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Rotary/USAID Alliance: Monitoring and Evaluation Plan for Alianza Agua Segura para los Niños Safe Water for the Children

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List of Acronyms

3-H – Health, Hunger and Humanity grant from the Rotary Foundation

BSF – Biosand filter

CAWST – Centre for Affordable Water and Sanitation Technology

DR – Dominican Republic

E. coli – Escherichia coli – a bacterial indicator of fecal contamination

HWT – Household drinking water treatment

JMP – Joint Monitoring Program

NTU – Nephelometric units – a measure of turbidity

RCT – Randomized controlled trial

SWS – Safe Water System

WHO – World Health Organization

\$RD – Dominican peso

L/min – liters per minute – a measure of flow rate

E. coli/100mL – a measure of drinking water quality

1. Literature Review

1.1 Lack of access to water, sanitation and hygiene

An estimated 884 million people worldwide lack access to improved sources of drinking water (WHO 2010). Poor water quality facilitates the transmission of waterborne illnesses such as cholera, typhoid, Hepatitis A, dysentery, dracunculiasis, and diarrhea. Almost 1.5 million deaths from diarrhea are as a result of lack of access to water, sanitation and hygiene (WHO 2009). Many developing countries lack the infrastructure necessary to provide potable water to their constituents for the foreseeable future.

One option available to households is to treat drinking water at the point-of-use. Household drinking water treatment (HWT) at the point-of-use holds great potential in providing clean, safe drinking water to those lacking. HWT places the ability to improve drinking water in the hands of household members by allowing treatment before consumption. Multiple systematic reviews suggest average diarrheal disease reductions of 35% or more by a variety of HWT technologies (Arnold and Colford 2007, Clasen et al., 2007, Fewtrell et al., 2005, Hunter 2009). Building on the growing evidence of the efficacy HWT interventions, the parameters of sustainability, cost effectiveness and scalability become critical as researchers, policy-makers, and implementers move forward to expand prevention efforts (Schmidt WP and S Cairncross 2009, Sobsey 2002). However, little rigorous evidence exists on the sustainability of HWT as measured by continued use (in the absence of intervention), consistent water quality improvement, and sustained health impact (Schmidt WP and S Cairncross 2009, Sobsey 2002). The existing evidence has shown that continued use and sustained impact based on improved water quality may decrease over time, often due to the difficulty of changing human behavior (Arnold and Colford 2007; Hunter 2009).

A variety of technologies are available for point of use drinking water treatment including:

- 1) The Safe Water System (SWS) which involves chlorination with a dilute sodium hypochlorite solution or tabs and safe storage in a protected container. The Centers for Disease Control and Prevention have worked on implementing the SWS for more than ten years in many countries.
- 2) Proctor and Gamble has developed a treatment that includes coagulation-flocculation followed by disinfection with chlorine which is also known as Pur. This has been disseminated through similar social marketing programs as the SWS.
- 3) Solar disinfection, also known as Sodis, involves treating drinking water by solar irradiation and heat in plastic bottles typically exposed to sunlight on roofs for many hours.
- 4) The ceramic water filter consists of a ceramic filter element (locally made or imported) that removes bacteria and larger organisms by physical straining. The addition of silver to the filters also provides bactericidal properties that can enhance microbe removal.

5) The biosand filter (BSF) consists of a concrete or plastic housing and approximately 50 cm of sand on top of gravel. The water in the filter is driven by gravity flow and works by various mechanisms including physical straining, biofilm development and predation, and adsorption of microbes.

A more thorough review of the technologies can be found at a variety of sites. See the following sites:

<http://www.cawst.org/en/themes/household-water-treatment>

<http://www.cawst.org/en/resources/pubs/category/25-fact-sheets-academic>

<http://sanitationupdates.wordpress.com/2010/11/09/usaiddcdc-slow-sand-filtration-fact-sheet/>

1.2 Recent evidence regarding BSF health impact, sustained use and microbiological efficacy

Recent studies on the BSF can be placed into three categories: randomized controlled trials (RCT) examining health and microbiological impact, prospective cohort studies which also examine health and microbiological impact, and cross-sectional assessments of microbial water quality and/or continued use. Over the last five years, six studies can be found in the published literature on the concrete BSF examining health and/or microbiological impact. Additional studies have been published on chemical removal and transformation in the BSF and these will be discussed later. These six recently published studies are briefly summarized below in table 1. Additional studies from the published literature not summarized here were studies that focused solely on laboratory research, examined chemicals or were reviews (see Appendix 1 with pubmed search list).

Table 1: Summary of published research on microbiological, health and continued use of the BSF since 2006

Author: (In Chronological order)	Title of Journal Article	Type of Study, Location	Result
Duke et al., 2006 (Rural and Remote Health)	The use and performance of BioSand filters in the Artibonite Valley of Haiti: a field study of 107 households.	-Cross-sectional -Continued use and fecal coliforms in water -Concrete BSF - Haiti	-In use on average 2.5 years. - <i>E. coli</i> reductions 98.5%. -97% of filtered samples had <10 <i>E. coli</i> /100mLs.
Stauber et al., 2006 (Water Science and Technology)	Characterisation of the biosand filter for <i>E. coli</i> reductions from household drinking water under controlled laboratory and field use conditions.	-Cross-sectional - 55 concrete BSFs - Bonao, DR	- <i>E. coli</i> reduction was 93%
Stauber et al., 2009 (American Journal of Tropical Medicine and Hygiene)	A randomized controlled trial of the concrete biosand filter and its impact on diarrheal disease in Bonao, Dominican Republic.	-RCT of 79 concrete BSFs in Bonao, DR - Health and water quality were over six months.	-Average of 47% fewer cases of diarrheal disease - Average <i>E. coli</i> reduction was 83%
Tiwari et al., 2009 (Tropical Medicine and International Health)	Intermittent slow sand filtration for preventing diarrhoea among children in Kenyan households using unimproved water sources: randomized controlled trial.	-RCT of 30 concrete BSFs in Nakuru and Molo districts -Rural Kenya	- 54% fewer days with diarrheal disease -Fecal coliform reduction was 94.4% - 27% of samples had <10 fecal coliforms/100mL.
Fiore et al., 2010 (Rural and Remote Health)	Assessment of biosand filter performance in rural communities in southern coastal Nicaragua: an evaluation of 199 households.	-Cross-sectional survey of 199 concrete BSFs -Continued use and water quality -Nicaragua	-78% of households still using concrete BSF -Median <i>E. coli</i> removal was 80% -17% of samples from the concrete BSF had <10 <i>E. coli</i> /100mL.
Liang et al., 2010 (World Bank Field Note on www.wsp.org)	Improving Household Drinking Water Quality - Use of BioSand Filters in Cambodia	-Cross-sectional survey of 336 concrete BSFs -Prospective cohort for 8 weeks in 65 HH with concrete BSFs -Cambodia	-87.5% still using concrete BSFs - <i>E. coli</i> reduction was 95% -Households with concrete BSFs reported 47% fewer cases of diarrheal disease

While published studies on the concrete BSF provide important insight into BSF continued use, microbiological efficacy and health impact, other studies have been completed and are available in the grey literature or are under revision for publication. These studies are summarized below:

Table 2: Brief summary of un-published literature on health, microbiological impact and continued use of the BSF

Author:	Source:	Type of Study, Location	Result
Paul Earwalker from Cranefield University	Student Thesis	-Cross-sectional -Continued use and fecal coliforms in water -57 Concrete BSF - Ethiopia	-In use 5 years, 70% were still in use. - <i>E. coli</i> reductions 87.9%. -75% of filtered samples had <10 <i>E. coli</i> /100mLs.
Aiken et al., 2011 from UNC-CH (in review AJTMH)	Article under review in journal	-Cross-sectional of 328 concrete BSFs -Prospective cohort for 8 weeks in 65 HHs -Bona, DR	- 90% were in use (1 year on average) - <i>E. coli</i> reduction 88% -61% fewer reported cases of diarrheal disease
Fabiszewski et al., 2011 (UNC-CH) (will be submitted to American Journal of Tropical Medicine and Hygiene)	Student thesis (part of a larger study in plastic BSFs)	-RCT of 89 plastic BSFs - Health impact and water quality - Honduras	-Average <i>E. coli</i> reductions were low (61%) -45% reduction in diarrheal disease (although not quite statistically significant)
Matt Stevenson at MIT	Student Thesis	Focused on developing effective monitoring tool for all HWT technologies including BSF	-Visited plastic and concrete BSF users in Ethiopia and Ghana. Spoke with implementers (including Osman Mumuni)

1.3 Chemical removal/testing in the BSF

Recently, studies have been published examining the ability of the BSF to remove or modify chemicals in drinking water (Liang, et al., 2010, Murphy et al., 2010, Chiew et al., 2009). The studies have focused on examining the concentration of nitrite and nitrate in the concrete BSFs in Cambodia (Liang et al., 2010, Murphy et al., 2010) and the removal of arsenic by concrete BSFs (Chiew et al., 2009). Since arsenic is not thought to be of concern in the DR, this summary will focus on the work on nitrite and nitrate.

Murphy et al., 2010 (also in Liang et al., 2010) examined the concentrations of nitrite and nitrate in 20 households with concrete BSFs in Cambodia. In their study, they found that nitrite increased in the concrete BSFs. The authors hypothesized that biological activity in the BSFs was contributing to the change in the concentrations. However, many of the water sources already had high concentrations of the contaminants prior to treatment. Therefore, it is important to have prior knowledge of nitrite and nitrate contamination to better understand how the BSFs might impact these chemicals in water being treated by the BSF.

1.4 BSFs in the DR

The Dominican Republic (DR) reports high (>80%) levels of coverage for improved drinking water supply (WHO 2010). However, the most recent data suggests that coverage in urban areas is decreasing. In addition, 30-67% of the population reports relying on bottled drinking water although the household may have access to what is considered an improved supply (JMP 2010).

The BSF is in use by more than 19,000 households in the DR (3-H application). Health interventions studies on the BSF in the DR and other locations have shown significant improvements in the concentration of *E. coli* in household drinking water and significantly decreased risk of diarrheal disease (Aiken et al., 2011 (in review) Stauber et al., 2009, Tiwari et al., 2009). While these studies demonstrate efficacy in an intervention setting, there is a need to document and evaluate the effectiveness of BSFs outside of the intervention setting particularly with the goal of understand barriers to effective use of the BSF.

On World Water Day 2009, the United States Agency for International Development (USAID) and Rotary International announced the International H₂O Collaboration. In a joint effort to increase the implementation of water, sanitation and hygiene projects around the world, the International H₂O Collaboration currently focuses on the implementation of water supply projects in three countries: the DR, Ghana and the Philippines (USAID 2009). In the DR, the Rotary portion of the project will include 80 communities. The focus of the Rotary portion of the program will include an expansion of the current Rotary District Program (District 4060) which has been underway for seven years. The program will include implementation of 10,000 household water filters (9,000 plastic BSFs and 1,000 ceramic water filters). During the implementation of the program there will be capacity building and training at various levels.

