is Rp.150.000 per unit, which is said to treat 15L per day and last for 2 years. Assuming 1day a week the filter is not used, to account for cleaning or other reasons, leaves 626 days of potential operation over a 2 year period. Hence, an estimated 9.390L could be treated over the filter lifetime. Normalizing that figure with the filter unit cost amounts to Rp.16 to treat 1L of water. However, cost remains a significant consideration as most are deterred from the capital cost.

The treatment cost for **SODIS** is virtually free, depending on the water bottles used. New 1.5L Aqua bottles cost Rp.2.500, but considering the immediate audiences of users are scavengers, used bottles will likely be reclaimed rather than purchasing new bottles. 1kg of plastic bottles (approximately 100 empty bottles) can be sold for Rp.1.000, which amounts to Rp.10 per bottle. Note that many of the plastic bottles scavenged will be unusable because of scratches. The useable bottles will ware within an estimated 3 months of use and need to be replaced. Yet, worn bottles are still eligible for sell to recyclers later; hence, the bottle cost is negligible aside from the time expense.

## 3.2. AVAILABILITY COMPARISON

The availability of the technology to the user is obviously a decisive factor. Each of the technologies discussed would not have been included if they were not available or potentially available to the users. "Infrastructure" for **boiling** treatment already exists in almost every household kitchen. ***Isi-ulang*** vendor stations are extensively established so use is not limited by availability either. Conversely, **ceramic filters** and **chlorine** additives are not as readily available to users. This is chiefly due to a lack of local production in the case of ceramic filters, and underdeveloped distribution markets and awareness & education around both technologies. Awareness & education around **SODIS** is also lacking, however, plastic bottles are abundantly available.

## 3.3. ACCEPTABILITY COMPARISON

For years Indonesians have **boiled** their drinking water and feel assured about the quality of boiled water. Though ***isi-ulang*** has become a relatively common practice, it still lacks the stronghold in acceptance that boiling holds. This highlights a key challenge in introducing different water treatments alternatives.

Despite reasoning presented, getting people to put into practice different water treatments than they are accustomed is a definite hurdle and will take persistent work to make such changes in behavior. Nonetheless, chlorination, ceramic filtration, and SODIS are each feasible treatment alternatives provided respective education regarding these technologies is effective. Educating users of the advantages of residual **chlorine** for example, is crucial in overcoming taste & odor issues typically unaccepted by Indonesians. **Ceramic filtration** acceptability is promising, with the only foreseeable impediment being the capital cost. Acceptance of **SODIS** is again a matter of education, and of practice.

# 3.4. SIMPLICITY COMPARISON

Each of the household water treatment alternatives discussed are included in this study because they are simple technologies. Some however, are more involved than others. **Boiling** water requires supervision in operation of the stove and ensuring the water is brought to a rolling boil for 1min. The storage container must also be cleaned properly to keep the treated water. The ***isi-ulang*** option is simply a refill method, so transporting the "gallon" and ensuring a properly cleaned container and dispenser (if available) are the main effort aspects. As for **chlorination**, after determining the volume of the water container, the chlorine dosing is straightforward. **Ceramic filtration** is likely the easiest of all to operate, with maintenance merely pertaining to periodic cleaning. Of the five alternatives discussed, **SODIS** is most demanding since weather changes and bottle care must be routinely taken into account.

# 3.5. RECONTAMINATION COMPARISON

The issue of recontamination is one of hygiene, not of treatment technology, yet the two matters are innately related. **Ceramic filtration** has the inherent advantage of safe storage where the treated water is directly collected into a dispenser container. ***Isi-ulang*** also has the added benefit of treated water delivered from the bottlenecked storage "gallon." (The bottleneck feature prevents users dipping cups into the treated water for example, hence, minimizes vectors of recontamination.) Similarly, recontamination is minimized with **SODIS** as well, where water is stored in the bottle it was treated in and is directly dispensed.

Water **chlorination** does not have an inherent proper storage system, although chlorine residuals help to combat recontamination. The treated water must however, be kept in a closed container until dispensed to consume. Likewise, boiled water lacks an intrinsic safe storage system. Though with all of the viable technologies, improper cleaning of containers, dispensers, etc. opens the chances for recontamination, this is especially pronounced in the case of **boiling** as water is typically cooled and transferred into a container that it was not treated in.

# 4. BENCH-SCALE INVESTIGATION

## 4.1. INTRODUCTION

Prior to implementing the alternative household drinking water treatments with communities for a field trial, it was important to investigate SODIS and ceramic filtration practice in Jakarta at bench-scale**.** SODIS feasibility under local conditions had not been established, and Plered Ceramic Filter viability remained unconfirmed. Chlorination is an established water disinfection practice, so there was no reason to prove the validity of that treatment at bench-scale. Also, water qualities from boiling and *isi-ulang* users in Jakarta have been previously studied.

It was important to show an effective removal of fecal coliform (FC) from both Plered Ceramic Filters and SODIS conducted in Jakarta. Therefore, it was imperative that the starting water quality contain 200 to 300 FC/100mL (maximum method detection limit) with turbidity <5 NTU (stipulated for effective treatment of most water technologies). Raw waters were collected from a shallow groundwater well in Bintaro Lama on 6 April 2006 (Figure 4.1) and from a stored tap water container in Teluk Gong on 11 April 2006 (Figure 4.2) to use for this experiment. These water sample contamination levels were within the ideal FC range for this experiment, so fortunately, creating a stock solution in the laboratory was unnecessary.

**Figure 4-1 Shared Well at Bintaro Lama.**

**Figure 4-2 Collecting Stored PDAM Sample.**

SODIS water samples were collected directly into 12 PET-bottles that were each rinsed 7 times with the sample water before filling them. At the same time, a 20L jerry-can was similarly rinsed and filled to use for the concurrent ceramic filtration experiment. Both the SODIS and ceramic filtration experiments commenced at 06:00 the morning after each of the respective collections. At that time, a sample was taken from the jerry-can, which served as the initial water quality measurement for both the SODIS and ceramic filter experiments.

# 4.2. SODIS BENCH-SCALE INVESTIGATION

The objectives of this investigation were to confirm that **SODIS** is **effective in Jakarta's climate** in local PET-bottles, and to decipher any significant differences between placing the bottles on a black cloth and using a windbreak, or not. The PET-bottles used were 1.5L Aqua® bottles that were spray-painted black on one half. Two tests were run (one with Bintaro Lama water and the other with Teluk Gong water), and each test had 12 bottles that were divided into two batches of six. For each test, the bottles were set atop zinc sheeting and run in parallel; one batch (A – optimized) on top of a black cloth and in a windbreak, and the other batch (B) without (see Figure 4.3).

**Figure 4-3 SODIS Bench-Scale Experiment in Jakarta**

The reason each batch consisted of six bottles was to discount for changes due to decrease in volume from sampling; 300mL had to be taken at each sample time. The temperatures of each of the bottles were measured at each time to confirm alike conditions. The maximum temperature differences from the average batch temperatures are shown in Table 4.1. The bottles that had been sampled from were not included in the average batch temperature or the **maximum temperature difference** calculations because of plausible temperature variations due to testing. Note that all of the bottles were at no point in the shade during the experiment.

.

**Table 4-1 Maximum Temperature Differences from the Average Batch Temperatures**

| (±°C) | Bintaro Lama water | | Teluk Gong water | |
|---|---|---|---|---|
| | A | B | A | B |
| **6:00** | 0.1 | 0.1 | 0.1 | 0.2 |
| **9:00** | 1.5 | 0.6 | 0.9 | 0.6 |
| **12:00** | 0.8 | 1.0 | 0.7 | 0.9 |
| **15:00** | 0.5 | 0.6 | 0.7 | 1.3 |
| **18:00** | 0.5 | 0.3 | 0.2 | 0.2 |
| **6:00 +1** | 0.2 | 0.2 | 0.0 | 0.2 |
| **12:00 +1** | - | - | 0.1 | 0.2 |
| **18:00 +1** | 0.1 | 0.1 | 0.2 | 0.1 |
| **6:00 +2** | 0.0 | 0.1 | 0.1 | 0.1 |
| **average** | **0.5** | **0.4** | **0.3** | **0.4** |

From this data it is apparent that the bottles within each batch were tested under similar conditions and can be considered **representative of each other**. The average temperature difference between bottles in the same batch was ±0.4°C, with the maximum difference from the average batch temperature recorded 1.5°C (from the 09:00 Bintaro Lama water A-optimized batch). Individual bottle temperature measurements, along with detailed water quality data gathered for this bench-scale SODIS experiment, are given in Annex 2.

Bottles in each batch were labeled 1 to 6, where bottles 1 were in the bottom right corners of the zinc sheets in Figure 4.3, bottles 2 were directly to the left of bottles 1, bottles 3 beneath bottles 1, bottles 4 to the left of bottles 3, and so on. Temperature and water quality testing were conducted sequentially. After each water test was completed, the 300mL used was poured back into the bottle and returned to its' original spot. This was done only to minimize any variation from environmental factors, so the tested bottles simply served as place-holders. Note that bottles 6 were never sampled from.

Tables 4.2 and 4.3 show the resulting total fecal coliform concentrations over time. The Bintaro Lama water test results given in Table 4.2 confirm an effective removal rate of 100% after 6hrs of exposure. This was the trend expected, and indicates **SODIS is a feasible alternative for water disinfection in Jakarta**. However, the Teluk Gong water test results given in Table 4.3 raise questions as to whether growth and/or re-growth within the bottles possible. These issues were brought up in the Hygiene Improvement Project Conference (HIP 2006), and from communication with Regula Meierhofer and Kevin McGuigan, the most logically explanation for these results was determined to be experimental error. Hence, SODIS remains a promising option, and water quality in pilot applications will be closely monitored.

**Table 4-2 Bintaro Lama Water SODIS Bench-Scale Water Quality Results**

| Time | A (FC/100mL) | B (FC/100mL) |
|---|---|---|
| **6:00** | 260 | 260 |
| **9:00** | 14 | 22 |
| **12:00** | 0 | 0 |
| **18:00** | 0 | 0 |
| **6:00 +1** | 0 | 0 |
| **6:00 +2** | 0 | 0 |

**Table 4-3 Teluk Gong Water SODIS Bench-Scale Water Quality**

| Time | A (FC/100mL) | B (FC/100mL) |
|---|---|---|
| **6:00** | 16 | 16 |
| **9:00** | 56 | 32 |
| **12:00** | 0 | 0 |
| **18:00** | 0 | 0 |
| **6:00 +1** | 0 | 0 |
| **6:00 +2** | 4 | 0 |

Figures 4.4 and 4.5 compare the average temperature measurements for both batches in the Bintaro Lama and Teluk Gong water experiments respectively. The highest average water temperatures achieved were on 7 April 2006 (Bintaro Lama experiment) at 57.0°C and on 12 April 2006 (Teluk Gong experiment) at 59.6°C. Both measurements were from bottles in Batch A (under optimum parameters); with their respective Batch B average temperatures 4.9°C and 4.4°C lower. Hence, although found not to be essential, users were advised to place bottles atop a black cloth and in a wind-break setting if possible.

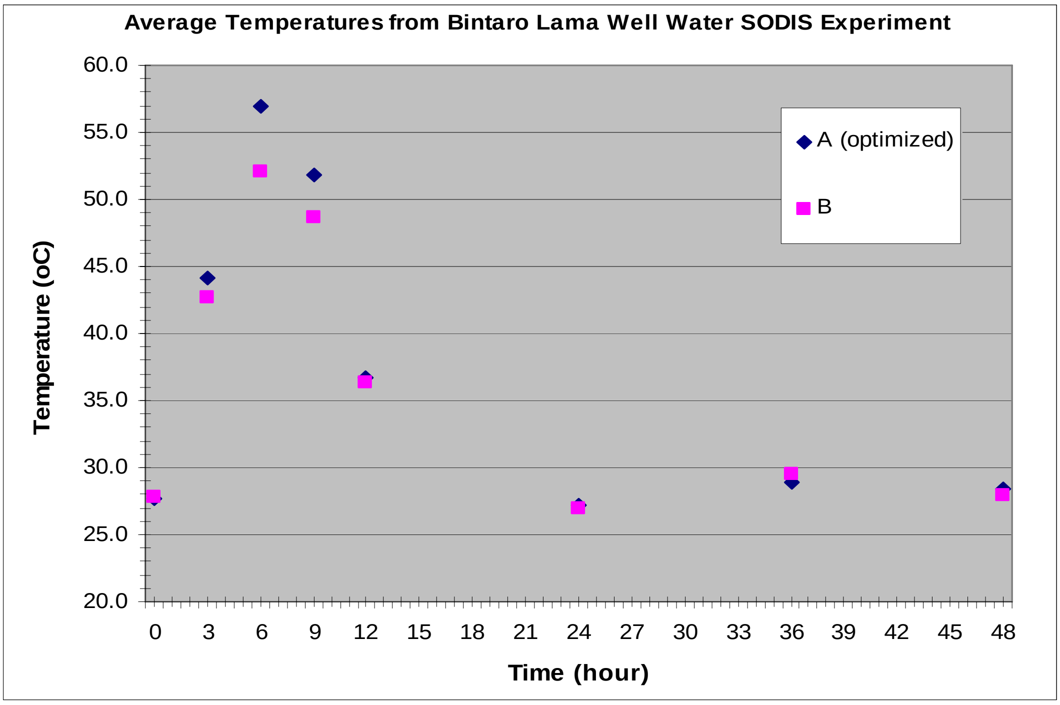


**Figure 4-4 Bintaro Lama Water SODIS Temperature Monitoring Bench-Scale Results.**

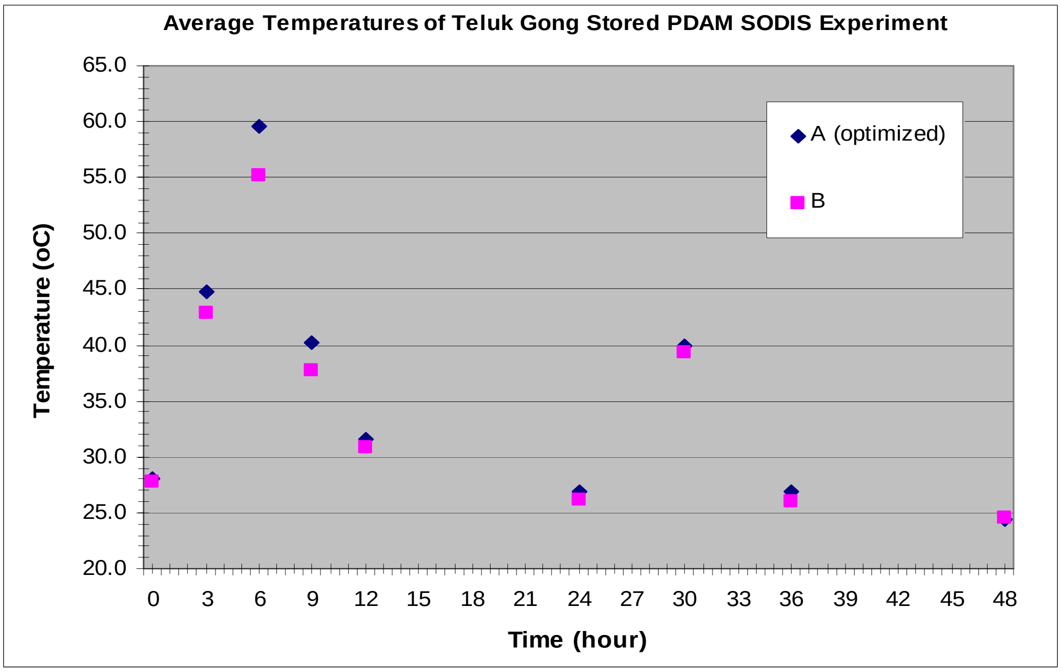


**Figure 4-5 Teluk Gong Water SODIS Temperature Monitoring Bench-Scale Results.**

Though the mid-day temperature during the second day of the Bintaro Lama experiment was not measured, there was a 19.6°C difference between the maximum average temperatures in the consecutive days of the Teluk Gong experiment recorded at 12:00. Note that it rained both afternoons. This highlights the flux of day to day maximum temperatures in Jakarta.

# 4.3. CERAMIC FILTRATION BENCH-SCALE INVESTIGATION

The objective of this investigation was to confirm the data provided by Plered Filter, and independently **determine filter effectiveness**. Primarily, investigate the effective removal of fecal coliform (FC) and the total inorganics. The data provided by Plered Filter states fecal coliform removal to <2 FC/100mL, whereas U.S. EPA stipulates fecal coliform content of drinking water to be 0 FC/100mL. Along with investigating the FC removal, it is important to address inorganic constituent removal.

**Figure 4-6 Plered Ceramic Filtration System.**

The cheapest filtration system made by Plered Filter was used since the target audiences opt for the most economical treatment option. Figure 4.6 shows the type of Plered Filter system used throughout this study.

To visualize the path of the water through the filter, the filter element was removed, submerged underwater, and air was blown in from the base outlet (as recommended by Ron Rivera from Potters for Peace). As shown in Figure 4.7, bubbles escaped from around the perimeter of the base, indicating the water is not filtering through the main body of the filter element. Still, the average of six filtration rates measured was 0.5 L/hour, which was much slower than the expected 1-2.5 L/hour. The determined Plered Ceramic filtration rate correlates to a **possible 12L filtered per day**. (The capacity of the upper receptacle is 16 L.)

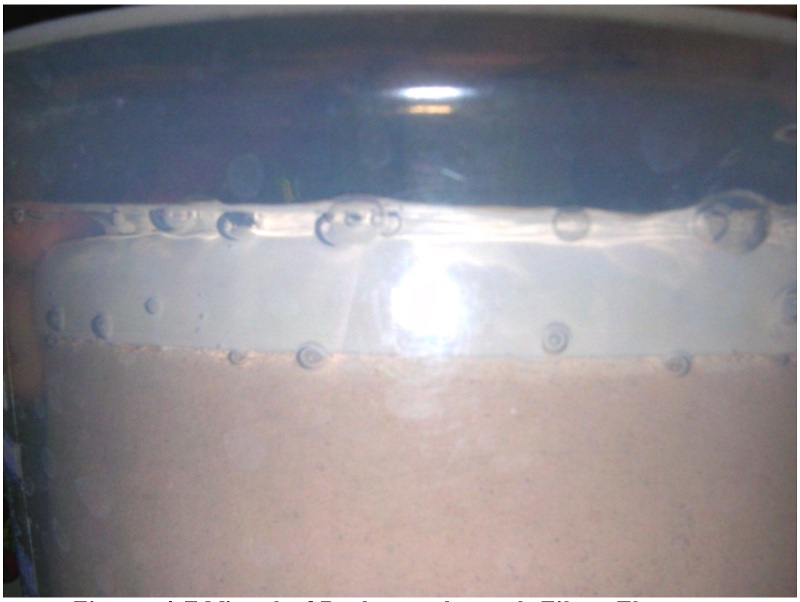

**Figure 4-7 Visual of Pathway through Filter Element.**

Nevertheless, to make further conclusions on the integrity of the filters with respect to water quality, water from Bintaro Lama and water from Teluk Gong were tested. The same filter was used to conduct both tests. The starting water qualities, the filtered water qualities, as well as that of the filtered waters filtered a second time, were analyzed. Table 4.4 shows the results of fecal coliform measurements of Bintaro Lama and Teluk Gong waters. Results show **effective total FC removal after one filtration**.

**Table 4-4 Fecal Coliform Content of Pre-filtered, Filtered and Re-filtered Water.**

| (FC/100mL) | Bintaro Lama water | Teluk Gong water |
|---|---|---|
| **Before filtration** | 260 | 16 |
| **Filtered once** | 0 | 0 |
| **Filtered twice** | 0 | 0 |

Chemical analysis at each of the six water stages, plus one duplicate, was conducted by PT. Unilab Perdana. The results from the Bintaro Lama water analysis are given in Table 4.5, along with maximum contaminant levels (MCL) issued by the Indonesian Health Ministry. Notice that the iron content in the unfiltered water is almost 4 times higher than the MCL, yet after one filtration, iron was removed effectively below the MCL. TSS, Ca, Mg, and TDS levels decreased after filtration to a lesser degree. Note that constituent levels changed more significantly after the first filtration than the second.

