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Evaluation of the Sustainability of Water and Sanitation Interventions in Central America after Hurricane Mitch
Second Sustainability Survey
February 14–March 5, 2009

Final Report

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Executive Summary

The American Red Cross (ARC) and the Centers for Disease Control and Prevention (CDC) collaborated on a sustainability evaluation in communities that received ARC interventions in response to Hurricane Mitch, which affected Central America in 1998. The evaluation was designed to determine whether the water, sanitation, and hygiene education interventions ARC implemented in Central America after the hurricane could be sustained. The evaluation used indicators to measure the continued effectiveness and performance of the interventions once the interventions were completed by ARC.

An initial three-year survey to determine the health impact of the interventions and their functionality after completion was done during the period of 2000–2002. This survey was conducted in eight communities in four countries—El Salvador, Guatemala, Honduras, and Nicaragua. Results recommended continued follow-up to determine sustainability. The 2009 sustainability evaluation was the second to be conducted since the initial three-year survey. The first sustainability survey was completed in 2006.

This sustainability evaluation had four components:

- household-level interview,
- community-level interview,
- water sampling and analysis from homes and community systems, and
- infrastructure evaluation.

The household interview and the community and infrastructure questionnaires were similar to the questionnaires used in 2000-2002; they focused on the three interventions—water, sanitation, and hygiene education.

Our results show that the ARC water and sanitation interventions were generally sustainable on a regional basis after seven years. Physical infrastructure, such as water systems and sanitation facilities, is still present and functioning to a certain degree in many communities. However, these communities continue to have the same issues identified in the 2006 sustainability survey and are in need of assistance in maintaining and repairing the physical infrastructure. Water systems are well-managed, but they experience periodic service disruptions due to seasonal flood damage. Sanitation facilities are present; however, they are reaching their maximum capacity and can no longer be used in some cases. Additional health education is needed to ensure continued proper use and maintenance of both water and sanitation interventions as it did not show significant improvement over time.

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1 Introduction

The American Red Cross (ARC) and the Centers for Disease Control and Prevention (CDC) have been collaborating on a sustainability evaluation of ARC-funded water, sanitation, and hygiene education interventions in Central America. These interventions were originally provided following Hurricane Mitch which impacted Central America in 1998. This sustainability evaluation was done in 2006 and 2009 when the interventions were completed and ARC was no longer providing support to these communities.

1.1 Summary of Previous Activities

CDC began collaborating with the ARC in 1999 to evaluate the ARC's post-disaster program after Hurricane Mitch in 1998. Table 1 summarizes work completed.

Table 1. Completed Work

Study	Data collected by Survey					Final Report (year)
	Households	Active Diarrhea Surveillance Participants	Household Water Samples	Community Water Samples	Community Surveys	
Initial 3-year Survey (2000-2002)						
Baseline Survey	638	213	107	39	14	2000
Mid-term Survey	765	208	82	36	11	2001
Final Survey	772	193	77	49	11	2002
Total	2175	613	265	124	36	
Sustainability Evaluation (2006)						
	94	--	93	15	8	2008
Sustainability Evaluation (2009)						
	138	--	133	31	11	2010

CDC used metrics from the United States Agency for International Development (USAID) Food and Nutrition Technical Assistance (FANTA) Title 2 Water and Sanitation Indicators Measurement Guide (FANTA Guide) (Billig et al., 1999) to measure improvements in health as a result of the ARC interventions. These metrics were the indicators originally specified by ARC for the initial three-year survey; thus for consistency, they have been used in each of the sustainability evaluations.

1.2 Purpose of the Sustainability Evaluation

A sustainability evaluation of the ARC-funded water and sanitation projects was recommended for the communities in this program as a result of the initial three-year survey. The purpose of the sustainability evaluation was to:

1. Examine the continued functioning and suitability of ARC-provided water and sanitation systems;
2. Measure the retention and application of hygiene education related to hand washing, water collection and treatment, and sanitation practices by persons responsible for obtaining and storing household water; and
3. Identify issues with the interventions that require additional or focused support for their continued maintenance.

Review of the results from these surveys can be used by ARC, as well as other non-governmental agencies (NGOs), in determining how to strengthen the programs at the outset. Significant funding is available at the beginning of disaster response programs, and the sustainability of the investments made to these communities should be ensured.

1.3 FANTA (Food and Nutrition Technical Assistance) Guide Indicators

ARC requested that CDC use the FANTA Guide indicators as the basis for measuring outcomes in the initial three-year survey. Use of the FANTA Guide indicators provides a consistent set of performance indicators for assessing and reporting the effect of water and sanitation interventions in developing countries.

There are eight FANTA Guide performance indicators consisting of four impact indicators and four monitoring indicators (provided in Appendix A). The impact indicators assess the effect of the interventions on the behaviors and health status of the beneficiaries; they include measures of disease burden, hygiene behavior, and maintenance and use of water supply and sanitation facilities. Monitoring indicators are used to evaluate the progress of the interventions in achieving programmatic goals. We were able to evaluate the ability of each community to meet each of the performance indicators.

Data collected for the initial three-year survey were meant to evaluate and demonstrate the effectiveness of ARC interventions in improving the health of the population impacted by the hurricane. In contrast, the sustainability evaluations focused on the long-term effectiveness of the water and sanitation infrastructure and the retention of hygiene education. As a result of the initial three-year survey, we found that we were able to collect reliable data to estimate the four indicators presented in Table 2. Each of the indicators specifically addressed one of the interventions. We used the goals provided in the FANTA Guide or as recommended by ARC.

Table 2. USAID FANTA Guide Indicators to Evaluate Program Sustainability

Intervention	Performance Indicator	Description Of Indicator	Goal
Water Infrastructure	Monitoring Indicator #1	Percent of households with year-round access to improved water source	100%*
Sanitation Infrastructure	Monitoring Indicator #2	Percent of households with access to sanitation facility	100%*
Hygiene Education	Impact Indicator #3	Percent of households with appropriate hand washing behavior (food preparer)	50% Increase
	Impact Indicator #4	Percent of population using hygienic sanitation facilities	75% In use

* Goal not defined in the FANTA Guide but by the American Red Cross.

2. Methods

All surveys included interviewing randomly selected households; interviewing community water committees; sampling water in homes, community water systems, and water sources; and a water and sanitation infrastructure evaluation. In addition, community and household questionnaires solicited information about natural disasters or other problems affecting the sustainability of water and sanitation systems since 2002.

The sustainability evaluation had four components:

1. A cross-sectional household survey, which included a questionnaire, visual inspection of household water and sanitation facilities, and visual assessment of hygiene behaviors;
2. Qualitative water sampling of community water sources and stored household water for indicators of microbial contamination;
3. A community survey conducted with one or more members of the community water committee; and
4. An infrastructure inspection/evaluation of the physical community water system to assess functionality, maintenance and sustainability.

2.1 Study Location

The study locations and communities chosen for the sustainability evaluation are listed in Table 3 and shown in Figure 1.

Table 3. Study Locations

Country	Communities/Study Areas	Surveyed		
		2000–2002	2006	2009
El Salvador	La Ceiba	√	√	√
	Las Pozas	√	√	√
Guatemala	Chiquimula (Plan Shalagua and Guayabo)*	√	√	√
	Huitzitzil (Not surveyed in 2000, baseline is 2001)	√	**No**	√
Honduras	Las Lomas	√	√	√
	Marcovia	√	√	√
Nicaragua	Nueva Segovia (Dipilto Nuevo and Dipilto Viejo)*	√	√	√
	Waspam (Andres and Koom)*	√	**No**	√

*Two communities grouped together as a study area so that a sufficient number of households could be surveyed

Figure 1. Study Location Map

2.2 Sample Size

Sample size was estimated in the same manner as in the 2006 sustainability evaluation. Sample size was calculated on the basis of how many households were needed to conduct statistical analysis of the hand washing behaviors on a regional, rather than local, basis. The target sample size for the entire region of eight communities is 120 households or 15 households per study area, based upon a probability of alpha = 0.05 and 80% power. A systematic random sample (every x^{th} household, based on community size) was done in each study area. If an unoccupied home was encountered, the next home was approached until contact was made with a potential study participant.

This approach was similar to the method used in the initial three-year survey where we calculated the number of household interviews needed in each community so that a statistically significant improvement in hand washing behaviors after the intervention could be detected. The FANTA Guide indicator for hand washing behaviors assumes proper hand washing occurs in 20% of households prior to an intervention and is predicted to increase to 40% following the intervention, based upon a probability of alpha = 0.05 and 80% power.

2.3 Statistical Analysis

Data from household interviews were entered into Epi Info (CDC 2008) at the end of each sampling day. Data from individual study areas were pooled, and descriptive statistics were calculated. Additional analyses were performed by the CDC investigators after their return to Atlanta by use of SAS Software versions 9.1 and 9.2 (SAS, 2002–2003). Key demographic data and other frequency data of interest (e.g., primary water source, hand washing technique, sanitation practices) were compared to the regional results reported in the 2002 Final Report and the 2006 Sustainability Report.

2.4 Evaluation Components

2.4.1 Household Interview

The household interview included a visual inspection of water and sanitation facilities at the home, a visual evaluation of hand washing and hand drying technique, questions about hygiene behaviors of the respondent (preferably the adult responsible for water use in the home), and collection of a household water sample. The 2009 household questionnaire was similar to the 2006 questionnaire, which was a condensed and revised version of the household questionnaire used in the initial three-year survey during 2000–2002. The CDC interviewer, accompanied by a person from the community, completed the interviews in randomly selected households.

Household questionnaire
In the sustainability evaluations in 2006 and 2009, questions were asked of the person responsible for the family's water use. The household questionnaire included questions that applied directly to the two impact and the two monitoring indicators from the FANTA Guide (Billig et al., 1999). We also included open-ended questions to allow the respondent, typically the female head of household, to comment on the adequacy of available water and sanitation systems to meet the family's needs. The interviewer and respondent discussed any problems encountered with the ARC-funded systems over the years since completion of their construction.

Visual inspection of household water and sanitation systems
Visual inspection of the household water supplies and sanitation facilities conducted by the interviewer used the same protocol that had been employed in earlier surveys in 2006 and 2000–2002. Interviewers noted whether drinking water was stored in covered containers and how it was dispensed from containers, as well as the estimated distance from the home to the primary water source. The condition of the latrine was evaluated based on the criteria from the FANTA Guide and used to calculate the indicator.

Hand washing and hygiene behaviors
The respondent was asked whether she had received instructions on hand washing, both during and in the period immediately after Hurricane Mitch and/or in subsequent years since 2006. The respondent was also asked to demonstrate or describe proper hand washing technique and hand drying and to explain when hands should be washed. A standard checklist, identical to that used in the earlier surveys, was used to record the elements of proper hand washing observed by the interviewer (Appendix B household survey, Section C). A summary score was calculated. The

respondent also was asked whether she had received instruction in water treatment, whether the household water is regularly treated, and the type of treatment, if applicable.

2.4.2 Water Sampling and Analysis

Water samples were collected for qualitative evaluation from each household and community water system in each study area. Household drinking water samples were collected from water stored in the home. The study participant was asked to give the interviewer a cup of water from the drinking water stored in the home. Results from the household water samples measure the proper handling of water by the family member responsible for water in the home as well as the adequacy of the water system's method for chlorination. Community water samples were from the source and from the distribution system when it reached the community, if water was available (i.e., if water was delivered by the distribution system at the time of sampling).