For the implementation and installation of the plastic BSF filters as part of the International H₂O Collaboration, Rotary Clubs or Peace Core Volunteers will apply for a project in the community and are required to do the following (from Instructivo para Clubes):

1. Identify a community with a need to improve their drinking water.
2. Working with community leaders, identify a community facilitator(s).

3. Send one to two people to be trained as facilitators. The facilitators will have the following responsibilities: attend the training course, form a water committee, educate the community about problems with water quality in the community, coordinate the delivery of the plastic BSFs to the community, install the filters, educate the families on use, provide follow-up especially for problems, and prepare a report about the project in the community.
4. The facilitator will provide information and education to the families about the filters. Each family should contribute \$RD 500 (USD13.60) for the filter. Part of the funds will be used to transport the filters to the community. The rest will be decided by the community's water committee and could be used to compensate the facilitator (if this person is not Rotarian).
5. Initially, projects will be limited to 40 filters per Rotary Club. After an evaluation, more filters can be solicited.

Other details regarding the expectations for the communities can be found in Instructivo para Clubes (See Appendix 4).

2. Monitoring and Evaluation Rationale and Definitions:

The following provides a description, rationale and set of important definitions for the suggested monitoring and evaluation program for the implementation of plastic BSFs in the DR. It will be divided into four sections highlighting the four critical issues: installation, proper use, continued use and microbiological effectiveness. In addition to the rationale and definitions, tools for data collection are provided in Appendix 3.

2.1 Indicators for proper plastic BSF installation:

Rationale: Proper installation of the plastic BSF will depend on two main functions: logistics of transport of plastic BSF kits and the physical installation of the plastic BSF in the household. The coordination and delivery of the plastic BSF to households is the first step. According to the “Instructivo para Clubes Rotarios y Comunidades Proyecto H2O Sana para Los Niños del Distrito Rotario 4060, Republica Dominicana” (Appendix 4), the local Rotarian group or facilitator will be responsible for coordination of the delivery of the plastic BSFs to the community. Upon removal of the plastic BSFs from storage, both the storage manager and the community facilitator will perform an inventory and physical inspection of the plastic BSF installation kits. Both will then sign a form indicating that the materials were delivered to the community facilitator. A filter delivery inventory sheet is provided in Appendix 3.

There is currently not a plan in place to provide any unique identification for the individual plastic filters. This will make any data collection and analysis difficult as it will require household member names to link documents together. It is highly recommended that the each plastic filter body be labeled with some unique identification number. A water- resistant, plastic sticker with large pre-printed number is recommended for this.

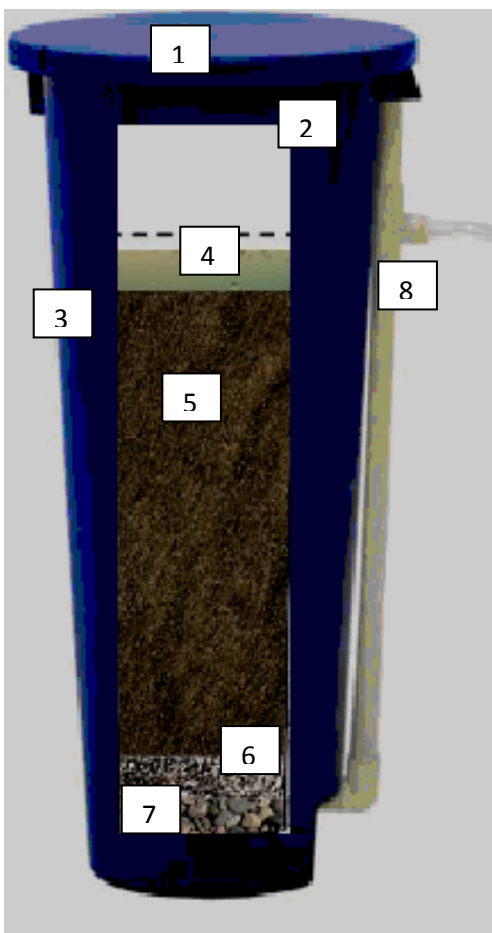
Monitoring the delivery of plastic BSF kits to communities will be measured using **Indicator 1.1:** Quantity of complete, undamaged plastic BSF installation kits delivered to communities. A **complete plastic BSF kit** will consist of all of the materials mentioned below in Figure 1 (taken from “Hydraid Manual”).

In addition, the plastic body including the lid and diffuser plate, plastic PVC tube and tubing will be examined and considered **undamaged** if these pieces are free from holes, cracks, chips. This will be documented with a form called “Filter Delivery Inventory Sheet”. In addition to the physical inspection, the date of delivery of the plastic BSFs to the community will be recorded on the form.

According to the “Manual para el Filtro de Bioarena”, the components of the plastic BSF are the following (Figure 1 was taken from page 10 from “Manual”):

1. Plastic filter body
2. Plastic top
3. Plastic diffuser plate
4. PVC exit pipe
5. Tubing attached to PVC exit pipe (currently clear)
6. Media stored in separate, pre-wrapped bags, 1 bag of each per filter:
 - a. Large gravel
 - b. Smaller gravel
 - c. Sand
 - d. Fine sand

Figure 1. Components of plastic BSF



1. Top
2. Diffuser
3. Plastic filter body
4. Fine sand layer
5. Sand layer
6. Smaller gravel
7. Coarse gravel
8. Plastic outlet tube and hose

Additional indicators used for monitoring and evaluation of plastic BSF installation include documenting the total number of beneficiaries and the date the plastic BSF was installed.

Indicator 1.2a: Total number of **beneficiaries** will include all people who live in the household where the plastic BSF is installed. This information will be reported by the community facilitator on a filter installation checklist (see filter installation check-sheet in Appendix 3). These data will be copied by the project coordinator and/or local Rotary Club/PCV main point of contact and summarized to document total number of beneficiaries including: both males and females ≥ 5 and < 5 years of age in each community and for the overall project. This will require tabulation of the data from the filter installation check-sheets from each community facilitator.

Indicators 1.2b, 1.3a Plastic BSFs with flow-rate $\leq 0.8\text{L}/\text{min}$: Flow-rate is one of the indicators used by implementation groups to document proper installation. The “Hydrad Manual” suggests flow-rate should not be faster than $0.8\text{L}/\text{min}$ when the top of the plastic BSF is filled with water. In addition to using this as an indicator of proper installation, a decrease in flow-rate compared to original installation flow-rate has been shown to be associated with filter ripening and enhanced microbial reductions (Elliott et al., 2008). To assess the proper installation of the plastic BSFs, the community facilitator will also document the plastic BSF flow-rate upon installation. The following procedure will be used to measure the flow-rate in liters per minute:

Method for measuring plastic BSF flow-rate:

Equipment needs per surveyor/installation team: stop watch, graduated beverage container

1. Household member will be asked to retrieve a large bucket full of water (approximately 5 gallons [20L] is needed).
2. Plastic BSF will be filled to top of plastic filter body.
3. Using a watch with a second hand, BSF will be allowed to filter for 30 seconds.
4. A graduated (with divisions of 100mL) container will be used to collect water in for 60 seconds.
5. The total volume collected will be written down on the form (see appendix 3).

Indicator 1.2c (documented at installation) and **1.3a** (documented by an independent survey team) will be documented by measuring the flow-rate as described above. The total number of households that have a flow rate of $\leq 800\text{mL}/\text{minute}$ ($0.8\text{L}/\text{min}$) will be determined and then divided by the total number of filters installed. This number will then be multiplied by 100% to calculate the percentage of all households with proper filter flow-rate. Those households with a flow-rate $> 0.8\text{L}/\text{min}$ will be noted and shared with the project coordinator.

Indicators 1.2c,d: Total household members trained in plastic BSF use and % of household that paid for plastic BSF. Community facilitators will be asked to document the following information during installation: which household member(s) was present during the installation and received the training on the plastic BSF as well as whether or not the household paid for the plastic BSF. As stated in the “Instructivo” (Appendix 4), households are going to pay \$RD500 for the plastic BSF. The household members will receive a receipt and the community facilitator will document the amount paid and who was trained on the filter installation checklist (see document in Appendix 3).

Indicators 1.3a,b: % of plastic BSFs with flow-rate <0.8L/min and % of plastic BSF with physical problems. These indicators will be measured by an independent survey field team. The benefits to the independent review are many and include the use of paid staff, trained in survey collection techniques. In addition, the interviewers will be visiting the households after the plastic BSFs have been installed and can therefore document problems that have occurred since installation. While the total sample will be a smaller proportion (~11%) of household, the sample is intended to be representative of the larger implementation population. Assessment of indicator 1.3a was discussed previously. Indicator 1.3b will require a physical inspection of the plastic BSF for the following: appearance of cracks, holes, chips or leaks. The plastic BSF will also be inspected for any modifications made to the outlet tube, missing lid, diffuser plate, etc. An inspection sheet will be provided for interviewers to use during inspection (see Household survey for Independent survey firm in Appendix 3).

2.2 Indicators of Proper Uptake and Usage:

Rationale: The growing body of evidence for household water treatment and storage has begun to develop definitions for proper usage and uptake of technologies. Stevenson (2008) drafted a guide to defining and measuring effective use for many household water treatment technologies. His work focused on incorporating ideal user practices and qualities that would provide the most protection to household members. These ideal qualities and practices have been identified in the table below (taken from Stevenson’s thesis) as well as in other documents (Sobsey et al., 2008):

Definition	Measurement	Data source
<p>(i) Household has treated water for drinking every day. Treatment may or may not occur every day. Frequency of treatment will depend on type of technology used and number of household members.</p> <p>(ii) All members in the household drink this treated water.</p>	<p>Three measurements are suggested. Preferably get the three of them if time and resources allow. From total households in study area:</p> <p>(i) Number of households that report having treated water for drinking in the house.</p> <p>(ii) Number of households that show treated water in the house.</p> <p>(iii) Number of households with a negative test for E.Coli in their treated water, OR positive test for chlorine residual among those using chlorine-based technology.</p>	<p>Household-based data; preferably population based survey.</p> <p>Data will include:</p> <p>(i) self-reported information;</p> <p>(ii) direct observation at end of survey</p> <p>(iii) tests for water safety</p>

Figure 2 Consistent water treatment

(Figueroa, 2005)

As a result, Stevenson developed standardized monitoring tools for each of the technologies to clearly define and document effective use. An example of the document provided for the BSF is in Appendix 2. Stevenson also divided the analysis of effective use into various categories including both the act of household water treatment and the behaviors and practices including safe storage and maintenance of clean storage containers and technologies. For the purposes of this monitoring and evaluation guide, some definitions will be borrowed from Stevenson. In addition, other information will be gathered to help assess proper usage and uptake.

Indicator 2.1a - % of households that report using plastic BSF qualified on optimal, sub-optimal, poor and no use of plastic BSF. Based on discussions with Bob Hildreth, and the ability of the plastic BSF to provide large quantities of water, the following definitions will be used to identify plastic BSF use:

1. **Optimal use** – household member reports using plastic BSF at least once per week and reports using it for drinking, cooking and/or bathing. (i.e. – reports using it for drinking and at least one other household hygiene activity).
2. **Sub-optimal use**– household member reports using the plastic BSF at least once per week for drinking water (although does not report using it for other household hygiene behaviors).
3. **Poor use** – household member reports using the plastic BSF at least once per week but does not use it for drinking (i.e. – uses it for bathing, cooking, etc).
4. **No use** – household member reports not using the BSF or reports using it less frequently than once per week.