**Table 4-5 Inorganic Content of Pre-filtered, Filtered and Re-filtered Bintaro Lama Water.**

| | **MCL** | **Bintaro Lama water pre-filtered** | **Bintaro Lama water filtered** | **Bintaro Lama water re-filtered** |
|---|---|---|---|---|
| **Parameter** | (mg/L) | 7-Apr-06 | 8-Apr-06 | 9-Apr-06 |
| **TDS** | **1000** | *246* | *244* | *244* |
| **TSS** | **n/a** | *14* | *5* | *3* |
| **Ag** | **0.05** | <0.002 | <0.002 | <0.002 |
| **Hg** | **0.001** | <0.0005 | <0.0005 | <0.0005 |
| **As** | **0.01** | <0.005 | <0.005 | <0.005 |
| **Fe** | **0.3** | ***1.15*** | *0.10* | *<0.06* |
| **Cd** | **0.003** | <0.003 | <0.003 | <0.003 |
| **Cr** | **0.05** | <0.02 | <0.02 | <0.02 |
| **Zn** | **3** | 0.12 | 0.11 | 0.12 |
| **Cu** | **2** | <0.02 | <0.02 | <0.02 |
| **Pb** | **0.01** | <0.01 | <0.01 | <0.01 |
| **Ca** | **n/a** | *44.39* | *37.07* | *37.56* |
| **Mg** | **n/a** | *13.25* | *11.57* | *11.23* |
| **Al** | **0.2** | <0.2 | <0.2 | <0.2 |

The results of the Teluk Gong water analysis are given in Table 4.6, also with the Indonesian government-issued MCL included. A replication of the unfiltered water was tested to confirm the precision of the analysis. Results show no major differences between replicated results. A slight decrease in Ca, TDS and TSS levels from Teluk Gong water were found after filtration, but generally, not much notable change in inorganic content levels as a function of filtration. Had initial constituent levels been higher, removal effectiveness may have been pronounced.

**Table 4-6 Inorganic Content of Pre-filtered, Filtered and Re-filtered Teluk Gong Water.**

| | **MCL** | **Teluk Gong water unfiltered** | **Teluk Gong water unfiltered (replicate)** | **Teluk Gong water filtered** | **Teluk Gong water re-filtered** |
|---|---|---|---|---|---|
| **Parameter** | (mg/L) | 12-Apr-06 | 12-Apr-06 | 13-Apr-06 | 14-Apr-06 |
| **TDS** | **1000** | *215* | *215* | *212* | *210* |
| **TSS** | **n/a** | ***5*** | ***4*** | 3 | 3 |
| **Ag** | **0.05** | <0.002 | <0.002 | <0.002 | <0.002 |
| **Hg** | **0.001** | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| **As** | **0.01** | <0.005 | <0.005 | <0.005 | <0.005 |
| **Fe** | **0.3** | *0.10* | *0.10* | *<0.06* | *0.10* |
| **Cd** | **0.003** | <0.003 | <0.003 | <0.003 | <0.003 |
| **Cr** | **0.05** | <0.02 | <0.02 | <0.02 | <0.02 |
| **Zn** | **3** | ***0.12*** | ***0.09*** | *0.09* | *0.11* |
| **Cu** | **2** | <0.02 | <0.02 | <0.02 | <0.02 |
| **Pb** | **0.01** | <0.01 | <0.01 | <0.01 | <0.01 |
| **Ca** | **n/a** | ***29.27*** | ***28.29*** | 27.32 | 27.19 |
| **Mg** | **n/a** | ***4.56*** | ***5.20*** | 5.08 | 4.86 |
| **Al** | **0.2** | <0.2 | <0.2 | <0.2 | <0.2 |

Since the filter elements are impregnated with colloidal silver, the silver content in the treated water was of interest. In all cases measured for this study, **silver content was below the MCL**.

From these bench-scale results, **inorganic water quality after filtration is adequate**. Whether this conclusion holds true through the duration of the 2 year filter-life as claimed by Plered, was not part of this investigation.

# 5. PILOT-SCALE INVESTIGATION

## 5.1. INTRODUCTION

Implementing the point-of-use alternatives with underprivileged households around Jakarta requires a considerable amount of time spent building relations and trust. Hence, it made sense to collaborate with Yayasan Emmanuel (YE) Water Program who has existing relations with several slum communities around Jakarta through their aid work over the past 3 years. An additional benefit to this collaboration was ensuring continued monitoring of the point-of-use projects implemented after this study is completed. For these reasons, Bintaro Baru, Bintaro Lama, Teluk Gong, and Tanjung Priok, which are all communities in different areas of Jakarta that YE Water Program works with, were chosen as those most appropriate for this investigation.

A total of three campaigns in each of the four communities were conducted during this study. Each campaign was presented to community members at large and lasted approximately one hour. Active campaign participation was encouraged by periodically asking the audience related questions and rewarding correct answerers with small prizes such as soap, for example. Similar campaign forums are regularly conducted by YE, and the point-of-use campaigns were fit into the usual schedule.

The first was a Water Handling & Hygiene Campaign, to explain to the communities reasons why water handling & hygiene are important as well as implications of improper practices. This served as an important precursor to implementing alternative water disinfection methods. The objective of this first campaign was to build an understanding of proper water handling & hygiene and the significance of water disinfection, as a lead-in to the following campaign.

In the second, Point-of-Use Water Treatment Alternatives Campaign, attendees were introduced to the different alternative point-of-use water treatments. Attendees then ranked their treatment preferences at that time. Afterwards, volunteers to try one of each of the treatment alternatives were assigned, and visits to each of the individual volunteers' households were made to set-up and re-explain the treatment method on a more personal basis. For the following month, each volunteer from all of the four communities was visited weekly. User feedback and water quality was monitored during that period.

After a month of monitoring the volunteer participants using the different alternative point-of-use treatments in the four communities, a follow-up campaign was conducted where the users shared their credited opinions on the water treatment they used. This was done in conjunction with the dissemination of the water quality results, inclusive of those from all four communities. Assistance to other community members consequently interested in pursuing alternative point-of-use treatments will be undertaken by YE Water Program in addition to further monitoring.

# 5.2. RESULTS

This section includes results of the pilot-study conducted in Bintaro Lama, Bintaro Baru, Teluk Gong, and Tanjung Priok communities. First reported are the campaign attendees' rankings after introducing the alternative point-of-use water treatments. Water quality data from the month-long study of boiling, *isi ulang*, chlorination, ceramic filtration, and SODIS technologies follow. Detailed water quality data is included in Annex 3. Lastly reported in this section are the campaign attendees' rankings after presenting results of the alternative point-of-use treatment pilot-study.

## 5.2.1. COMMUNITY TECHNOLOGY RANKING PRE-TRIAL

Attendees of the Point-of-Use Water Treatment Alternatives Campaign in each of the four communities involved in this pilot-study were asked to rank the explained technologies 1 (most preferred) to 5 (least preferred). Photos from each of the campaigns and the individual ranking data are given in Annex 4.

Table 5.1 summarizes the points allocated by individual scoring[6], and shows the overall distribution of ranking-scores. From the hundred attendees surveyed**, boiling is the most preferred** at 25.5%. Ceramic filtration, chlorination and SODIS, at 20.6%, 19.1% and 18.0% respectively, were sequentially preferred, and *isi-ulang* least at 16.8%.

**Table 5-1 Summary of Pre-Trial Rankings by Campaign Attendees.**

| | Boiling | Ceramic Filtration | Chlorination | SODIS | Isi Ulang | # of attendees |
|---|---|---|---|---|---|---|
| **Bintaro Lama** | 39 | 40 | 22 | 18 | 31 | 15 |
| **Bintaro Baru** | 67 | 60 | 48 | 17 | 38 | 23 |
| **Teluk Gong** | 82 | 61 | 72 | 73 | 52 | 34 |
| **Tanjung Priok** | 67 | 45 | 49 | 72 | 47 | 28 |
| Overall | **25.5%** | **20.6%** | **19.1%** | **18.0%** | **16.8%** | **100** |
| **RANKING** | **1** | **2** | **3** | **4** | **5** | |

Although only slightly, it is noteworthy to highlight that in Bintaro Lama, ceramic filtration was ranked higher than (albeit almost the same as) boiling as the overall most preferred technology. SODIS was ranked first in Tanjung Priok and last in Bintaro Baru. This variability is likely a function of the presentation and explanation of the technologies.

Table 5.2 shows the same data in terms of summarizing the attendees' first-choices, that is, the technology they ranked 1. **Boiling stands out at 44.0% as the prominently preferred** point-of-use technology of the five. Only 7.0% of the 100 attendees ranked *isi-ulang* as their most preferred technology. This spread was not as defined from the first data analysis and is thought to indicate which technology is most trusted. Also made apparent from this analysis is that SODIS was more often ranked first than chlorination, even though its' overall ranking was slightly lower. This may be in part attributed to curiosity of SODIS treatment.

6 The sum of the points allocated for the vote of each technology was subtracted from the total points possible (5 multiplied by the number of voters) so that most preferred is represented by the highest rather than lowest number in the tables reported.

**Table 5-2 Summary of Pre-Trial Campaign Attendees' First-Choices.**

| | Boiling | Ceramic Filtration | SODIS | Chlorination | Isi Ulang | # of attendees |
|---|---|---|---|---|---|---|
| **Bintaro Lama** | 6 | 7 | 0 | 2 | 0 | 15 |
| **Bintaro Baru** | 12 | 7 | 0 | 0 | 4 | 23 |
| **Teluk Gong** | 12 | 5 | 11 | 5 | 1 | 34 |
| **Tanjung Priok** | 14 | 1 | 6 | 5 | 2 | 28 |
| Overall | **44.0%** | **20.0%** | **17.0%** | **12.0%** | **7.0%** | **100** |
| **TOP PICK** | **1** | **2** | **3** | **4** | **5** | |

## 5.2.2. BOILING

**Determining the Cost of Boiling Drinking Water**

Four stoves were procured to use in the pilot-study in order to monitor the boiled water quality while **quantifying fuel costs directly related to boiling drinking water**. One stove was given to one family in each of the four communities, along with a 1L container for fuel, and a calendar and pen to mark the days they bought 1L of fuel. It was made clear with each family, while setting up the stove in their home, that the new stove was to be used for boiling water only. It was also made clear that the stoves were not being donated, rather loaned for the duration of the pilot-study. Nevertheless, at the end of the study they were left with the volunteers as gifts for participating.

To **calculate the cost of boiling 1L of water**, the number of family members, cost of kerosene in their location, and volume of kerosene used over a certain number of days monitored were gathered for the volunteer in each of the communities. Sometimes, the number of family members drinking boiled water changed because, for example, the husband in the participating Tanjung Priok family works on a two-weeks-away, one-week-home rotation. Or in the case of Bintaro Lama, there was a community project during 2 weeks of this study so the community leader supplied free drinking water, plus, the baby got sick the last week so the mother took the children back to their home village. Hence, the number of family members using boiled water was adjusted accordingly*.

It was **assumed that each family member uses 1.5L of boiled water daily**. Using the aforementioned data collected along with this assumption, the cost of boiling 1L of water was calculated. From this work it was found that the **cost of boiling 1L of water ranges from Rp.77 to Rp.190**, with an **average cost of Rp.149/L**. Hence, the pre-calculated value determined, Rp.128/L, served as a reasonable estimation. Table 5.3 summarizes the actual data results relevant to the field tests discussed.

**Table 5-3 Results of Boiled Water Quality Monitoring with Volume/Person Assumption.**

| | Rp./L of kerosene | Family members | Days monitored | Total volume kerosene used | Rp./L of boiled water |
|---|---|---|---|---|---|
| **Bintaro Lama** | 2,800 | 1* | 36 | 3 | **156** |
| **Bintaro Baru** | 2,800 | 3 | 36 | 10 | **173** |
| **Teluk Gong** | 3,000 | 3 | 35 | 10 | **190** |
| **Tanjung Priok** | 2,700 | 4* | 35 | 6 | **77** |

These experiments exemplify the variability in the cost of boiling water; namely, the **variable boiling times**. This variability remains evident even after the first two campaigns as well as the household visits, where users were all told and reminded that water should be kept at a rolling boil for one minute. Variability due to stove efficiency, which decreases when stoves are not maintained properly, is not a factor since each of the participants was given the same new stove.

### Boiled Water Quality Data

A summary of the weekly monitoring of total fecal coliform contamination in the boiled water from users in each of the four communities is given in Table 5.4. Low risk of fecal coliform contamination was found from each of the boiled waters during Week 1. After one-on-one user discussions regarding water handling & hygiene measures, **water disinfection improved to 0 FC/100mL.** The exception is the 1 FC/100mL found in Week 3 in Bintaro Baru.

**Table 5-4 Results of Boiled Water Quality Monitoring May 2006.**

| (FC/100mL) | Week 1 | Week 2 | Week 3 | Week 4 |
|---|---|---|---|---|
| **Bintaro Lama** | 3 | 0 | 0 | 0 |
| **Bintaro Baru** | 1 | 0 | 1 | 0 |
| **Teluk Gong** | 1 | 0 | n/a | 0 |
| **Tanjung Priok** | 5 | 0 | n/a | 0 |

Results from inorganic water content analysis of Bintaro Baru water are shown in Table 5.5. An analysis of Aqua® water is included for comparison. The Bintaro Baru water parameter values that differ are italicized; iron content showing the most prominent difference. Take into account that although the samples are from the same source water, they are not measurements from the same sample. Without that consideration, boiling would appear to remove inorganics from the un-evaporated water. There is no evidence to show that boiling concentrates inorganics significantly.

**Table 5-5 Inorganic Water Content Before and After Boiling (mg/L).**

| | **Aqua®** | **Bintaro Baru water UNBOILED** | **Bintaro Baru water BOILED** |
|---|---|---|---|
| **Parameter** | 27-Jan-06 | 22-May-06 | 22-May-06 |
| **TDS** | 135 | *193* | *162* |
| **TSS** | <2 | *13* | *12* |
| **Ag** | - | <0.002 | <0.002 |
| **Hg** | <0.0005 | <0.0005 | <0.0005 |
| **As** | <0.005 | <0.005 | <0.005 |
| **Fe** | <0.06 | ***0.42*** | *<0.06* |
| **Cd** | <0.003 | <0.003 | <0.003 |
| **Cr** | <0.02 | <0.02 | <0.02 |
| **Zn** | 0.04 | *0.14* | *0.11* |
| **Cu** | <0.02 | <0.02 | <0.02 |
| **Pb** | <0.01 | <0.01 | <0.01 |
| **Ca** | 18.4 | *32.92* | *25.54* |
| **Mg** | 8.8 | *8.17* | *6.86* |
| **Al** | <0.2 | <0.2 | <0.2 |

### 5.2.3. ISI-ULANG

The *isi-ulang* waters tested for the pilot-study were all from users, not directly from *isi-ulang* stations. The purpose was to monitor *isi-ulang* water quality at point-of-use, focusing on water handling & hygiene above the disinfection technology itself. Hence, no inorganic content measurements were made for this part of the study. A summary of the weekly monitoring of total fecal coliform contamination in the *isi-ulang* waters tested at point-of-use in each of the four communities is given in Table 5.6. The different patterned-shadings indicate different users.

**Table 5-6 Results of Isi-Ulang Water Quality Monitoring May 2006.**

| (FC/100mL) | Week 1 | Week 2 | Week 3 | Week 4 |
|---|---|---|---|---|
| **Bintaro Lama** | 3 | 1 | 0 | n/a |
| **Bintaro Baru** | 1 | 1 | 0 | 0 |
| **Teluk Gong** | 0 | 0 | 0 | 0 |
| **Tanjung Priok** | 1 | 0 | 0 | 0 |

Bintaro Lama showed low risk at first, then no risk after 3 weeks of one-on-one household discussions impressing the importance of keeping water dispensers and taps clean. By Week 4, Mas Kamsir from Bintaro Lama had switched from *isi-ulang* to chlorination. No change in the level of FC contamination was seen in the first two weeks of monitoring in Bintaro Baru. No risk was detected in *isi-ulang* water from Ibu Tina of Bintaro Baru. Teluk Gong *isi-ulang* water showed no risk of fecal coliform contamination during the monitoring period. Only one of the four *isi-ulang* waters tested at point-of-use in Tanjung Priok indicated low risk (1 FC/100mL), whereas the others indicated no risk.

### 5.2.4. CHLORINATION

The volunteers for this chlorination pilot-study were each given two 5L jerry-cans and two bottles of Air RahMat. The first bottle of Air RahMat was given after explanation with the users in their households', and the second was given after Week 2. A summary of the weekly monitoring of total fecal coliform contamination in the chlorinated waters from the participants in each of the four communities is given in Table 5.7.

**Table 5-7 Results of Chlorination Water Quality Monitoring May 2006**

| (FC/100mL) | Week 1 | Week 2 | Week 3 | Week 4 |
|---|---|---|---|---|
| **Bintaro Lama** | 0 | 4 | 0 | 0 |
| **Bintaro Baru** | 0 | 0 | 0 | n/a |
| **Teluk Gong** | 0 | 0 | 0 | 0 |
| **Tanjung Priok** | 4 | n/a | 0 | 1 |

There was no risk of fecal coliform contamination evident in the chlorinated waters from Bintaro Baru or Teluk Gong. During Week 2 of monitoring in Bintaro Lama, 4 FC/100mL found (this sample was yellow color). Low risk (4 FC/100mL) was shown in Week 1 and (1 FC/100mL) Week 4 from monitoring results in Tanjung Priok. The detection of fecal coliform is an indication of a starting water quality with a **high chlorine demand**. A high chlorine demand results from high levels of inorganic reducing agents (such as iron) and/organic compounds (Sawyer et al. 1994).

The organic content of the waters was not measured; however, the inorganic content was, and is shown in Table 5.8. Keep in mind that this inorganic data comparison between treated and non-treated is not of the exact same water sample before and after treatment, rather a sample of the same water source used. The chlorinated water sampled was prepared from water taken from the source one or two days prior. This consideration is important when making a comparison of the results.

**Table 5-8 Inorganic Water Content Before and After Chlorination (mg/L).**

| | MCL | Bintaro Lama water | Bintaro Lama water | Bintaro Lama water with Air RahMat | Bintaro Baru water | Bintaro Baru water with Air RahMat |
|---|---|---|---|---|---|---|
| **Parameter** | **(mg/L)** | 7-Apr-06 | 10-May-06 | 10-May-06 | 10-May-06 | 10-May-06 |
| **TDS** | **1000** | *246* | *140* | *163* | *184* | *190* |
| **TSS** | **n/a** | *14* | 5 | 5 | *4* | *10* |
| **Ag** | **0.05** | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| **Hg** | **0.001** | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| **As** | **0.01** | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| **Fe** | **0.3** | ***1.15*** | <0.06 | <0.06 | 0.55 | <0.06 |
| **Cd** | **0.003** | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| **Cr** | **0.05** | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Zn** | **3** | 0.12 | *0.10* | *0.13* | *0.14* | *0.11* |
| **Cu** | **2** | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| **Pb** | **0.01** | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| **Ca** | **n/a** | *44.39* | *11.66* | *14.71* | *15.96* | *17.40* |
| **Mg** | **n/a** | *13.25* | *2.71* | *2.94* | *3.44* | *3.66* |
| **Al** | **0.2** | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |

## 5.2.5. CERAMIC FILTRATION

The volunteers for the ceramic filter pilots were "lent" the filter system and given a cleaning sponge. Each user was given individual instruction on the operation and maintenance of the system in their households. With every participant there was an agreed understanding that the systems were being loaned for the purpose of the pilot-study. At the end of the study, users were given the option to buy the filters for Rp.100,000, in monthly installments (instead of the flat Rp.150,000 market cost).

A summary of the weekly monitoring of total fecal coliform contamination in the filtered waters from each of the four participants is given in Table 5.9. There was **no risk of fecal coliform** contamination evident from the filtered waters, with the exception of the 1 FC/100mL found in Week 1 in Bintaro Lama.

**Table 5-9 Results from Ceramic Filtration Water Quality Monitoring May 2006.**

| (FC/100mL) | Week 1 | Week 2 | Week 3 | Week 4 |
|---|---|---|---|---|
| **Bintaro Lama** | 1 | 0 | n/a | 0 |
| **Bintaro Baru** | 0 | 0 | 0 | 0 |
| **Teluk Gong** | 0 | 0 | 0 | 0 |
| **Tanjung Priok** | 0 | 0 | 0 | 0 |

The inorganic content of the unfiltered and filtered waters in both Teluk Gong and Tanjung Priok were measured on two different dates. Table 5.10 shows the results of the first set of tests. Differences between parameter results are italicized. Only slight differences in total dissolved solids, zinc, calcium, and magnesium resulted. Hence, **no notable impact in inorganic content from ceramic filtration** is evident.