All water samples were tested for bacterial contamination with a Hach kit for total coliform bacteria and *E.coli* (Product #: 2401650/2401612). The Hach disposable water sampling kit is a 125 ml plastic bottle that contains a nutrient reagent that is mixed with a 100 ml water sample. The MUG reagent (4-methylumbelliferyl-beta-D-glucuronide) is specific for growth of *E.coli*, as indicated by fluorescence. Water samples incubate at room temperature for 24 to 48 hours. Color change and/or fluorescence indicate the presence or absence of total coliforms and *E. coli*. An ultraviolet light (UV) is used to show fluorescence. The following color changes indicate the presence of coliforms:

Presence of total coliforms = yellow
Presence of *E. coli* = yellow + fluorescence
Absence of total coliforms and *E. coli* = red / purple

Water systems that used chlorine for disinfection were also tested for free chlorine residual by use of the Hach Free and Total Chlorine Test Kit, Model CN-70 Color Disc Method (Cat.No. 14542-00). Chlorine test kits containing DPD colorimetric reagent are used most often for monitoring potable water. The kit contains powder DPD, which reacts quickly with chlorine and gives accurate results in a range of 0 to 3.5 mg/L. The desired range for piped distribution systems is 0.2–0.5 mg/L (ppm) throughout (WHO 1997).

2.4.3 Community Interview

A CDC interviewer administered the community questionnaire to one or more members of the water committee or community leaders. The questionnaire included questions about changes in the community after the installation of the ARC-funded water and sanitation systems from 2002, the continuing adequacy of the systems to meet the needs of the community, and problems with the water system or latrines since 2006. A copy of the community survey is provided in Appendix C.

2.4.4 Infrastructure Evaluation

A CDC investigator completed the water infrastructure evaluation (in Appendix D) with assistance from the ARC water-sanitation delegate. This evaluation included visual inspection of the water storage tanks, the chlorination system (if applicable), the distribution system and pipes, and the community water source(s).

Qualitative water samples were collected at the source to determine if bacterial contamination was present. Water samples were also collected from the distribution system at the point at which it reached the community. If chlorine was used in the distribution system, then water was tested for free chlorine residual.

3. Results

Table 4 summarizes data collected in eight study areas in the 2009 survey. Water sample results include both household and community water samples. A copy of the household questionnaire with frequencies of responses has been included in Appendix E.

Table 4. Number of Surveys Completed and Number of Water Samples Collected

Country	Community	Household Survey	Water Samples	Community Survey	Infrastructure Survey
El Salvador	La Ceiba	18	19	1	1
	Las Pozas	18	19	1	1
Guatemala	Chiquimula				
	--Plan Shalagua	9	10	1	1
	--Guayabo	9	11	1	1
	Huitzitzil	16	13	1	1
Honduras	Las Lomas	18	22	1	1
	Marcovia	16	18	1	1
Nicaragua	Nueva Segovia				
	--Dipilto Nuevo	8	11	1	1
	--Dipilto Viejo	8	10	1	1
	Waspam				
	--Andres	9	9	1	1
	--Koom	9	20	1	1
Total		**138**	**162**	**11**	**11**

3.1 Household Questionnaire Results

Data were collected from 138 households, covering 833 individuals. On average, six persons lived in each home (range 1 to 16). Sixty two (45%) of the families had at least one child less than 36 months. The families surveyed were similar in demographics to those seen in 2002 and 2006. Results are presented to address each intervention: water, sanitation, and hygiene education.

3.1.1 Water Infrastructure

Percent of households with year-round access to improved water source
An improved water source is defined as a direct connection to the home or having a public facility within 200 meters of the home; it is a monitoring indicator associated with water infrastructure. Three variables are combined to calculate this indicator: distance, year-round supply, and type of water source (tap, well, etc). Sixty-three percent (87/138) of all households surveyed in 2009 had access to an improved water source on the basis of the FANTA Guide definition.

A look at individual variables that do not include distance reveals that 67% (92/138) of the households, for example, obtained water for household use (drinking and cooking) from a community water system by means of a private tap located near the home and 6% (8/138) obtained water from a shared tap. Fifteen households obtained water from wells, 7% (10/138) from a shared well, and 4% (5/138) from a private well. The median distance traveled to obtain water for domestic purposes was five meters (range 0 to 600 meters).

Table 5 is a summary of water availability and storage. Sixty-seven percent of households (93/138) reported that the tap provided water all day, and 79% (109/138) reported having water available at all times of the year. An estimation of the volume of water used per day is difficult to make, and in any case it would not be a good indicator of sufficient water availability per household. The indicator regarding the quantity of water used per capita per day was excluded in this assessment due to the high variability and unreliability in this measurement, as found in the initial three-year survey. However, when the respondent was asked if the family members had 'enough water' for their daily use, 80% (111/138) of all households indicated that sufficient water was available.

Most homes had a *pila* or a 55-gallon drum at or near the tap. A *pila* is an uncovered rectangular concrete tank capable of storing several hundred liters of water. At the time of the 2009 survey, 50% (65/131) of the families had water stored in a *pila* and 86% (113/132) stored water in the home in bottles or other containers for domestic use such as for washing dishes or cleaning the home. Separate from the water held in the *pila* or containers, 94% (130/138) of the families had drinking water stored in the home. Eighty-two percent (101/123) of the drinking water containers were observed to be covered. Fifty-nine percent (81/138) of respondents said they had experienced no problems with the water system and had no suggestions for improving the system.

Table 5. Household Availability and Storage

	Total Number of Households Surveyed	Number of Households with Water	Percent %
Availability			
Households with water all day from tap	138	93	67
Households with water all year from tap	138	109	79
Household with "enough water for daily needs"	138	111	80
Storage			
Households with water stored in home (domestic use)	138	131	95
Households with drinking water stored in home	138	130*	94
Covered drinking water in home**	123	101	82

* Eight households were excluded because four did not store water in the home and took drinking water from the tap and four homes did not have water that day—i.e., no water delivered or else the water system was offline
** Drinking water storage container was not observed in 7 households (5%)

3.1.2 Sanitation Infrastructure

Percent of households with access to a sanitation facility
This indicator measures the percent of households with access to a sanitation facility. A sanitation facility is defined as a toilet or latrine. The condition or use of the facility is not taken into account with this indicator—only that the household has access to a private or shared facility. Condition and use are taken into account with one of the hygiene education indicators, as will be described in section 3.1.3.

Table 6 is the summary of the evaluation of the sanitation facilities. Ninety-three percent (129/138) of the households surveyed had access to a latrine, either on the property or at the home of a nearby neighbor or relative. One hundred and twelve (84%) of the 133 respondents knew the circumstances under which the latrine they used had been constructed (i.e., post-Hurricane Mitch ARC program). The same latrine, originally constructed in the post-Mitch program, was still in use in 79% (89/112) of the households.

Of the households that had latrines, visual observations were made on the state or condition of that latrine. Ten percent (13/129) of the observed latrines were found to be full of solids and, therefore, not considered usable. Five percent of the latrines (6/129) were observed to be in poor condition, i.e., structural damage to the latrine housing so that it could no longer be used or a tank collapse with pour-flush latrines. Several households self-reported that they were not using their latrines due to damage to the structure (e.g. broken door) or because the latrine pit was full. The difference in percent between the observations and self-reporting shows that some of the latrines were still being used, even though they had reached their maximum use.

Table 6. Household Sanitation Facility Evaluation

	Total Number of Households Surveyed	Number of Households	Percent %
Have access to sanitation facility	138	129	93
Received latrine post-Mitch	133*	112	84
Same latrine still in use?	112	89	79
Households with latrines			
Observed as full, not usable	129	13	10
Observed to be in poor condition**	129	6	5
Households self-reporting non-use of their latrine	129	11	9

* Five respondents did not know when the sanitation facility was constructed

** Poor condition means there was structural damage to the latrine housing or that there was damage to the receiving tank of the pour-flush latrines, allowing wastewater to escape.

3.1.3 Hygiene Education

Two impact indicators were used to evaluate the hygiene education program: hand washing behavior and percent of population using hygienic sanitation facilities.

Percent of households with appropriate hand washing behavior

Hand washing behavior was evaluated by use of criteria from the FANTA Guide. Every woman interviewed (138) responded to this portion of the questionnaire. Overall, 52% (72/138) of the women interviewed demonstrated appropriate hand washing technique based on a potential maximum total score of 10. However, these results are adjusted for households with no children less than 36 months old. Adjusted scores can be a potential maximum total score of nine. Fifty-five percent (76/138) of homes did not have children less than 36 months of age. Adjusted behaviors showed that nearly 73% (101/138) of all women surveyed, which includes women with and without children, had proper hand washing technique.

Statistical comparison between the two groups showed no statistically significant difference ($p=0.3585$) between the hand washing scores for women with young children and women without young children. However, women who did not have children less than 36 months of age in the home demonstrated slightly better hand washing technique as a group (76%, 58/76) than those who had young children, 69% (43/62).

Sixty-six percent (91/138) of the women interviewed recalled having received instruction on hand washing at some point. Seventy-three (80%; 73/91) of the women recalled being instructed and had appropriate hand washing technique while 28 women (60%; 28/47) did not recall ever having instruction on hand washing and also displayed proper hand washing technique. Table 7 is a summary of scoring for appropriate hand washing behavior and past education.

Table 7. Hand Washing Behaviors and Education

	Total Number of Women Interviewed	Number of Women Demonstrating Proper Handwashing Technique	Percent %
Appropriate hand washing behaviors*	138	72	52
Adjusted appropriate hand washing behaviors**	138	101	73
Hand washing education			
Received instruction	91	73	80
Did not receive instruction	47	28	60

* Defined as a score of ≥8 out of 10 for all respondents

** Defined as a score of ≥7 out of 9 for respondents with no children <36 months old in the home AND a score of ≥8 out of 10 for respondents with children <36 months old in the home

Of the 91 women who recalled receiving instruction, 77 could recall the year or years in which they had been taught proper hand washing techniques; 52 of the 77 (68%) said that the most recent instruction was after 2002 (the end of the original ARC intervention). Thirty-six of the 77 (47%) said that the most recent instruction was after 2006 (the time of the first sustainability evaluation).

Percent of population using hygienic sanitation facilities

The second impact indicator used to evaluate the hygiene education program was the percent of the population using a hygienic sanitation facility. The FANTA Guide outlined the criteria to define a latrine that was hygienic and in use. A latrine was considered hygienic if it had three or fewer flies and no evidence of feces outside the latrine. A latrine was considered 'in use' if there was evidence that it had been cleaned recently, had been swept, had a path to it, was in good repair, and/or lacked spider webs in the latrine. One hundred thirty-eight households were visited by interviewers and 129 had access to a latrine. By use of these criteria, 97 of 126 inspected latrines (77%) were considered to be hygienic and in use.

Sixty-four percent (89/138) of the women said that they had been instructed on the use and maintenance of the sanitary facility, while 35% (49/138) reported that they had not received such instruction. Eighty-eight percent (78/89) of the households could give the year in which they had received instruction, and 12% (11/89) said they had received instruction, but could not recall the year in which they received it. The last time instruction was provided to the communities ranged between 1998 and 2008. Table 8 is a summary of the households with access to sanitation and the percent that are hygienic and, of those, how many received education and had a latrine in good condition.

Table 8. Household Hygienic Sanitation Facility Evaluation

	Total Number of Households	Number of Households	Percent %
Households with access to sanitation facility	138	129*	93
Households with access to latrine and hygienic	126**	97	77
Received sanitary facility education	89		
Received instruction, latrines hygienic	87†	67	77
Did not receive instruction, latrines hygienic	48†	30	63

* Nine households did not have latrines
** Three households' latrines not inspected
† Observations were not allowed at three households to determine if facility is hygienic

3.2 Water Sampling Results

Water samples were collected from the drinking water stored in the home and from the community water source. Tap water samples were collected from the distribution system, where possible. Table 9 is a summary of the number and types of all water samples collected and analyzed.