The purpose of the four categories is to provide an idea of the range of use (and possible impact on water quality) of the plastic BSF.

Stevenson also proposed measures of proper storage. Since the use of a safe storage container was mentioned in the “Hydrad Manual”, documenting proper storage of BSF treated water can provide further documentation of proper usage. For the purpose of the plastic BSF, this could also be measured and classified as the following:

1. **Optimal storage** – household member reports using a separate treated drinking water storage container and a separate untreated water collection container, the storage container has a narrow opening and a lid.
2. **Sub-optimal storage** – household member is using a storage container with a narrow opening or a lid and reports using separate containers for untreated and treated drinking water.
3. **Poor storage** – household member is using a storage container that does not have a narrow opening or lid and does not report using separate containers for treated and untreated drinking water.

Questions to support the analysis of these factors are included in the household survey.

Indicator 2.1b - % of follow-up visits completed by community facilitator. The original monitoring and evaluation plan (see Appendix 5) indicated that the community facilitator would visit the households 1-2 weeks, 1-2 months, and 6 months after plastic BSF installation. ***For the purpose of this indicator, a complete visit is defined a visit to the household and speaking with at least one member of the household about the plastic BSF along with a visual inspection of the plastic BSF.*** These visits may provide important support for household members, especially as they start using the plastic BSF. Therefore, it is recommended that community facilitators collect data regarding these visits. This is also a variable that will fluctuate per facilitator and may have an impact on proper uptake and usage of the plastic BSF. A form is provided in Appendix 3 for the facilitator to use to document the household visits. This form can be copied and the data can then be tabulated and compared across community facilitators. This tabulation can be performed by the project coordinator and/or local Rotary Club/PCV groups.

Indicator 2.2a - Independent documentation (in a representative sample) of the % of households that report plastic BSF use. A representative sample of households will be surveyed by an independent survey team. Households will be surveyed and classified according the use definitions provided above. In addition, the proportion of household classified as not using the plastic BSF will be calculated.

Indicator 2.2b: Map of households surveyed by independent organization. At each household surveyed, the survey team will be asked to gather the GPS coordinates of the household. This will provide an opportunity to map the households with plastic BSFs and also help to provide

validation that different locations were visited. The GPS data will be collected with hand held gps units and imported into a map making program such as ARC GIS.

2.3 Indicators of continued use of the plastic BSF:

Rationale: Based on previous work, the long-term usage of ceramic filters was significantly impacted by breakage (Brown et al., 2008). In a study performed on concrete BSF continued use in the DR, Aiken et al., 2011 found that the major reason for disuse was dislike of the filter (17 households out of 328 households). In addition, Aiken's work also found that households that had participated in six months of intensive follow-up were much more likely to be still using the concrete BSF as compared to households that received one or two visits immediately following installation (Aiken et al., 2011). In a study in Cambodia, water source played an important role in continued use of concrete BSFs (Liang et al., 2010). Water source may also be an important consideration for households in the DR as well and should be asked during the survey (by the independent field team).

Indicator 3.1a - % of households that were visited by community facilitator. This can be measured by an analysis of the community facilitator data as well as during the independent survey. The community facilitator can respond to concerns or problems around BSF usage with the users. His or her presence in the community will vary but may also impact the total number of households using the plastic BSFs in the long run, particularly if the community facilitator is the person trained in flow-rate restoration. This measure overlaps with indicator 2.1b.

Indicator 3.1b - % of household members who state that they know where to go or who to contact if they have problems with plastic BSF. In addition, the proportion that list the community facilitator as source of info/assistance with BSF problems should be documented.

Indicator 3.2 - Independent documentation (in a representative sample) of the % of households that report plastic BSF use over time. This measure will overlap with indicator 2.2a. However, data will be gathered from the community facilitator and/or the household to determine the length of time in use. The filter installation check-sheets will be needed to document the time in use for each household visited by the independent survey team. Without a unique identification number for each filter, this information will be difficult to link up to other data sources collected such as filter installation date, etc. If no unique identifier is used, linking these data to other resources will require extensive use of household member names which can be problematic.

As part of the evaluation of the support of the community facilitator, the independent survey firm will ask questions regarding the household member's interaction with the community facilitator surrounding BSF problems and concerns. Questions that will be asked by the

independent survey team will include % of household members who state that they know where to go for replacement parts of if they have problems with plastic BSF; proportion that list the community facilitator as source of info/assistance with BSF problems. In addition, household members will be asked about the following and percentages will be determined:

-% of households that report visits by community facilitator

-% of households who have reported a change in plastic BSF flow-rate, a problem with the plastic BSF but are still using or performing (or having someone perform) the sand maintenance procedure

-% of plastic BSFs broken including breakage, cracks or leaks in any of the following: filter body, diffuser plate, top, PVC tubing (see Figure 1).

2.4 Indicators of Microbiological Efficacy of Plastic BSF

Rationale: In the absence of a health impact study, microbiological quality of treated drinking water is often used as one measure of the plastic BSF impact (please refer to Table 1). The benefit to measuring water prior to and after treatment is that a comparison can be made to determine the amount of indicator bacteria that are removed as a result of the plastic BSF. The World Health Organization has set forth suggested levels of risk where water that has <10 E. coli/100mL is considered low risk for diarrheal disease (WHO GDWQ 3rd addition). The collection of three samples mentioned below will allow for a comparison of the quality of water before filtration, the impact of the plastic BSF and also the possible recontamination after BSF treatment.

Indicator 4.1a - % of untreated water samples with <10 E. coli/100mL

Indicator 4.1b - % of water samples direct from plastic BSF with <10 E. coli/100mL

Indicator 4.1c - % of stored, treated water that has <10 E. coli/100mL

Indicator 4.2: Geometric mean % reduction of *E. coli*

Indicator 4.3: Mean % reduction of turbidity

Indicator 4.4: % of all samples that have detectable chlorine for BSF treated and stored water

For the purposes of these indicators, the following definitions are important:

Untreated water samples – Household member should be asked to gather water that she typically uses to pour into the BSF but has not yet been treated by the plastic BSF.

Water direct from BSF – This water sample is taken directly from the outlet tube of the plastic BSF. It is necessary to pour water into the BSF in order to be able to capture this sample.

Treated and stored BSF water – Household member will be asked if he or she has BSF treated water available. The sample will be taken from the storage container. The type of storage container should also be noted (in terms of storage practices).

Geometric mean % reduction of *E. coli* and turbidity.

See description and training materials in Appendix 3 for details on how to perform water sampling and the required calculations to calculation geometric mean % reduction of *E. coli* and turbidity.

Methods for drinking water collection, transport and analysis for *E. coli*. Field staff can be trained by Dr. Elpidio Gonzalez at Universidad ISA (or by another appropriately trained person or institution) in water sample collection techniques.

Laboratory analysis for *E. coli*:

Laboratory analysis for *E. coli* can include membrane filtration on a chromogenic medium such as Biorad Rapid'E coli 2. An example procedure for membrane filtration is provided in Appendix 6 in Spanish.

3. Monitoring and Evaluation Framework

3.1 Critical Issue 1: Installation

Objective: Proper Installation of 9000 plastic BSFs in X months (timeframe?)

Indicator	Level of evaluation /Person responsible	Critical Issue – Proper and Timely Installation - Output	Sources of data collection and methods	When to collect, how frequently
Indicator 1.1 - Quantity of complete, undamaged plastic BSF installation kits delivered to communities	Community measure/ Children’s Safe Water Coordinator or person at storage location	Successful transportation and delivery of plastic BSFs, sand to community facilitator	Inventory sheet which includes: -Date delivered to community in bulk (BSF + sand) -# delivered -# damaged or unusable	-At delivery -One time per community (unless multiple deliveries are made)
Indicator 1.2a - Total number of beneficiaries (male, female, <5s) and average length of time for installation upon delivery Indicator 1.2b – Measure of proper installation flow-rate (0.8L/min (range 0.6-0.8l/min)) Indicator 1.2c –Total number of household members trained in plastic BSF usage Indicator 1.2d – % of household that paid for plastic BSF and amount paid	Household measure/ Community facilitator	Proper and timely installation of plastic BSF in households	Household installation sheet which includes: -Date installed -Name of main caretaker and total beneficiaries in HH (male/female and <5s) -Flow Rate (liters/min) -Who in the household received brochure and discussion of use? -Was payment collected?	-At BSF installation (per HH)
Indicator 1.3a -% of plastic BSFs installed that comply with flow-rate (no > 0.8 L/min) Indicator 1.3b –% of plastic BSFs that have physical problems	Household measure/ Independent survey group - Entrena	Observation of BSF in (10%) randomly selected households	Household visit, physical inspection, flow rate measurement (liters/min) Observation: Leaks, cracks, dry filter, outlet hose	-At first follow up visit and no more frequently than every six months

3.2 Critical Issue 2: Proper uptake and usage

Objective: Proper use in 85% of households where plastic BSF was installed

Indicator	Level of evaluation/ Person responsible	Critical Issue – Proper Usage - Output	Sources of data collection and methods	When to collect, how frequently
<p>Indicator 2.1a - % of households that report using plastic BSF qualified on optimal, sub-optimal, poor and no use of plastic BSF</p> <p>Indicator 2.1b - % of follow-up visits completed by community facilitator.</p>	Household level/ Community facilitator	Household uses plastic BSF	Survey during follow up visits: -Physical observation of plastic BSF -Brief household survey by community facilitator	Community facilitator will document frequency of household visits at 7-14 days, 1-2 months and 6 months post installation A brief survey is recommended once by community facilitator
<p>Indicator 2.2a - Independent documentation (in a representative sample) of the % of households that report plastic BSF use % of plastic BSFs not in use</p> <p>Indicator 2.2b: Map of households surveyed by independent organization.</p>	Household level/ Independent survey group - Entrena	Survey of proper plastic BSF use	Household survey for independent survey group GPS coordinate of each household surveyed	Once per year (during initial year)

3.3 Critical Issue 3: Continued Use

Objective: Continued use of plastic BSF

Indicator	Level of evaluation/ Person responsible	Critical Issue – Continued use	Sources of data collection and methods	When to collect, how frequently
<p>Indicator 3.1a - % of community facilitators that have complied with follow-up</p> <p>Indicator 3.1b - % of households who cite community facilitator as source of info/assistance with BSF problems</p>	<p>Community facilitator/ Project Coordinator and/or Rotarians and PCVs</p>	<p>Analysis of community facilitator data</p>	<p>-Review of data collected by community facilitator including installation check-sheets</p> <p>-Survey questions regarding interaction with community facilitator</p>	<p>-After initial 6 months since installation</p> <p>-Again after 12-18 months of installation</p>
<p>Indicator 3.2 - Independent documentation (in a representative sample) of the % of households that report plastic BSF use</p> <p>% of plastic BSFs not in use</p> <p>-% of households that report visits by community facilitator</p> <p>-% of households who have reported problems with plastic BSF but still use</p> <p>-% of plastic BSFs broken</p>	<p>Household level/ ndependent survey group - Entrena</p>	<p>Survey of continued use</p>	<p>Household survey questions that focus on:</p> <p>-problems with plastic BSF</p> <p>-knowledge of where to go for repairs or assistance for BSF</p> <p>-interaction with community facilitator</p> <p>-Factors associated with use (or disuse)</p>	<p>Once per year (during initial year)</p>