**Table 5-10 Inorganic Water Content Before and After Ceramic Filtration.**

| | (mg/L) | **Teluk Gong water UNFILTERED** | **Teluk Gong water FILTERED** | **Tanjung Priok water UNFILTERED** | **Tanjung Priok water FILTERED** |
|---|---|---|---|---|---|
| **Parameter** | **MCL** | 15-May-06 | 15-May-06 | 12-May-06 | 12-May-06 |
| **TDS** | **1000** | *164* | *169* | *184* | *158* |
| **TSS** | **n/a** | <2 | <2 | <2 | <2 |
| **Ag** | **0.05** | <0.002 | <0.002 | <0.002 | <0.002 |
| **Hg** | **0.001** | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| **As** | **0.01** | <0.005 | <0.005 | <0.005 | <0.005 |
| **Fe** | **0.3** | <0.06 | <0.06 | <0.06 | <0.06 |
| **Cd** | **0.003** | <0.003 | <0.003 | <0.003 | <0.003 |
| **Cr** | **0.05** | <0.02 | <0.02 | <0.02 | <0.02 |
| **Zn** | **3** | *0.07* | *0.08* | *0.07* | *0.08* |
| **Cu** | **2** | <0.02 | <0.02 | <0.02 | <0.02 |
| **Pb** | **0.01** | <0.01 | <0.01 | <0.01 | <0.01 |
| **Ca** | **n/a** | *14.17* | *14.53* | *17.40* | *15.61* |
| **Mg** | **n/a** | *1.44* | *1.40* | *1.60* | *1.32* |
| **Al** | **0.2** | <0.2 | <0.2 | <0.2 | <0.2 |

Table 5.11 is given to compare the consistency of inorganic water quality data from Teluk Gong's unfiltered PDAM water on three different days. Any differences between parameter results are italicized. Results indicate that the TDS, Ca and Mg levels in the PDAM tap water are higher in April than May.

**Table 5-11 Comparison of Inorganic Content Results for Unfiltered Teluk Gong Water.**

| | (mg/L) | **Teluk Gong water unfiltered** | **Teluk Gong water unfiltered (replicate)** | **Teluk Gong water unfiltered** | **Teluk Gong water unfiltered** |
|---|---|---|---|---|---|
| **Parameter** | **MCL** | 12-Apr-06 | 12-Apr-06 | 15-May-06 | 23-May-06 |
| **TDS** | **1000** | *215* | *215* | *164* | *163* |
| **TSS** | **n/a** | *5* | *4* | *<2* | *6* |
| **Ag** | **0.05** | <0.002 | <0.002 | <0.002 | <0.002 |
| **Hg** | **0.001** | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| **As** | **0.01** | <0.005 | <0.005 | <0.005 | <0.005 |
| **Fe** | **0.3** | *0.10* | *0.10* | *<0.06* | *0.10* |
| **Cd** | **0.003** | <0.003 | <0.003 | <0.003 | <0.003 |
| **Cr** | **0.05** | <0.02 | <0.02 | <0.02 | <0.02 |
| **Zn** | **3** | *0.12* | *0.09* | *0.07* | *0.14* |
| **Cu** | **2** | <0.02 | <0.02 | <0.02 | <0.02 |
| **Pb** | **0.01** | <0.01 | <0.01 | <0.01 | <0.01 |
| **Ca** | **n/a** | *29.27* | *28.29* | *14.17* | *14.77* |
| **Mg** | **n/a** | *4.56* | *5.20* | *1.44* | *2.73* |
| **Al** | **0.2** | <0.2 | <0.2 | <0.2 | <0.2 |

### 5.2.6. SODIS

After each of the Point-of-Use Water Treatment Alternatives Campaign, SODIS volunteers where given six 1.5L Aqua® bottles that were painted half black, a bottle scrubber, and a black cloth. Household visits were made thereafter to explain the procedure on a more personal level and to get the first treatment started. This was done so that the users felt more comfortable with this method and choose a proper bottle setting. A summary of the weekly monitoring of total fecal coliform contamination in the SODIS-treated waters from each of the four participants is given in Table 5.12.

**Table 5-12 Summary of Results of SODIS Water Quality Monitoring May 2006.**

| (FC/100mL) | **Week 1** | **Week 2** | **Week 3** | **Week 4** |
|---|---|---|---|---|
| **Bintaro Lama** | 8 | n/a | n/a | 0 |
| **Bintaro Baru** | 3 | 0 | 0 | 0 |
| **Teluk Gong** | 0 | 0 | 0 | 0 |
| **Tanjung Priok** | 0 | 0 | 0 | 0 |

There was **no risk of fecal coliform contamination** evident from any of the Teluk Gong and Tanjung Priok waters sampled. During the first week, Bintaro Lama and Bintaro Baru results indicate low risk due to fecal coliform contamination (8 FC/100mL and 3 FC/100mL respectively). However, thereafter the quality of water increased; no risk was evident from subsequent weekly tests. This is likely attributed to reiterating proper treatment procedures with the users. Note that no samples were available to test during Weeks 2 and 3 in Bintaro Lama.

It was impractical to measure the inorganic content of the exact same water before and after treatment, so the data given is from a sample of the well water source used and of the SODIS-treated well water. Only slight differences are evident between the inorganic content measurements of TDS, TSS, Fe, Zn, Ca and Mg (italicized in Table 5.13) from the source and post-treated Bintaro Lama water. Theoretically, since these measurements are of total content and SODIS is not a method designed to remove in-organics, there should not be any significant variation.

**Table 5-13 Inorganic Content of SODIS Bintaro Lama Water.**

| | (mg/L) | **Bintaro Lama water BEFORE SODIS** | **Bintaro Lama water AFTER SODIS** |
|---|---|---|---|
| **Parameter** | **MCL** | 22-May-06 | 22-May-06 |
| **TDS** | **1000** | *258* | *249* |
| **TSS** | **n/a** | *16* | *14* |
| **Ag** | **0.05** | <0.002 | <0.002 |
| **Hg** | **0.001** | <0.0005 | <0.0005 |
| **As** | **0.01** | <0.005 | <0.005 |
| **Fe** | **0.3** | *0.32* | *0.29* |
| **Cd** | **0.003** | <0.003 | <0.003 |
| **Cr** | **0.05** | <0.02 | <0.02 |
| **Zn** | **3** | *0.10* | *0.06* |
| **Cu** | **2** | <0.02 | <0.02 |
| **Pb** | **0.01** | <0.01 | <0.01 |
| **Ca** | **n/a** | *48.62* | *42.46* |
| **Mg** | **n/a** | *10.51* | *9.84* |
| **Al** | **0.2** | <0.2 | <0.2 |

## 5.2.7. COMMUNITY TECHNOLOGY RANKING POST-TRIAL

Attendees of the User's Feedback & Water Quality Results Campaign in each of the four communities involved in this pilot-study were asked to again rank the explained technologies 1 (most preferred) to 5 (least preferred). Photos from each of the campaigns and the individual ranking data are given in Annex 5. There were a total of 100 attendees at the first campaigns and 87 total at the post-campaigns. The lower number of campaign attendees is due to an unforeseen communal relocation effort in Bintaro Lama, funeral service in Teluk Gong, and abnormal campaign day schedule in Tanjung Priok.

Table 5.14 summarizes the ranking points allocated by individual scoring, showing the overall distribution of ranking-scores. From the 87 attendees surveyed, **boiling remains the most preferred**, up 1.6% to 27.1%. Ceramic filtration went from 20.6% in the pre-trial survey to 18.0% post-trial, chlorination from 19.1% to 16.1%, and *isi-ulang* from16.8% to 15.7%. SODIS conversely rose in preference from 18.0% to 23.0%.

**Table 5-14 Summary of Post-Trial Rankings by Campaign Attendees.**

| | Boiling | SODIS | Ceramic Filtration | Chlorination | Isi Ulang | # of attendees |
|---|---|---|---|---|---|---|
| **Bintaro Lama** | 37 | 20 | 15 | 13 | 10 | 12 |
| **Bintaro Baru** | 65 | 60 | 56 | 52 | 42 | 30 |
| **Teluk Gong** | 57 | 69 | 40 | 36 | 38 | 24 |
| **Tanjung Priok** | 63 | 40 | 37 | 31 | 39 | 21 |
| Overall | **27.1%** | **23.0%** | **18.0%** | **16.1%** | **15.7%** | **87** |
| **RANKING** | **1** | **2** | **3** | **4** | **5** | |

In Bintaro Lama, SODIS went from ranked last to second only after boiling, whereas ceramic filtration went from first to third. In Bintaro Baru, SODIS was also ranked last after the initial point-of-use campaign, rising to second after the post-trial campaign. SODIS ranked above boiling as the overall most preferred technology in Teluk Gong from the post-trial scoring. SODIS was scored first from the pre-trial campaign and a close second with *isi-ulang* after the post-trial campaign in Tanjung Priok.

Table 5.15 shows the same data in terms of summarizing the technologies ranked first by the post-trial campaign attendees. **Boiling remains the overall top-pick**, despite the 3.8% drop from the pre-trial campaign results. SODIS rose 9.4% to second most first-picked, and *isi-ulang* rose 12.5% to third most first-picked. Ceramic filtration dropped 9.7% to fourth, and chlorination 8.6% to fifth.

**Table 5-15 Summary of Post-Trial Campaign Attendees' First-Choices.**

| | Boiling | SODIS | Isi Ulang | Ceramic Filtration | Chlorination | # of attendees |
|---|---|---|---|---|---|---|
| **Bintaro Lama** | 9 | 1 | 1 | 1 | 0 | 12 |
| **Bintaro Baru** | 9 | 9 | 6 | 4 | 2 | 30 |
| **Teluk Gong** | 8 | 9 | 5 | 2 | 0 | 24 |
| **Tanjung Priok** | 9 | 4 | 5 | 2 | 1 | 21 |
| Overall | **40.2%** | **26.4%** | **19.5%** | **10.3%** | **3.4%** | **87** |
| **TOP PICK** | **1** | **2** | **3** | **4** | **5** | |

# 6. USERS FEEDBACK

This chapter reports on each of the community participants' feedback with notes and photos from the project field work.

## 6.1. BOILED WATER USERS' FEEDBACK

**Bintaro Lama**
The Sikem family from Bintaro Lama volunteered to designate the new stove to boiling for the purpose of monitoring the water quality and cost associated (see Figure 6.1). They sometimes used scrap wood to burn for water-boiling, and were very welcoming to participating in this pilot-study. The following notes were made during the weekly monitoring visits.


**Figure 6-1 Pak Sikem & water-boiling stove.**

Thursday 4 May (12:00): No one was home, but their neighbor says it is going fine and let me in to take a sample. They barely had enough boiled drinking water to sample.
Wednesday 10 May (11:15): Because results from the week before show low risk, I reviewed proper boiling and storage practice. Both the husband and wife share the chore of boiling water. I spoke with the wife.

Tuesday 16 May (09:17): Both parents were home because the baby has had fever for 5 days. I told them about the positive results of their water quality (no bacteriological risk evident). They are getting free drinking water from their community leader for being part of a 2-week community work project.
Monday 22 May (09:08): Ibu took the baby back to the kampung because she was very sick. Pak treated the water sampled the night before, which was then stored in a plastic pitcher. He tried SODIS and thinks it tastes just the same, but is waiting to hear the water quality results before switching. He knows it will save them money but since his wife volunteered for boiling he feels obliged to continue boiling their water this month.

**Total number of users in family**: 4
**Water source**: communal shallow jet-pumped well
**Where boiled water is kept**: plastic pitchers with lids
**How often water container is cleaned**: mostly 3times/week
**Cost per L of kerosene**: Rp.2.800
**Days of pilot-boiling**: 36
**Volume of kerosene used during pilot**: 3L

User's post-pilot comment: *"I like the taste better compared to when I have to boil water using wood. I get used to it. After I found out total rupiah I spent for buying fuel for boiling, it really* *surprised me. Luckily, my boss provided us with drinking water for 2 weeks during "Gotong-Royong"* ("Working-Together")."

**Bintaro Baru**
The Itoh family from Bintaro Baru volunteered to designate the new stove to boiling for the purpose of monitoring the water quality and cost associated. Ibu Itoh was delighted to have a new stove in her home and asked if she could keep it after the pilot study. (She was told not to expect to keep the stove.) The following notes were made during the weekly monitoring visits.

**Figure 6-2 Ibu Itoh with her Stove Used for Boiling Wate.**

<u>Thursday 4 May (10:00)</u>: No problems reported. Everything seems to be going well.
<u>Wednesday 10 May (09:40)</u>: Results from the week before show low risk. She puts her boiled water in a small dispenser that she claims to clean with warm water 3 times a week. I reviewed proper boiling, cleaning and storage practice.
<u>Tuesday 16 May (11:09)</u>: She asked me if she could please keep the stove I am lending her. (I said I will ask the stove owner.) She was happy to learn that no fecal coliform were detected from her water sample last week. She tells me she has been cleaning her water dispenser more often now.
<u>Monday 22 May (10:55)</u>: I took a sample for chemical analysis of both her boiled water and pretreated well water that was stored in a covered plastic container since the day before. She still has not bothered to try water from the alternative treatments.

**Total number of users in family**: 3
**Water source**: shared jet-pumped well near toilet
**Where boiled water is kept**: plastic pitcher and small plastic square dispenser
**How often water container is cleaned**: 3 times/week
**Cost per L of kerosene**: Rp.2.800
**Days of pilot-boiling**: 36
**Volume of kerosene used during pilot**: 10L

<u>User's post-pilot comment</u>: *"Well since I always boil my water, I am accustomed to the taste. And I like it. I never calculate about the cost for my drinking water. Since it is a basic need, and I only have a stove, so I should by kerosene. For me it is just what should be. I don't think to boil water is complicated. I used to it. And it is ok. I used to boil my drinking water at evening, when I don't have things to do again."*

**Teluk Gong**
Two families were part of this boiling pilot-study in Teluk Gong because halfway through, the first volunteer family had to return to their village. The Nita family volunteered during the last two weeks of the study; Figure 6.3 shows their water-boiling stove on the right-hand-side of the photo. Both families were very welcoming to participating in this pilot-study. The following notes were made during the weekly monitoring visits.

Friday 5 May (14:00): They had 3 different water pitchers, none with enough for 600mL sample. So to collect the sample volume needed, 2 containers that each had a little boiled water left were finished off, and then topped-off with sample with still-hot/just-boiled water.

Friday 12 May (10:04): Ibu is behind on her water-boiling chore again, so I am sampling hot water from a small plastic pitcher. We discussed water quality results from the previous weeks, and determined it will be better to clean her water containers using boiled/treated water. There are three people in her family, and they are leaving for a month visit back to their village tonight. So we are transferring the stove and monitoring to her neighbor Ibu Nita's (who also has 3 people in their family). Ibu Nita currently uses *isi ulang*, but is curious to compare the price difference with boiling.

**Figure 6-3 Ibu Nita's Water-Boiling Stove.**

Wed 17 May (09:30): The water vendor had not yet come, so there was no water to sample. They ask their neighbors for water to use in the meantime.

Tuesday 23 May (09:23): She buys water from a vendor and stores it in a covered plastic bucket. The sample taken was boiled earlier that morning. She use to use *isi ulang*, which she says tastes the same, but since she can see the water boiling herself, she has more trust in boiling treatment. She has relatively outstanding hygiene habits in my opinion after talking with her about her cleaning practices.

**Total number of users in family**: 3
**Water source**: bought from vendor
**Where boiled water is kept**: plastic pitcher
**How often water container is cleaned**: everyday
**Cost per L of kerosene**: Rp.3.000
**Days of pilot-boiling**: 35
**Volume of kerosene used during pilot**: 10L

User's post-pilot comment: *"I think the taste is the same with isi ulang. Since I don't know what kind of treatment used at isi ulang, I like boiled water better. I feel surer about my drinking water when I see boiling for myself. Compare to isi ulang, I have to spend more money for buying fuel. But still I like boiling water better."*

**Tanjung Priok**

The Rohyati family from Tanjung Priok volunteered to designate the new stove to boiling for the purpose of monitoring the water quality and cost associated. Figure 6.4 shows their a) PDAM water tap b) new stove for water-boiling and c) water storage dispenser. Ibu seemed very happy to participate in this pilot-study. The following notes were made during the monitoring visits.

**Figure 6-4 Ibu Rohyati's a) tap source b) stove for boiling c) drinking water storage.**

Friday 5 May (12:00): A government supplied (PDAM) tap was installed 5 days prior. This water is free (included in rent cost) and is used to boil, and then it is put in a "gallon" dispenser. [NOTE: Water quality decreases with boiling! Refer to Table B.1.4]
Friday 12 May (12:54): There are 5 people in her family, but the father only comes home once every 2 weeks. I gave her the results from the previous week (her tap source water was no risk, and treated/stored drinking water was medium risk.) We discovered that, although she cleans her "gallon" regularly, she never cleaned the dispenser tap. She never thought about it, and was thankful for the advice.
Wed 17 May (11:16): No one was home, but the family will be returning at nighttime.
Tuesday 23 May (12:03): Her husband cleaned their dispenser yesterday, and she said she was surprised at how dirty the tap was. She refilled the dispenser "gallon" with boiled water earlier this morning.

**Total number of users in family**: 5
**Water source**: PDAM connection
**Where boiled water is kept**: "gallon" dispenser
**How often water container is cleaned**: every 4 days
**Cost per L of kerosene**: Rp.2.700
**Days of pilot-boiling**: 35
**Volume of kerosene used during pilot**: 6L

User's post-pilot comment: *"I think the taste is the same as I drink isi ulang water. I realize boiling is little bit complicated and time-consuming, but since I get use to it, it is no problem for me. For me, it is relatively cheap compare to isi ulang, because if I buy isi ulang, I have to pay for the becak to carry it on."*

# 6.2. ISI-ULANG USERS' FEEDBACK

**Bintaro Lama**
Only two households in Bintaro Lama use *isi-ulang*, and only one of them joined the campaign, Mas Kamsir. The water from his dispenser was tested for this pilot (see Figure 6.5), and notes from the monitoring visits follow.

Thursday 4 May (12:00): The same person that is trying out chlorination also uses *isi-ulang*. I tested his *isi-ulang* water, but he informs me that he no longer intends to use *isi ulang* because he likes the chlorine option better because it is cheaper.


**Figure 6-5 Mas Kamsir's Isi Ulang Dispenser.**

Wednesday 10 May (11:30): Mas Kamsir was not home, but his younger brother let me take a sample of the *isi-ulang* water. He was so shy that it was not easy to get any feedback.
Tuesday 16 May (09:32): He had a "gallon" filled with chlorinated water ready to replace the *isi-ulang* "gallon" and use the dispenser for the chlorinated water. However, sediment formed at the bottom of the chlorinated "gallon" so it would clog up the dispenser if he did that. I took a sample of the cooled *isi-ulang* water from the dispenser.
Monday 22 May (09:44): They are not using *isi-ulang* water anymore. They are filling their "gallon" with chlorinated water, filtering it through a cloth, and then putting it onto the dispenser to use.

**Bintaro Baru**
Two different users from Bintaro Baru were part of this pilot-study; the first two weeks the neighbor of the boiling-volunteer, and the last two weeks Ibu Tina. Figure 6.6 shows Ibu Tina about to pour some water from her *isi-ulang* dispenser.

**Figure 6-6. Ibu Tina filling sample bottle.**

Thursday 4 May (10:00): The neighbor of the boiling-treatment volunteer happily let me sample her *isi-ulang* water.
Wednesday 10 May (09:40): Results from the week before show low risk, I reviewed proper water handling and storage practice. She rinses out her "gallon" with well water then again cleans it at the *isi-ulang* station. She unlikely ever cleaned the tap.
Tuesday 16 May (11:16): The woman I sampled from last week went back to her village for the week, so I sampled from her neighbor, Ibu Tina. She pays Rp.3,500/"gallon" for *isi-ulang* to be delivered to her home. She has "been using *isi-ulang* this way for a long time because it is the most simple." She doesn't have a dispenser though; she poured a sample for me straight from the "gallon."
Monday 22 May (11:03): The "gallon" sampled from was bought 4 days prior. Ibu Tina poured from her "gallon" directly into my sample bottle. I asked her if she had tried water from the alternative treatments and she had not. I cannot tell if she is just shy or feels uneasy asking.

**Teluk Gong**
Ibu Sumiyati (see Figure 6.7) is a regular campaign participant who wanted very much to participate in this pilot-study. Notes from weekly monitoring visits follow.


**Figure 6-7 Ibu Sumiyati and her isi-ulang water.**

Friday 5 May (14:00): The neighbor of SODIS volunteer cheerfully let me sample her water. She keeps the water in a pitcher (because it is easier to pour) instead of a dispenser like most (because it is too expensive).
Friday 12 May (11:01): She does not use *isi-ulang* for her baby because she does not trust it completely, so she boils vendor water too. She serves *isi-ulang* drinking water from a plastic pitcher that she fills from the "gallon." I informed her of the water quality tests from the week prior (no risk evident from fecal coliform.)
Wed 17 May (09:46): She buys *isi-ulang* water from the nearby exchange depot. The sample was taken straight from the "gallon" bought the day before. One "gallon" lasts her family of 5 about 2 days. She boils this water when making coffee, tea, and milk.
Tuesday 23 May (09:42): She bought the water I was sampling 2 days prior. She poured a sample directly from her "gallon."

User's post-pilot comment: *"I feel by buying isi-ulang, its more practice. Compare to money I spend for buying fuel, it less costly. For me, isi-ulang is ok."*

**Tanjung Priok**
There are several *isi-ulang* users living in Tanjung Priok, and to get a broader scope of *isi-ulang* point-of-use water quality, four different users' *isi-ulang* water were tested for this pilot-study. The third week, *isi-ulang* water bought from a new station that was opened during this study was tested from the user's dispenser.