Table 9. Total Number of Water Samples

Country	Community	Household Water	Community Water Source / Water Storage Tank	Tap Water**	Well**
El Salvador	La Ceiba	18	1 / 0	--	--
	Las Pozas	18	0 / 1	--	--
Guatemala	Chiquimula				
	--Plan Shalagua	8	1 / 1	--	--
	--Guayabo	9	1 / 1	--	--
	Huitzitzil*	10	--	--	3
Honduras	Las Lomas	18	3 / 1	--	--
	Marcovia	16	0 / 2	2	--
Nicaragua	Nueva Segovia				
	--Dipilto Nuevo	8	0 / 3	--	--
	--Dipilto Viejo	8	0 / 2	--	--
	Waspam				
	--Andres	8	0 / 0	--	1
	--Koom	9	0 / 0	--	11
Total		**130**	**17**	**2**	**15**

* Household water samples in this community were from household containers that were filled with purchased bagged or bottled water or stored well water.
**Tap water is from the distribution system, not in the household / Well water samples came directly from the well.

Household water sample results

Seventy-eight percent (108/138) of respondents reported that they had not previously treated water collected on the day of the interview. Of 138 who responded to the question asking how often they treated water, 58% (80/138) said 'never', 22% (30/138) said 'sometimes', and 20%

(28/138) said 'always.' The most frequent reason given for not treating water in the home was that it was unnecessary because the water system chlorinates at the storage tank. Table 10 is a summary by community of the distribution of those who never treat drinking water.

Table 10. Household Treatment of Drinking Water

Country	Community	Total Number of Households	Number of Households that Never Treat Drinking Water	Percent %
El Salvador	La Ceiba	18	16	89
	Las Pozas	18	15	83
Guatemala	Chiquimula			
	--Plan Shalagua	9	6	67
	--Guayabo	9	4	44
	Huitzitzil	16	11	69
Honduras	Las Lomas	16	8	44
	Marcovia	16	9	56
Nicaragua	Nueva Segovia			
	--Dipilto Nuevo	8	2	25
	--Diplito Viejo	8	3	38
	Waspam			
	--Andres	9	1	11
	--Koom	9	5	56
Total		**138**	**80**	**58**

Thirty-seven percent (50/137) of the interviewees said they had never received instruction on treating water stored in the home (one person could not recall); 56% (76/137) could give the year of at least one presentation they had attended on household water treatment; and 8% (11/137) said they had received instruction, but could not remember when. Thirty women remembered receiving instruction at least once during the period of the original ARC interventions (2000 through 2002) while 50 women reported receiving some type of training between 2003 and 2009.

During the interview, the study participant was asked to provide the interviewer a glass of drinking water. Stored drinking water typically was kept in the home in a covered container. Water was either poured directly into a drinking glass or else a cup was used to dip into the container. Table 11 contains the results for household water samples. Communities with a chlorinated water system were likely to have less bacterial contamination. *E. coli* was found in two samples in two of the study areas that chlorinated their water systems (El Salvador).

Table 11. Qualitative Results for Household Water Samples

Country	Community	Total Number of Household Samples	Samples Positive for Total Coliforms	Samples Positive for *E.coli*	Samples with Negative Results*	Chlorinated water system?
El Salvador	La Ceiba	18	8	1	10	**Yes**
	Las Pozas	18	15	1	3	**Yes**
Guatemala	Chiquimula					
	-Plan Shalagua	8	8	3	0	No
	-Guayabo	9	9	3	0	No
	Huitzitzil	13	12	2	1	No
Honduras	Las Lomas	18	18	0	0	**Yes**
	Marcovia	16	9	0	7	**Yes**
Nicaragua	Nueva Segovia					
	-Dipilto Nuevo	8	8	1	0	No
	-Dipilto Viejo	8	8	0	0	No
	Waspam					
	-Andres	8	8	2	0	No
	-Koom	9	9	4	0	No
Total		**133**	**112 84%**	**17 13%**	**21 16%**	**4 of 8**

* Negative results mean an absence of total coliforms and E. coli

An attempt was made to collect water samples from communities that had a water system that delivered water to taps at the home or within the community. Two communities were sampled in 2006, Las Pozas, El Salvador and Guayabo, Guatemala. These two locations could not be tested again due to lack of water in the system because of maintenance, intermittent distribution, or lack of water at the source. Tap water samples from the distribution system were collected only from Marcovia, Honduras. The water sample was collected by first wiping down the tap with an alcohol wipe, turning the water on and allowing it to run for half a minute, then directly filling the Hach bottle with 100 ml of water from the tap. Results in Table 12 for this location show that since the water system was chlorinating the water, there were no total coliform or *E.coli* present.

Table 12. Qualitative Results for Tap Water Samples

Country	Community	Total Number of Tap Water Samples	Samples Positive for Coliforms	Samples Positive for *E.coli*	Chlorinated water system?
Honduras	Marcovia	2	0	0	**Yes**

Community water source sample results

Water quality from the water sources for each community was also tested. After the infrastructure evaluation, a water sample was drawn directly either from the source (spring, well) or the water storage tank or both. Table 13 is a summary of the results. All sources tested positive for total coliforms, except for two (Marcovia and Las Pozas) that obtained water from deep wells. One chlorinated water system (Las Lomas) showed the presence of *E.coli* in water

from a source providing water to the distribution system but none in the household water samples after chlorination (see Table 11).

Table 13. Qualitative Results for Community Water Sources

Country	Community	Total Number of Community Water Source Samples*	Samples Positive for Total Coliforms	Samples Positive for *E.coli*	Samples with Negative† Results	Chlorinated water system?
El Salvador	La Ceiba	1	1	0	0	**Yes**
	Las Pozas	1	0	0	1	**Yes**
Guatemala	Chiquimula					
	-Plan Shalagua	2	2	1	0	No
	-Guayabo	2	2	2	0	No
Honduras	Las Lomas	4	2	2	2	**Yes**
	Marcovia	2	0	0	2	**Yes**
Nicaragua	Nueva Segovia					
	-Dipilto Nuevo	3	3	2	0	No
	-Dipilto Viejo	2	2	1	0	No
	Waspam					
	-Andres	1	1	1	0	No
	-Koom	11	10	5	1	No
Total		**29**	**23 79%**	**14 48%**	**6 21%**	**4 of 8**

* Water samples were from the source and/or storage tank or well

† Negative results mean the absence of total coliforms and E. coli

Four community water systems used chlorine for disinfection. Water systems in the other four communities were not disinfecting water prior to delivery to homes. Table 14 is a summary of the chlorine residuals measured in the distribution system. When chlorine is used as a disinfectant in a piped distribution system, free chlorine residual of 0.2–0.5 mg/L (ppm) throughout is desired to reduce the risk of microbial regrowth and health risk of recontamination (WHO 1997).

Table 14. Free Chlorine Residuals in Water Systems Using Chlorine Treatment

Country / Community	Type of Chlorination System	Free Chlorine Levels (ppm)	Location of Sample
El Salvador			
La Ceiba	Continuous through tablet chlorinator at tank	0.4	Storage tank at 2:55 pm
		N/A	Water not flowing through the system at time of visit
Las Pozas	Continuous through tablet chlorinator at tank	0.1	Sink near storage tank at 11 am
		0.0	No water in all sectors due to maintenance of water system. Water sample is from home nearest tank from water stored in household tank
Honduras			
Las Lomas	Continuous through drip chlorinator at tank	0.3	Storage tank at 3:00 pm
		0.15	Home closest to tank 3:15 pm
		0.15	Home furthest from tank 3:24 pm
Marcovia	Batch chlorination of tank once/day	0.4	Elevated storage tank 7:20 am *
		0.7	Sector 1 home closest to tank 7:35 am**
		0.4	Sector 2 home furthest from tank 7:45 am**

N/A no water available in the distribution system to test

*Measured during filling of storage tank in the morning. Chlorine level does not represent what is being delivered to each home.

** Measured while water being delivered to homes in morning.

3.3 Community Questionnaire Results

Results from the community questionnaire reflect information that was gathered from water committees or other community members, such as *fontaneros* [plumbers], who had knowledge of the water and sanitation facilities.

Table 15 is a summary of the key information obtained from the community questionnaire for each of the study areas. All communities received an integrated ARC program consisting of water and sanitation interventions and hygiene education, with the exception of Huitzitzil, Guatemala and Waspam, Nicaragua. Huitzitzil received only latrines and health education on the care and maintenance of composting latrines. Waspam consists of two communities. Only Koom received the integrated water, sanitation, and hygiene education program from ARC. The other community, Andres, did not receive any interventions by ARC. The ARC provided supplies to this community to construct wells while a NGO provided health education.

Specific issues identified in the community surveys help to explain problems encountered with the interventions, especially the community-level interventions such as community water systems. These issues are described for each community in the following sections. In general, the 2009 visit found that communities that continued to have an active water committee with long-standing members with a savings account for repairs were generally able to maintain their water systems better than those without an active water committee.

Table 15. 2009 Community Questionnaire Results

Country / Community	Water system / Water Source	No. of Households	Collecting Fees for Service?	Account	Water Committee	Sanitation	Education post-2002?
El Salvador							
La Ceiba	2002 ARC system / Spring, gravity flow to pumping station, pumped to storage tank, continuous chlorine tablet treatment, gravity flow from storage tank to household taps	100–105 homes 97 connected	Yes (same as 2006) $3.00 USD for 6 m^3 / month +0.25 / m^3	Yes Balance not provided	Yes	Composting latrines, some pit latrines, open defecation	None after 2004
Las Pozas	2001 CARE system / Deep drilled well, pumped to storage tank, continuous chlorine tablet treatment, gravity flow to household taps with water meters	1004 homes 696 active accounts	Yes, increase $4.00 USD for 20 m^3 / month + 0.25 / m^3	Yes $3,745 USD	Yes	Composting latrines, some pit latrines 2006 & 2009	None
Guatemala							
Chiquimula --Plan Shalagua	2001 ARC system / Spring, gravity fed to tank, gravity flow to public taps. Landslide in 200? affected source quantity	300 homes	No / Yes restarted '09 3 quetzales / month $0.38 USD (no payment no water)	No	Yes As of Feb 2009	Pit latrines	None after 2002
--Guayabo	2001 ARC system / Spring, conduction line to storage tank, chlorine tablet treatment system installed but not operating, gravity flow to household taps	180 homes 135 served	Yes (same as 2006) 5 quetzales month $0.63 USD	No	Yes	In 2001, pit latrines	None; 2001 was last training by the Red Cross
Huitzitzil	No water intervention from ARC, using bottled water/well water.	320 homes	N/A 15 quetzales for bottled water	N/A	N/A	Composting latrines, some pour flush	None