3.4 Critical Issue 4: Microbiological efficacy

Objective: Improved drinking water quality through treatment with plastic BSF

Specific aim: 75% of samples direct from BSF have ≤ 10 E. coli/100mL

Indicator	Level of evaluation Monitoring/Person responsible	Critical Issue – Drinking Water Quality	Sources of data collection and methods	When to collect, how frequently
<p>Indicator 4.1a - % of untreated water samples <10 E. coli/100mL</p> <p>Indicator 4.1b - % of BSF treated water (direct from BSF) that has <10 E. coli/100m:</p> <p>Indicator 4.1c - % of BSF-stored, treated water that has <10 E. coli/100mL</p> <p>Indicator 4.2: Geometric mean % reduction of <i>E. coli</i></p> <p>Indicator 4.3: Mean % reduction of turbidity</p> <p>Indicator 4.4: % of all samples that have detectable chlorine (source and BSF treated and stored)</p>	<p>Household level/ Project Coordinator* Independent survey firm* Community facilitator*</p>	<p>Improvement of household drinking water quality by the plastic BSF</p>	<p>At house: Colorimetric measure for free chlorine for BSF treated and stored Collected at house and taken to a laboratory: Drinking water quality testing at the following levels: 1 Water prior to BSF treatment 2) Direct from BSF outlet 3) In storage container after BSF treatment Analyzed for <i>E. coli</i> or fecal coliforms and turbidity Reported as concentration of E. coli/100mL or NTUs</p>	<p>A cross-sectional sampling of BSFs should be performed in 1/3 of all households independently surveyed at least one month since installation.</p>

* - Assumes person was trained in appropriate sample collection, storage and transport to laboratory. Methods for sample collection, storage, and transport to laboratory are provided in Appendix 3.

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Appendix 1 : Pubmed Search on Biosand Filter on October 26, 2010

Results: 10

1.
[Assessment of biosand filter performance in rural communities in southern coastal Nicaragua: an evaluation of 199 households.](#)
Fiore MM, Minnings K, Fiore LD.
Rural Remote Health. 2010 Jul-Sep;10(3):1483. Epub 2010 Aug 24. PMID: 20795755 [PubMed - in process]Free Article[Related citations](#)
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Murphy HM, McBean EA, Farahbakhsh K.
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3.
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Hunter PR.
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Chiew H, Sampson ML, Huch S, Ken S, Bostick BC.
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[Cost-benefit comparisons of investments in improved water supply and cholera vaccination programs.](#)
Jeuland M, Whittington D.
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Elliott MA, Stauber CE, Koksal F, DiGiano FA, Sobsey MD.
Water Res. 2008 May;42(10-11):2662-70. Epub 2008 Jan 25.PMID: 18281076 [PubMed - indexed for MEDLINE][Related citations](#)
- 9.
[Characterisation of the biosand filter for E. coli reductions from household drinking water under controlled laboratory and field use conditions.](#)
Stauber CE, Elliott MA, Koksal F, Ortiz GM, DiGiano FA, Sobsey MD.
Water Sci Technol. 2006;54(3):1-7.PMID: 17037125 [PubMed - indexed for MEDLINE][Related citations](#)
- 10.
[The use and performance of BioSand filters in the Artibonite Valley of Haiti: a field study of 107 households.](#)
Duke WF, Nordin RN, Baker D, Mazumder A.
Rural Remote Health. 2006 Jul-Sep;6(3):570. Epub 2006 Aug 2.PMID: 16889468 [PubMed - indexed for MEDLINE]Free Article[Related citations](#)

Appendix 2: Example of Stevenson Tool

Biosand Filter Effective Use Monitoring Checklist		
Monitor Name:		
Community:		
Interviewee Name:		
Household/Code:		
Date and Time:		
GPS Coordinates:		
Notes:		
Instructions: For each observation, fill in Yes, No, or NA for observations that do not apply. Add up the total #Yes, divide by the total # of observations made, and multiply by 100 for % Observational Effective Use.		
Monitoring Observations	Checklist	(Yes/No/ NA)
Treatment	1. Water is added daily to the filter.	
	2. Uses separate containers to fetch/pour dirty water and store filtered water.	
	3. Adds water slowly with the diffuser plate in place.	
	4. Pretreatment is claimed for turbid waters (>100NTU).	
	5. The spout is unobstructed and clean.	
	6. Smooth and level sand bed at water depth of 4-6 cm.	
	7. BSF is sitting flat on firm ground.	
	8. The lid to the filter is in place and clean.	
	9. System is out of direct sunlight.	
	10. System is out of reach of animals.	
	11. Filter has no visible leaks or cracks.	
	12. Filter flowrate is ~0.6 L/min.	
Storage	13. Dedicated safe storage unit is used.	
	14. Design of safe storage unit incorporates a tap or a small sealable opening for pouring.	
	15. The safe storage container has a lid that is kept on tight except for adding or pouring treated water.	
	16. Safe storage container is located with the BSF indoors, out of the sun, off of the floor, in a stable position and out of reach of animals and small children.	
	17. Safe storage unit is visibly clean.	
Maintenance	18. User uses and demonstrates "swirl and dump" cleaning method:	
	18.1. Adds ~4 liters of water to the top of the filter	
	18.2. Scoops out dirty water with small container, levels sand and replaces diffuser plate.	
	18.3. Fills with water and repeats the process if flow rate is still slow.	
	21. Filter cleaning schedule is determined by significant reduction in flowrate.	
	22. BSF cleaned less than once a week.	

	23. User cleans the spout and storage unit with treated water and soap or chlorine solution each week.			
	24. Soap or disinfectant used to clean storage unit can be produced by user.			
Physical Inspection	25. Water bottles for use during travel or school are clean and producible to the interviewer if consistent use is claimed outside the home.			
	26. User demonstrates hygienic method when asked to add water to filter and fetch a glass of water.			
	27. A dedicated clean drinking cup is associated with the safe storage unit.			
Percentage of observations passed = #Yes / (#Yes + #No) X 100 %				
Notes:				
Water Quality Monitoring		(Yes/No/ NA)		
<i>Turbidity</i>	Treated water is clear (Turbidity of <5 NTU).			
<i>Chlorine Residual</i>	Free available chlorine presence in safe storage if chlorine treatment is claimed			
<i>Microbial Testing</i>	Microbial testing shows <10 <i>E.coli</i> CFU/100 ml in water from both running spout and storage unit.			
Notes:				
Sample from running spout	24 hr Colilert (Yes/No)	24 hr Petrifilm (Count)	# <i>E.coli</i> /100ml	Risk Level
	Yellow?	Fluoresces?		
Sample from storage of treated water	24 hr Colilert (Yes/No)	24 hr Petrifilm (Count)	# <i>E.coli</i> /100ml	Risk Level
	Yellow?	Fluoresces?		
<p>Incubate Colilert and Petrifilm at body temperature (35°C) for 24 hours (or until results appear), then check</p> <p>Colilert: If the water is clear: <10 Total Coliform/100ml and <10 <i>E.coli</i>/100ml If the water is yellow: >10 Total Coliform/100ml If the water is yellow and fluoresces: >10 Total Coliform/100ml and >10 <i>E.coli</i>/100ml</p> <p>Petrifilm: # of colonies w/gas X 100= # of Total Coliform/100ml; # of Blue w/gas X 100= # of <i>E.coli</i>/100ml; No Blue colonies with gas= <100 <i>E.coli</i>/100ml; No colonies wth gas = <100 TotalColiform/100ml.</p> <p>Risk Level: Low is <10 <i>E.coli</i> /100ml; Intermediate is 10-100 <i>E.coli</i> /100ml; High is >100 <i>E.coli</i> /100ml.</p>				
Sampling Procedure	1. Take a sample of treated water from the storage unit for microbial analysis (if available). If chlorine treatment is claimed in stored water, test for presence of chlorine residual while at the household and use a Sodium Thiosulphate sampling bag for transporting sample to laboratory. Keep the sample out of the sun and start microbial tests within 6 hours.			
	2. Fill the BSF to a consistent level (not to the top).			
	3. Check the turbidity of the filtering water if it is visible and sufficient volume exists.			
	4. While taking a sample for microbial analysis from the pouring BSF spout, take a flow rate measurement by counting seconds until 100ml is full in the Whirlpak bag.			

Appendix 3: Tools for use in M and E

1. Filter Delivery Inventory Sheet in English
2. Filter Installation Data and Checklist in English and Spanish
3. Household Survey for Assessment of Proper and Continued Use in English
4. Shorter household survey for use by community facilitator in English
5. Community Facilitator Visit Worksheet in English and Spanish
6. Details for water sample collection and storage in English with some slides with pictures in Spanish
7. Description of calculations for water quality data in English
8. Sampling framework in English

(Indicator 1.1a) Filter Delivery Inventory

Name of facilitator receiving materials: _____

Name of person at storage unit providing materials: _____

Date: _____

Community name and location: _____

Form of transportation to the community: _____

INVENTORY:

Total	Plastic Body, top, diffuser plate	PVC Tubing	Outlet hose	Large Gravel	Small Gravel	Sand	Fine Sand
# Received							
# Damaged							

Comments:

(Indicator 1.1a) Inventario para Entrega de Filtros Bioarena

Nombre de facilitadora y/o persona quien recibe las materiales: _____

Nombre de persona en el almacenamiento quien entregó las materiales: _____

Fecha: _____

Nombre de la comunidad y ubicación de la comunidad: _____

Manera de transporte a la comunidad: _____

INVENTARIO:

Total	Cuerpo plástico, tapa, placa difusora	Tubo PVC	Manguera para salida	Grava para drenaje	Grava para separación	Arena	Arena Fina
# Recibido							
# con problemas							

Comentarios:

(Indicator 1.2a, 1.3a) Method for measuring plastic BSF flow-rate:

Equipment needs per surveyor/installation team:

- stop watch
- graduated beverage container

Procedure:

1. Household member will be asked to retrieve a large bucket full of water that is typically used in the plastic BSF (approximately 5 gallons or 20 liters is needed).
2. Plastic BSF will be filled to top of plastic filter body without water spilling from the sides.
3. Using a watch with a second hand or a stop watch, BSF should be allowed to filter for 30 seconds.
4. A graduated container (preferred divisions of 100mL) will be used to collect water for 60 seconds.
5. The total volume collected will be written down on the form (see Appendix 3, document filter installation check-sheet or the survey form for independent evaluations).
6. Households with a flow-rate $>0.8\text{L}/\text{min}$ (or $800\text{mL}/\text{minute}$) will be identified on the filter installation worksheet or the survey form.