**Figure 6-8 Ibu Syane's children and water dispenser.**

Friday 5 May (12:00): The people living next to where we park happily let me sample their *isi-ulang* water. They have a hot/cold dispenser; my sample was taken chilled. They did not seem interested in the water sampling as much as they were just interested that I was there.
Friday 12 May (13:15): Ibu Ida, neighbor of SODIS user, has only used *isi-ulang* water for the last year or more. She does not boil her water.
Wed 17 May (11:15): A new RO *isi-ulang* station opened up in the neighborhood about 2 weeks ago. They sell for Rp.5.000/"gallon" and customers are allowed to borrow "gallon" containers so there is no initial investment. Ibu Mina, who lives between the chlorine and boiling volunteers, was happy for me to sample the water she bought from there earlier that day. She has a hot/cold dispenser that I sampled from.

Tuesday 23 May (12:51): One "gallon" usually lasts Ibu Syane's family of 5 about 3 days. (See Figure 6.8.) All they use is *isi-ulang* (they do not boil any of their water.) The sample taken was from a "gallon" bought 3 days prior (not from the new RO station, but from the one they always use.)

# 6.3. CHLORINATION USERS' FEEDBACK

**Bintaro Lama**

Mas Kamsir (see Figure 6.9) lives with his father and brother. He is a former *isi-ulang* user who now uses water from a shallow communal jet-pumped well to chlorinate and drink. Mas Kamsir leaves the cap off for <5mins to decrease the odor after chlorination. The following notes were made during household monitoring visits.

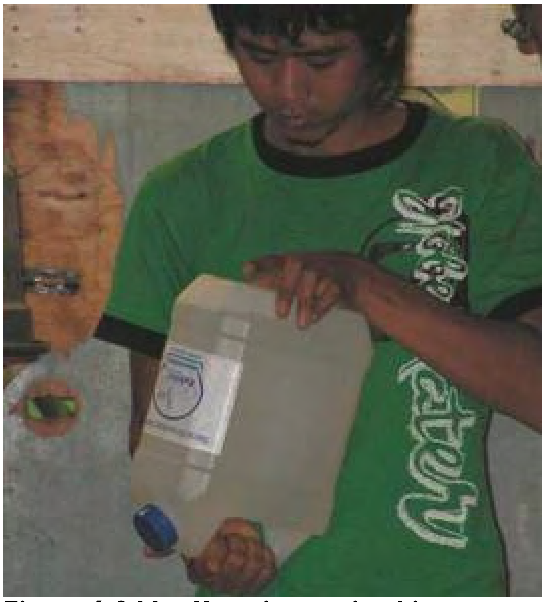

**Figure 6-9 Mas Kamsir treating his water.**

Thursday 4 May (12:00): The water is not clear, but they are using it anyway. They say they like it, and even put the Air RahMat sticker on their front window.

Wednesday 10 May (11:33): Mas Kamsir's little brother does not drink it, and his dad drinks it sometimes. His little brother said the smell and taste is a little bitter. I would have thought he would say because of the appearance. The **treated water had a yellow color** whereas the untreated water did not. I took extra sample to send to the lab to analyze the water chemistry.

Tuesday 16 May (09:32): He said he shared with his neighbors, but they like SODIS better because of the taste. He thinks it is much easier to chlorinate his drinking water. He had filled a "gallon" with chlorinated water (treated 4 days prior) to replace his *isi-ulang* "gallon," but there was **sediment in the bottom of the chlorinated water**. I took a sample of that water. One of his 5L jerry-can's water was treated 3 days ago, and it had ants crawling on the container and floating in the water. He said he was still planning on drinking it though. His other 5L jerry-can's water was treated the day before and I took a sample of that water too (both 0 FC/100mL). Rob Ainslie from USAID-SWS was with me this day.

Monday 22 May (09:44): They are using chlorinated water in place of *isi-ulang* water now. After the water is treated it turns yellow, so they filter it through a cloth again before loading it on the dispenser. The sample was taken from the dispenser. No one knew for sure how many days ago the water in the dispenser had been treated since Mas Kamsir is the only one who takes care of the water-chlorinating and he was not home. Mas Kamsir's sister and father were home. His sister was on holiday in Bantan Province last week and saw Air RahMat for sale. His dad is excited now that he talked with us because his son never talked to him about this new process. (I gave them a folder of information on the first day, but he cannot read.) He is sure they are saving money by not buying *isi-ulang* water. So their whole family is drinking it now. He wanted to know if he added more chlorine to the treated water, would it take out the yellow color. They tried the water from the ceramic filter but say it tastes bitter and they prefer the chlorine taste. That is the first I hear of that, making me cautious as to if I'm being told that because he thinks that is what I want to hear.

User's post-pilot comment: "*I use to drink isi-ulang water. For me, the taste between chlorinated water and isi-ulang is relatively the same, except for the odor. I feel uncomfortable with the odor at the beginning but I get use to it. I plan to use it* [Air RahMat] *continually… it is much less costly compare to isi-ulang water. I consider this method very simple and not take a lot of time.*"

**Bintaro Baru**
Figure 6.10 shows Ibu Marni chlorinating her drinking water. She uses non-chlorinated water to boil for making tea and coffee, and for her youngest daughter to drink because she doesn't like the taste of the chlorinated water. Ibu Marni collects all their freshwater from a shared jet-pumped well and stores it in a covered plastic basin to settle for 1-2 days.

**Figure 6-10 Ibu Marni Using Air RahMat.**

Thursday 4 May (10:00): Ibu and her husband like it, but her kids do not drink it because of the taste. The 5L jerry-can that was treated the same day looked fine, but the other 5L jerry-can that was **treated 2 days prior had brown flocculants** in it. Ibu says this **happens to her boiled water after a couple days too**, but the flocculants are not so big. Hence, she still drinks the chlorinated water until she starts to see flocculants.
Wednesday 10 May (10:05): The neighbors are not interested in trying it because of the smell. Ibu Marni agrees that it smells, but says it tastes fine. She leaves the treated water for 1-2 days to get rid of the smell, but over that time, the colored sediment appears. I took extra sample to send to the lab to analyze the water chemistry.
Tuesday 16 May (10:37): The water I sampled was treated 2 days before. She has 4 family members, but her youngest child doesn't drink it. She likes I the same as boiled water "and it is easier because it is more efficient." She is using water straight from the pump instead of letting it sit for 2 days as she would for boiled water. I reminded her again that she should treat the water the same as she did for boiling.

Monday 22 May (10:40): She was away the past 2 days, so no water was prepared. Since she normally settles her water for a day before chlorinating it, it was not possible for her to prepare a normal sample. I recommended she consider simply filtering the water first through a cloth, gave her water quality results from the week before, and reminded her about the upcoming campaign.

User's post-pilot comment: *"The taste is ok, except the odor, it smells like medicine. But I get used to it. I can save money now. It is cheaper than boiling. Usually I spend 1L kerosene in 2 days, now it lasts for 4days. It is simple too. The information in the booklet also helps me to understand the method. I just follow the instruction given."*

**Teluk Gong**
Ibu Sus (see Figure 6.11) was enthusiastic about being part of this pilot-study. She buys her family's water from a mobile/cart vendor. Her and husband have three children, and on average they use two 5L jerry-cans of chlorinated water daily and boil water. At first the odor bothered them, then she began leaving the lid off the jerry-can for <10mins after treating and that that helped.

**Figure 6-11 Ibu Sus Chlorinating her Water.**

Friday 5 May (14:00): She and her husband prefer the chlorinated water, but kids prefer drinking boiled water so she does both.
Friday 12 May (10:05): She had a party at her house yesterday, and she served chlorinated water and all guests liked it. She is excited because she says it is much easier than boiling. She has three kids; the youngest does not drink it because he does not like the smell.
Wed 17 May (10:06): She didn't have any drinking water prepared, so made some as we spoke. It was good actually to she her prepare it because I saw that she didn't clean the jerry-can out first as instructed at the start. I reminded her of this and gave her another Air RahMat bottle. She has a groundwater electric-pumped well, but just uses that for washing; the water she chlorinates is bought from a vendor. I informed her that no fecal coliform was found in her drinking water sampled last week. She told me again that she really likes the water and her whole family is now drinking it.
Tuesday 23 May (09:50): She was about to leave when I arrived. She did not have any drinking water prepared, but made some up for me on the spot. I shared water quality results, and reminded her about the upcoming campaign.

User's post-pilot comment: "*The taste is almost the same as boiled water, except for the odor but it is ok. It is much less costly compare to boiling. I like chlorine better. Boiling is more complicated I think.*"

### Tanjung Priok

Ibu Wiwien, shown in Figure 6.12, chlorinates water bought from a mobile/cart vendor for her family of six. (She still boils vendor water for making coffee and tea.) She puts their chlorinated water into the "gallon" dispenser shown.

**Figure 6-12 Ibu Wiwien.**

Friday 5 May (12:00): Her whole family likes it and she is sharing Air RahMat with her neighbors. She estimates that her family is drinking about 5L/day. After she chlorinates her water, she puts it in a "gallon" dispenser.
Friday 12 May (12:43): All family members like it, even their neighbors. Not much different than other drinking water in her opinion. She does not have any treated water to sample though because there has been no clean water to buy today. She says this rarely happens.
Wed 17 May (11:01): I asked if she cleans her

jerry-can prior to refilling and she reassures me she does. The sample taken was treated earlier the same day and put in a dispenser. There are 6 people in her family and they go through a "gallon" in about 2 days. I gave her another Air RahMat bottle and asked if she noted any money savings from this cheaper water treatment alternative. She tells me no because that money is quickly spent on other things so they still have no money and that is how come she cannot tell any difference. She offers the treated water to her neighbors who told her "*ok, if I want some I will ask you*," but none have.
Tuesday 23 May (12:03): She buys water from a vendor. She chlorinates the water and fills a "gallon" to use on the dispenser. The sample taken was treated the day before.

User's post-pilot comment: "*At first, I don't like the odor. But then, I get used to it. It's ok for me. It is better than boiling. Less costly than if I have to buy fuel for boiling. I want to use this* [Air RahMat] *regularly, so I can save money. I like doing this practice more than boiling.*"

# 6.4. CERAMIC FILTRATION USERS' FEEDBACK

**Bintaro Lama**

Many of the campaign attendees wanted to try the ceramic filter, and between them they decided to let the Weri's use it and they would share. The Weri's are an older couple, so this was likely decided on a basis of seniority. Nevertheless, the filter was stationed in their home and six of their neighbors used it too over the 36-day duration of the pilot-study (see Figure 6.13). They even use the filtered water to make tea and coffee.

**Figure 6-13 Ibu Weri's ceramic filter set- up.**

The water used is from a communal shallow well. The water is jet-pumped from the well and fed to their house through a hose that has a cloth strapped to the outlet as a rudimentary pre-filter. They were all very pleased with the filter performance, as was noted during the monitoring visits.

Thursday 4 May (12:00): The old couple really likes the filter and asked me how they can buy it to keep. They are sharing with their neighbors who all like it too.
Wednesday 10 May (11:07): They really like it, and it is working well. They asked again if they would be able to keep it after the 4-weeks are over. Ibu says she cleans the filter every 3 days.
Tuesday 16 May (09:20): They were not home to get a water sample or feedback from unfortunately.
Monday 22 May (09:20): Ibu Weri just cleaned both the top and bottom receptacles with untreated water that morning. She cleans the filter system this way every 3 days. She says she used to buy 1L of fuel every 2 days, but since they got the filter, she only has to buy 1L every 3days. She has not tried any of the other alternatives because she is satisfied with this one.

User's post-pilot comment: "*I like the ceramic filtration. Even though it is costly compared to the other methods, but considering it will last for two years, it is worth it. Also, the taste is good.*"

### Bintaro Baru

Deciding who was going to pilot the ceramic filter after the Point-of-Use Alternatives Campaign came down to three women who played a hand-game to ultimately choose. A photo of the winner and two of her children with the filter in their home is given in Figure 6.14. There are a total number of five users in their family whose water treatment was monitored over a 4-week duration.

**Figure 6-14 Ibu Yati next to her ceramic filter.**

The water used comes from a communal shallow jet-pumped well nearby. They settle the water in a covered plastic basin in their house overnight before using it. Ibu Yati cleans the filter element every other day. For making tea and coffee, she uses water from the storage basin.

Thursday 4 May (10:30): They like the treated water but the tap leaks. (I tested all the filters before I gave them to volunteers. No doubt this happened because of the poor filter system quality.) After helping her tighten the tap back, she says none of her neighbors are interested in trying the filtered water. (I think this stems from a jealousy issue.)
Wednesday 10 May (10:00): She says the neighbors are not interested in trying it. She thinks the filtered water tastes just like boiled water. As we were talking, her kid licked the tap outlet.
Tuesday 16 May (10:46): Yati says the resulting water tastes fine and she wants to keep the filter even if she has to buy it because she is saving money. I gave her water quality results from the week before, which showed no evidence of fecal coliform contamination.
Monday 22 May (10:46): She cleaned the filter 2 days prior, and added the water to start filtering last night. She has not tried the other alternatives because "*I already trust this technology so I do not need to try the others.*"

User's post-pilot comment: "*The taste is just like boiled water; my kids even feel this water more fresh. When I used to boil my water, after I keep it for 3days, it turn to dusty. Surprisingly, after using ceramic filtration, my water stay clear, even it have been store for 3days. For me, even if I have to pay Rp.150.000 at times, it still cheaper compare to cost I have to spend for buying kerosene. It is much much simple than boiling. I like this method a lot.*"

### Teluk Gong

Ibu Hariah lives with ten other people, whom all were glad to try the ceramic filter over the 35 day pilot-trial. The filtered water was not enough for all 11 users, so they still boiled water too. The water they use comes from a PDAM tap (although they pay a flat fee for it, the legality of the connection is questionable.). The following are notes from weekly monitoring visits, and Ibu Hariah is pictured with her ceramic filter in Figure 6.15.

Friday 5 May (14:00): Family and neighbors all really like it and expressed interest in wanting to keep it for good.
Friday 12 May (10:49): Neighbors come over to drink it. Her whole family likes it. She cleans the filter every 3 days. She gets the water to treat from a pipe connection behind her home. I took a sample of both her untreated and treated water to send to the lab for chemical analysis.
Wed 17 May (09:39): 3 families share a house and they also boil water because the ceramic alone is not enough. None of them prefer one over the other. They have not noticed a cost savings because they use an electric stove to boil (stolen electricity/flat fee).
Tuesday 23 May (09:09): Ibu Hariah was not home, but others in her housemates said they would tell her I stopped by and they let me take extra samples to send to the lab.

**Figure 6-15 Ibu Hariah by her ceramic filter.**

User's post-pilot comment: "*The taste is almost the same as boiled water. Even I like this better. I think the price is relatively affordable, considering it will last for 2yrs. It's very simple. I don't feel spend a lot of time for doing this.*"

**Tanjung Priok**
Pak Haris is respectable community leader with definite initiative, so when he expressed interest in trying the ceramic filter, there was no debate. (A photo of his wife and their ceramic filter is shown in Figure 6.16.) He lives with his wife and teenage son, and they buy their water from a vendor (see Figure 6.17) and store it in a covered plastic basin. They still boil water from the storage basin to make tea and coffee. Notes from weekly monitoring over the 35-day duration of this pilot-study follow.

**Figure 6-16 Ibu Haris and her ceramic filter.**

Friday 5 May (12:00): Pak was not home but his wife says he likes it, even though she is skeptic and still boils her own water. They keep in their bedroom and have not yet shared the filtered water with others.

Friday 12 May (12:25): They moved the filter to the living room. Pak Haris is praying now, but his son is here and claims he likes drinking the water. His wife is here too, but says she does not drink the water from the filter because she doubts the quality. Their neighbors are not trying it for the same reason. I showed her the bacteriological results (no risk) from last week's test. I took extra sample to send to the lab for chemical analysis.

**Figure 6-17 Water vendor's supply cart.**

Wed 17 May (11:48): His wife is now drinking the filter-treated water. They use water that they buy from a vendor to filter. A full filter container lasts them 3 days, after which, Pak Haris cleans not only the filter but also inside the receptacle (since he noticed algae growing behind the tap.) He cleaned the system earlier the same day I took the sample. He said he used warm vendor water to clean the inside of the receptacle. He serves this water to his guests who all like it because it doesn't smell like chlorine.
Tuesday 23 May (12:44): He just prepared the water I sampled this morning. Sometimes he still boils water, but only if guests are visiting who are unsure of this technology. He and his family really seem to like the filter system.

User's post-pilot comment: "*The taste is fine. Its' taste is the same as my boiled water. I think it is worth it for Rp.150.000 since it lasts for 2yrs. I think ceramic filtration is the most simple one, compare to the other methods. I like it.*"

# 6.5. SODIS USERS' FEEDBACK

**Bintaro Lama**

Ibu Kana's SODIS set-up in Week 1 is pictured in Figure 6.18. It has since moved to different spots depending on available space. She has learned over the course of the month that she only needs to treat 4 bottles a day to meet her family's needs. There are four people in her family, and they treat water from a communal shallow jet-pumped well to drink. Notes from monitoring visits to Ibu Kana's follow.

Thursday 4 May (12:00): They like the water fine, their neighbors have asked to borrow their bottles. Even though they still filter their water through a cloth before filling the bottles, the water looks slightly turbid to me.
Wednesday 10 May (11:00-12:00): Unfortunately, the family was not home so I was not able to take a sample. I observed 3 of their SODIS bottles out in the sun.
Tuesday 16 May (09:15): They were not home again this week. Although, I saw 3 bottles set out in the sun, and another half-empty tied to a cart.
Monday 22 May (08:48): There are 4 in their family (parents and their 5yrs and 1.5yrs children) whom all drink the water treated by SODIS. I took extra samples this day to send to the lab for chemical analysis. They filter the water through a cloth that is directly attached to the hose outlet they fill their bottles with (no water storage stage). They are finishing one bottle before opening another. Sample taken was from a bottle treated

**Figure 6-18 Ibu Kana's SODIS Set-up.**

the day before. They drink directly from the bottles that they take with them to work, but when they are home, they pour the water into a pitcher. Their 3 neighbors also like this SODIS process. They all tried the ceramic water and like it too. They used 1L of fuel /day before, and now they can use 1L of fuel /2days since they no longer boil their water. (Fuel currently costs Rp.2.800 in Bintaro Lama.) They are planning to move to the lot behind their house next week.

User's post-pilot comment: "*My family used to boil drinking water. After trying SODIS application we found the taste is relatively the same with boiled water. I can save money because I don't have to buy fuel for boiling. It's simple. Me and my husband just put it on the zinc roof, and we leave it until we back from work. We don't have to check it most of the times. We only make sure with our neighbors whether that day is cloudy/rainy or not.*"

**Bintaro Baru**
There was not much interest from Bintaro Baru community in piloting SODIS at the beginning. Ironically, by the end of the study SODIS became the most preferred technology (with the exception of boiling, which was only slightly more preferred). After the first week, replication by neighbors had begun.

Figure 6.19 shows Pak Yayan's (pilot volunteer) SODIS set-up. They use water from their boss's shallow jet-pumped well, which they collect and store overnight in a covered plastic basin before filling their bottles to treat. There are five people/users in their family; notes from monitoring visits to their household follow.


**Figure 6-19 Pak Yayan's SODIS bottles on his roof.**

Thursday 4 May (10:00): They are excited about SODIS and are lending bottles to their neighbors. Another neighbor found her own bottle to use and told me because the bottom is not painted black so she is leaving it out all day long.
Wednesday 10 May (10:20): Users say it tastes like boiled water. Their neighbor had 16 bottles she collected and painted half black that were out on a black cloth over metal sheeting. She is treating 16 bottles at a time so that she can fill her dispenser. This replication was great to see, although there were large bubbles in her bottles. I reviewed the practice with her and learned that Ibu Yayan taught her pretty well, she just missed the bubble step. She even washed her hands before touching her bottles to add the water to get rid of the bubbles! This was really rewarding to see because it proved she learned from the Water Handling & Hygiene Campaign.

Tuesday 16 May (10:58): Pak Yayan tells me they let their collected well water settle for 2 days before the treat it (as they did for boiling). They were pleased to learn that their water quality results from the previous week showed no evidence of fecal coliform contamination. I took a sample from a bottle treated the day before.
Monday 22 May (10:26): Ibu Yayan's sister lent her a "gallon" and dispenser that she now has filled with SODIS-treated water. I took a water sample from the dispenser (the water was treated 2 days prior). She hasn't tried the other technologies, and has no reason as to why not.

User's post-pilot comment: "*The taste is the same as I used to boil my water. Except this water is more fresh. My neighbors said the same way too, so that's why they borrow my bottles and tried it themselves. My fuel consumption is much less than it used to be. For me, it is relatively easy to do. It's not complicated, and can be done in relax situation*."