Table 15. (continued) Community Questionnaire Results

Country / Community	Water system / Water Source	No. of Households	Collecting Fees for Service?	Account	Water Committee	Sanitation	Education post-2006?
Honduras							
Las Lomas	2001 ARC system / Spring, gravity flow to storage tank, drip chlorinator treatment, gravity flow to household taps	Increase 500 homes 478 connected	Yes (same as 2006) 20 lempiras / month—$1.08 USD	Yes 25,000 lempiras $1,336 USD	Yes	In 2001, 150 pour flush latrines	Oct 2005 Red Cross and Ministry of Public Health, water, sanitation and hygiene
Marcovia	2001 ARC system / Deep drilled well, submersible pump to storage tank, daily chlorine batch treatment, gravity flow to homes, water 2 hours/day	245 homes	Yes Increase 50 lempiras $2.70 USD -35 lmps/mo Not all pay	Yes Savings 174,430 lempiras $9,427 USD	Yes, very active	In 2001, pour flush latrines	2003 Honduran and Swiss Red Cross, water quality, sanitation, hygiene
Nicaragua							
Nueva Segovia --Dipilto Nuevo	2002 local municipality system + ARC improvements Stream—filtration treatment, gravity flow to storage tank, household taps	50 homes	No (same as 2006) 10 cordobas per month—$0.51 USD	No, Emer-gency funds only (see Sect 3.3.4)	Yes	Pit latrines ARC 42 homes	None
--Dipilto Viejo	2003 local municipality system + ARC expansion Stream—Gravity flow to storage tank thru rock filter, no disinfection treatment, household taps	90 homes Added 2 more commu-nities +129 homes	No (same as 2006) 10 cordobas per month—$0.51 USD	No	Yes, not active	In 2000, Pit latrines +40 new latrines (June 2007)	Yes, 2008 MINSA—hand washing, water, sanitation, garbage, waste water
Waspam --Andres	No wells constructed by ARC / 3 community wells	191 homes	None Wells/river	N/A	N/A	Composting latrines	Yes, Acción Médica 2007
--Koom	16 deep bored wells installed by ARC-2009 10 working wells	283 homes	None Wells	N/A	N/A	Pit latrines	CARE 2007

3.3.1 El Salvador

La Ceiba. This community received both a water and sanitation project from the ARC, as well as hygiene education. In 2002, there were a total of 100 houses with approximately 600 people; 65 houses participated in the water project, and 73 houses participated in the latrine project. In 2009, there were 100–105 homes with approximately 650 people. The ARC provided a spring-fed system that fills a gravity-fed cistern that is pumped uphill to a distribution tank. The water flows downhill to household spigots of the connected households. Composting latrines were provided to this community.

The notable problems with the water system identified in 2009 resulted from storms that have damaged the pipeline that delivers water to the community. Storm events cause the nearby river to overflow. This problem was noted in the 2006 survey as well. Those without water connections, either because they are new homes or because the household did not participate in the construction of the original water project, obtain water from a neighbor's house or collect water from the river or a well. The residents in these homes chose not to pay to connect to water service. Water quality was reported to be tested by ARC in 2001, and no contamination was found.

The water committee, along with volunteers from the community, performs all repairs and maintenance on the system, as there is no *fontanero*. The standard monthly water fee is $3.00 USD per 6 m^3 of water delivered to the home, with an additional $0.25 per m^3 charge for usage over 6 m^3. This fee structure has not changed since 2006. Failure to pay after three months results in disconnection of water service. Revenues from water fees are used to cover the necessary maintenance of the water system; however at times, the revenue collected is not enough. An attempt was made to provide water meters for each household. There are household water meters for this system, but 17 of the 97 meters are broken. A reported 40 homes do not have water service. Every summer or during the dry season, funds are accrued for the water system service. In the winter, or rainy season, all the money accrued is spent on repairs due to the storm events in the winter. If funds are insufficient, repairs are not performed.

Houses without latrines, such as newer homes and homes where people did not participate in the water system construction, have excavated open pit latrines. In the 2006 survey, problems were reported with these open pit latrines, as they fill with water and overflow during the rainy season. In 2009, the homes without latrines continued to have this problem, and their residents practice open defecation during the rainy season. The committee noted that there are not enough latrines for large families and that many latrines are used improperly.

Health education for the community on water, sanitation, and hygiene was provided shortly after completion of the water system by a health committee (now disbanded) formed by ARC in 2002. This group of local women continued to provide house-by-house health education until 2004. The training emphasized proper use and maintenance of the composting latrines.

Las Pozas. This community received a water system in 2001 from CARE, with support from ARC. The composting latrine project was provided solely by ARC. In 2002, there were 1004 homes reported in this resettlement community. A number of the homes in Las Pozas were

uninhabited in 2006, as people had left the community. In 2009, the population in the community had not changed since 2006, with 800 residents in 1004 houses and a number of uninhabited homes remaining.

The water system was designed by CARE for 1040 houses. It includes a deep drilled well that pumps into a central tank. From the tank, water flows by gravity to individual household taps. Water quality was analyzed by Fundemune (a CARE project) in 2002, and the analysis reported no contamination in the water; however, the water committee did not recall if the analysis was for chemical and/or microbiological contamination. A repair on the water system included replacement of a broken pump in June 2006. It was replaced by the *fontanero*, with no assistance from outside the community. The only other work done on the water system was reported in 2001, when a new pump shut-off valve was installed. The community has sufficient funds to cover necessary maintenance on the water system.

All homes in Las Pozas have water meters, and households pay $4 dollars/month for 20 m^3 of water. An additional fee ($ 0.25) is charged for every additional meter cubed of water above the 20 m^3 allowance per household. This is a small increase since 2006 in the water fees, which were then $3.50/month. Water service is discontinued for households that do not pay for 3 consecutive months, and those households must then obtain water from their neighbors. Water service, however, is available to most all homes in this community. The water committee has a spending account for operation and maintenance, and the committee indicated satisfaction with this water system. Of the 1004 homes, there are 696 active accounts, and 494 had paid for water service for the month of February at the time of the February 2009 visit. Water service had been disconnected from the many uninhabited homes in this community.

ARC provided composting latrines to this community as part of the post-Hurricane Mitch interventions. The project was completed in 2001. Of the composting latrines checked as part of this survey, eight of nine were still functioning and/or in use. However, it was reported that very few homes still have a functioning composting latrine. Seven of 14 (50%) interviewees who indicated they received a composting latrine after Hurricane Mitch were still using them. One household no longer uses the latrine it received after Hurricane Mitch, although the latrine is still present. Some latrines were damaged by the 2001 earthquake and have never been repaired. Materials from latrines that had fallen into disrepair were salvaged for other building projects. Some residents had constructed their own pit latrines or were sharing latrines with neighboring houses.

Although some residents are now using pit latrines, water committee members indicated that the composting latrines were much more hygienic when properly used. Management of grey water is also a problem. The water committee indicated that it needed assistance in learning how to deal with grey water. No health education had been provided since 2006. The health committee in Las Pozas last provided education in 2001–2002. Other natural disasters that have affected this community included earthquakes and seasonal storms that cause flooding from the creek as well as damage to the homes of people who live near the creek.

3.3.2 Guatemala

Chiquimula consists of two communities, Plan Shalagua and Guayabo. Both communities received wat-san programs from the ARC.

Plan Shalagua. Plan Shalagua was reported to have 78 houses and 450 people in 2002. There were 130 homes and 650 residents reported in 2006. By 2009, there were a reported 300 homes with approximately 1500 inhabitants. There was an existing rehabilitated gravity-fed piped water system with public taps, and a tank with a chlorinator was built and completed in 2002. This community received ventilated dry pit latrines as part of the ARC interventions.

The survey in 2006 reported that the September 2005 rain from Hurricane Stan resulted in a landslide that significantly diminished the quantity of spring flow at the source. Consequently, the system was barely functioning in 2006. In 2009, the condition of the water system had not changed. Only a small number of tap stands at low points in the system still provide water. Households obtain drinking water from these taps (which means traveling a distance of one kilometer or more for some households), while these households choose to bathe and wash in a nearby river. Some residents who are further out from the water system obtain water from wells.

The community has been unable to fix the system. Review in 2009 found seven taps: of these, three were broken and not repairable, two were not working properly but could provide water, and two were in good condition, with handles to turn the water on and off. A nearby resident would remove one of the tap handles so that it could not be stolen by others in the community. A fee of 3 quetzales ($0.38 USD) is charged each month, but due to the lack of water service, many residents do not pay the fee. Sufficient funds are not available to repair the water system. In some cases, the community members pool funds and contribute 5 quetzales ($0.64 USD) for repairs. There is no *fontanero* for maintenance. The water committee had dissolved, but it recently was re-convened in February 2009 to address the water problems of the community.

Puesto de Salud, the local health agency, checked the water quality of the system in 2007; however, the results were not provided to the community. Previously, the water quality was analyzed during construction in 2001, possibly by ARC, but none of the interview participants knew the results of that analysis. When the landslide reduced source volume, the community located a different spring source above the current source. In 2006, the municipality was willing to sell Plan Shalagua the new source, but the community has not been able to find assistance from an outside entity/organization to explore the feasibility of and funding for use of the new source. No improvements had been made by 2009. There is concern that the water source will be insufficient if nothing is done to repair it or if another source cannot be located nearby.

The latrine program was completed in 2001. Not all houses received a pit latrine because latrines could not be built in certain locations. In addition, the community has new homes. Those residents who do not have latrines dig their own or practice open defecation. The community indicated a need for more latrines.

ARC provided training in water, sanitation, and hygiene to the community at the time the water system was constructed. No additional health education was reported to have been provided

since 2006. Only one household reported training in 2003, and three households reported receiving training in 2002.

Guayabo. In 2002 Guayabo had 147 houses and 767 people. There were 150 homes reported in 2006. By 2009, there were 180 homes and approximately 999 people. Guayabo received a new gravity-fed piped water system in 2002 that originated at a spring, fed into a tank with a chlorinator, and then distributed to household taps. This community also received ventilated dry pit latrines as part of the ARC interventions.

Reviews of the water system in 2002 and 2006 found that water was supposed to be treated at the storage tank with a solid chlorine tablet system. However, the tablets were never readily available, and chlorine disinfection was never used. In 2009, water continued to be untreated. Although the community was generally satisfied with the system, problems have occurred. The high mineral content of the water at the source has caused deterioration of the galvanized metal pipe used for part of the conduction line between the source and the storage tank. In addition, because this portion of galvanized pipe runs above ground through a forested area, falling trees sometimes damage the pipeline. Also, the exposed pipe becomes hot, increasing the potential for corrosion. For both of these reasons, repairs to the conduction line have become frequent. The leaders of the community and other community members perform maintenance. Water fees in 2009 were 5 quetzales/month ($0.64 USD), rather than a fee every three months as was charged in previous years. The fees paid, however, are not enough to cover the costs for the frequent need for repairs. No water savings account exists. Consequently, when repairs are needed, the water committee goes to the community for extra funds. Assistance has also been sought from the mayor of the municipality in which Guayabo is located.

This water system does not service all homes. The homes that are not connected to the water system did not participate in the construction of the system in 2001. Households without water connections haul water from old water wells. A technician from the *Centro de Salud* from Camotán conducted water testing of the system in 2005 and found it to be free of microbial contamination. Other problems reported for the water system included lost/stolen tubing in 2006. In 2008, the water system was repaired throughout the year. There were a reported 20 repairs due to various storm events and about seven repairs due to creek flooding.

This community received simple ventilated pit latrines. The project was finished in 2001. Some households that did not receive pit latrines (the same group that did not want to participate in the water system construction) have dug their own latrines or practice open defecation. Newly constructed homes do not have latrines. These pit latrines tend to fill and overflow during the winter/rainy season.

Health education from the ARC on water, sanitation, and hygiene was last provided in 2001. After that time, *promotoras* (women in the community) provided hygiene education to the community at the *Centro de Salud* until 2002. No other education has been provided to this community.

Huitzitzil. Huitzitzil was not included in the 2006 survey because this community received only a sanitation and hygiene education program from the ARC, with no water system provided. This community was surveyed in 2009.