(Indicators 1.1b, 1.3b) Filter installation check-sheet

Filter Installation Worksheet

Date: ____/____/____

Money paid : \$RD _____

1. Community: _____
2. Household number (if available) _____
3. Name of facilitator present during the installation _____
4. Name of the household member present during installation _____
5. ¿Who is the person responsible for caring for the filter?

OBSERVATION:

6. Did the user receive the following?

- Si No **a.** Brochure
- Si No **b.** Explanation of how to use
- Si No **c.** Top
- Si No **d.** Diffuser plate
- Si No **e.** Was the outlet tube cleaned

7. Where was the filter installed in the home?

8. Flow rate measure: _____ mL per minute

9. Beneficiaries:

Sex:	>=5 years old	<5	Total
Male			
Female			

Other observations:

Instalación del filtro

Fecha: ____/____/____

Dinero pagado : \$RD _____

1. Comunidad: _____
2. Numero de la casa _____
3. Nombre de facilitador presente durante la instalación _____
4. Nombre de persona presente durante instalación _____
5. ¿Quien es la persona encargada de usar y cuidar el filtro?

OBSERVACIÓN:

6. Recibió el usuario lo siguiente?

- Si No **a.** Brochure
- Si No **b.** Explicación de cómo usar el filtro
- Si No **c.** Tapa del filtro
- Si No **d.** Placa difusora
- Si No **e.** Fue limpiado el tubo de salida del filtro

7. Donde fue instalado el filtro?

8. Medida del flujo: _____ mL por minuto

9. Beneficiarios:

Sexo:	>=5 de edad	<5	Total
Varón			
Hembra			

Otras observaciones:

(Indicators 2 and 3) Household Survey: to be administered by independent survey firm
Evaluation of Plastic Biosand Filter Use in the Dominican Republic

1. Date of Interview: ____/____/2010 Time at start of interview: _____

2. Community: _____

3. Name of interviewer: _____

4. Name of person interviewed: _____ Nickname: _____

5. Please note the age and sex of people who live in the household:

Sex:	>=5 years of age	<5 years of age	Total
Female			
Male			

6. Were you present the day the filter was installed?

(1) Yes 2) No

7. Were you the person who received training on how to use the filter?

(1) Yes, I am 2)No, I am not

8. Have you received follow-up visit from your community facilitator who helped install the filter?

(1) Yes _____# of visits (2) No, I have not

9. Are you still using the filter?

(1) Yes, I am (2)No, I am not (if not, please respond below)

If not, why? (Don't read the options, circle all that they say)

- a) the filter broke and was unable to be fixed
- b) you did not like using it
- c) you felt it was not necessary
- d) you felt it was not improving the quality of your water
- e) you found it to be too time consuming
- f) it is no longer here in this household
- g) you have found a better or more trusted source of water?

If the BSF is no longer in this household, please describe where it went or is? _____

If not using the BSF, what is your main source of drinking water? _____

Note: For households not using the BSF, this concludes the survey. For households using the BSF, continue with question #10 until the end of the survey.

10. Have you sought training or information for the BSF outside of that which was provided to you?

- (1) Yes (2) No (if no, please go to question 12)

11. If you received additional training, from whom did you receive the training (please read the options and select all that apply)?

- (1) A family member
(2) A community member
(3) The community facilitator trained in BSF
(4) An organization
(5) Other, please specify: _____

12. Have you had to maintain the sand to restore the flow-rate in the BSF since you have had it?

- (1) Yes (if yes, go to 13) (2) No (if no, go to 16)

13. How many times have you maintained the sand in the BSF? (Put N/A if never cleaned)

14. When was the last time you cleaned the sand to restore the flow rate? (N/A if never)

Day: _____ / Month: _____ / Year: _____

15. Who usually does the process of maintaining the BSF sand?

- (1) Interviewee
(2) Other, please specify: _____
(3) N/A

16. Do you clean the filter spout?

- 1) Yes 2) No (If no, go to 18)

17. How often do you clean the filter spout?

18. How many times do you use the BSF each week?

19. What is the main drinking water source you use in the BSF?

20. Do you use the BSF-treated water to drink (please read and select one)?

- (1) Yes, always
(2) Yes, sometimes
(3) Yes, not very often
(4) No

29. If yes, what was the problem?

- (1) Slow or no flow
- (2) The diffuser plate broke
- (3) The top of the filter broke
- (4) The filter was leaking
- (5) The water wasn't potable
- (6) Other _____
- (7) N/A

30. Who do you ask for assistance to fix the BSF (Please do not read answer but select all that apply)?

- (1) The community facilitator trained in BSF
- (2) Community water committee
- (3) Neighbor
- (4) Repair myself
- (5) Do not repair
- (6) Other: _____

Note: The following next steps include are observations.

31. Does the filter have a top?

- 1. Yes
- 2. No

32. Is the outlet hose free of restrictions? (nothing attached)

- 1. Yes
- 2. No. Specify _____.

33. Is there a diffuser plate?

- 1. Yes
- 2. No

34. Are there any visible cracks or leaks in the filter body, diffuser plate or outlet tubing?

- 1. Yes
- 2. No

35. Measure the flow-rate: _____ mL per minute

Other Observations:

Thank the participant for his or her time.

(Indicators 2 and 3) Short-form for Evaluation of Plastic Biosand Filter Use in the Dominican Republic

1. Date of Interview: ____/____/2010
2. Community: _____
3. Name of interviewer: _____
4. Name of person interviewed: _____ Nickname: _____
5. Were you present the day the filter was installed? 1)Yes 2) No
6. Were you the person who received training on how to use the filter?
1)Yes 2)No
7. Are you still using the filter?
1) Yes 2)No
8. If not, why? (Don't read the options, circle all that they say)
 - h) the filter broke and was unable to be fixed
 - i) you did not like using it
 - j) you felt it was not necessary
 - k) you felt it was not improving the quality of your water
 - l) you found it to be too time consuming
 - m) it is no longer here in this household
 - n) you have found a better or more trusted source of water?

If the BSF is no longer in this household, please describe where it went or is? _____

Note: For households not using the BSF, this concludes the survey. For households using the BSF, continue with the next set of questions until the end of the survey.

9. How many times do you use the BSF each week?

10. Do you use the BSF-treated water to drink (please read the options)?

- (5) Yes, always
- (6) Yes, sometimes
- (7) Yes, not very often
- (8) No

11. When was the last time you filtered water?

12. Do you use the same container to collect untreated water and to store BSF treated water?

- 1) Yes
- 2) No

13. What do you use treated water for (please read options and circle all that apply)?

- (1) Drinking
- (2) Washing vegetables, washing food, and cooking
- (3) Hand washing
- (4) Washing dishes and kitchen ware
- (5) Bathing
- (6) Other, please specify: _____

14. Have you had any problems with the BSF?

- (1) Yes, I have
- (2) No, I have not

15. If yes, what was the problem?

- 1) Slow or no flow
- 2) The diffuser plate broke
- 3) The top of the filter broke
- 4) The filter was leaking
- 5) The water wasn't potable
- 6) Other _____
- 7) N/A

Note: The following next steps include observations of the filter.

- | | | |
|--------------------------------------------------------------------------------------------|--------|-------|
| 16. Does the filter have a top? | 1. Yes | 2. No |
| Is the outlet hose free of restrictions? | 1. Yes | 2. No |
| Is there a diffuser plate? | 1. Yes | 2. No |
| Are there any visible cracks or leaks in the filter body, diffuser plate or outlet tubing? | 1. Yes | 2. No |

Other Observations:

Thank the community member for his or her time.

(Indicators 2 and 3) Community Facilitator Visit Worksheet

Nombre de facilitador: _____

Comunidad: _____

Número de filtros instalados: _____

Nota: Visita completa ocurre cuando la facilitadora puede entrar la casa, hablar con el recipiente y ver el filtro.

Nombre de recipiente	Visita 1 (1-2 semanas)	Visita 2 (1-2 meses)	Visita 3 (6 meses)	Comentarios
	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	
	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	
	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	
	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	
	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	
	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	
	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	Fecha: _____ Completa: Si o No	

Facilitator name: _____

Community: _____

Number of filters installed: _____

Note: A complete visit consists of the facilitator entering the house, speaking with the recipient and seeing the filter.

Name of recipient	Visit 1 (1-2 weeks)	Visit 2 (1-2 months)	Visit 3 (6 months)	Comments
	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	
	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	
	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	
	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	
	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	
	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	
	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	Date: _____ Complete: Yes o No	

(Indicator 4) DRINKING WATER TESTING: Sampling in the field

List of equipment needed for the field:

Sample Equipment List

- Cold box with shoulder strap to store samples collected at each household
- Cooler (to store samples if cold box is full or on way back to lab)
- Ice packs
- Sterile plastic bags for drinking water sample collection that capture at least 125mLs or 250mLs (three per household).

STEPS FOR COLLECTING WATER QUALITY SAMPLES FOR TESTING AT THE LABORATORY

- Follow these steps for sample collection:
 1. Identify the household drinking water source that will be used for testing. Three samples should be collected: one sample of water prior to BSF treatment, one directly from the BSF, and one of BSF treated and stored water. Each sample should have an ID number from the household and an indicator of before, after, stored.
 2. Take care handling the drinking water sample. Try to ensure that hands or other objects do not come into contact with the water sample during collection that might contaminate the sample.
 3. The interviewer will record the unique household ID number on the test bottle or bag. The interviewer will then ask the primary respondent to show the different types of drinking water for testing. The interviewer will collect up to the marked line on the bottle.



Fill sample bag to line marked with appropriate volume. This should be at least 100mL. Label the side of the bag with number that corresponds to interview.

- Note: Avoid sample contamination during collection. Carefully open each sample container just prior to collection, and close immediately following collection.

SAMPLE COLLECTION, PRESERVATION AND STORAGE

1. Water samples are collected in sterile polypropylene sample containers with leak-proof lids or in sterile whirlpak bags. At least 100mLs should be collected for each sample.
2. Storage Temperature and Handling Conditions: Ice or refrigerate water samples at a temperature of 1-4°C during transit to the laboratory. Use insulated containers to assure proper maintenance of storage temperature. Take care that sample bottles or bags are not totally immersed in water from melted ice during transit or storage.
3. Holding Time Limitations: Analyze samples as soon as possible after collection. Drinking water samples should be analyzed within 30 h of collection although within 8 hours is preferable.
4. A chain of custody should be provided to the laboratory that includes the sample number and sample identification. See example provided below.

PHOTOGRAPHS AND SLIDES IN SPANISH DESCRIBING SAMPLE COLLECTION AND TRANSPORT TO THE LABORATORY

La toma de muestra

- Recipiente o contenedor estéril
- Si la fuente del agua contiene cloro, se neutraliza con tiosulfato de sodio
- Recipiente está rotulada con información sobre la muestra y/o un código para el laboratorio



Toma de muestra



Toma de muestra



Preservación y almacenamiento



- Refrigere o enfrie las muestras a una temperatura de 4°C durante el trayecto hacia el laboratorio
- Asegurese de que las recipientes no estén completamente inmersas en agua que se haya derritdo del hielo utilizado durante el almacen/transito

CHAIN of CUSTODY and LABORATORY RESULTS

Name of person who collected samples: _____

Total number of samples to be processed: _____

Date collected: _____ Date processed: _____

Other comments on samples: _____

Household Identification #	Type of sample: before, direct BSF, stored BSF	Lab results: Total coliforms/100mLs	Lab results: E. coli/100mLs	Lab results: Turbidity (NTU)
103A	Before	>200	42	3
103B	Direct from BSF			
103C	Stored BSF			

Text in red should be filled in by person collecting the samples. Note: It is recommended that each household sampled be assigned a number and that number be used with a letter for identification in the lab. This sheet can be copied and one left with the analyst. The laboratory will fill in text in blue.