**Teluk Gong**

Ibu Nur is the most enthusiastic volunteer of them all. A photo of her pointing to her SODIS bottles is shown in Figure 6.20. Altogether there are four people in her family that all use SODIS, except she still boils water for making coffee and tea. The water she treats is bought from a cart/mobile vendor and stored in a covered plastic basin until used. Notes from monitoring visits follow.

Friday 5 May (14:00): Her whole family is excited about SODIS and the potential money savings. She even **announced SODIS to the parents in her daughter's class** yesterday! Her roof is in the shade, so she sets up a table behind the Mosque for the bottles. She does not use the full capacity of the bottles treated, so she takes them inside after treatment and saves them for later days. The sample I took was **treated 5-days ago**.

**Figure 6-20 Figure 6.20 Ibu Nur pointing to her SODIS bottles on the roof of the Mosque.**

Friday 12 May (10:04): Ibu Nur is now using the roof of the Mosque to set her bottles. She tells me how hot the bottles get. I told her the good results of the water tests form the previous week, which she was happy to learn. The sample I took this time has was treated 2 days ago and stored since. Her family really likes the water, even her neighbors, but not her neighbor's husband.

Wed 17 May (09:45): She buys her water from a vendor and stores it until she treats in (SODIS and/or boiling). Between the 4 members in her family, they use about two 1.5L bottles each day. She boils water for making tea, coffee, and *jamu/obat* (traditional medicine). The sample taken was from a bottle treated the day before. She had questions about the impacts of rainy weather and scratches on the bottles/ bottle-life.

Tuesday 23 May (09:37): She is using another rooftop now because the Mosque is under construction. The sample was taken from a bottle treated 4 days prior.

User's post-pilot comment: "*The taste is the same as my boiled water. I can save money since I used to use 4L kerosene for a week, now I only buy 2L for a week. I think this method is easy to do. For me it is not time-consuming*."

**Tanjung Priok**

Ibu Yuli's family of three all use SODIS-treated water. She uses water from a PDAM tap connection in her home and treats enough in case it is cloudy the next day. Ibu Yuli's SODIS setting is shown in Figure 6.21, and monitoring notes follow.

**Figure 6-21 Ibu Yuli's SODIS setting.**

Friday 5 May (12:00): Only 3 bottles were up on the neighbor's ceramic tiled roof because Ibu was sick with a bad headache. When I arrived, she was laid out on the floor with coin-scrapes all over her neck and chest (to let out the wind). She says that her and her family and neighbors like the way is tastes, especially because she keeps it in the refrigerator in a pitcher after it has been exposed to the sunshine. 2 of the 3 bottles on the roof at that time were at 10:00/04:00 rather than 09:00/03:00 angles; I re-explained the importance of bottle-positioning to her, her kids, neighbors, and the many others who gathered for this sampling occasion. I got a sample from the pitcher keep in the refrigerator this day.
Friday 12 May (13:12): The sample taken was from a bottle treated the day before. There were no bottles on the roof because she treated 8 yesterday. She puts some of the treated water in a "gallon" dispenser and some in a plastic pitcher in her refrigerator. I shared the good results from the bacteriological water quality tests (no risk) from the sample taken last week. There are 3 people altogether living in her home, and they all like the SODIS water and so do her neighbors.
Wed 17 May (11:24): The sample taken was treated the day before. She is keeping the treated bottles in a cardboard box in her kitchen, from which she refills a pitcher that she keeps in her refrigerator. There were 3 bottles on her ceramic-tiled roof at the time of the visit. She would put more out but is afraid the roof would break under the weight of added bottles.
Tuesday 23 May (12:22): Two bottles out on the roof, and the black cloth was blown over the bottom of the bottles. Sample was taken from her dispenser holding water treated the day before. She had cleaned the "gallon" but not the dispenser tap. I gave her a wipe for the tap.

User's post-pilot comment: "*Compare to isi-ulang it is more fresh. I can save money. I don't have to pay at all. I think it is simple. Not time consuming. I just leave it on the roof.*"

# 7. TECHNOLOGY IMPLEMENTATION ANALYSIS

Each of the technologies piloted are discussed in this section in terms of results, changes in acceptability, and replication feasibility & advice.

## 7.1. BOILING ANALYSIS

Results from monitoring the four families boiling practice is likely representative of similar household users in Jakarta. The average cost of boiling 1L of water was found to be Rp.149, within a range of Rp.77 – Rp.200. This spread in cost is predominantly attributed to variability in boiling times. Even after campaigns and household visits explaining water disinfection requires only one minute at a rolling-boil, variability in boiling times remained evident. In addition to irregular boiling procedures, proper water handling & storage methods found were insufficient. This was made clear through both regular household visits and talking with users as well as water quality tests. After one-on-one discussions regarding water handling & hygiene measures, water disinfection improved from low risk to no risk of fecal coliform contamination.

As proven by the Indonesian government's success in establishing boiling treatment years ago, there is no doubt replication is feasible. The strength of the success is that practically all households are equipped with stoves for boiling water. The resulting vast number of people who boil their drinking water stresses the profound acceptance for this disinfection method. Before and after the point-of-use campaigns presented in this research, while most of the other technology preferences varied, boiling was preferred overall[7]. Although this is not to say the individual attendees did change their scoring over the course of the pilot-study, results do indicate the overall stronghold in popularity of the boiling method. As echoed by Ibu Maemunah of Teluk Gong: "*I am use to boil my water, so I rather keep doing it.*"

Advice for future implementers is to educate locals through a regular regime at household-level, clarifying the necessary time to boil and the importance of properly cleaning dispensers and taps. As a result of this pilot-study, volunteer Ibu Nita of Teluk Gong, switched from *isi-ulang* to boiling on the basis of being able to see for herself the treatment in action. However, volunteer Pak Sikem of Bintaro Lama, switched from boiling to SODIS on the basis of cost. Considering many users are willing to pay the high cost to boil their drinking water given cheaper options reiterates the established trust many locals have in boiling for their point-of-use water treatment. Hence, it is essential to include boiling in future promotions for point-of-use technologies in Indonesia.

7 With reference to Tables 5.1, 5.2, 5.14 & 5.15; 25.5% of attendees surveyed initially preferred boiling overall, with 44.0% ranking boiling as their first-choice, and after, 27.1% overall with 40.2% ranking boiling as their first-choice.

## 7.2. ISI-ULANG ANALYSIS

The five main types of *isi-ulang* stations (reverse osmosis, membrane filtration, ozone, UV, and exchange depots) are discussed in the introductory report of this study. A new approach, where users no longer need to supply their own "gallon" (Rp.30.000), was seen in Tanjung Priok; the new station rents refilled "gallons" for Rp.5.000 (verses the customary Rp.3.000 for refill only). There are numerous stations in operation, and several community members voiced their doubt of the water quality were curious to learn of the pilot-results. Of the eight different users' *isi-ulang* water tested, three showed low risk and five showed no risk. However, these findings do not directly indicate inadequate water treatment because of the water handling & storage factor.

Similar to boiling, the other locally established alternative, not much variance was evident in the acceptance scores of *isi-ulang* before and after the point-of-use campaigns. On the other hand, *isi-ulang* was **least preferred overall** (with only 16.8% of the attendees' votes) after the pre-trial campaign, yet ranked as the second first-choice (with 20.0% ranking *isi-ulang* as their top-pick). *Isi-ulang* was still the least preferred technology overall after the post-trial campaign (with only 15.7% of the attendees' votes), although now ranking as the third first-choice (with 19.5% ranking *isi-ulang* as their top-pick).

During the course of this study, no new *isi-ulang* users were sited. Two of the *isi-ulang* volunteers, Mas Kamsir of Bintaro Lama and Ibu Sumiyati from Teluk Gong, switched to chlorination after this pilot-study because it is cheaper. The other existing *isi-ulang* users monitored are comfortable with their current drinking water. Based on discussions with community members, aside from cost, transporting the "gallons" and unclear water treatment & quality information are core concerns. Thus, including delivery service and clearly posted water quality information are suggested approaches for recruiting *isi-ulang* users. Retailers are further advised to remind users to keep dispenser taps clean.

## 7.3. CHLORINATION ANALYSIS

The chlorinated well waters in Bintaro Lama and Bintaro Baru turned yellow with brown flocculants forming after 1-2 days. These changes were not found in the treated vendor waters from Teluk Gong and Tanjung Priok. Beyond the inorganic content, **investigation of organic content in the well waters is recommended** for future work. Low risk of fecal coliform contamination was found in volunteers' water from Bintaro Lama (Week 2) and Tanjung Priok (Weeks 1 & 4). Both users treat their water in 5L jerry-cans and transfer it to 19L "gallon" dispensers. **Providing/selling appropriate containers together with Air RahMat is highly recommended**. Subsequent questions stemming from the changed water color and observation of unperfected treatment/storage application indicate the importance of follow-up household visits to monitor Air RahMat practice.

After the pre-trial point-of-use campaign, chlorination was ranked overall below boiling and ceramic filtration, and above *isi-ulang* and SODIS.[8] After the post-trial campaign, chlorination was the second-least preferred technology overall, and ranked last as first-choice. Referring to Table 5.15, post-trial campaign survey results show only 3 out of 87 attendees chose chlorination as their first-choice. In the respective campaigns, volunteer Mas Kamsir from

8 19.1% of the pre-trial attendees' voted chlorination as their preferred treatment overall (median choice), sinking 3% to the second-least preferred overall after the post-trial campaign. A similar trend was seen in terms of top-picks, where after the pre-trial campaign 12.0% ranked chlorination as their first-choice (4th ranked out of 5) with only 3.4% (last choice) in the post-trial campaign. (Refer to Tables 5.1, 5.2, 5.14 & 5.15)

Bintaro Lama was absent, but volunteer Ibu Sus from Teluk Gong was present. It is odd that Ibu Sus did not rank chlorination as her first-choice because she is still using Air RahMat and requested more to bring back to her village.

All of the pilot-study volunteers have switched from boiling (Mas Kamsir though switched from *isi-ulang*) to chlorination as a result of this study, on the grounds that it is **cheaper and easier**. One other family started using Air RahMat in Tanjung Priok, as did two others in Teluk Gong. Replication is slow because locals are taught from a young age that clean water has no smell. This mindset has locals associating the smell of chlorine with un-pure water. This also highlights the importance of educating the public to successfully promote this technology. Some points suggested for future implementers to make a convincing introduction to this technology follow.

- Chlorination is as customary to Westerners as boiling is to Indonesians.
- Medicine has a bitter taste too but we still take it to keep healthy.
- Indonesia's municipal water is chlorinated.

None of the volunteers switched to using chlorination because that they felt healthier or liked the taste; so, stressing the residual disinfectant power or offering alternant/flavored tastes is not perceived to be an effective approach. Prospect users understand chlorination is a cheaper alternative (likely why they are listening), so it is advised to **emphasize the easiness of the treatment**.

The following quotes are from Teluk Gong community members gathered August 2006.

Ibu Sumiyati (*isi-ulang* volunteer): "*Compare to other new alternatives that we have been taught, I prefer to use Air RahMat because it is the simplest one. It is cheaper than isi-ulang too.*"

Ibu Atin: "*I live upstairs my sister in law's house and I don't have my own kitchen, my family rarely boil water. Also, it is difficult for vendors to carry up my clean water every time we bought it. That is why I used to buy isi ulang. Since you gave me Air RahMat on the last couple weeks, my family has not buy the isi-ulang any longer. At the beginning it taste like unboiled/untreated water, but later on we get used to it. It is only about habitual method.*"

Ibu Devi: "*I have been tried Air RahMat, compare to SODIS Air RahMat is simpler. If ceramic filtration, we have to spend some money at times, and we can't make it.*"

# 7.4. CERAMIC FILTRATION ANALYSIS

From the bench-scale investigation it was found that water is not filtering through the main body of the Plered filter element. Still, the average of six filtration rates was slower than expected, 0.5 L/hour (correlating to a possible 12L filtered per day). Inorganic water quality after filtration was adequate. Removal of iron was detected, and silver content was confirmed to remain below the MCL. Comparing the inorganic water quality between the vendor and PDAM water on different days showed rational variability (mainly in water hardness), more noticeably from vendor water. Moreover, as confirmed by pilot-study results, fecal coliform measurements show effective total FC removal after one filtration.[9]

9 Whether this conclusion holds true through the 2-year filter-life duration as claimed was not part of this investigation.

After introducing the point-of-use alternatives to the communities, ceramic filtration was the second most preferred technology overall and the second top-pick. Ceramic filtration actually ranked above all the other technologies in Bintaro Lama after the pre-trial campaign. After the post-trial campaign however, ceramic filtration preference decreased significantly.[10] The initial interest is a probable outcome of a convincing introduction to the technology; the post-trial ranking was likely forthcoming and represent preferences' more accurately.

Convincing points for the introduction of ceramic filtration follow:

- Ceramic filters are used widely used in other parts of the world like Nicaragua and Cambodia for example, but are only recently developing in Indonesia.
- Boiling uses heat to destroy microbial contaminants still in water, whereas ceramic filters have germicidal properties and strain water to remove contaminants. (Chemical disinfection with the colloidal silver is a relatively advanced concept to convey, so focusing on physical aspects of the filtration process is a more gainful approach.)

As a result of the study, each of the pilot-trial volunteers decided to switch from boiling to ceramic filtration on the grounds that the filtered water tastes good, the filtration method is simple, and the investment makes economic sense. Pak Haris from Tanjung Priok still boils water though because the lid to his system broke. Ibu Hariah from Teluk Gong boils in addition to ceramic filtration since the filtration rate is not fast enough to meet her household water demand. Two new community members in Bintaro Lama have expressed interest in procuring filters of their own.[11]

Unfortunately, it became evident through this study that contacting the distributors has become ridiculously difficult. For this reason, and because of the poor system quality noted from the start, endorsing Plered Filters for replication is regarded as impractical. Nonetheless, ceramic filtration remains an appropriate technology albeit sufficient production and distribution has yet to be established in Indonesia.

# 7.5. SODIS ANALYSIS

From the bench-scale experiments, results indicate SODIS is a feasible alternative for water disinfection in Jakarta. Placing bottles atop a black cloth and inside a wind-break were found not to be essential, though users were advised to preferably use dark surfaces sheltered from wind where possible. Along with pilot-study samples tested the days directly after SODIS treatment,[12] two samples tested 2-days after, one 4-days after, and another 5-days after treatment, all had 0 FC/100mL. Though SODIS users were advised to use treated water within 1-2 days, these results confirm the effectiveness of SODIS in Jakarta.

At first introduction, SODIS was preferred second-to-last overall, with only 18.0% of the attendees' votes after the pre-trial campaigns. Note that in Bintaro Lama and Bintaro Baru, SODIS was preferred last overall with no votes for first-choice. However, after the post-trial

10 Pre-trial surveys show 20.6% preferred ceramic filtration overall and 20.0% ranked it their top-pick, second only to boiling. However, overall preference sunk to 18.0% in post-trial surveys (now third out of five) with only 10.3% ranking ceramic filtration as their top-pick (second least favored).

11 This was the outcome of offering an adjusted financing plan (independent of Plered) of three Rp.50.000 payments which was announced during the post-trial campaigns.

12 Bintaro Lama and Bintaro Baru waters had low risk of FC in Week 1 from samples treated the day before, but not in any samples tested thereafter.

campaigns, SODIS rose on average to the second most preferred technology overall.13 Both Bintaro Lama and Bintaro Baru now prefer SODIS most after boiling. In Teluk Gong, more users prefer SODIS than any of the other technologies including boiling.

The drastic differences between communities' pre-trial survey results are contributed chiefly to the introduction and explanation when presenting the technologies. The following two points were stressed in Teluk Gong & Tanjung Priok and are suggested to include in future promotion of this technology:

- SODIS uses a natural ways to make water healthier to drink.
- SODIS uses two types of energy from the sun to make water healthier to drink: heat and UV. Visualize your arm in the sun for example; you sweat because of the heat and your skin becomes darker because of the UV.

The increase in interest by the end of the pilot might also be related to SODIS treatment visibility. All the pilot-users have now adopted SODIS as their chosen water disinfection method. Lack of prior knowledge is thus thought to be the main hindrance to acceptability initially, which indicates a promising future for replication. Two new families in Bintaro Lama and two in Bintaro Baru have since begun using SODIS as a result of this work. Though Teluk Gong voted SODIS as their overall preference, new users have yet to surface. Several others commented that the washing of bottles etc. is too complicated for them to handle.

Bottle ware has 3-months later come into question; Figures 7.1 and 7.2 are photos of SODIS bottles from Bintaro Lama and Tanjung Priok respectively. Users have begun exchanging worn 1.5L bottles with other 1.5L or 600mL bottles scavenged from rubbish which are still in decent shape. The pilot-study bottles were painted half black, which created an additional obstacle to ensure users' bottles were aligned correctly. Past SODIS projects suggested bottles be painted black on one half, though recent recommendations say not to paint the bottles[14]. Not painting the bottles simplifies the procedure and makes a more sustainable option.

13 SODIS rose from fourth to second most preferred technology with 23% of the post-trial attendees' votes. Initially, 17.0% of pre-trial attendees ranked SODIS as their top-pick (median choice); SODIS rose to second top-pick with 26.4% votes.

14 Personal communications, 30 May 2006, Regula Meierhofer, Eawag, Water and Sanitation in Developing Countries (Sandec) Ueberlandstrasse 133, 8600 Duebendorf, Telp +41 (0)44 823 5073, www.sandec.ch.

**Figure 7-1 Bintaro Lama User's SODIS Bottle Ware After 3-months + a Fly.**

**Figure 7-2 Tanjung Priok User's SODIS Bottle Ware After 3-months.**

-----Original Message-----
From: mindy weimer [mailto:mindy.weimer@gmail.com]
Sent: Dienstag, 30. Mai 2006 02:11
To: kmcguigan@rcsi.ie; Prajwal Baral; Meierhofer Regula
Subject: SODIS related response... with attachment

Dear Regula, Kevin, and Prajwal,

Thank you for your prompt response to my inquiry last week. I apologize that it has taken me this long to reply.

The method I used to test for total FC is that prescribed in the DelAgua field kit manual. I have been using that frequently over the past year to test a full range of water samples. My reasoning for not attributing this detection to the method was because I ran them in triplicate.

The simplest explanation of course is to attribute the detection to experimental error. However, I am pretty confident in my water testing skills as I trained Oxfam field engineers how to use the DelAgua kit and water test; so I thought it best to not assume I made an error without inquiring to see if others had seen a similar trend somewhere.

"An increase of Faecal coliforms or other pathogens during solar exposure has never been observed nor could we find any regrowth of E.coli within one week after the water had been treated with SODIS.
Could it be that your test samples were recontaminated during sampling?" –Regula

I honestly cannot think of another explanation. I needed that confirmation from you though, and am actually pleased to learn that I can attribute those results to experimental error and not need to worry about regrowth.

"Nevertheless we changed our protocol to recommend that the SODIS water is consumed as soon as possible after exposure and not left for more than 24 hours before consumption." –Kevin

I have been monitoring the water quality of 4 SODIS users in 4 different Jakarta slums each week this month. A couple of the users have been treating 16 bottles at a time to refill their dispenser containers, so have not been drinking the water the very next day. Of the 5, 4, 2, and 2 days post-treated, all results show 0 FC/100mL. I still encourage them not to wait so long to drink the water, but just thought I would share that with you.

Thanks for you Kevin and Regula for insight re: thalates leaching from the plastic.

"In the beginning days, I could not believe and trust on this technology being so simple but after consulting some related professional I get satisfied on this technology. Basically, I am interested to familiarize this simple technology in most of our rural areas so I'd like to hear more detail information and your realistic experience so that I could do some thing for the people who are not able to adopt this very simple technic in their daily life." –Prajwal

I too had to prove it to myself, and ran tests of my own before I introduced SODIS to the urban communities I work with. Attached are the results of those tests, and I am still working on my report covering more detailed information of my "realistic experience" implementing and monitoring SODIS with community members. I will be happy to send it to you, though likely at the end of July.

Respectfully,
Mindy

--
Mindy Weimer
+62 81 315 425 860

# 8. REPLICATION

## 8.1. METHOD CONCLUSIONS

The pilot-study conducted provides grounds for replicating similar work to reach other underprivileged households in need of improved point-of-use drinking water treatment. Presenting proper water hygiene & handling measures and a menu of appropriate alternatives empowers participants to make informed decisions about the way they treat their drinking water. Regardless of whether the technologies presented change as appropriate for the target audience, it is advisable to always **include familiar/traditional technologies** so audiences may easier relate and compare information given.

Boiling and SODIS treatments were found to be the most preferred technologies in Bintaro Lama, Bintaro Baru, Teluk Gong and Tanjung Priok. Although likely representative of a majority of underprivileged households in Jakarta, it is still worthy to include the other technology options. Each of the technologies presented was favored by some and none of them were chosen unanimously. Even within the same community, household water sources, treatment and values differ; thus, **presenting a range of appropriate technologies** is a valuable endeavor.