The final health survey in 2002 found 201 households and 1200 people in this rural community, located on the southeast coast of Guatemala. The composting latrine project was being operated extremely well at that time. Most residents consumed bottled water prior to ARC's arrival as bottled water was readily available in this area. Residents report being told by various groups that well and river water was contaminated, but no water quality test results were available. In 2002, about 40% of residents used bottled water for drinking and cooking; however, some residents were not able to afford bottled water. This community also received extensive hygiene education about care and use of the composting latrines and about hand washing skills. The community expressed an interest in a drinking water project, but no project was developed, at least partially because no suitable water source was identified and a water system to treat the current water source was expensive.

In 2009, there were 320 homes with a population of about 1500 people. Residents continued to purchase bottled water for drinking and cooking, and they bathed with well water. Not all residents were able to purchase bottled water in 2009, and they continued to obtain water from nearby wells. Problems occur with the wells during the dry season when the river dries up and allows saltwater to enter the wells. This community is located near the ocean. Although there is no water committee, there is a committee for community development.

Composting latrines were provided to this community, and during the original ARC intervention, a group of women from the community visited each household multiple times to teach proper use and maintenance of the latrines and other hygiene topics. Results from the 2002 survey indicated a high success rate in this community for hygienic sanitation facilities (90%). Homes built after 2002 were not a part of the ARC program and did not have any sanitation facilities; residents of these homes practice open defecation. Hurricane Stan affected this community in 2005, damaging some composting latrines. No outside aid came to this community after the storm, and these latrines were never repaired due to the expense of obtaining construction materials.

3.3.3 Honduras

Las Lomas. In 2002, there were 220 houses and approximately 1300 people in Las Lomas. There were 400 homes and more than 1000 residents reported in 2006. By 2009, there were 500 homes with approximately 3000 residents. The water project in this community, completed in 2002, consisted of an upgrade to an existing water system, including construction of a water tank and more household connections. Household pour/flush latrines were constructed, and an education program was included to address latrine maintenance, hygiene, and water use.

A storm in 2008 caused flooding that washed out the conduction line between the spring source and the storage tank. Water was rationed by providing water for two days to each sector of the community while the line was being repaired. Past problems as far back as 2001 included flow control problems with the distribution network valves and washing out of the conduction line from the source to the tank during storms. Eight such washouts occurred from 2002 to 2006.

The conduction line has been provisionally repaired with leftover construction materials and volunteer labor, but the line continues to be susceptible to washing out. The ARC provided 250 bags of cement in 2002 to put in a new intake structure at the source and, and walls were built to protect the conduction line during flooding.

There were 478 connections from this water system to the community in 2009. The monthly water fee is 20 Honduran lempiras/month ($1.07 USD), and the fee has not changed since 2006. Water service has been cut to 32 houses for non-payment of water service fees or because the houses are vacant. In 2009, 68 homes were vacant. It costs 4,000 lempiras ($214 USD) to connect to the water system, a cost-prohibitive fee for some families (this fee was set to reflect the value of the labor that residents originally put into constructing the system). Houses without connections obtain water from neighbors, as do new houses that cannot pay the connection fee. Although water fees are being collected, the revenue is not always sufficient to cover costs related to maintenance of the water system (e.g., chlorine, salary for the *fontanero*, supplies) and to meet the needs of a growing community. This community currently has two paid *fontaneros* to make repairs to the system, with support from the water committee. Water quality was last tested in November 2008 by the Ministry of Public Health (MINSA) for microorganisms and was reported to be contaminated. Past water testing was positive for microorganisms but no other contamination. No health education has been provided since 2006.

The pour flush latrine project was completed by ARC in 2002. As new houses have been built, residents have built their own dry pit latrines or else they use a neighbor's latrine or practice open defecation. This type of latrine also has problems during the rainy season. Tank collapses, which allow for the latrine contents to overflow and flood the community with sewage, have been reported. Although problems exist, the community expressed gratitude for its water system and latrines.

Marcovia. There were 240 households and an estimated population of 1300 people in 2002. In 2006, the number of homes remained the same, with a population of 1200 to 1920 residents (at that time an estimated five to eight people per household). By 2009, there were 245 homes and an estimated 987 to 2000 residents (an estimated four to eight people per household). The ARC water project for this community, originally installed in 2002, consists of a well from which water is pumped to a tank and gravity-fed water distribution system. The storage tank is filled during the night, batch chlorinated early in the morning, and then distributed to homes in the community for two hours per day. Each home that participated in the project received a household tap. Household pour/flush latrines were also constructed in this community. Since 2006, problems with the water and sanitation systems have continued.

At times, there is not enough water for the community during the dry season. Water system improvements in 2002 included a pump upgrade. Currently, a five-horsepower pump draws water from the well. The community also changed the piping on the well in 2008. Some homes are not part of the water system project because they are newly built. These residents must go to a neighbor's home to obtain water. Water to the community, however, is chlorinated and was recently dosed at the time of the site visit. Water quality was last tested in November of 2008 by the MINSA, but the water committee did not know the results. An active water committee continues, and water fees are collected. In 2006, the monthly water fee was 35 lempiras/month

($1.87 USD), and the fee had increased to 50 lempiras/month ($2.70 USD) by 2009. Residents who do not pay the water fee are disconnected. Water fees have been more than sufficient to cover repairs to the water system, and the water committee has a savings account with a substantial balance to cover future repairs and equipment replacement.

The ARC completed the latrine project in 2001. In 2006, problems with these latrines were noted, because many of the seepage tanks attached to the latrines had collapsed. During the rainy season, this damage allows for the contents of the tank to spill out to the surface and contaminate the surrounding environment with sewage. Soil permeability is poor in this area, and there is standing sewage throughout much of the community. The water committee is concerned that the nonworking latrines have the potential to contaminate the water well, although the well is deep enough that this should not present an immediate hazard. In addition, some homes still do not have a latrine, and residents of them use a neighbor's facility or practice open defecation. At the time of the 2009 visit, a neighboring community was in the process of constructing a sewer system. The water committee and community members expressed that they would like to be a part of that sewer project if possible; however, it would be costly for this community to connect to it.

No health education was reported to have occurred since 2006. Health education on water quality, sanitation, and hygiene was last provided in 2001 (CARE) and in 2003 (Honduran and Swiss Red Cross).

3.3.4 Nicaragua

Nueva Segovia consists of two communities, Dipilto Nuevo and Dipilto Viejo. These communities together comprised 100 households with approximately 600 people in 2002. The municipality-supported water interventions in both communities were stream-fed, gravity-filled tanks with a distribution system to a spigot to each household. The ARC sanitary interventions in both communities were dry pit latrines at each household. The ARC health education intervention involved the establishment of a water board for each community, regular meetings for training and capacity building, meetings for community members, and house-to-house visits.

Dipilto Nuevo (Barrio San Agustín). This community had 50 homes and approximately 180 people in 2009. In 2006, 55 homes were reported, with the original 42 homes connected to the water system. This water system was reported to have been completed in 2004. The local government provided the older part of the water system, and the ARC constructed the newer part of the system. During the summer months, low water pressure in the system is a problem. During low pressure times, water is provided for half a day in one section of the community and the rest of the day in the other section. The community has a water committee and a paid *fontanero* who takes care of the system. The community has not sought outside assistance for any repairs. The monthly water fee is 10 cordobas/month ($0.60 USD), the same as in 2006. There is no savings account and the monthly paid fees are not enough to cover the operation and maintenance of the system. The committee keeps emergency funds in case repairs need to be done quickly. Homes that are not connected to the water system obtain water through illegal taps when their water is cut due to non-payment. At the time of the site visit, the water system

was last chlorinated in January 2009. Chlorine is used to clean the system. Water was last tested in 2004 by the Nicaraguan RC but was found to be contaminated with microorganisms. New houses cannot be connected to the water system and repairs to system infrastructure cannot be made, because the water system account has no savings. The water system provides inconsistent service due to drought and damage to the system near the source. There were reports that livestock near the source water, as well as disturbances due to logging, had adversely affected water quality and quantity in 2006.

The original 42 houses have pit latrines provided by ARC in 2001. New houses in this community have built their own latrines. When latrines are filled, some homes report that they move their latrine housing once they dig a new pit. Health education has not been provided since 2006.

Dipilto Viejo (Barrio Solidaridad). In 2009, this community had 90 homes and 600 people. There were 80 homes reported in 2006. The water system for this community has expanded, because there was not enough water, and the system provided inconsistent service due to drought and damage to the system near the source. The new expanded system was completed in June 2007. The government funded expansion of this system, and now it provides water to two additional communities, Naranjo and Tablacon. The current water fee of 10 cordobas/month ($0.60 USD) has remained the same since 2006. Collected fees and assistance from the community and local municipality help fund repairs when needed, although damage from high winds and heavy rains from a storm in 2008 had not been repaired at the time of the 2009 visit. There is still an active water committee with a savings account. The last water quality analysis of the system was conducted in early 2005, but results were not provided to the community.

Ventilated pit latrines were provided to this community. Additional latrines were provided by FISE (Fondo de Inversión Social de Emergencia-Emergency Social Investment Fund) in June 2007. FISE funds are made available by the Nicaraguan government. Those homes that did not receive a latrine built their own. A problem with the latrines has been that when they fill, the homeowners need to dig new pit latrines and there is not enough land within each house plot to do so.

Health education was recently provided in 2008 by the MINSA, going door-to-door. Topics covered were latrine care and maintenance, hand washing, garbage disposal, water use and conservation, and grey water disposal.

Waspam consists of two communities, Andres and Koom, in the Gracias a Dios region along the Rio Coco. This remote rural area is in the Miskito region in northeastern Nicaragua toward the Honduran border. Both communities were selected to receive interventions; however, only Koom received water, sanitation, and hygiene education interventions from ARC. The two communities are discussed separately below. CDC did not visit these communities for the 2006 survey.

Andres**.** The water, sanitation, and hygiene education interventions in Andres were provided by other NGOs, not by ARC. Acción Médica has been working primarily in this community for

many years. Three wells were constructed, as well as latrines for most households. Hygiene education was also provided by other NGOs.

In 2009, there were 191 homes with a population of 1423 people. The number of homes is similar to that reported in the 2002 survey, although a much larger number of people was reported in 2002 (1960 persons). It was reported that people have left this community to seek employment. Water is drawn primarily from one well and the river. Two wells were dry in 2009 (in 2002 all three wells were providing water). Residents also use wells adjacent to the banks of the river (known locally as sand wells); however, water from this type of well is noted as not being of very good quality. Since the last survey in 2002, ARC had provided no assistance to this community. There is no water committee, but community leaders attempt to address the needs of the community.

Previously, in 1990, it was reported that UNICEF tested the one well that is currently in use and noted that it was contaminated with chemicals and microorganisms. UNICEF provided composting latrines about that time as well. Hurricane Felix hit this region in 2007. Acción Médica provided 50 additional latrines after the hurricane, as well as water and sanitation education that same year in 2007. During the hurricane, the river crested its banks and caused flooding issues in this community for 1.5 months. In September 2008, the regional government provided a chlorine generating system so that the community could make its own chlorine. No training in the use of the system was provided, and the unit has therefore not been used since it was received.

Koom**.** The ARC installed 16 deep bored wells with rope pumps (1 well/15 families) with 100% latrine coverage. In 2002, two wells were broken and some of the wells were noted to go dry during the dry season. Households received ventilated pit latrines and a hygiene education program by the ARC.