6. DESCRIPTION OF CALCULATIONS FOR WATER QUALITY DATA

Indicator 4.1a - % of untreated water samples with <10 E. coli/100mL

Data from laboratory should be provided as concentration of E. coli CFU or MPN/100mL. Based on the results from the laboratory, concentrations of E. coli can be categorized into the following categories: <1 E. coli/100mL, 1-9.9 E. coli/100mL, 10-99 E. coli/100mL, ≥100 E. coli/100mL. The proportion of samples in each group should be calculated as the proportion in the category divided by the total number of samples and then multiplied by 100%.

Indicator 4.1b - % of water samples direct from plastic BSF with <10 E. coli/100mL

Data from laboratory should be provided as concentration of E. coli CFU or MPN/100mL. Based on the results from the laboratory, concentrations of E. coli can be categorized into the following categories: <1 E. coli/100mL, 1-9.9 E. coli/100mL, 10-99 E. coli/100mL, ≥100 E. coli/100mL. The proportion of samples in each group should be calculated as the proportion in the category divided by the total number of samples and then multiplied by 100%.

Indicator 4.1c - % of stored, treated water that has <10 E. coli/100mL

Data from laboratory should be provided as concentration of E. coli CFU or MPN/100mL. Based on the results from the laboratory, concentrations of E. coli can be categorized into the following categories: <1 E. coli/100mL, 1-9.9 E. coli/100mL, 10-99 E. coli/100mL, ≥100 E. coli/100mL. The proportion of samples in each group should be calculated as the proportion in the category divided by the total number of samples and then multiplied by 100%.

Indicator 4.2: Geometric mean % reduction of *E. coli*. To calculate the geometric mean % reduction E. coli, the following steps should be taken. All concentrations (of E. coli/100mL) should be log₁₀ transformed. Then, the following equation should be used:

Equation 1: $\text{Log}_{10} \text{ untreated} - \text{Log}_{10} \text{ direct BSF} = \text{Log}_{10} \text{ reduction BSF}$

These results should then be averaged as a log₁₀ reduction. To convert to a %, the following equation should be used:

Equation 2: % reduction = $[1 - 10^{(-\text{avg. log}_{10} \text{ reduction value})}] * 100\%$.

Indicator 4.3: Mean % reduction of turbidity. The same approach for E. coli should be used for turbidity. To calculate the geometric mean % reduction turbidity, the following steps should be taken. All turbidity measurements (NTU) should be log10 transformed. Then, the following equation should be used:

Equation 1: $\text{Log}_{10} \text{ untreated} - \text{Log}_{10} \text{ direct BSF} = \text{Log}_{10} \text{ reduction by BSF}$

These results should then be averaged as a average log10 reduction. To convert to a %, the following equation should be used:

Equation 2: $\% \text{ reduction} = [1 - 10^{(-\text{avg. log}_{10} \text{ reduction value})}] * 100\%$.

Indicator 4.4: % of all samples that have detectable chlorine (BSF treated and stored). This is assuming that chlorine will be tested in households. A variety of chlorine tests are available. The proportion that test positive divided by the total number of samples tested multiplied by 100% will provide the % of sample positive.

7. Sampling Framework:

Determination of sample size.

A user friendly resource describing sample size calculations is shared below. A sample of approximately 1050 households is recommended for sampling from the 9000 plastic BSFs that will be installed during the implementation program. The following equation was used to calculate sample size:

Appendix 3: An Equation for Determining Final Sample Size

$$n = \frac{\left(\frac{P[1-P]}{\frac{A^2}{Z^2} + \frac{P[1-P]}{N}} \right)}{R}$$

Where:

- n = sample size required
- N = number of people in the population
- P = estimated variance in population, as a decimal: (0.5 for 50-50, 0.3 for 70-30)
- A = Precision desired, expressed as a decimal (i.e., 0.03, 0.05, 0.1 for 3%, 5%, 10%)
- Z = Based on confidence level: 1.96 for 95% confidence, 1.6449 for 90% and 2.5758 for 99%
- R = Estimated Response rate, as a decimal

Source: Penn State Tip Sheet (<http://extension.psu.edu/evaluation/pdf/TS60.pdf>)

Since a sample of this magnitude has not previously been performed before in the Dominican Republic, the following assumptions had to be made about the population in order to estimate the sample size needed:

- 1) A 95% confidence interval was assumed (Z = 1.96).
- 2) Sample size should be increased to take into account non-responses (Non-response rate assumed to be 10%)
- 3) A 3% margin of error is acceptable. This indicates that if the percentage of the population adopting the plastic BSF is 85%, we would know that the actual range is between 82-88%.
- 4) We are making assumptions about the distribution of the population being normal. This assumption is stronger as the total sample size increases.

Based on the following assumptions, the sample size determined to be adequate was 1059 households for a population of 9000, with 95% confidence, (+/-)3% precision, assumed population variance at 0.5, and a response rate of 90%. There are limitations to the use of this calculation (such as unknown population variance, assumption of normality, no adjustment for clustering). A sample of this size should provide insight into the overall continued and proper use of the plastic BSFs from this implementation program. This sample size is also similar to the number that was originally mentioned in the original M and E plan provided by Bob Hildreth.

In addition to the above mentioned sample size, it is recommended that cluster random sampling be performed. This is recommended as the method for sampling to be performed by the independent survey firm (Entrena). Based on the description provided in "Instructivo (Appendix 4)", at least 40 filters will be installed in each community that solicits filters. It is recommended that at least 35 clusters (randomly selected) be visited and at least 30 households (75% in each community) with plastic BSFs be

visited within each cluster. This represents about 12% (1050 filters) of the total number of plastic BSFs that will be installed during the course of the project. The original monitoring and evaluation plan suggested that 50 communities would be visited and 20 households from each community would be sampled. The smaller the cluster size (30 versus 20), the lower the clustering impact will be on the overall sampling results. Therefore, it is recommended that at least 35 communities be visited and as many as 50 be visited. This sampling plan seems to be within reach as it was previously included in the original M and E plan. Cluster sampling will reduce some of the cost associated with independent survey because it can maximize interviewer time and reduce travel costs.

Drinking water sampling:

Based on previous data collected in the Dominican Republic and sample size calculations performed, a sample size of 350 households in 35-50 clusters would be adequate to detect a 50% reduction in total number of samples with ≥ 10 *E. coli* per 100mL and a significant reduction in *E. coli* by the plastic BSF of 35% or greater. These sample calculations were performed in EpiInfo and assumed 95% confidence, 80% power to detect at least a 50% change in proportion of samples with *E. coli*. Therefore, it is recommended that approximately 30% of the households in each of the clusters provide drinking water samples. Every third household in the cluster should be approached for drinking water samples. This will provide approximately 6- 10 households per cluster (35 vs. 50 clusters) with drinking water analysis (each household will provide up to 3 samples). The total number of households asked to provide drinking water samples will be approximately 350 households or 33% of households surveyed by the independent survey team. It is recommended that households in each cluster provide drinking water samples because the results of the water quality analysis will be dependent on the source water quality in each community.

It is highly recommended that the independent survey team conduct household visits without the community facilitator present as his or her presence may bias the household member's responses. It is also recommended that the survey team select households for interview in each cluster independent of the community facilitator. The purpose is to avoid the community facilitator directing the survey teams to model households which will bias the overall results. Ideally, the community facilitator would provide a list of all households with plastic BSFs and the survey team would select randomly from the list to reach 20-30 households per cluster.

Appendix 4: Instructivo para Clubes Rotarios y Comunidades

Proyecto H2O Sana Para Los Niños

3H 70426

Objetivo

El objetivo de este documento es orientar a los Clubes Rotarios y comunidades que interesan participar en el Proyecto H2O Sana para Los Niños del Distrito Rotario 4060, Republica Dominicana.



Filtro BioArenA HydrAid instalada

Proceso de involucramiento en Breve

1. Identificar comunidad con necesidad de mejorar su calidad de agua potable
2. Trabajando con los líderes de la comunidad, identificar personas responsables que puedan servir como facilitador.
3. Coordinando con el comité operacional del proyecto, enviar uno o dos facilitadores a un curso para entrenar como facilitadores. Las responsabilidades de los facilitadores son los siguiente: asistir y cumplir el curso de facilitador, formar un comité del agua dentro la comunidad, educar la comunidad sobre sus problemas de calidad de agua, promover soluciones, coordinar adquisición de filtros BioArenA, instalar los filtros, educar las familias en uso adecuado de filtro y buen higiene familiar, dar seguimiento a problemas en el uso de dichos filtros, prepara informe de la comunidad.

4. Facilitador promueva filtros por un proceso de educación, concientizando familias sobre los problemas del agua hasta la familias son interesado en obtener un filtro y dispuesto de contribuir por los mismo. Cada familia debe contribuir al fondo del comité del agua por lo menos \$RD 500 cada filtro. Parte de los fondos serán utilizados para el transporte de los filtros hacia la comunidad. El balance debe ser utilizado para una necesidad de la comunidad y/o puede ser utilizado como una compensa del facilitador (no Rotario).
5. Solicitar filtros vía comité operacional del proyecto. Inicial proyectos serán limitado a 40 filtros por Club Rotario. Después de la evaluación mas filtros pueden ser solicitado, tomando en cuenta hay prioridad a clubes quien no han participado en la subvención.
6. Coordinar transporte de filtros del almacén a la comunidad.
7. Recibir e instalar filtros.
8. Dar seguimiento sobre el uso adecuado de los filtros
9. Preparar en enviar un reporte de evaluación cada 2 meses luego de recibir los filtros
10. Asesorar visita de evaluación a la comunidad
11. Preparar Reporte de Cierre dentro 30 días de competición instalaciones

Sobre los Cursos para Facilitadores

Los cursos para educar facilitadores se programa más o menos mensual. En general se ofrecerá los cursos en Santiago o Santo Domingo en lugares especiales y probados. El curso inicia los viernes en la tardecita y termina el domingo temprano en la tarde. Se brinda todas las comidas y dormitorios para dormir. Hay un cupo máximo de 12 personas por curso. Las facilitadores y direcciones a los centros educativos dependen en la fecha y programación. Se suministrará los detalles de cada curso previo a los invitados. El costo de los cursos esta costeadado por el proyecto. Cada club o comunidad debe costear el transporte al curso y de regreso. Los cursos están bien organizados. Se pida a las personas invitadas a los cursos ser puntuales y no faltar, como los costos de cada cupo no son recuperables. En caso que un club reserva un cupo para un curso y no asisten el becario, el club tendrá la responsabilidad de reembolsar el Distrito por el costo del curso (\$RD 8,000 por persona) antes de enviar otra persona, si la beca no fue sustituido por otra persona.