The cost comparison "menu" of technologies given in Table 3.2, was revised to reflect results of this study. Table 8.1 shows the **revised cost comparison** with regards to the boiling and ceramic filtration cost. From the pilot-study boiling findings discussed, the initial estimated cost of boiling (Rp.128/L) was recalculated to Rp.147/L. The initial ceramic filtration cost estimate of Rp.16/L was recalculated to Rp.20/L based on the slower filtration rate discovered (from the said 16L/day to the found 12L/day).

**Table 8-1 Household Water Treatment Alternatives: Cost Comparison.**

| Treatment | Cost (Rp./L) |
|---|---|
| Boiling | 147 |
| *Isi-Ulang* | 108† |
| Chlorination | 7 |
| Ceramic Filtration | 20‡ |
| SODIS | 0 |

† Price does not include fixed cost of Rp.50/L for the water treated.
‡ Despite low normalized cost, capital cost remains concern for users.

Along with a cost comparison, the **presentation of technologies impacts community opinion** to a great extent. After the campaigns introducing each of the technologies in Bintaro Lama and Bintaro Baru, it was difficult to find volunteers for chlorination and SODIS while many attendees were coveting ceramic filter. So for the same campaigns in Teluk Gong and Tanjung Priok, more time was spent enthusiastically discussing chlorination and SODIS. As a result, chlorination and SODIS scores changed from low preference in Bintaro Lama and Bintaro Baru, to high in Teluk Gong and Tanjung Priok. Nonetheless, post-trial campaign surveys show community preference results more-or-less congruent. This proves that **pilot-trials and/or community member testimonies mitigate presentation biases**.

The alternative treatments were presented from a non-partisan standpoint as to avoid perceived bias. It was made clear during each campaign that the purpose of the campaigns was to inform community members of point-of-use options and that no technology sale benefits the presenter. Although not representative of the majority of attendees, Ibu Devi points out another presentation approach for product-distributors promoting Air RahMat, *isi-ulang*, and the no-longer-relevant Plered Ceramic Filters, for example.

> Ibu Devi (attended 1st campaign): "*We finally knew that beside boiling and isi-ulang, there are others alternatives to get healthy drinking water. Still, there are some families who have not informed about these alternatives, they must not attend the campaigns and considered as submissive one to whatever activities we have in this kampung. But some of us little bit confuse, if it is safe why it never been promoted before. I think it's the producers' responsibility to promote their technology.*"

Considering that introductory presentation biases do not impact enduring acceptance, most important is that there is regular follow-up. For example, even after repeated explanation, questions regarding color change with the addition of Air RahMat and observations of jerry-cans not being cleaned between use arose. No matter what technology, even in the established boiling and *isi-ulang* cases, **regular household visits were repeated shown to be an effective method of improving point-of-use drinking water quality**.

# 8.2. WITHIN COMMUNITIES

After introducing alternant technologies and sufficiently following-up with users, there is likely strong opportunity for further implementation within the same community. Ideally, the new users would be empowered to promote replication of the technology they learned to use, but this is not typically the case. While **new users** are open to assisting others interested, and casually introduce friends to a degree, they **lack initiative and time to promote and monitor others** their selves.

The following quotes were gathered during August 2006 from Teluk Gong community members who did not attend any of the campaigns.

> Ibu Endang: "*I have been so busy, that is why I never attend the campaigns. I heard about Air RahMat and tried it once from Ibu Sus. If it is still available, I really want to use it at least one bottle.*"
>
> Ibu Ida: "*I never attend the campaigns, but I heard from Ibu Sus about Air RahMat. I tried it once, but I don't like the smell.*"
>
> Ibu Maemunah: "*Even though I never attend the campaigns, but I was informed by my neighbors that there is alternative to have drinking water by putting some chemical liquid into our clean water.*"

These comments impress potential for progression of replication within communities where alternative treatments have already been introduced. A next step may be to work with new users to host small discussion groups in their homes for potential users in their community who have inquired or otherwise identified interest. As shown in this study, it is effectively influential for interested community members to learn from testimonies of their neighbors. Hence, making advantage of this means for information transfer should be prioritized before expending efforts to replicate in other communities.

## 8.3. OTHER COMMUNITIES

Replications with other communities are most effective through organizations already engaged in related work and have established relations with communities. Collaborating with such organizations to provide basic training on conducting field demonstrations, focus group discussions, and other means by which to reach those most in need of point-of-use alternatives is suggested. Whether the implementer is from a non-partisan group or represents a certain technology, the described treatment **comparison method** is recommended.

In addition, institutionalizing hygienic water handling and alternative disinfection methods into the local education system would be advantageous. This indeed is a hefty task, however, the current misconception that if water is tasteless, colorless and odorless it is safe to drink, compounded by the lack of knowledge of disinfection alternatives, exemplify the potential wide-spread benefit. Supporting the Indonesian Ministry of Educational Affairs to mandate such **educational action**, if at least in elementary schools, would mark a progressive step toward addressing drinking water problems for the people.

Furthermore, heightening awareness through **diverse means** will enhance replication efforts. Supporting the Indonesian Health Ministry with related materials correlating health issues with improper water-handling, to broadcast public media campaigns for example. Such campaigns or advertisements need be designed for an uneducated audience, in a catchy format that is easy to grasp. Related information on alternative point-of-use water treatment methods distributed at local *puskesmas* centers is also suggested. Furthermore, compiling developed materials & information and lessons learned for effective point-of-use applications in Indonesia to publish on the World Wide Web is recommended to provide a resource for other implementers and a platform for future developments in point-of-use implementation methods.

# 9. ANNEXES

ANNEX 1: Bibliography
ANNEX 2: Bench-Scale SODIS Data
ANNEX 3: Pilot-Trial Water Quality Data
ANNEX 4: Pilot-Trial Community Initial Survey Data
ANNEX 5: Pilot-Trial Community Final Survey Data

# ANNEX 1: BIBLIOGRAPHY

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# ANNEX 2: BENCH-SCALE SODIS DATA

The data in Annex 2 includes that from the bench-scale SODIS experiment. Tables A.1 and A.2 detail the temperature data gathered for Bintaro Lama and Teluk Gong waters respectively. * indicates bottles sampled from prior to temperature measurement. Brief notes on weather conditions and ambient temperatures at those times are available upon request to mindy.weimer@gmail.com. Tables A.3 and A.4 detail the FC measurements made for the discussed Bintaro Lama and Teluk Gong waters at time-intervals in the bench-scale SODIS experiments.

**Table A.1 Bintaro Lama Water SODIS Bench-Scale Temperature Data**

| Friday, 7 April'06, 06:00 | | | | Friday, 7 April'06, 09:00 | | | | Friday, 7 April'06, 12:00 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (°C) | A | B | std dev | (°C) | A | B | std dev | (°C) | A | B | std dev |
| 1 | 27.7 | 27.8 | 0.1 | 1 | 45.7 | 43.2 | 1.8 | 1* | 55.9 | 52.6 | 2.3 |
| 2 | 27.6 | 27.7 | 0.1 | 2 | 45.4 | 43.0 | 1.7 | 2 | **57.5** | 52.8 | 3.3 |
| 3 | 27.7 | 27.8 | 0.1 | 3 | 44.3 | 42.9 | 1.0 | 3 | **57.5** | 52.6 | 3.5 |
| 4 | 27.7 | 27.8 | 0.1 | 4 | 44.2 | 42.4 | 1.3 | 4 | 57.4 | 52.5 | 3.5 |
| 5 | 27.8 | 27.7 | 0.1 | 5 | 42.6 | 42.3 | 0.2 | 5 | 56.3 | 51.3 | 3.5 |
| 6 | 27.7 | 27.7 | 0.0 | 6 | 42.8 | 42.0 | 0.6 | 6 | 56.4 | 51.1 | 3.7 |
| avrg | **27.7** | **27.8** | 0.1 | avrg | **44.2** | **42.6** | 1.1 | avrg | **57.0** | **52.1** | ***3.3*** |

| Friday, 7 April'06, 15:00 | | | | Friday, 7 April'06, 18:00 | | | | Saturday, 8 April'06, 06:00 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (°C) | A | B | std dev | (°C) | A | B | std dev | (°C) | A | B | std dev |
| 1* | 50.2 | 47.1 | 2.2 | 1* | 37.0 | 36 | 0.7 | 1* | 27.1 | 24.7 | 1.7 |
| 2* | 49.9 | 45.9 | 2.8 | 2* | 37.1 | 35.5 | 1.1 | 2* | 27.4 | 27.0 | 0.3 |
| 3 | 52.3 | 48.8 | 2.5 | 3 | 37.0 | 36.4 | 0.4 | 3* | 27.1 | 26.9 | 0.1 |
| 4 | 52.3 | 48.0 | 3.0 | 4 | 36.8 | 36.1 | 0.5 | 4 | 27.5 | 27.2 | 0.2 |
| 5 | 51.2 | 48.8 | 1.7 | 5 | 36.3 | 36.7 | 0.3 | 5 | 27.2 | 27.0 | 0.1 |
| 6 | 51.2 | 48.9 | 1.6 | 6 | 36.5 | 36.5 | 0.0 | 6 | 27.2 | 26.9 | 0.2 |
| avrg | **51.8** | **48.6** | 2.3 | avrg | **36.7** | **36.4** | 0.5 | avrg | **27.3** | **27.0** | 0.4 |

| Saturday, 8 April'06, 18:00 | | | | Sunday, 9 April'06, 06:00 | | | |
|---|---|---|---|---|---|---|---|
| (°C) | A | B | std dev | (°C) | A | B | std dev |
| 1* | 29.4 | 29.8 | 0.3 | 1* | 29.2 | 28.4 | 0.6 |
| 2* | 29.5 | 29.6 | 0.1 | 2* | 29.1 | 28.4 | 0.5 |
| 3* | 29.3 | 29.0 | 0.2 | 3* | 28.6 | 28.4 | 0.1 |
| 4* | 29.5 | 29.0 | 0.4 | 4* | 28.8 | 28.9 | 0.1 |
| 5 | 28.8 | 29.5 | 0.5 | 5 | 28.4 | 27.8 | 0.4 |
| 6 | 28.9 | 29.4 | 0.4 | 6 | 28.4 | 28.0 | 0.3 |
| avrg | **28.9** | **29.5** | 0.3 | avrg | **28.4** | **27.9** | 0.3 |

**Table A.2 Teluk Gong Water SODIS Bench-Scale Temperature Data**

| Wed, 12 April'06, 06:00 | | | | Wed, 12 April'06, 09:00 | | | | Wed, 12 April'06, 12:00 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (°C) | A | B | std dev | (°C) | A | B | std dev | (°C) | A | B | std dev |
| 1 | 28.1 | 28.0 | 0.1 | 1 | 45.7 | 43.0 | 1.9 | 1* | 58.5 | 55.5 | 2.1 |
| 2 | 28.0 | 27.8 | 0.1 | 2 | 45.1 | 43.0 | 1.5 | 2 | ***60.2*** | 55.3 | 3.5 |
| 3 | 28.1 | 27.7 | 0.3 | 3 | 44.7 | 42.7 | 1.4 | 3 | 60.1 | 56.1 | 2.8 |
| 4 | 28.1 | 27.9 | 0.1 | 4 | 44.3 | 42.9 | 1.0 | 4 | 59.0 | 55.0 | 2.8 |
| 5 | 28.2 | 27.8 | 0.3 | 5 | 44.4 | 43.0 | 1.0 | 5 | 59.6 | 55.3 | 3.0 |
| 6 | 28.1 | 27.8 | 0.2 | 6 | 44.5 | 42.2 | 1.6 | 6 | 58.9 | 54.5 | 3.1 |
| avrg | **28.1** | **27.8** | 0.2 | avrg | **44.8** | **42.8** | 1.4 | avrg | **59.6** | **55.2** | **2.9** |

| Wed, 12 April'06, 15:00 | | | | Wed, 12 April'06, 18:00 | | | | Thurs, 13 April'06, 06:00 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (°C) | A | B | std dev | (°C) | A | B | std dev | (°C) | A | B | std dev |
| 1* | 39.4 | 36.9 | 1.8 | 1* | 31.2 | 30.4 | 0.6 | 1* | 26.5 | 26.3 | 0.1 |
| 2* | 37.7 | 35.4 | 1.6 | 2* | 31.2 | 30.2 | 0.7 | 2* | 26.3 | 26.3 | 0.0 |
| 3 | 39.7 | 37.1 | 1.8 | 3 | 31.5 | 30.6 | 0.6 | 3* | 27.3 | 26.4 | 0.6 |
| 4 | 39.7 | 36.8 | 2.1 | 4 | 31.6 | 30.8 | 0.6 | 4 | 26.9 | 26.4 | 0.4 |
| 5 | 41.0 | 39.1 | 1.3 | 5 | 31.7 | 31.0 | 0.5 | 5 | 26.9 | 26.1 | 0.6 |
| 6 | 40.7 | 38.1 | 1.8 | 6 | 31.4 | 30.8 | 0.4 | 6 | 26.9 | 26.1 | 0.6 |
| avrg | **40.3** | **37.8** | 1.7 | avrg | **31.6** | **30.8** | 0.6 | avrg | **26.9** | **26.2** | 0.4 |

| Thur, 13 April'06, 12:00 | | | | Thur, 13 April'06, 18:00 | | | | Fri, 14 April'06, 06:00 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (°C) | A | B | std dev | (°C) | A | B | std dev | (°C) | A | B | std dev |
| 1* | 39.3 | 39.6 | 0.2 | 1* | 27.7 | 26.0 | 1.2 | 1* | 24.7 | 24.5 | 0.1 |
| 2* | 40.0 | 39.2 | 0.6 | 2* | 27.1 | 26.0 | 0.8 | 2* | 24.6 | 24.6 | 0.0 |
| 3* | 39.9 | 39.3 | 0.4 | 3* | 27.1 | 26.1 | 0.7 | 3* | 24.7 | 24.5 | 0.1 |
| 4 | 40.0 | 39.1 | 0.6 | 4* | 26.9 | 26.2 | 0.5 | 4* | 24.5 | 24.6 | 0.1 |
| 5 | 39.9 | 39.5 | 0.3 | 5 | 27.0 | 26.0 | 0.7 | 5 | 24.4 | 24.5 | 0.1 |
| 6 | 40.0 | 39.3 | 0.5 | 6 | 26.7 | 25.9 | 0.6 | 6 | 24.3 | 24.4 | 0.1 |
| avrg | **40.0** | **39.3** | 0.4 | avrg | **26.9** | **26.0** | 0.7 | avrg | **24.4** | **24.5** | 0.1 |

**Table A.3 Bintaro Lama SODIS Bench-Scale Water Quality Data**

| Time | A (FC/100mL) | | B (FC/100mL) | |
|---|---|---|---|---|
| **6:00** | TMTC | **260** | TMTC | **260** |
| | 235 | | 235 | |
| | 285 | | 285 | |
| **9:00** | 18 | **14** | 19 | **22** |
| | 15 | | 25 | |
| | 8 | | 23 | |
| **12:00** | 0 | **0** | 0 | **0** |
| | 0 | | 0 | |
| | 0 | | 0 | |
| **18:00** | 0 | **0** | 0 | **0** |
| | 0 | | 0 | |
| | 0 | | 0 | |
| **6:00 +1** | 0 | **0** | 0 | **0** |
| | 0 | | 0 | |
| | 0 | | 0 | |
| **6:00 +2** | 0 | **0** | 0 | **0** |
| | 0 | | 0 | |
| | 0 | | 0 | |

**Table A.4 Teluk Gong SODIS Bench-Scale Water Quality Data**

| Time | A (FC/100mL) | | B (FC/100mL) | |
|---|---|---|---|---|
| **6:00** | 17 | **16** | 17 | **16** |
| | 19 | | 19 | |
| | 13 | | 13 | |
| **9:00** | 58 | **56** | 31 | **32** |
| | 62 | | 28 | |
| | 49 | | 37 | |
| **12:00** | 0 | **0** | 0 | **0** |
| | 0 | | 0 | |
| | 0 | | 0 | |
| **18:00** | 0 | **0** | 0 | **0** |
| | 0 | | 0 | |
| | 0 | | 0 | |
| **6:00 +1** | 0 | **0** | 0 | **0** |
| | 0 | | 0 | |
| | 0 | | 0 | |
| **6:00 +2** | 7 | **4** | 0 | **0** |
| | 2 | | 0 | |
| | 4 | | 0 | |

# ANNEX 3: PILOT-TRIAL WATER QUALITY DATA

Annex 3 includes result details from the pilot-trial water quality tests of boiling, *isi-ulang*, chlorination, ceramic filtration, and SODIS treatments, respectively. Some tables include extra measurements made to show results of tests run at other times using the same water source. This is done to give the reader a perspective of source water or pre-pilot water quality.

## B.1 Boiling

**Table B.1.1 Bintaro Lama Boiling Pilot-Trial Water Quality Results (also refer to Tables A.3, 4.5, and B.3.1)**

| BOILING | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Kartini stored well | 1/24/2006 11:07 | slightly unclear | "apek" old-person's house | 122 | 0.00 | TMTC | too many too count | All covered with tiny yellow colonies. |
| b, Kartini stored well | | | | | | TMTC | | |
| c, Kartini stored well | | | | | | TMTC | | |
| d, Kartini boiled well | 1/24/2006 11:13 | slightly unclear | "apek" old-person's house | 144 | 0.00 | 34 | >29 | Plate f covered with tiny yellow colonies. |
| e, Kartini boiled well | | | | | | 23 | | |
| f, Kartini boiled well | | | | | | TMTC | | |
| Sikem 1 | 5/4/2006 12:23 | slightly yellow | bland | 214 | 0.1 | 7 | 3 | Yellow filtrate. |
| Sikem 2 | | | | | | 1 | | |
| Sikem 3 | | | | | | 1 | | |
| Sikem 4 | 5/10/2006 9:40 | clear | bland | n/a | 0.01 | 0 | 0 | Many small clear colonies on all. |
| Sikem 5 | | | | | | 0 | | |
| Sikem 6 | | | | | | 0 | | |
| Sikem 7 | 5/16/2006 9:17 | clear | plain | 188 | 0.0 | 0 | 0 | Covered in tiny yellow layer of colonies. |
| Sikem 8 | | | | | | 0 | | |
| Sikem 9 | | | | | | 0 | | |
| Sikem 10 | 5/22/2006 9:08 | clear | bland | 212 | 0.0 | 0 | 0 | Covered in small yellow colonies. |
| Sikem 11 | | | | | | 0 | | |
| Sikem 12 | | | | | | 0 | | |

**Table B.1.2 Bintaro Baru Boiling Pilot-Trial Water Quality Results (also refer to Tables B.3.2 and B.4.2)**

| BOILING | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| A, Marni boiled well | 2/23/2006 10:15 | faintly cream | plain | 168 | 0.01 | 4 | 2 | Covered in tiny colonies. |
| B, Marni boiled well | | | | | | 1 | | |
| C, Marni boiled well | | | | | | 2 | | |
| a, Marni stored well | 2/23/2006 10:25 | faintly cream | plain | 162 | 0.00 | 16 | 18 | Covered in tiny colonies. |
| b, Marni stored well | | | | | | 22 | | |
| c, Marni stored well | | | | | | 17 | | |
| d, Itoh stored well | 6/2/2006 12:30 | clear | plain | 164 | 0.00 | 6 | 6 | Slightly yellow filtrate. |
| e, Itoh stored well | | | | | | 0 | | |
| f, Itoh stored well | | | | | | 12 | | |
| Itoh 1 | 5/4/2006 10:33 | clear | bland | 140 | 0.1 | 0 | 1 | Plate 3 was covered with tiny colonies. |
| Itoh 2 | | | | | | 0 | | |
| Itoh 3 | | | | | | 2 | | |
| Itoh 4 | 5/10/2006 9:40 | clear | bland | n/a | 0.01 | 0 | 0 | Many small clear colonies on all. |
| Itoh 5 | | | | | | 0 | | |
| Itoh 6 | | | | | | 0 | | |
| Itoh 7 | 5/16/2006 11:08 | clear | plain | 140 | 0.1 | 0 | 1 | Many small, several medium-sized colonies. |
| Itoh 8 | | | | | | 3 | | |
| Itoh 9 | | | | | | 0 | | |
| Itoh 10 | 5/22/2006 10:50 | clear | plain | 135 | 0.0 | 0 | 0 | Many medium yellow/clear colonies. |
| Itoh 11 | | | | | | 0 | | |
| Itoh 12 | | | | | | 0 | | |