In 2009, this community had 283 homes with 1997 people. The number of homes and the population had increased since the 2002 survey, when 257 homes with a total population of 1735 people were reported. Water is drawn mainly from the bored wells, as well as from sand wells. The person living nearest the well is the designated caretaker; however, some of the wells were vandalized: rocks were thrown down the well, or the rope was removed so that water could not be drawn. In 2007, after Hurricane Felix, CARE came to this community to provide assistance. Eleven of the wells were repaired. A casing with a lock was placed around the working wells, and a concrete pad was constructed underneath each well. The concrete pad helped to divert the excess water from the well away from the borehole to help avoid contaminating the well. New homes have been constructed since 2002, and they are located further from the wells. The residents of these new homes use a nearby creek as a water source. Many of the wells were still noted to go dry during the dry season. Water from the wells is not treated, nor has it been tested. Ventilated dry pit latrines were provided by ARC in 2002. Residents of homes that did not receive latrines use a neighbor's latrine or else practice open defecation.

ARC provided health education in 2002, but no additional training was provided to this community until 2007. CARE provided the well improvements discussed above and additional

latrines after Hurricane Felix in 2007. The community had not received any other assistance since that time.

3.4 Infrastructure Evaluation Results

The results of the infrastructure surveys mainly reflect the observations of the CDC/ARC team from our review of the water and sanitation facilities. Community surveys reflect self-reported data from the communities.

The infrastructure survey evaluated physical water and sanitation infrastructure and the administrative structures set up to manage that infrastructure. The longer term sustainability of the ARC post-Mitch water and sanitation projects generally was related directly to their level of functioning at the time of the final health impact survey in 2002. The systems that were generally well operated and managed in 2002 continued to be well operated and functioning at the same level in 2006 and 2009. Two communities have experienced a significant change, one as a result of a natural disaster (Plan Shalagua, Guatemala) and another by a water system expansion (Dipilto Viejo, Nicaragua). These will be further explained under each community section below.

3.4.1 El Salvador

La Ceiba. The drinking water system in La Ceiba continued to function as designed. Water is disinfected by a tablet chlorinator at the storage tank. In 2006, issues were identified that could lead to larger problems if they were not addressed. The conduction line from the catchment structure to the pumping station has three river crossings. The pipeline is encased in gabions (wire mesh boxes filled with large rocks) at points where it crosses the riverbed. The gabions have been washed out when there are high flows in the river, as occurred during the rainy season and Hurricane Stan, threatening to also wash out the conduction line. The fence around the catchment structure was also broken, allowing access to the source and making it more easily subject to contamination. No changes had occurred to the condition of the water system since 2006. Also no changes had occurred with the composting latrines that were installed. Among those inspected, most latrines were being operated properly. Some operational problems with the latrines, such as not adding ash, were evident during the 2009 visit.

Las Pozas. The drinking water system in Las Pozas continued to function as designed. Observations during this assessment indicate that water was being chlorinated at the tank (0.1 ppm); however, because repairs to the system were being done at the time of the site visit, chlorine residual in the extensive distribution system could not be measured.

Financial viability was the largest challenge facing this system in 2006. There were 987 homes connected to the water system in 2002, with 925 of them being occupied and receiving water. In 2006, only 690 homes were occupied. Many of the residents had left because of a lack of economic opportunities in the area. The water committee noted that many of the residents who had been relocated to Las Pozas after Hurricane Mitch had returned to the coastal areas from which they had come, where the fishing and shrimp industries offer employment. A 2006 cost analysis looked at the normal operating expenses and the approximate number of subscribers

needed to meet those expenses. From 2002 to 2006, the community had lost at least 25% of its residents, and if more than an additional 10% of those residents left, the water system would not be able to pay its operating costs. This financial strain was evident in 2006 because the water committee did not have sufficient funds to pay for all necessary repairs to the system. The community was able to pay a private contractor to complete some of the needed repairs, but repairs that could not be completed since the 2001 earthquake remained. In 2006, it appeared that income from water fees would not be sufficient to continue running the water system.

A financial evaluation was done in 2009 to determine if financial difficulties continued in this community. Review of the financial records showed that there was sufficient cash on hand and funds to cover the monthly operating costs. The water committee stated that the electric bill for running the pump continued to be a significant expense to the community, and pumping was limited to 6–7 hours per day to save on electricity. The water fee had also increased slightly since 2006. In addition, it appears that the community is no longer losing residents, as it had during the 2002–2006 period. These three factors (limited electricity use, increase in water fee, and stabilized population) appear to have helped to stabilize the financial situation in Las Pozas, and the water committee currently has a savings account with funds to pay for future expenses. A comparison of the 2006 and 2009 financial data is provided in Appendix F.

Problems with the composting latrines that were installed in Las Pozas were evident during this assessment. Although the majority of the people interviewed in the community that received these types of latrines after Mitch were still using them (8/14, 57%), many of the latrines were not being operated properly. Essential steps for these facilities to function properly and not create odor and fly problems include using ash as a drying material and maintaining a seat cover on the latrine. Neither of these practices were being followed for many of these latrines. Some of these same problems were also present during the 2002 and 2006 infrastructure assessment. Eleven of the 14 latrines (78.6%) provided post-Mitch were hygienic and in use. There is also a problem with grey water, and the community was asking for guidance on how to best deal with this problem.

3.4.2 Guatemala

Chiquimula consists of two communities, Plan Shalagua and Guayabo.

Plan Shalagua**.** In the 2006 survey, it was noted that heavy rains associated with Hurricane Stan in 2005 caused a large landslide above and adjacent to the spring source for the water system. Before the landslide occurred, the water system was operating at an adequate level. The landslide caused a reduction of at least 50% in the flow from the spring. Because of this diminished flow at the source, only a trickle of water arrives at one or two of the original 23 public tap stands. Review of the tap stands in 2009 showed that only seven taps remained that could provide water to the community with the diminished flow; however, only two of those worked properly. The original system had been designed to chlorinate water before distribution, but chlorination was not occurring even before the landslide because chlorine was not easily available. Another issue with the system noted in 2006 was that the storage tank was small for a public tap system and it was not adequately protected from contamination because it is located inside a cattle corral. No improvements had been made to the water system since 2006.

Ventilated dry pit latrines were constructed in Plan Shalagua, and they appeared to be functioning well in 2009; however, many were reaching their fill capacity. Some households were digging new pits or else practicing open defecation as they did before the latrines were constructed.

Guayabo**.** This system was originally designed to use a solid chlorine tablet system for disinfection at the storage tank, but chlorine tablets were never available. The drinking water system in Guayabo still functions, but it has the same problems with leaks in the 19 km. conduction line from the spring source to the storage tank as it did in 2006. The water from the spring has a high mineral content that contributes to corrosion, in turn causing leaks in the galvanized iron pipeline. Long stretches of this galvanized iron pipeline run above ground through a forested area. Falling trees sometimes break the pipeline. An attempt to replace the pipeline occurred in 2006, but the tubing was stolen. A storm also occurred in 2008, and it caused damage to the conduction line, with heavy rains and flooding washing out some of the pipeline.

Repairing these problems was causing some financial strain on the community in 2006. Monthly water fees were not always sufficient to pay for repairs. The water committee has no reserve funds for making needed repairs. Recently, this community had turned to the local municipal government to seek additional funds to repair the water system. In the past, the residents were asked to make additional contributions beyond their normal monthly water fees. Review of the catchment area in 2009 showed that the cracks in the concrete apron at the spring that were noted in 2006 had still not been repaired. This catchment area covers the seep spring, and the cracks allow surface water to enter the collection box. The collection box fills and water flows through the conduction line to the storage tank in the community.

Ventilated dry pit latrines were installed in Guayabo. Community members reported in 2009 that many of the latrines fill with water during the rainy season and become unusable. Some of the latrine housings were also in need of repair. Many of the latrines have reached their capacity, and some residents have returned to the practice of open defecation.

Huitzitzil. There is no community water system in this community, and many residents of Huitzitzil have been purchasing bottled or bagged water to meet their drinking and cooking needs. It was anticipated that this type of water acquisition would not be sustainable; however, the 2009 survey showed that these residents continue to purchase water for their households. The residents of this community reside in a banana-growing region of Guatemala and there is employment in the area; consequently, many residents have cash incomes and can purchase water. In 2002, some residents reported that they were not able to purchase water. In 2009, as in 2002, residents surveyed reported that some were not financially able to purchase water or could not purchase it in sufficient quantities to meet their needs. Wells in the area are used for obtaining water for some of these households; however, the water from the wells reportedly is not suitable for drinking. Water quality test results to verify the assertions were not available.

The ARC provided composting latrines for this community, and a strong health education program included latrine operation and maintenance. Results from the 2002 survey showed that all residents contacted were performing proper maintenance on this type of latrine. In 2009,

most of the surveyed composting latrines were still in use and in good condition. Flooding in this community had damaged some of the latrines and those were no longer in use. Latrine repair was cost-prohibitive for some of the residents and had not been done since the last flood event. Residents often shared their facility with a neighbor.

3.4.3 Honduras

Las Lomas. The gravity flow system in this community continues to function, and water is chlorinated at the storage tank before being delivered to users. In the 2006 survey, it was reported that the conduction line from the source to the tank had been washed out eight times between 2002 and 2006. Tropical storm 16 occurred in 2008 and again washed out this conduction line. This section of pipeline typically is repaired every year, especially during the rainy season. The pipeline is still subject to being washed out, and it is almost continually being repaired. The survey in 2006 noted that the catchment structure at the spring source had been rebuilt to capture more water but was subject to more surface contamination. No improvements have been made since 2006.

This community also has a very active water committee that is able to fund two *fontaneros* to perform repairs and provide maintenance. The community expressed satisfaction with the water system and takes pride in its ability to maintain it. In the past, the two paid *fontaneros* reviewed the system for leaks and cut water service to any house that was two months behind in paying water fees. At the time of the survey, 32 houses were cut off from water service. This community has grown since 2006, and newly constructed homes are not a part of the distribution system. Water service is divided into two sectors because the system is not able to provide water to all houses that are part of the system, which now includes 478 subscribers. Water is provided to each sector for two days at a time. This water committee, like the one in Marcovia, has also benefited from several "champions" who are highly committed to ensuring that the system continues to function and provide service.

The sanitation facilities provided in Las Lomas consist of pour-flush latrines. This community has also experienced problems with these latrines' filling up during the rainy season and suffering from collapse of the seepage pits connected to the latrines. New houses constructed have built pit latrines. The water committee indicated that it was interested in becoming part of a sewer system project that is under construction in a neighboring community. The Spanish Red Cross is involved with that project and may include this community in the future.

Marcovia. In Marcovia, the water system consists of a deep drilled well that pumps water to an elevated storage tank. Water is chlorinated at the tank and flows by gravity to users. This system was originally designed to provide water for approximately two hours per day to each household. In 2006, the system continued to operate according to the original design and deliver high quality water to users. There were sometimes minor problems in the distribution system during the dry season, and not all homes received water. In 2009, there continued to be a problem with supplying water during the dry season. Despite an upgrade to a larger pump in the past, pump capacity needs to be increased again to meet the demands on the system. The piping on the well was changed in 2008, but no other improvements have been made since 2006. There is a very active water committee in this community, and that committee ensures that the system is

maintained and that water fees are collected. One of the factors noted in 2006 that appeared to contribute to this success is the presence of several committed persons on the committee who have acted as "champions". This element has been identified in prior work as being important for the successful maintenance of rural water systems (Katko 1993). The water committee had a savings account with a 2008 balance of 174,429 lempiras ($9,427 USD) for monthly expenses and repairs.

The sanitation system in Marcovia consists of pour-flush latrines. In 2006, they were generally not functioning adequately. The soils in this area are not highly permeable and consequently not ideally suited to these types of latrines. Many latrines continue to fill up during the rainy season and are unusable. Many residents who do not use their latrines have returned to the practice of open defecation. There continues to be a problem with grey water pooling in this community, potentially creating vector breeding habitat.