Solicitud para Curso de Filtros de Agua

Comunica con uno de los miembros operativo del proyecto para ser considerado, por correo electrónico, si posible, si no puede enviar vía fax a 809 586-4512. Incluye nombre, ocupación, teléfono, correo electrónico, comunidad, Club Rotario y contacto electrónico y teléfono del responsable en el club.

Solicitud de Filtros

Cualquier comunidad pueda solicitar filtros de agua para su distribución. Los pasos son 1) elegir y enviar una o dos personas para ser entrenado como facilitador de filtros de agua, 2) concientizar familias sobre los problemas del agua, 3) preparar una relación de las familias interesado en recibir su filtros de agua, 4) llenar y enviar el formulario de solicitud, 5) ser seleccionado para recibir filtros.

Aprobación de Entrega de Filtros

David, Roberto o Alexandra evalúa la solicitud si la comunidad llena los requisitos para ser beneficiado de recibir filtros en base de la información suministrada en el formulario de solicitud de filtros y posibles visitas por parte de miembros del proyecto. Según aprobación técnica el final autorización será por aprobación del Comité Fideicomisarios del Distrital del 3-H. Es preferible realizar las comunicaciones con los miembros del comité por correo electrónico lo más posible.

En general los criterios para ser elegido para filtros de agua son, los siguientes:

1. necesidad mostrado de carencia de calidad de agua,
2. el agua no es salubre, el filtro no remueve sal,
3. grupo comunitario organizado para supervisar programa,
4. facilitador entrenado y capacitado para instalar filtros y dar mantenimiento,
5. determinación que los filtros son adecuado para la comunidad con su fuente de agua y que se considera que dichos filtros pueda mejorar la salud de la comunidad,
6. hay suficiente demanda para filtros y no está saturado la comunidad de filtros, la solicitud tendrá un registro de beneficiarios.

Entrega de Filtros

Luego de ser aprobado para recibir filtros de agua, se coordina con la persona responsable en la comunidad dicho entrega. Es preferido que la comunidad organice su propio transporte. Se recoge sus filtros en el lugar del almacén el día y horario acordado. El almacenista entregará la cantidad exacta de los filtros y todos sus asesorios y materiales. Es importante que se revise las cantidades entregadas como no se acepta reclamos luego. Se presentará un documento para firmar que se llama **Formulario Entrega Filtros y Descargo de Responsabilidad**.

Reporte de Cierre Proyecto

Dentro treinta días de cumplir la instalación de todos los filtros cada club es obligado de entregar un reporte de cierre el proyecto. El club es responsable de mantener un registro de beneficiarios en lo cual el club tendrá de mantener. El club será responsable y dispuesto de facilitar visitas para el monitoreo del proyecto a la solicitud del Distrito por un periodo de 3 años. Adicional filtros no pueden ser solicitados hasta su reporte de cierre esta aceptado. Los clubes también deben tomar fotos y enviarlos al Distrito y conseguir publicidad al nombre de la Colaboración de Agua Sana de Rotary USAID.

Contactos a los miembros operacionales del proyecto:

David Crow d.crow15@gmail.com, teléfono 809-723-7933 cel

Alexandra Martínez de Adams doctoralexandra@gmail.com, teléfono ????????????

Robert Hildreth rec.hildreth@gmail.com, teléfono 809 586-2423

Formularios Anexos:

- 1. Informe Seguimiento Proyecto**
- 2. Formulario de Petición de Filtros**
- 3. Formulario Entrega Filtros y Descargo de Responsabilidad**
- 4. Checklist para Entrega de Filtros**
- 5. Reporte de Cierre Proyecto**

Appendix 5: Original draft of M and E plan

Monitoring and evaluation RI-USAID Dom Rep

On the Rotary side of the proposed project we have designed various levels of monitoring for operational evaluation. The monitoring and evaluation is designed to assure compliance and proper utilization of the filters and not a scientific evaluation of the effectiveness of the filter. A major Health Impact Study was concluded in the Dominican Republic by the University of North Carolina, a significant health improvement has been documented with the utilization of the filter. The following layers of monitoring have been built into the project:

Level 1 – Community Facilitator: Responsible for the individual installation and follow up to each family beneficiary. CF prepares a list of all beneficiaries and makes post implementation visits at 7-14 days 1-2 months and 6 months. Also visits as required by beneficiaries to resolve operational issues. 100% coverage.

Level 2 – Community Access Partners (Rotary Clubs and or partner organizations), responsible to select and monitor the Community Facilitators. Required to file project reports to District committee as to utilization, compliance and completion. Required to make one 100% evaluation of beneficiaries within 30-60 days upon completion of all installations.

Level 3 – Project Manager: Will provide technical support and evaluation of proper utilization of technology in community projects as directed by the District Committee. Proposed to make 80 site visits. Roughly 1,500 family surveys indicating utilization and functionality of the filters will be compiled. Basically 100% of the communities will be visited at least once.

Level 4 – Entrena: External monitoring and evaluation will consist of interviewing beneficiaries and taking water samples from 400 homes (before and after). 11% of the beneficiary families (1,000 families in 50 communities) will be interviewed by Entrena, a statically significant sampling. Water samples will be sent to ISA University for analysis. Data will be compiled and summary and conclusion information will be provided by Dr. Christine Stauber of GA State University. Problem communities will be notified and remedial solutions will be addressed.

Level 5- Rotary Water Committee: Members will make numerous field site visits to include some with the Project Manager and Entrena as overall quality monitoring of field personnel and evaluation process.

Note: Due to the nature of the filter it is not possible to directly correlate results of input and output of water during field sampling. The filter maintains about 5 gallons of water at all times and so when testing the water introduced is not the water which comes out, additionally the water introduced is intermingled with the residual water. Bacterial removal rates are determined by a statistical average of numerous samplings of before and after.

Proyecto Agua Sana Para Los Niños

Distrito Rotario 4060/USAID-RD

SUBVENCION 3-H 70426

INFORME Usuario

Investigador: _____ Fecha Entrevista: _____

1. Nombre de la comunidad:
2. Dirección de la Casa:
3. Organización padrino; Club Rotario u otro ONG: _____
4. Nombre Usuario: _____
5. Tipo de filtro (HydrAid o Cerámica) Fecha instalada: _____
6. Número de personas utilizando el filtro: _____, menores de 5 años: _____
7. ¿Han pagado alguna cuota por su filtro? ¿qué cantidad?
8. ¿Se le ha entregado botellón, gotero de cloro y brochure informativo?
 ¿Lo utilizan? ¿Ubicado donde?
9. ¿Con qué frecuencia filtran agua? Qué cantidad? Quien lo hacen?
10. ¿De dónde proviene el agua que filtran?
11. ¿Para que usan el agua filtrada? (tomar, bañar, preparar comida, limpiar, otros)
12. ¿Utiliza el cloro después de filtrar? ¿Cuanto cloro Utilizan?
13. Anteriormente en su familia tenían problemas de salud como amebas, parásitos, diarreas, infeccione, problemas de la piel como manchas etc.?
14. ¿Desde que están usando el filtro han podido notar cambios en la salud o economía de su familia?
15. ¿De qué son mas disgustado con del filtro?
16. ¿Han tenido problemas con el filtro? (si contesta sí, quien y como resolvieron?)
17. Grado de satisfacción del filtro. (No satisfecho, más o menos, satisfecho, excelente)
18. Otros comentarios por parte del beneficiario:

Inspección del filtro:

Instalación:

Funcionamiento:

Estado general del filtro:

Usuario sabe bien cómo usar y mantener el filtro:

Estado de la casa, nivel: 1 2 3 *(1= casa muy pobre, barracón, etc. 2= casa media madera y zinc, 3= casa block techo en buen estado)*

Estado higiene casa general: 1 2 3 *(mala, regular, buena)*

Prueba o evidencia de cloro, post filtración:

Prueba (Cloro libre PPM):

Utilizan un contenedor seguro para conservar el agua de beber:

Tomo pruebas de agua (pre y post filtración) No: _____

Appendix 6: Procedure for membrane filtration for total coliforms and *E. coli* in water (in Spanish)

Enumeración en agua de Coliformes totales y *Escherichia Coli* mediante filtración por membrana utilizando una técnica de detección simultánea.

1. **Capacidad y Aplicación:** Este método describe un medio de filtro de membrana el cual es diferencial y sensitivo, utilizando agar Biorad Rapid E.Coli 2™ para la detección simultanea y enumeración tanto de Coliformes Totales como de *E.coli* en muestras de agua, en 24 horas o menos basándose específicamente en la actividad enzimática. Este medio incluye dos substratos de enzimas, los cuales cambian de color cuando las enzimas de los Coliformes Totales o de *E.coli* son detectadas en el medio. Los Coliformes Totales producen colonias con un pigmento verde/azul y las colonias de *E.coli* son violetas cuando se incuban a 35°C.
 - a) Los coliformes totales incluyen especies que habitan los intestinos de animales de sangre caliente como también se encuentran de manera natural en la tierra, vegetación y agua. Generalmente se encuentran en agua contaminada con materia fecal y frecuentemente se asocian con enfermedades. Aunque la mayoría de los coliformes totales no son patógenos de por si, su presencia en agua potable indica la posible presencia de otros patógenos.
 - b) *E. coli*, una especie del grupo de los coliformes, siempre se encuentra en material fecal, por tanto es un indicador más directo de contaminación fecal y de la posible presencia de patógenos entéricos. Además, algunas cepas de *E.coli* son patógenas.

Ya que se puede analizar un amplio rango de volúmenes o diluciones utilizando la técnica de filtración por membrana, esto facilita la detección y enumeración de un amplio rango de niveles de coliformes totales y *E.coli* en el agua.

2. **Resumen del método:** Un volumen apropiado de la muestra de agua (100 ml de agua potable) se filtra a travez del filtro de membrana de celulosa de Ester de 47 Mm, el cual posee poros de 0.45- μm lo cual retiene la bacteria presente en la muestra. Procedemos a colocar el filtro en un plato de 5-ml de agar Bio-rad Rapid E.Coli 2™ o en un paquete absorbente saturado con 2-3 ml de caldo; este plato es incubado a 35C por hasta 24h. Las colonias bacterianas que crezcan en el plato son inspeccionadas para determinar la presencia de color verde/azul para coliformes totales y la presencia de colonias violetas las cuales indican *E.coli*.

3. Interferencia y Contaminación:

a. Turbidez o partículas suspendidas: muestras de agua que contengan material coloidal o partículas suspendidas pueden obstruir el filtro de membrana, impidiendo la filtración o pueden propiciar la propagación de colonias bacterianas las cuales interfieren con la identificación de las colonias a estudiar. Sin embargo, las colonias violetas de *E. coli* frecuentemente pueden ser contadas en platos con un gran número de partículas o altas concentraciones totales de bacteria.

b. La presencia de cierta difusión lateral de color violeta escapando de las colonias de *E. coli* a estudiar, puede afectar la enumeración y selección de colonias en los platos con altas concentraciones de *E. coli*. Este problema no debe afectar filtraciones de conteos bajos, como aquellos obtenidos de agua potable o muestras diluidas adecuadamente.