**Table B.1.3 Teluk Gong Boiling Pilot-Trial Water Quality Results (also refer to Tables A.4, 4.6, B.3.3 and B.5.3)**

| BOILING | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| g, Nita stored vendor | 6/2/2006 10:02 | clear | plain | 140 | 0.07 | 0 | 0 | Many tiny colonies. |
| h, Nita stored vendor | | | | | | 0 | | |
| i, Nita stored vendor | | | | | | 1 | | |
| Nita 1 | 5/5/2006 14:02 | clear | raw | 113 | 0.01 | 0 | 1 | Dirty filtrate. |
| Nita 2 | | | | | | 1 | | |
| Nita 3 | | | | | | 1 | | |
| Nita 4 | 5/12/2006 11:15 | clear | plain | n/a | 0.1 | 0 | 0 | 2 splotches on plate 6. |
| Nita 5 | | | | | | 0 | | |
| Nita 6 | | | | | | 0 | | |
| Nita 7 | 5/17/2006 0:00 | | | | | | | Family not home so could not take sample. |
| Nita 8 | | | | | | | | |
| Nita 9 | | | | | | | | |
| Nita 10 | 5/23/2006 9:23 | slightly yellow | plain | 171 | 0.1 | 0 | 0 | Only one small clear colony on plate 3. |
| Nita 11 | | | | | | 0 | | |
| Nita 12 | | | | | | 0 | | |

**Table B.1.4 Tanjung Priok Boiling Pilot-Trial Water Quality Results (also refer to Table B.5.4)**

| BOILING | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| g, Yati tap | 5/5/2006 11:59 | clear | chlorine | 140 | 0.94 | 0 | 0 | Tap water prior to boiling, from new PDAM connection. |
| h, Yati tap | | | | | | 0 | | |
| i, Yati tap | | | | | | 0 | | |
| Yati 1 | 5/5/2006 11:54 | clear | metal | 122 | 0.02 | 8 | 5 | About the same # in plate 2, only clear colonies. Many clear on all. |
| Yati 2 | | | | | | 0 | | |
| Yati 3 | | | | | | 7 | | |
| Yati 4 | 5/12/2006 12:54 | clear | plain | n/a | 0.0 | 0 | 0 | Many medium, just below countable size, on all. |
| Yati 5 | | | | | | 0 | | |
| Yati 6 | | | | | | 0 | | |
| Yati 7 | 5/17/2006 0:00 | | | | | | | Family not home, so could not take sample. |
| Yati 8 | | | | | | | | |
| Yati 9 | | | | | | | | |
| Yati 10 | 5/23/2006 12:40 | clear | plain | 189 | 0.0 | 0 | 0 | Many tiny clear colonies on plates 16 & 17. Many small yellow colonies on plate 18. |
| Yati 11 | | | | | | 0 | | |
| Yati 12 | | | | | | 0 | | |

## B.2 Isi-Ulang

**Table B.2.1 Bintaro Lama Isi-Ulang Water Quality Results**

| ISI ULANG | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Nurian's dispenser | 1/24/2006 11:18 | clear | bland | 62 | 0.01 | 0 | 0 | Hundreds of non-yellow colonies. |
| b, Nurina's dispenser | | | | | | 0 | | |
| c, Nurina's dispenser | | | | | | 0 | | |
| 1 | 5/4/2006 12:12 | clear | bland | 53 | <0.1 | 3 | 3 | Large colonies formed. |
| 2 | | | | | | 3 | | |
| 3 | | | | | | 4 | | |
| 4 | 5/10/2006 11:30 | clear | plain | n/a | 0.00 | 2 | 1 | Several splotchy clear colonies on all. |
| 5 | | | | | | 1 | | |
| 6 | | | | | | 0 | | |
| 7 | 5/16/2006 9:32 | clear | plain | 55 | 0.0 | 1 | 0 | Many tiny, and a few medium-sized colonies. |
| 8 | | | | | | 0 | | |
| 9 | | | | | | 0 | | |
| 10 | 5/22/06 0:00 | | | | | | | No sample available. |
| 11 | | | | | | | | |
| 12 | | | | | | | | |

**Table B.2.2 Bintaro Baru Isi-Ulang Water Quality Results**

| ISI ULANG | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Ibu Enok's dispenser | 2/23/2006 10:23 | clear | plain | 50 | 0.00 | 0 | 0 | n/a |
| b, Ibu Enok's dispenser | | | | | | 0 | | |
| c, Ibu Enok's dispenser | | | | | | 0 | | |
| d, membrane station | 2/23/2006 10:35 | clear | plain | 50 | 0.00 | 0 | 0 | n/a |
| e, membrane station | | | | | | 0 | | |
| f, membrane station | | | | | | 0 | | |
| g, UV/ozone station | 2/23/2006 11:00 | clear | plain | 55 | 0.01 | 0 | 0 | n/a |
| h, UV/ozone station | | | | | | 0 | | |
| i, UV/ozone station | | | | | | 0 | | |
| 1 | 5/4/2006 10:40 | clear | plain | 51 | <0.1 | 0 | 1 | n/a |
| 2 | | | | | | 2 | | |
| 3 | | | | | | 2 | | |
| 4 | 5/10/2006 9:40 | clear | bland | n/a | 0.01 | 1 | 1 | n/a |
| 5 | | | | | | 3 | | |
| 6 | | | | | | 0 | | |
| 7 | 5/16/2006 11:16 | clear | plain | 65 | 0.0 | 0 | 0 | Covered with very tiny clear colonies. |
| 8 | | | | | | 0 | | |
| 9 | | | | | | 0 | | |
| 10 | 5/22/2006 11:03 | clear | plain | 56 | 0.0 | 0 | 0 | Covered with tiny clear colonies. |
| 11 | | | | | | 0 | | |
| 12 | | | | | | 0 | | |

**Table B.2.3 Teluk Gong Isi-Ulang Water Quality Results**

| ISI ULANG | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, exchange station | 12/16/2005 13:00 | clear | bland | 57 | 0.01 | 0 | 0 | 2 non-yellow colonies on plate c. |
| b, exchange station | | | | | | 0 | | |
| c, exchange station | | | | | | 0 | | |
| d, aeration station | 12/16/2005 13:12 | clear | bland | 61 | 0.01 | 0 | 1 | Several non-yellow colonies on all plates. |
| e, aeration station | | | | | | 0 | | |
| f, aeration station | | | | | | 3 | | |
| 1 | 5/5/2006 13:57 | clear | plain | 132 | 0.01 | 0 | 0 | Many medium clear colonies on all. |
| 2 | | | | | | 0 | | |
| 3 | | | | | | 0 | | |
| 4 | 5/12/2006 11:01 | clear | plain | n/a | 0.0 | 1 | 0 | Covered in small yellow colonies. |
| 5 | | | | | | 0 | | |
| 6 | | | | | | 0 | | |
| 7 | 5/17/2006 9:46 | clear | plain | 62 | 0.0 | 0 | 0 | Covered in tiny clear colonies. |
| 8 | | | | | | 0 | | |
| 9 | | | | | | 0 | | |
| 10 | 5/23/2006 9:42 | clear | plain | 147 | 0.1 | 0 | 0 | Covered in tiny and many small colonies. |
| 11 | | | | | | 0 | | |
| 12 | | | | | | 0 | | |

**Table B.2.4 Tanjung Priok Isi-Ulang Water Quality Results**

| ISI ULANG | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, station 66 | 1/20/2006 12:20 | clear | bland | 54 | 0.02 | 0 | 0 | n/a |
| b, station 66 | | | | | | 0 | | |
| c, station 66 | | | | | | 0 | | |
| d, station 66 user's | 1/20/2006 11:50 | clear | bland | 58 | 0.01 | 0 | 0 | n/a |
| e, station 66 user's | | | | | | 0 | | |
| f, station 66 user's | | | | | | 0 | | |
| 1 | 5/5/2006 12:05 | clear | plain | 77 | 0.01 | 1 | 1 | Many large clear colonies on all. |
| 2 | | | | | | 1 | | |
| 3 | | | | | | 2 | | |
| 4 | 5/12/2006 13:15 | clear | plain | n/a | 0.0 | 0 | 0 | Covered with tiny clear colonies. |
| 5 | | | | | | 0 | | |
| 6 | | | | | | 0 | | |
| 7 | 5/17/2006 11:15 | clear | plain | 5 | 0.0 | 0 | 0 | Many tiny clear colonies. |
| 8 | | | | | | 0 | | |
| 9 | | | | | | 0 | | |
| 10 | 5/23/2006 12:51 | clear | plain | 69 | 0.0 | 0 | 0 | Covered with tiny clear & several small colonies. |
| 11 | | | | | | 0 | | |
| 12 | | | | | | 0 | | |

## B.3 Chlorination

**Table B.3.1 Bintaro Lama Chlorination Water Quality Results (also refer to Tables A.3, 4.5, and B.1.1)**

| CHLORINATION | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, straight well | 3/22/06 11:02 | hardly at all | full | 243 | n/a | 0' | 0' | 'Covered with small yellow colonies barely under countable size. |
| b, straight well | | | | | | 0' | | |
| c, straight well | | | | | | 0' | | |
| d, straight well+1day | 4/6/06 0:00 | murky | chemical | 218 | 0.0 | TMTC | >260 | Plates e & f were 20mL dilutions. |
| e, straight well+1day | | | | | | 235 | | |
| f, straight well+1day | | | | | | 285 | | |
| Kamsir 1 | 5/4/2006 12:10 | slightly yellow | chlorine | 147 | 2.0 | 0 | 0 | Yellow filtrate. |
| Kamsir 2 | | | | | | 0 | | |
| Kamsir 3 | | | | | | 0 | | |
| Kamsir 4 | 5/10/2006 11:33 | yellow | plain | n/a | 0.70 | 4 | 4 | Yellow filtrate. |
| Kamsir 5 | | | | | | 3 | | |
| Kamsir 6 | | | | | | 6 | | |
| Kamsir 7 | 5/16/2006 9:37 | clear | slightly like chlorine | 147 | 0.1 | 0 | 0 | Many small colonies. Slightly yellow filtrate. |
| Kamsir 8 | | | | | | 0 | | |
| Kamsir 9 | | | | | | 0 | | |
| Kamsir 10 | 5/16/2006 10:01 | clear | strong chlorine | 160 | 0.2 | 0 | 0 | Very clean. |
| Kamsir 11 | | | | | | 0 | | |
| Kamsir 12 | | | | | | 0 | | |
| Kamsir 13 | 5/22/2006 9:44 | tiny orange flocs | plain | 157 | 0.2 | 0 | 0 | A few clear colonies. Dusty filtrate. |
| Kamsir 14 | | | | | | 0 | | |
| Kamsir 15 | | | | | | 0 | | |

**Table B.3.2 Bintaro Baru Chlorination Water Quality Results (also refer to Tables B.1.2 and B.4.2)**

| CHLORINATION | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Marni stored well | 2/23/2006 10:25 | faintly cream | plain | 162 | 0.00 | 16 | 18 | Covered in tiny colonies. |
| b, Marni stored well | | | | | | 22 | | |
| c, Marni stored well | | | | | | 17 | | |
| d, Marni stored well | 6/1/2006 10:25 | clear | plain | 161 | n/a | 19 | 15 | Yellow tinted filtrated with many small colonies just under countable size. |
| e, Marni stored well | | | | | | 16 | | |
| f, Marni stored well | | | | | | 9 | | |
| Marni 1 | 5/4/2006 10:49 | barely tinted | chlorine | 165 | 2.0 | 0 | 0 | Yellow filtrate. |
| Marni 2 | | | | | | 0 | | |
| Marni 3 | | | | | | 0 | | |
| Marni 4 | 5/10/2006 10:05 | yellow, floating particul ates | chlorine | n/a | 1.23 | 0 | 0 | Dark yellow filtrate. |
| Marni 5 | | | | | | 0 | | |
| Marni 6 | | | | | | 0 | | |
| Marni 7 | 5/16/2006 10:37 | clear | slightly like chlorine | 162 | 0.2 | 0 | 0 | Very clean, except for a dead ant in filtrate 7. |
| Marni 8 | | | | | | 0 | | |
| Marni 9 | | | | | | 0 | | |
| Marni 10 | 5/22/2006 0:00 | | | | | | | No sample available. |
| Marni 11 | | | | | | | | |
| Marni 12 | | | | | | | | |

**Table B.3.3 Teluk Gong Chlorination Water Quality Results (also refer to Tables A.4, 4.6, B.5.3 and B.1.3)**

| CHLORINATION | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Suswati stored vendor | 11/25/2005 12:52 | clear | plain | 139 | 0.03 | 4 | 5 | Many other non-yellow colonies present. |
| b, Suswati stored vendor | | | | | | 6 | | |
| c, Suswati stored vendor | | | | | | 5 | | |
| d, Suswati boiled vendor | 11/25/2005 12:55 | clear | plain | 146 | 0.02 | 0 | 0 | n/a |
| e, Suswati boiled vendor | | | | | | 0 | | |
| f, Suswati boiled vendor | | | | | | 0 | | |
| Suswati 1 | 5/5/2006 13:45 | clear | chlorine | 90 | 0.74 | 0 | 0 | Very clean. |
| Suswati 2 | | | | | | 0 | | |
| Suswati 3 | | | | | | 0 | | |
| Suswati 4 | 5/12/2006 10:05 | clear | chlorine | n/a | 6.2 | 0 | 0 | Very clean. |
| Suswati 5 | | | | | | 0 | | |
| Suswati 6 | | | | | | 0 | | |
| Suswati 7 | 5/17/2006 10:06 | clear | chlorine | 146 | 6.3 | 0 | 0 | Very clean. |
| Suswati 8 | | | | | | 0 | | |
| Suswati 9 | | | | | | 0 | | |
| Suswati 10 | 5/23/2006 9:50 | slightly yellow | strong chlorine | 177 | 5.3 (Hach), 2.91 (Palintest), 3.0-2.0 (colorimetric) | 0 | 0 | Very clean, but slightly colored filtrate. |
| Suswati 11 | | | | | | 0 | | |
| Suswati 12 | | | | | | 0 | | |

**Table B.3.4 Tanjung Priok Chlorination Water Quality Results (also refer to Table B.4.4)**

| CHLORINATION | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Wiwin stored vendor | 6/3/2006 10:55 | clear | chlorine | 217 | 0.06 | 0 | 0 | Dirty filtrates. |
| b, Wiwin stored vendor | | | | | | 0 | | |
| c, Wiwin stored vendor | | | | | | 0 | | |
| Wiwin 1 | 5/5/2006 11:48 | clear | plain | 90 | 0.02 | 0 | 4 | Many tiny clear colonies on all. |
| Wiwin 2 | | | | | | 0 | | |
| Wiwin 3 | | | | | | 13 | | |
| Wiwin 4 | 5/12/2006 0:00 | | | | | | | No sample available because there was no water for Ibu to buy today. |
| Wiwin 5 | | | | | | | | |
| Wiwin 6 | | | | | | | | |
| Wiwin 7 | 5/17/2006 11:01 | clear | chlorine | 157 | 5.1 | 0 | 0 | Very clean. |
| Wiwin 8 | | | | | | 0 | | |
| Wiwin 9 | | | | | | 0 | | |
| Wiwin 10 | 5/23/2006 12:03 | clear | plain | 202 | 0.1 | 0 | 1 | Several small colonies on all. |
| Wiwin 11 | | | | | | 4 | | |
| Wiwin 12 | | | | | | 0 | | |

## B.4 Ceramic Filtration

**Table B.4.1 Bintaro Lama Ceramic Filtration Water Quality Results (also refer to Tables A.3, 4.5, B.3.1 and B.1.1)**

| CERAMIC FILTER | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| Weri 1 | 5/4/06 12:03 | clear | bland | 133 | 0.1 | 1 | 1 | Many tiny clear colonies. |
| Weri 2 | | | | | | 1 | | |
| Weri 3 | | | | | | 1 | | |
| Weri 4 | 5/10/06 10:00 | clear | bland | n/a | 0.02 | 0 | 0 | Several small clear colonies on all. |
| Weri 5 | | | | | | 0 | | |
| Weri 6 | | | | | | 0 | | |
| Weri 7 | 5/16/2006 0:00 | | | | | | | Family not home, so could not take sample. |
| Weri 8 | | | | | | | | |
| Weri 9 | | | | | | | | |
| Weri 10 | 5/22/2006 9:20 | clear | bland | 157 | 0.0 | 0 | 0 | Several small clear colonies on all. |
| Weri 11 | | | | | | 0 | | |
| Weri 12 | | | | | | 0 | | |

**Table B.4.2 Bintaro Baru Ceramic Filtration Water Quality Results (also refer to Tables B.1.2 and B.3.2)**

| CERAMIC FILTER | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Yati stored well | 6/1/2006 10:38 | clear | plain | 169 | n/a | 21 | 24 | Yellow tinted filtrate, covered in tiny colonies. |
| b, Yati stored well | | | | | | 31 | | |
| c, Yati stored well | | | | | | 21 | | |
| Yati 1 | 5/4/06 10:30 | clear | bland | 159 | <0.1 | 0 | 0 | n/a |
| Yati 2 | | | | | | 0 | | |
| Yati 3 | | | | | | 1 | | |
| Yati 4 | 5/10/06 10:00 | clear | bland | n/a | 0.02 | 0 | 0 | Several small clear colonies on all. |
| Yati 5 | | | | | | 0 | | |
| Yati 6 | | | | | | 0 | | |
| Yati 7 | 5/16/2006 10:46 | clear | plain | 161 | 0.1 | 0 | 0 | Clean. |
| Yati 8 | | | | | | 0 | | |
| Yati 9 | | | | | | 0 | | |
| Yati 10 | 5/22/2006 10:46 | clear | bland | 163 | 0.0 | 0 | 0 | Very clean. |
| Yati 11 | | | | | | 0 | | |
| Yati 12 | | | | | | 0 | | |

**Table B.4.3 Teluk Gong Ceramic Filtration Water Quality Results**

| CERAMIC FILTER | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Hadriah direct PDAM | 6/2/2006 10:30 | clear | plain | 149 | 0.89 | 0 | 0 | Clean. |
| b, Hadriah direct PDAM | | | | | | 0 | | |
| c, Hadriah direct PDAM | | | | | | 0 | | |
| Hadriah 1 | 5/5/06 13:54 | clear | full | 150 | 0.02 | 0 | 0 | Very clean. |
| Hadriah 2 | | | | | | 0 | | |
| Hadriah 3 | | | | | | 0 | | |
| Hadriah 4 | 5/12/06 10:49 | clear | plain | n/a | 0.0 | 0 | 0 | Very clean. |
| Hadriah 5 | | | | | | 0 | | |
| Hadriah 6 | | | | | | 0 | | |
| Hadriah 7 | 5/17/2006 10:39 | clear | plain | 128 | 0.0 | 0 | 0 | Very clean. |
| Hadriah 8 | | | | | | 0 | | |
| Hadriah 9 | | | | | | 0 | | |
| Hadriah 10 | 5/23/06 9:09 | clear | bland | 168 | 0.0 | 0 | 0 | n/a |
| Hadriah 11 | | | | | | 0 | | |
| Hadriah 12 | | | | | | 0 | | |

**Table B.4.4 Tanjung Priok Ceramic Filtration Water Quality Results (also refer to Table B.3.4)**

| CERAMIC FILTER | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Haris stored vendor | 12/16/2005 10:08 | clear | plain | 124 | 0.01 | 0 | 0 | n/a |
| b, Haris stored vendor | | | | | | 0 | | |
| c, Haris stored vendor | | | | | | 0 | | |
| d, Haris boiled vendor | 12/16/2005 10:08 | clear | plain | 130 | 0.00 | 0 | 0 | n/a |
| e, Haris boiled vendor | | | | | | 0 | | |
| f, Haris boiled vendor | | | | | | 0 | | |
| Haris 1 | 5/5/06 12:12 | clear | sharp | 144 | 0.01 | 0 | 0 | Plate 3 had 1 small clear colony. |
| Haris 2 | | | | | | 0 | | |
| Haris 3 | | | | | | 0 | | |
| Haris 4 | 5/12/06 12:25 | clear | plain | n/a | 0.0 | 0 | 0 | Many tiny colonies on all. |
| Haris 5 | | | | | | 0 | | |
| Haris 6 | | | | | | 0 | | |
| Haris 7 | 5/17/2006 11:48 | clear | plain | 154 | 0.0 | 0 | 0 | Many tiny clear colonies. |
| Haris 8 | | | | | | 0 | | |
| Haris 9 | | | | | | 0 | | |
| Haris 10 | 5/23/2006 12:51 | clear | plain | 185 | 0.0 | 0 | 0 | n/a |
| Haris 11 | | | | | | 0 | | |
| Haris 12 | | | | | | 0 | | |

## B.5 SODIS

**Table B.5.1 Bintaro Lama SODIS Water Quality Results (also refer to Tables A.3, 4.5, B.3.1 and B.1.1)**

| SODIS | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| Kana 1 | 5/4/2006 12:27 | slightly less yellow | natural | 216 | <0.1 | 0 | 8 | Yellow filtrate. |
| Kana 2 | | | | | | 2 | | |
| Kana 3 | | | | | | 22 | | |
| Kana 4 | 5/10/2006 0:00 | | | | | | | Family not home so could not take sample. |
| Kana 5 | | | | | | | | |
| Kana 6 | | | | | | | | |
| Kana 7 | 5/16/2006 0:00 | | | | | | | Family not home, so could not take sample. |
| Kana 8 | | | | | | | | |
| Kana 9 | | | | | | | | |
| Kana 10 | 5/22/2006 8:48 | slightly unclear | plain | 210 | 0.0 | 0 | 0 | Yellow filtrate. Many small colonies. |
| Kana 11 | | | | | | 0 | | |
| Kana 12 | | | | | | 0 | | |