The water committee noted that the community would prefer to have a sewer system. This alternative was previously investigated by ARC and found to be cost-prohibitive. A nearby community does have a sewer system; however, the feasibility and cost of connecting to that system is not known.

3.4.4 Nicaragua

Nueva Segovia consists of two communities, Dipilto Nuevo and Dipilto Viejo. The water systems were constructed by the local municipality (not completely by Red Cross), and they were not originally designed or adequately constructed to meet local norms and standards. The sources for both water systems were not providing adequate quantities of water at the time of the 2006 evaluation. In addition, the sources are unprotected surface water that is highly subject to contamination.

Dipilto Nuevo (Barrio San Agustín)**.** The water system in Dipilto Nuevo was a tank constructed by ARC, with piping provided by ARC to a second set of three tanks constructed in series by the local government with funding from Ayuda Popular Norueaga (APN). The tanks in series are settling and holding tanks. The first tank is filled by the creek, and it overfills into a second tank, which in turn overfills to a third tank. Piping from these tanks was provided in part by APN and ARC. Water continues down to a storage tank in the community constructed by ARC. Water is distributed to the community to each home via a household spigot. Initially, the system had problems with air blocks in the conduction line from the source to the storage tank because no air release valves were installed at high points in the line. It is approximately 1 km from the source to the storage tank. A previous review of the system in 2006 noted that the "filters" installed below the source in Dipilto Nuevo were not functioning at the time of that assessment, and, from their size and appearance, they likely were never able to actually function effectively as filters to improve and maintain water quality. The 2009 review of the system found that the tank cover of the second tank of the three was uncovered and that the third tank cover was broken, allowing pine needles and leaf litter to get into the tank. Modifications to the tanks were noted to be done by the *fontanero*. The pipe from the third settling tank, the one leading to the storage tank in the community, was moved to a lower position along the wall of the settling tank. This move was

done in an effort to draw water from the bottom of the settling tank to maintain water flow to the storage tank and to the community during the dry season when there was low flow.

The tap stands at each home were constructed of PVC pipe, which breaks easily. Tap stands are typically constructed of galvanized iron pipe to avoid this problem. PVC is a less expensive material. The water committee invested in purchasing galvanized piping for system improvements; however, the tubing was stolen and no upgrading could be done. Design problems are also evident in source selection. The water source is located on private land, and it flows downhill to land that is used for grazing livestock. The second set of three tanks is located in this area.

Because of these issues, the water system in Dipilto Nuevo did not deliver an adequate level of service to users, as evidenced by the survey results from previous years and the 2009 survey. This situation has continued. Intermittent flow and a low level of service caused many users to refuse to pay their water fees. This non-payment, in turn, creates a situation in which the water committee has no resources to repair or upgrade the system. Repairs can be done only in case of emergency.

Latrines in this community were still functioning properly but were reaching the end of their useful capacity. Some residents took it upon themselves to move the latrine housing after digging another pit. Homes of new residents who had moved to the area did not have latrines at all.

Dipilto Viejo (Barrio Solidaridad**).** The water source for the water system for this community is amidst a coffee field approximately 7 kms away. This water system has worked well in the past, but previous surveys showed that road work between the community and the source had damaged the conduction line delivering water from the source. The fees collected were sufficient to allow for making repairs when needed. This initial project was constructed by the local government with funds from APN. It was a basin catchment to a storage tank. The system was expanded around 2007 to add an additional series of three storage tanks. The expansion project was paid for by FISE, which is funded by the Nicaraguan government. The system now includes two additional communities, Naranja (26 homes) and Tablacon (16 homes). The system always provides water with the expanded catchment and rarely runs dry, except during the dry season months.

Water is directed from the catchment area to a tank at the top of a hill. Water flows through a sand filter and then to a second tank, where it should be chlorinated before going downhill to the communities. However, the filter was in need of maintenance and there was no chlorine to disinfect the water prior to distribution to the communities. Maintenance of this type of filter requires care to maintain its integrity. The person associated with this community's water system seemed to have little technical knowledge about how to properly clean this type of filter.

In addition to the water system expansion, an additional 40 dry pit latrines were constructed. The new latrines were provided to the community in June 2007. Again, community growth is the cause for some homes' not having a private latrine. Recent community education was

provided in 2008 by the MINSA, and that education also included coverage of such issues as proper garbage disposal, how to conserve water, and how to manage household wastewater.

Waspam consists of two communities, Andres and Koom. These communities were selected and combined so that a sufficient number of households could be available for the initial three-year health survey.

Andres. This community was selected to receive ARC interventions, but instead, a local NGO was provided the construction materials and equipment to install three new wells. The majority of water used by each household is taken directly from the Rio Coco. During the 2009 survey, water was available from one well via a bucket on a rope. The other wells were dry. Water sampling in 2002 reported one dry well. This community had composting latrines that were originally constructed by Acción Medica. The latrines observed were not well maintained—i.e., damaged housing, no ash used, cover at the back of the latrines missing.

Koom. The ARC provided water, sanitation, and health education to this river community. Initially, 16 drilled wells equipped with rope pumps were all installed by 2002. Only 14 of those wells were still working properly at that time. In 2009, there were 10 wells that were still being used; six of the wells had been vandalized and were no longer operational. Ropes were removed, piping was broken off, or rocks were thrown down the well, rendering them unusable. Hurricane Felix in 2007 caused flooding in the region. CARE provided assistance to this community after the storm. CARE checked all the wells and constructed locking well housings on the operating wells to avoid further vandalism. Concrete pads were also installed to divert surface water away from the wells and avoid contamination. Many of the wells were not locked in 2009. Latrines in this community were dry pit latrines. There was 96% latrine coverage in this community in 2002. Many of the latrines were damaged during Hurricane Felix and still in need of repair in 2009.

3.5 Regional Results

The regional results for the USAID FANTA Guide indicators are shown in Table 16. Statistical comparisons were made in the same six communities that were evaluated in 2006 (Huitzitzil, Guatemala and Waspam, Nicaragua were excluded in 2006 due to logistical constraints). Results for the study areas can be compared from the 2000 baseline to 2002, 2006, and 2009 data. Goals for the program are provided in the table. Although the sample sizes were different (526 in 2000, 569 in 2002 vs. 94 in 2006 vs. 138 in 2009), these results represent regional outcomes of variables that were measured by use of sample sizes designed to show statistically significant differences. A separate table is provided for the results for the two communities that were not included with these results, Huitzitzil, Guatemala and Waspam, Nicaragua.

In general, there was a statistically significant decline for two indicators from 2002 to 2006—water infrastructure (households with year-round access to improved water source) and hygiene education (population using hygienic sanitation facilities). Comparison of results between 2006 and 2009 showed that all indicators remained about the same.

Table 16. USAID FANTA Guide Indicators, Regional Results

Intervention (input)	Description of Indicator	Goal	Baseline %	2002 %	2006 %	2009 %	p-value (2002 vs. 2006)	p-value (2006 vs. 2009)
Water Infrastructure	Households with year-round access to improved water source	100%	47	89	71	74	<0.0001	0.60
Sanitation Infrastructure	Households with access to sanitation facility	100%	54	97	98	95	0.97	0.53
Hygiene Education	Appropriate hand washing behavior	50% increase above baseline ≥ 35%*	23	**55**	**44**	**51**	0.06	0.33
		[53%]* †	[35] †	[**67**] †	[**57**] †	[**73**] †	[0.06] †	[0.02] †
	Population using hygienic sanitation facilities	75% In use	36	**87**	**77**	**77**	0.01	0.90

Bold indicates that the goal was met. Underline means a statistically significant difference.
* Goal is calculated as 50% increase above baseline.
[ ] numbers in brackets indicate an adjusted hand washing value
† Adjusted value. Women in homes without young children were not expected to answer that they washed their hands after diapering. The hand washing score is recalculated as ≥7 out of 9 as a passing score for those women.

Water infrastructure had a goal of 100%. Although a goal of 100% is not truly feasible for this indicator, 74% of the households surveyed in 2009 had year-round access to an improved water source. Sanitation infrastructure also had a goal of 100% set by the ARC. Nearly 100% of the households (95%) in 2009 had access to a sanitation facility. Most of the study participants who knew the source of funding for their latrine (112/138, 81%) confirmed that they lived in a home that had received a latrine from the ARC post-Hurricane Mitch latrine project. The majority of those latrines, 80% (89/112), were still usable. On a regional basis, this indicator demonstrated an improvement of greater than 90% over the baseline, although it did not reach the original 100% goal.

There are two impact indicators that measure the success of the health education program, appropriate hand washing technique and population using hygienic sanitation facilities. In 2009, the overall percentage of households with appropriate hand washing behavior on a regional basis still represented more than a 50% increase over the 2000 baseline (meeting the original goal), even though in 2009 this indicator decreased from the final results in 2002. No statistical difference was found between the hand washing behaviors in 2006 and 2009, except when adjusted to address the households that did not have children under the age of 36 months (the values in brackets).

A look at subsets of these data for 2009 and a comparison of the two groups shows that women who did not have children less than 36 months old in the home (76% (58/76)) did not demonstrate a statistically significant increase but had better hand washing technique than those who did have children less than 36 months old in the home (69% (43/62)). These results are not shown in the above table. Also, the percentage of the population having access to hygienic sanitation facilities showed a statistically significant decrease from the 2002 results but still met the original goal of 75% usage.

Huitzitzil, Guatemala and Waspam Nicaragua were not evaluated in 2006 and not included in Table 16. These two study areas did not receive complete ARC intervention programs. Huitzitzil received only the sanitation and hygiene education interventions from ARC. This community uses dug wells and bottled water for its drinking water supply. The dug wells reportedly are contaminated, most likely due to close proximity to banana fields and coastal saline intrusion. Some families in this community have used bottled water since the original baseline study was done in 2001. In 2002, the majority of households did use private or shared wells, but well water use for drinking declined when these wells were reported to be contaminated. It is important to note that bottled water is not considered an improved water source because it is dependent on the financial stability of each household and the availability of bottled water service. The composting latrine program in Huitzitzil was successful in 2002 due to the strong education program. In 2009, hygienic sanitation facility use declined, but no education had been provided to this community for several years.

The Waspam study area consists of the two communities Andres and Koom combined. Andres received limited wells and latrines through other NGOs, with no ARC interventions. Koom received interventions from ARC—water (wells), sanitation, and hygiene education. The two communities are combined for each indicator to represent Waspam. Values for this study area are not good measures due to the fact that even though the ARC did not provide interventions to one community, that community was included as part of the study area so that a sufficient number of homes could be surveyed. Table 17 compares the 2009 results for Huitzizil, Guatemala and Waspam, Nicaragua to previous years' data.

Table 17. Summary of Monitoring Indicators—Huitzitzil and Waspam

Intervention		Goal	Year	Huitzitzil Guatemala %	Waspam Nicaragua %
Water Infrastructure	Households with year-round access to improved water	100%*	Baseline 2000	N/A†	14
			Midterm 2001	79†	17
			Final 2002	92	34
			Long Term 2009	38	22
Sanitation Infrastructure	Households with access to sanitation facility	100%*	Baseline 2000	N/A†	21
			Midterm 2001	58†	26
			Final 2002	97	59
			Long Term 2009	88	89
Hygiene Education	Appropriate hand washing behavior	50% Increase (Goal)‡	Baseline 2000	N/A†	16 [21]
			Midterm 2001	30 [42] †	**37** [**44**]
			Final 2002	**79** [**87**]	**61** [**67**]
			Long Term 2009	**69** [**88**] (≥ 45/[63])‡	**44** [**61**] (≥ 24/[32])‡
	Population using hygienic sanitation facilities	≥75% Usage	Baseline 2000	N/A†	13
			Midterm 2001	42†	19
			Final 2002	**89**	42
			Long Term 2009	67	44

* Goal defined by American Red Cross and not in the FANTA Guide
N/A not available
† The baseline survey in Huitzitzil was performed in 2001; a mid-term survey was not performed in this study area.
Bold indicates reaching the goal
[ ] Brackets indicate adjusted hand washing value
‡Goal is estimated as 50% over baseline.