4. Seguridad: El analista/técnico debe conocer y seguir los procedimientos de seguridad requeridos en un laboratorio microbiológico mientras prepara, utiliza y desecha los cultivos, reagentes y materiales; y mientras opera el equipo de esterilización. Debe de utilizar el autoclave para todos los platos y materiales contaminados al final del análisis.

5. Lista de Equipos y Materiales.

- a. Incubadora programada a $35^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$, con aproximadamente 90% de humedad si se utilizan platos petri de cobertura laxa.
- b. Contenedor de pipetas de acero inoxidable, aluminio o cristal Pyrex.
- c. Cilindros graduados (100-ml para agua potable) cubiertas con papel aluminio o papel kraft y esterilizadas.
- d. Unidades de filtración de membrana (base del filtro y embudo), de cristal, plástico o acero inoxidable. Estas deben de cubrirse con papel aluminio o papel kraft y ser esterilizadas.
- e. Caja de luz ultravioleta germicida (254nm) para higienizar los embudos de los filtros sería ideal, pero es opcional.
- f. Succionador de línea, bomba eléctrica de succión o un succionador son utilizados como la fuente de aspiración. En caso de emergencia, se puede utilizar una bomba manual o una jeringuilla. Estos equipos que producen succión deben de estar equipados con una válvula especial para evitar el retorno del flujo de aire.
- g. Botella para succión del filtro, generalmente 1 litro, con las mangueras adecuadas. Sería deseable tener diversos filtros que soporten un número de bases de filtros distintas, pero es opcional.
- h. Botella con trampa de seguridad, colocada entre la botella del filtro y la fuente de aspiración.

- i. Fórceps de hojas rectas (preferiblemente) o curvas, con bordes suaves para permitir un fácil manejo de los filtros sin dañarlos.
- j. Alcohol, etanol 95% en contenedores pequeños de boca ancha, para esterilizar los fórceps.
- k. Unidad incineradora eléctrica o mechero tipo Bunsen o Fischer.
- l. Pipetas bacteriológicas estériles o de Mohr, de cristal o de plástico (volúmenes de 1-ml y 10-ml)
- m. Filtros de membrana blancos, con marcador de medidas, Ester de celulosa, de 47-mm de diámetro, con poros de $0.45 \mu\text{m} \pm 0.02\text{-}\mu\text{m}$, pre-estériles o esterilizadas por 10 minutos a 121°C (15-lb. de presión).
- n. Agua para dilución estéril con un buffer de fosfato, preparada en grandes volúmenes (por Ej. 1 litro) para humedecer las membranas antes de añadirlas a la muestra y para enjuagar el embudo luego de la filtración de la muestra de agua.
- o. Marcador de tinta indeleble para rotular los platos.
- p. Termómetro calibrado y certificado con el NIST (Instituto Nacional de Ciencia y Tecnología) o un termómetro comparable con un termómetro del NIST.
- q. Platos petri, estériles, plásticos de 9 x 50mm, con coberturas justas o platos de 15 x 60 mm de cristal o plásticos con coberturas laxas. También se pueden utilizar platos de 15 x 100 mm.
- r. Botellas, cristal de silicato de boro, coberturas enroscables recubiertas de neopreno marcadas a 99ml para 1:100 diluciones (si es necesario). Se permite el uso de botellas de dilución marcadas a 90mL o tubos marcados a 9mL para diluciones 1:10.
- s. Botellas, cristal de silicato de boro, tapas enroscables, volumen de 250-2000ml para preparación del agar.
- t. Baño de agua mantenido en 50°C para aclimatar el agar.

6. Reagentes y Estándares

- a. Preparación: Coloque el medio en el autoclave por 15 minutos a 121°C (15-lb. presión) utilice la pipeta para transferir el medio a los platos petri de 9x50mm (platos de 5mL). Almacene los platos a 4°C por hasta 2 semanas. El pH final debe de ser 6.95 ± 0.2 .

7. Toma de la muestra, preservación y almacenamiento

- 12. Las muestras de agua son colectadas en contenedores estériles de polipropileno con coberturas resistentes a derrames o goteos.
- 13. La presencia de residuos de cloro en muestras de agua potable deben de ser neutralizadas con tiosulfato de sodio al momento de ser colectadas. El seguimiento estricto del procedimiento para preservar las muestras y la adherencia a los límites de

tiempo establecidos, son medidas cruciales para la producción de datos de validez. Las muestras que no cumplan con estas reglas no serán analizadas.

14. Temperatura de almacén y condiciones para manipulación de la muestra: Refrigere o enfríe las muestras a una temperatura de 1-4°C durante el trayecto hacia el laboratorio. Utilice empaques aislantes para asegurar una correcta temperatura de la muestra. Asegúrese de que las botellas con la muestra de agua no estén completamente inmersas en agua que se haya derretido del hielo utilizado durante el tránsito o el almacén de las mismas.
15. Limitaciones del tiempo de espera: Analice las muestras tan pronto como sea posible luego de la colección. Las muestras de agua de beber deben de ser analizadas en un período menos de 30 horas luego de ser colectadas. *No guarde muestras de la fuente de agua por más de 6 horas entre la colección de la muestra y el inicio del análisis. Todos los análisis deben de ser completados dentro de un periodo de 8 horas luego de la toma de la muestra.*

8. Calibración and estandarización

- a. Examine la temperatura de las incubadoras 1 vez al día para asegurar su correcta operación dentro de los límites establecidos. Compare los termómetros al menos una vez al año, con un termómetro certificado por el NIST. Inspeccione si hay rupturas en la columna de mercurio.

9. Control de Calidad

- a. Compare el comportamiento de cada lote de agar con cultivos ya conocidos (*E.coli*, Coliformes totales y un no-coliformes) y haga los ajustes necesarios (Ej. ajuste reacciones enzimáticas).
- b. Controles de Agar: Coloque uno o más platos de agar o paquete de agar en la incubadora por 24 horas a 35°C. Si utiliza agar en paquete (caldo) debe de ser incubado con el lado ranurado hacia arriba, no invertido como los platos de agar. La ausencia de crecimiento indica la esterilidad de los platos.

10. Procedimiento

- a. Prepare agar Bio-rad Rapid *E.coli* 2™ como fue descrito en la sección 6. Si los platos fueron preparados de antemano y guardados en el refrigerador, retírelos y espere a que alcancen temperatura ambiente.
- b. Rotule la cara inferior de los platos de agar con el número de la muestra/identificador y el volumen de muestra a ser analizado. Rotule los platos de control de calidad.

- c. Utilizando fórceps flameados, coloque un filtro de membrana con el lado ranurado hacia arriba, en el plato poroso de la base del filtro. Si usted tiene dificultad en remover los papeles de separación del filtro debido a la estática, coloque un filtro con el papel sobre la base del embudo y encienda la succión. El papel de separación se enrollara, lo cual facilita su remoción.
- d. Una el embudo a la base de la unidad del filtro, tratando de no dañar o separar el filtro. El filtro de membrana ahora estará colocado entre el embudo y la base.
- e. Agite el contenedor de la muestra VIGOROSAMENTE 25 veces.
- f. Mida un volumen apropiado (100mL de agua potable) o una dilución de la muestra con una pipeta estéril o cilindro graduado, y viértala en el embudo.
- g. Retire el embudo de la base de la unidad de filtración. Puede utilizar una caja de luz ultravioleta (254nm) para higienizar el embudo entre filtraciones. Se necesita por lo menos 2 minutos de tiempo de exposición para la descontaminación del embudo. Proteja sus ojos de la irradiación ultravioleta con lentes o con una cámara encerrada para luz UV.
- h. Sosteniendo el filtro de membrana en el borde con los fórceps flameados, con delicadeza levante el filtro y colóquelo con el lado ranurado hacia arriba sobre el plato de agar. Deslice el filtro sobre el agar utilizando una técnica de barrido para evitar la creación de burbujas de aire entre el filtro de membrana y el agar. Recorra el borde del filtro con los fórceps para asegurar el contacto del filtro con el agar. Reacomode la membrana si ocurren áreas secas debido a burbujas de aire.
- i. Invierta el plato petri con el agar e incube el plato a 35°C por 24 horas. Si utilizó los paquetes con agar (caldo), estos deben de ser incubados con el lado ranurado hacia arriba a 35°C por 24 horas. Si utiliza platos de coberturas laxas, los platos deben de ser colocados en una cámara húmeda.
- j. Cuente todas las colonias violetas en todos los platos de agar Bio-rad Rapid E. coli 2™ bajo luz ambiental/normal y anote los resultados. Este es el conteo de *E.coli*. Resultados positivos que ocurran antes de las 24 horas son válidos, pero no puede anotar resultados negativos hasta no completar 24 horas de período de incubación.
- k. Cuente todas las colonias azul/verde en cada agar Bio-rad Rapid E. coli 2™ agar. Estos son los coliformes totales.

11. Cálculos y Análisis de Datos

- a. Utilice las siguientes reglas generales para calcular *E.coli* o CT por 100mL de muestra:
 - i. Seleccione y cuente los filtros con <200 colonias totales por plato.

- ii. Seleccione y cuente los filtros con <100 colonias de estudio (idealmente, 20-80).
- iii. Si el número total de colonias o CT en un filtro son demasiadas numerosas para contar o muy confluentes, anote el resultado como “CT” (NTCT) y cuente el número de E.coli. Si ambos organismos de estudios son >200, anote el resultado como CT*EC*(NTCT).

E. coli/100mL = Numero de colonias violetas/Volumen de muestra filtrado (ml) *100

Coliformes Totales/100mL = Numero de colonias azul/verde/Volumen de muestra filtrado (ml) *100

12. Prevención de Contaminación: Prevención de contaminación es cualquier técnica que reduce o elimina la cantidad o toxicidad del desperdicio en el lugar de generación. Es la herramienta ambiental preferida por encima del desecho de basura o reciclaje. Cuando sea posible, los empleados del laboratorio deben utilizar técnicas de prevención de contaminación, como preparación de menor cantidad de volúmenes de reagentes, estándares, medios de cultivo o disminuir las unidades de evaluación en el método. Los empleados del laboratorio también deben de revisar los equipos y materiales para desarrollar nuevas maneras de disminuir y prevenir la contaminación. Considere el método de reciclaje cada vez que sea práctico.

13. Manejo de Desperdicios: La Agencia de Protección Ambiental de EEUU requiere que las prácticas de manejo de desperdicios del laboratorio sean consistentes con todas las reglas y regulaciones que apliquen. La agencia estimula e impulsa a los laboratorios a proteger el aire, agua y tierra minimizando y controlando los desechos de sus operaciones, adherirse a los permisos de desecho de aguas negras, cumplir con las regulaciones de desechos sólidos y tóxicos, especialmente la identificación de los desechos peligrosos y obedecer las restricciones de desechos en tierra. Todos los desechos infecciosos deben de ser tratados con el autoclave antes de ser desechados.