**Table B.5.2 Bintaro Baru SODIS Water Quality Results**

| SODIS | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Yayan stored boss's well | 6/2/2006 12:30 | clear | plain | 201 | n/a | 7 | 6 | A few smaller colonies. |
| b, Yayan stored boss's well | | | | | | 9 | | |
| c, Yayan stored boss's well | | | | | | 3 | | |
| Yayan 1 | 5/4/2006 11:00 | clear | natural | 192 | <0.1 | 1 | 3 | n/a |
| Yayan 2 | | | | | | 2 | | |
| Yayan 3 | | | | | | 5 | | |
| Yayan 4 | 5/10/2006 10:20 | clear | bland | n/a | 0.00 | 0 | 0 | n/a |
| Yayan 5 | | | | | | 0 | | |
| Yayan 6 | | | | | | 0 | | |
| Yayan 7 | 5/16/2006 10:58 | clear | plain | 195 | 0.0 | 0 | 0 | Clean. |
| Yayan 8 | | | | | | 0 | | |
| Yayan 9 | | | | | | 0 | | |
| Yayan 10 | 5/22/2006 10:26 | clear | plain | 57 | 0.0 | 0 | 0 | Many tiny clear colonies. |
| Yayan 11 | | | | | | 0 | | |
| Yayan 12 | | | | | | 0 | | |

**Table B.5.3 Teluk Gong SODIS Water Quality Results (also refer to Tables B.3.3, A.4, 4.6 and B.1.3)**

| SODIS | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Nur 1day stored vendor | 6/2/2006 9:40 | clear | plain | 128 | 0.05 | 0 | 0 | Covered in small semi-yellow colonies. |
| b, Nur 1day stored vendor | | | | | | 0 | | |
| c, Nur 1day stored vendor | | | | | | 0 | | |
| Nur 1 | 5/5/2006 13:11 | clear | natural | 135 | 0.03 | 0 | 0 | Very clean. |
| Nur 2 | | | | | | 0 | | |
| Nur 3 | | | | | | 0 | | |
| Nur 4 | 5/12/2006 10:04 | clear | plain | n/a | 0.0 | 0 | 0 | 1 splotch on plate 19. |
| Nur 5 | | | | | | 0 | | |
| Nur 6 | | | | | | 1 | | |
| Nur 7 | 5/17/2006 9:45 | clear | plain | 144 | 0.0 | 0 | 0 | Very clean. |
| Nur 8 | | | | | | 0 | | |
| Nur 9 | | | | | | 0 | | |
| Nur 10 | 5/23/2006 9:37 | clear | bland | 148 | 0.1 | 1 | 0 | n/a |
| Nur 11 | | | | | | 0 | | |
| Nur 12 | | | | | | 0 | | |

**Table B.5.4 Tanjung Priok SODIS Water Quality Results (also refer to Table B.1.4)**

| SODIS | Date, Time | Color | Smell | TDS (ppm) | Free Cl- (mg/L) | FC/100mL | Average | Comment |
|---|---|---|---|---|---|---|---|---|
| a, Yuli stored PDAM | 6/3/2006 10:58 | clear | plain | 141 | 0.00 | 6 | 4 | n/a |
| b, Yuli stored PDAM | | | | | | 5 | | |
| c, Yuli stored PDAM | | | | | | 2 | | |
| Yuli 1 | 5/5/2006 12:25 | clear | plain | 155 | 0.02 | 0 | 0 | All covered in tiny clear colonies. |
| Yuli 2 | | | | | | 0 | | |
| Yuli 3 | | | | | | 0 | | |
| Yuli 4 | 5/12/2006 13:12 | clear | plain | n/a | 0.0 | 0 | 0 | n/a |
| Yuli 5 | | | | | | 0 | | |
| Yuli 6 | | | | | | 1 | | |
| Yuli 7 | 5/17/2006 11:24 | clear | plain | 147 | 0.1 | 0 | 0 | n/a |
| Yuli 8 | | | | | | 0 | | |
| Yuli 9 | | | | | | 0 | | |
| Yuli 10 | 5/23/2006 12:22 | clear | plain | 162 | 0.0 | 0 | 0 | Very clean. |
| Yuli 11 | | | | | | 0 | | |
| Yuli 12 | | | | | | 0 | | |

# ANNEX 4: PILOT-TRIAL COMMUNITY INITIAL SURVEY DATA

Figure C.1 shows the Initial Point-of-Use Campaign conducted in **Bintaro Lama** on 26 April 2006. Table C.1 gives the survey data gathered from the attendees on how they rank the treatment alternatives.

**Figure C.1 Bintaro Lama Initial Point-of-Use Campaign.**

**Table C.1 Bintaro Lama Initial Point-of-Use Campaign Survey Data**

| Initial Survey | Boiling | Ceramic Filtration | Chlorination | SODIS | Isi Ulang | families |
|---|---|---|---|---|---|---|
| | 5 | 1 | 4 | 3 | 2 | 15 |
| | 4 | 1 | 3 | 2 | 5 | |
| | 3 | 1 | 4 | 5 | 2 | |
| | 1 | 4 | 5 | 3 | 2 | |
| | 1 | 2 | 3 | 5 | 4 | |
| | 1 | 2 | 5 | 3 | 4 | |
| | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 4 | 5 | 3 | 2 | |
| | 3 | 1 | 4 | 5 | 2 | |
| | 3 | 1 | 4 | 5 | 2 | |
| | 3 | 1 | 4 | 5 | 2 | |
| | 3 | 1 | 4 | 5 | 2 | |
| | 3 | 5 | 1 | 2 | 4 | |
| | 1 | 4 | 3 | 5 | 2 | |
| | 3 | 5 | 1 | 2 | 4 | |
| **Overall Ranking** | **2** | **1** | **4** | **5** | **3** | |
| **# of 1st Choices** | 6 | 7 | 2 | 0 | 0 | |

Figure C.2 shows the Initial Point-of-Use Campaign conducted in **Bintaro Baru** on 27 April 2006. Table C.2 gives the survey data gathered from the attendees on how they rank the treatment alternatives.

**Figure C.2 Bintaro Baru Initial Point-of-Use Campaign.**

**Table C.2 Bintaro Baru Initial Point-of-Use Campaign Survey Data**

| Initial Survey | Boiling | Ceramic Filtration | Chlorination | SODIS | Isi Ulang | families |
|---|---|---|---|---|---|---|
| | 1 | 3 | 4 | 5 | 2 | 23 |
| | 4 | 1 | 3 | 5 | 2 | |
| | 5 | 1 | 2 | 4 | 3 | |
| | 1 | 5 | 3 | 4 | 2 | |
| | 1 | 4 | 2 | 5 | 3 | |
| | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 2 | 4 | 5 | 3 | |
| | 1 | 2 | 3 | 4 | 5 | |
| | 1 | 2 | 3 | 4 | 5 | |
| | 2 | 1 | 4 | 3 | 5 | |
| | 2 | 1 | 4 | 3 | 5 | |
| | 3 | 2 | 4 | 5 | 1 | |
| | 1 | 3 | 2 | 4 | 5 | |
| | 1 | 3 | 2 | 4 | 5 | |
| | 2 | 4 | 3 | 5 | 1 | |
| | 1 | 4 | 2 | 5 | 3 | |
| | 1 | 3 | 2 | 4 | 5 | |
| | 5 | 1 | 2 | 4 | 3 | |
| | 4 | 3 | 2 | 5 | 1 | |
| | 2 | 4 | 3 | 5 | 1 | |
| | 5 | 1 | 2 | 3 | 4 | |
| | 2 | 1 | 5 | 4 | 3 | |
| **Overall Ranking** | **1** | **2** | **3** | **5** | **4** | |
| **# of 1st Choices** | 12 | 7 | 0 | 0 | 4 | |

Figure C.3 shows the Initial Point-of-Use Campaign conducted in **Teluk Gong** on 28 April 2006. Table C.3 gives the survey data gathered from the attendees on how they rank the treatment alternatives.

**Figure C.3 Teluk Gong Initial Point-of-Use Campaign.**

**Table C.3 Teluk Gong Initial Point-of-Use Campaign Survey Data**

| Initial Survey | Boiling | Ceramic Filtration | Chlorination | SODIS | Isi Ulang | families |
|---|---|---|---|---|---|---|
| | 4 | 2 | 5 | 3 | 1 | 34 |
| | 1 | 3 | 2 | 4 | 5 | |
| | 1 | 2 | 5 | 4 | 3 | |
| | 1 | 2 | 4 | 3 | 5 | |
| | 1 | 5 | 2 | 4 | 3 | |
| | 3 | 2 | 5 | 1 | 4 | |
| | 2 | 5 | 3 | 1 | 4 | |
| | 1 | 3 | 4 | 5 | 2 | |
| | 1 | 5 | 3 | 4 | 2 | |
| | 3 | 1 | 2 | 5 | 4 | |
| | 3 | 4 | 1 | 2 | 5 | |
| | 3 | 2 | 1 | 5 | 4 | |
| | 2 | 3 | 1 | 4 | 5 | |
| | 3 | 1 | 5 | 2 | 4 | |
| | 4 | 1 | 5 | 2 | 3 | |
| | 3 | 1 | 4 | 2 | 5 | |
| | 2 | 1 | 4 | 5 | 3 | |
| | 4 | 3 | 2 | 1 | 5 | |
| | 4 | 3 | 2 | 1 | 5 | |
| | 4 | 3 | 2 | 1 | 5 | |
| | 1 | 3 | 5 | 4 | 2 | |
| | 4 | 5 | 1 | 3 | 2 | |
| | 4 | 2 | 1 | 3 | 5 | |
| | 4 | 5 | 2 | 1 | 3 | |
| | 4 | 5 | 2 | 1 | 3 | |
| | 1 | 4 | 3 | 5 | 2 | |
| | 1 | 4 | 3 | 5 | 2 | |
| | 1 | 4 | 5 | 3 | 2 | |
| | 4 | 3 | 2 | 1 | 5 | |
| | 4 | 3 | 2 | 1 | 5 | |
| | 4 | 5 | 2 | 1 | 3 | |
| | 4 | 5 | 2 | 1 | 3 | |
| | 1 | 5 | 3 | 4 | 2 | |
| | 1 | 4 | 3 | 5 | 2 | |
| **Overall Ranking** | **1** | **4** | **3** | **2** | **5** | |
| **# of 1st Choices** | 12 | 5 | 5 | 11 | 1 | |

Figure C.4 shows the Initial Point-of-Use Campaign conducted in **Tanjung Priok** on 1 May 2006. Table C.4 gives the survey data gathered from the attendees on how they rank the treatment alternatives.

**Figure C.4 Tanjung Priok Initial Point-of-Use Campaign.**

**Table C.4 Tanjung Priok Initial Point-of-Use Campaign Survey Data**

| Initial Survey | Boiling | Ceramic Filtration | Chlorination | SODIS | Isi Ulang | families |
|---|---|---|---|---|---|---|
| | 2 | 1 | 4 | 3 | 5 | 28 |
| | 1 | 3 | 4 | 2 | 5 | |
| | 1 | 2 | 5 | 4 | 3 | |
| | 4 | 5 | 1 | 3 | 2 | |
| | 1 | 5 | 4 | 3 | 2 | |
| | 5 | 3 | 1 | 2 | 4 | |
| | 5 | 3 | 1 | 2 | 4 | |
| | 1 | 5 | 3 | 4 | 2 | |
| | 1 | 4 | 5 | 3 | 2 | |
| | 1 | 3 | 5 | 2 | 4 | |
| | 5 | 4 | 2 | 1 | 3 | |
| | 5 | 4 | 1 | 2 | 3 | |
| | 1 | 4 | 3 | 2 | 5 | |
| | 5 | 3 | 4 | 1 | 2 | |
| | 5 | 3 | 2 | 1 | 4 | |
| | 1 | 5 | 3 | 2 | 4 | |
| | 4 | 3 | 2 | 1 | 5 | |
| | 1 | 2 | 5 | 4 | 3 | |
| | 2 | 3 | 5 | 4 | 1 | |
| | 1 | 4 | 3 | 2 | 5 | |
| | 1 | 3 | 2 | 4 | 5 | |
| | 5 | 2 | 3 | 4 | 1 | |
| | 5 | 2 | 3 | 1 | 4 | |
| | 5 | 3 | 1 | 2 | 4 | |
| | 1 | 4 | 5 | 2 | 3 | |
| | 1 | 5 | 4 | 2 | 3 | |
| | 1 | 3 | 5 | 4 | 2 | |
| | 2 | 4 | 5 | 1 | 3 | |
| **Overall Ranking** | **2** | **5** | **3** | **1** | **4** | |
| **# of 1st Choices** | 14 | 1 | 5 | 6 | 2 | |

# ANNEX 5: PILOT-TRIAL COMMUNITY FINAL SURVEY DATA

Figure D.1 shows the Final Point-of-Use Campaign conducted in **Bintaro Lama** on 31 May 2006. Table D.1 gives the survey data gathered from the attendees on how they rank the treatment alternatives.

**Figure D.1 Bintaro Lama Final Point-of-Use Campaign.**

**Table D.1 Bintaro Lama Final Point-of-Use Campaign Survey Data**

| Final Survey | Boiling | Ceramic Filtration | Chlorination | SODIS | Isi Ulang | families |
|---|---|---|---|---|---|---|
| | 1 | 2 | 4 | 3 | 5 | 12 |
| | 5 | 2 | 3 | 1 | 4 | |
| | 1 | 4 | 3 | 2 | 5 | |
| | 1 | 2 | 4 | 3 | 5 | |
| | 1 | 4 | 3 | 2 | 5 | |
| | 2 | 4 | 3 | 5 | 1 | |
| | 2 | 1 | 4 | 3 | 5 | |
| | 1 | 2 | 4 | 3 | 5 | |
| | 1 | 5 | 4 | 3 | 2 | |
| | 1 | 5 | 4 | 3 | 2 | |
| | 1 | 4 | 3 | 5 | 2 | |
| | 1 | 5 | 3 | 2 | 4 | |
| **Overall Ranking** | **1** | **3** | **4** | **2** | **5** | |
| **# of 1$^{st}$ Choices** | 9 | 1 | 0 | 1 | 1 | |

Figure D.2 shows the Final Point-of-Use Campaign conducted in **Bintaro Baru** on 1 June 2006. Table D.2 gives the survey data gathered from the attendees on how they rank the treatment alternatives.

**Figure D.2 Bintaro Baru Final Point-of-Use Campaign.**

**Table D.2 Bintaro Baru Final Point-of-Use Campaign Survey Data**

| Final Survey | Boiling | Ceramic Filtration | Chlorination | SODIS | Isi Ulang | families |
|---|---|---|---|---|---|---|
| | 1 | 2 | 4 | 3 | 5 | 30 |
| | 5 | 1 | 3 | 4 | 2 | |
| | 5 | 3 | 2 | 1 | 4 | |
| | 5 | 4 | 3 | 1 | 2 | |
| | 1 | 2 | 5 | 3 | 4 | |
| | 2 | 1 | 3 | 4 | 5 | |
| | 1 | 4 | 3 | 5 | 2 | |
| | 2 | 1 | 4 | 3 | 5 | |
| | 2 | 1 | 4 | 3 | 5 | |
| | 4 | 2 | 3 | 1 | 5 | |
| | 2 | 4 | 1 | 5 | 3 | |
| | 2 | 4 | 3 | 5 | 1 | |
| | 2 | 4 | 3 | 5 | 1 | |
| | 1 | 5 | 2 | 3 | 4 | |
| | 2 | 3 | 5 | 4 | 1 | |
| | 1 | 2 | 5 | 4 | 3 | |
| | 4 | 2 | 1 | 5 | 3 | |
| | 2 | 3 | 5 | 1 | 4 | |
| | 3 | 2 | 4 | 1 | 5 | |
| | 5 | 2 | 4 | 3 | 1 | |
| | 5 | 3 | 4 | 2 | 1 | |
| | 2 | 4 | 3 | 1 | 5 | |
| | 5 | 4 | 2 | 3 | 1 | |
| | 1 | 3 | 4 | 2 | 5 | |
| | 1 | 5 | 2 | 3 | 4 | |
| | 1 | 5 | 2 | 3 | 4 | |
| | 4 | 3 | 2 | 1 | 5 | |
| | 3 | 5 | 2 | 1 | 4 | |
| | 1 | 2 | 3 | 4 | 5 | |
| | 5 | 3 | 2 | 1 | 4 | |
| **Overall Ranking** | **1** | **3** | **4** | **2** | **5** | |
| **# of 1st Choices** | 9 | 4 | 2 | 9 | 6 | |

Figure D.3 shows the Final Point-of-Use Campaign conducted in **Teluk Gong** on 2 June 2006. Table D.3 gives the survey data gathered from the attendees on how they rank the treatment alternatives.

**Figure D.3 Teluk Gong Final Point-of-Use Campaign.**

**Table D.3 Teluk Gong Final Point-of-Use Campaign Survey Data.**

| Final Survey | Boiling | Ceramic Filtration | Chlorination | SODIS | Isi Ulang | families |
|---|---|---|---|---|---|---|
| | 1 | 3 | 5 | 4 | 2 | 24 |
| | 2 | 5 | 4 | 3 | 1 | |
| | 5 | 2 | 3 | 4 | 1 | |
| | 2 | 3 | 4 | 5 | 1 | |
| | 2 | 3 | 5 | 4 | 1 | |
| | 1 | 4 | 5 | 2 | 3 | |
| | 4 | 5 | 2 | 1 | 3 | |
| | 1 | 4 | 5 | 2 | 3 | |
| | 3 | 4 | 2 | 1 | 5 | |
| | 1 | 4 | 3 | 2 | 5 | |
| | 2 | 5 | 4 | 3 | 1 | |
| | 4 | 2 | 3 | 1 | 5 | |
| | 1 | 4 | 5 | 3 | 2 | |
| | 2 | 5 | 3 | 1 | 4 | |
| | 4 | 2 | 3 | 1 | 5 | |
| | 1 | 4 | 3 | 2 | 5 | |
| | 2 | 5 | 3 | 1 | 4 | |
| | 5 | 2 | 4 | 1 | 3 | |
| | 4 | 2 | 3 | 1 | 5 | |
| | 5 | 1 | 3 | 2 | 4 | |
| | 5 | 1 | 3 | 2 | 4 | |
| | 4 | 2 | 3 | 1 | 5 | |
| | 1 | 4 | 3 | 2 | 5 | |
| | 1 | 4 | 3 | 2 | 5 | |
| **Overall Ranking** | **2** | **3** | **5** | **1** | **4** | |
| **# of 1$^{st}$ Choices** | 8 | 2 | 0 | 9 | 5 | |

Figure D.4 shows the Final Point-of-Use Campaign conducted in **Tanjung Priok** on 3 June 2006. Table D.4 gives the survey data gathered from the attendees on how they rank the treatment alternatives.

**Figure D.4 Tanjung Priok Final Point-of-Use Campaign.**

**Table D.4 Tanjung Priok Final Point-of-Use Campaign Survey Data**

| Final Survey | Boiling | Ceramic Filtration | Chlorination | SODIS | Isi Ulang | families |
|---|---|---|---|---|---|---|
| | 1 | 3 | 4 | 2 | 5 | 21 |
| | 2 | 3 | 4 | 1 | 5 | |
| | 2 | 3 | 4 | 5 | 1 | |
| | 1 | 3 | 4 | 5 | 2 | |
| | 1 | 3 | 5 | 4 | 2 | |
| | 4 | 2 | 5 | 3 | 1 | |
| | 1 | 4 | 5 | 3 | 2 | |
| | 1 | 4 | 2 | 3 | 5 | |
| | 2 | 1 | 4 | 3 | 5 | |
| | 2 | 5 | 4 | 3 | 1 | |
| | 1 | 4 | 3 | 2 | 5 | |
| | 5 | 4 | 3 | 1 | 2 | |
| | 2 | 4 | 1 | 3 | 5 | |
| | 2 | 3 | 5 | 4 | 1 | |
| | 4 | 1 | 2 | 3 | 5 | |
| | 1 | 4 | 5 | 3 | 2 | |
| | 4 | 3 | 2 | 5 | 1 | |
| | 1 | 3 | 2 | 5 | 4 | |
| | 2 | 5 | 3 | 1 | 4 | |
| | 2 | 4 | 3 | 1 | 5 | |
| | 1 | 2 | 4 | 5 | 3 | |
| **Overall Ranking** | **1** | **4** | **5** | **2** | **3** | |
| **# of 1st Choices** | 9 | 2 | 1 | 4 | 5 | |

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