A further comparison of the communities that represent the study area of Waspam is useful. The sample sizes for these two communities are small and not suitable for statistical analysis, so this further comparison looks only at trends in the differences between these two communities. Table 18 is a side-by-side comparison of Andres and Koom. Andres received limited interventions from NGOs, while Koom received all interventions from ARC. Results show that Koom generally had better results for each indicator and met the goals for two indicators—access to a sanitation facility and appropriate hand washing technique. Andres met only the goal for appropriate hand washing technique. The superior performance of Andres may be attributed to continuing work in this community by Acción Medica, which has a long history of working in this community, in comparison to Koom, where no education was provided by any other NGOs.

Table 18. Comparison of Two Communities in Waspam, Nicaragua

Intervention		Goal*	Year	Koom %	Andres %
Water Infrastructure	Households with year-round access to improved water	100%*	Baseline 2000	27	0
			Midterm 2001	30	4
			Final 2002	69	0
			Long Term 2009	44	0
Sanitation Infrastructure	Households with access to sanitation facility	100%*	Baseline 2000	18	23
			Midterm 2001	23	30
			Final 2002	96	22
			Long Term 2009	**100**	78
Hygiene Education	Appropriate hand washing behavior	50% Increase (Goal) †	Baseline 2000	13 [18]	20 [23]
			Midterm 2001	**26** [**32**]	**48** [**56**]
			Final 2002	**62** [**68**]	**60** [**66**]
			Long Term 2009	**22** [**44**] (≥ 20 [27]) †	**67** [**78**] (≥30[35]) †
	Population using hygienic sanitation facilities	≥75% usage	Baseline 2000	13	14
			Midterm 2001	17	20
			Final 2002	68	16
			Long Term 2009	33	56

Bold indicates reaching the goal
[ ] Brackets indicate adjusted hand washing value
* Goal defined by American Red Cross
† Goal is estimated as 50% over baseline.

4. Strengths and Limitations

There are strengths and limitations with every methodology, including the one used in this study. One of the strengths of this study is that most communities were not advised in advance of the CDC visit. Experience indicated that when a site visit was planned, local health workers would advise the community of the pending visit and prepare in advance by doing community cleanups. The unannounced visit provides a true picture of the condition of the community. For example, the ability to demonstrate proper hand washing knowledge and practice in the community could be assessed without any advanced coaching. Also, the observation of the cleanliness of the sanitation facilities demonstrates the condition in which these facilities are maintained on a regular basis.

One limitation in the study is in the area of hygiene education. The knowledge of appropriate hand washing behavior and technique was evaluated in this sustainability evaluation by use of the USAID guide. We collected data in the same manner as was used throughout the entire project since 2000 so that our methods were consistent and data across years could be readily compared. Each interviewee was requested to demonstrate hand washing technique and identify critical times for hand washing. There have been recent improvements in capturing information on hygiene practices which are better at evaluating their knowledge which were not used. The newer approach includes questioning and observing the use of soap, identifying at least two critical times for hand washing, asking about recent hygiene promotion, and asking the interviewee about knowledge of

the danger signs of diarrhea and ways to prevent it, as well as asking about how to treat drinking water (EHP 2004). Other limitations with regard to the results in this sustainability evaluation affect the sanitation and hygiene component:

- Population changes occurred in many of the communities between 2002 and 2009. The communities have mostly increased in size, including adding new residents who were not part of the original ARC program at all—not connected to water system, no sanitation facility (latrine), no hygiene education;
- No attempt was made in 2009 to identify persons who had received health education during the intervention time period. Study participants were recruited first, then asked if they had participated in this study before. New residents who were not a part of the original ARC program were included;
- Many of the respondents could not recall when they had received instruction on hygiene or when their sanitation facility was built; and
- Failure to maintain a sanitary latrine may have been due either to deteriorated physical condition of the latrine (broken doors, missing roof, etc.) or to the fact the latrine had reached its capacity and could no longer be used hygienically. Many of these households reported that they would use and maintain the latrine if it were functioning (i.e., not full to its capacity, not deteriorating).

5. Discussion of Regional Results

The post-Hurricane Mitch ARC program provided integrated water and sanitation interventions, including physical infrastructure and hygiene behavior elements. The regional results show that physical infrastructure interventions generally continued to be sustainable over time but that hygiene behavior-based interventions, such as hand washing and maintenance of hygienic latrines, had declined since completion of the original program.

The "hardware" interventions of physical infrastructure (water systems and latrines) were generally sustainable from 2002 to 2009. However, these overall indicator results mask some differences between communities. Some communities continue to experience major problems with physical infrastructure. These problems were noted in both the 2006 and 2009 sustainability evaluations, and no improvements had been made in the intervening years. The results show that emphasis continues to be needed on the "software" components—such as hygiene education—to ensure long-term sustainability of water and sanitation projects. Specific results for each calculated indicator, community and infrastructure surveys, and water quality sampling are further described below.

5.1 Water Infrastructure

Percentage of households with year-round access to improved water source
Access to an improved water source means that the home is directly connected to a piped system or that a public well or standpost is located within 200 meters of the home. In addition, water should be available year-round, including during times when the water supply is least reliable. Access to water signifies that water must be sufficient for drinking, cooking, cleaning, and bathing. Unprotected surface waters, such as rivers, lakes and streams, are not considered improved sources (Billig et al., 1999). It is important to note that water quality is not a part of this indicator—only access is. Many of the households continue to obtain water from a private spigot in the yard (81%

in 2002, 90% in 2006, and 67% in 2009). Greater than 90% of the households store water in the home, either in a 'pila' or in drums for domestic purposes.

In 2006 and 2009, a qualitative question was asked of each household—whether the household had sufficient water for all needs. We did not attempt to quantify the amount of water used per household. Experience has shown that estimating the amount of water was not a straightforward piece of information to collect. Families reported having sufficient water for domestic uses readily available, even in communities where water was available for only several hours a day. This survey was carried out during the dry season, when water quantity is usually at its lowest. Results from 2006 and 2009 showed that there had not been much change in the year-round availability of water (76% in 2006 vs. 79% in 2009). Also, the median distance to a water source has not changed significantly since the 2006 survey, 3 meters in 2006 vs. 5 meters in 2009.

On a regional basis, the three most frequently reported problems in 2006 with regard to the water source were: 1) seasonal lack of water; 2) cost of community water; and 3) complaints about water service, such as intermittent service and low pressure. Regional results in 2009 showed that seasonal lack of water continues to be a problem. Such a shortage occurs annually during the rainy season, when the tendency for flooding due to heavy rains is greater. High water from flooding can wash out pipelines every year in these communities. Some communities collect fees throughout the year, only to spend all the funds on repairs. The regional cost of water has not changed dramatically since 2006. In some cases, the fees have increased slightly so that needed repairs could be made with the funds. The other issue with regard to the cost of water is lack of payment. In many communities, residents continue not to pay water fees. There is distrust of the water committees' management of the funds. Users often become unwilling to pay for erratic service, and the non-payment results in lack of funds for repairs to improve the level of service. Complaints are often associated with a lack of continuity of water service. Maintaining continuous water service is a key element for sustainability. It is a variable included in calculating this indicator. Continuity of water service remains an important indicator that ARC should continue to include in future evaluations of all water and sanitation programs.

5.2 Sanitation Infrastructure

Percentage of households with access to a sanitation facility
A sanitation facility (toilet or latrine) is defined as a facility for the disposal of human waste. Access means that the household has a private facility or shares a facility with another household. ARC's goal was to provide 100% coverage—meaning a sanitation facility for each household. The goal was not reached, but 95% or greater coverage was provided on a regional basis.

The household interviews indicate that 81% of the respondents had a facility provided as a result of the post-Hurricane Mitch work. Results in 2006 showed that many of the dry pit latrines were beginning to reach their capacity and had problems with the pits filling with runoff and overflowing during the rainy season. Many respondents reported digging a new pit when the old ones filled up and reusing the structure from the old pit location. Households with pour-flush latrines had the same problems as in the 2006 survey—septic tanks filling up or else a leaking of contents into the streets during the rainy season if the tank was collapsed. Composting latrines were mostly used in Huitzitzil, Guatemala. Some of the latrines were still being properly operated and maintained, with ash added and the seat properly covered, while others were not. One respondent reported that she was using the contents of her latrine as compost for the nearby banana trees. It is not known if other

residents in that community are similarly using the composting latrine contents. Other storms have passed through the region and damaged latrines. Evidence of the past storm events can still be noted in certain communities because there was still evidence of damaged latrines—e.g., in Waspam, Nicaragua, and Huitzitzil, Guatemala. Some households do not have the funds for construction materials in order to repair their latrines.

Problems with pit latrines' reaching maximum capacity were much more evident during the 2009 survey than in prior years. Some households reported that they have returned to the practice of open defecation. Actual use of the latrine is not a variable included in the indicator. The percentage reporting having access to a latrine may be high, but it does not always reflect an actual decline in latrine use. ARC should consider including guidance to each household on what to do when the household's sanitation facility reaches its maximum fill capacity.

5.3 Hygiene Education

Percentage of households with appropriate hand washing behavior
This indicator measures the appropriate hand washing behavior of the caregiver in the home. This caregiver is typically the female head of the household responsible for cooking, cleaning, and caring for those in the home. For this indicator, we have adjusted the scoring for households without children. The goal was to increase appropriate hand washing behavior by 50% over the baseline value.

Sustainability of improved hand washing behavior after a program has been completed is an important issue that requires attention. The goal for this indicator was achieved in 2002, but the behavior declined in 2006 and remained about the same in 2009 in comparison to 2006 results. The ARC provided a hygiene education program and training to the local health educators. Consistent messaging was provided throughout the original ARC program but was discontinued after 2002, when construction of the interventions was complete. A qualitative comparison of the hand washing results for the two communities that make up Waspam revealed that continued health education was provided to Andres from an NGO that has worked in this community for many years. The other community, Koom, received some support from CARE post-Hurricane Felix in 2007, and the CARE support may have helped to reinforce health messaging to sustain the improved behaviors.

Other local health agencies, such as the MINSA and local Red Cross chapters, continued going to some communities to discuss proper hand washing techniques. Only 66% of the women in 2009 could remember ever having been taught about hand washing, compared to 68% in 2006 and 78% in 2002. The lower percentage may be attributable to the limited health education that continued in these communities after the initial ARC interventions were completed. This indicator does not specifically take into account any changes in the community, such as the entry of new residents who have not received any health education, and such changes can account for measured declines in proper hand washing technique. Most communities have increased in population since 2002, with the exception of one community in El Salvador (Las Pozas).

We further evaluated the results of the appropriate hand washing scores in two groups of women: those with children younger than 36 months of age and those without children younger than 36 months of age. Regional results show an increase since baseline in both groups, followed by a decline in 2006, and an increase in 2009. The adjusted percentages for women with no children

younger than 36 months of age followed the same pattern of increase, decrease, then increase. We included the variable of receiving health education between 2006 and 2009. Results in 2009 showed that for all women, there is evidence of an association between hand washing scores and receiving health education—i.e., women who received health education are twice as likely to get a passing hand washing score. Hand washing scores for the subgroups of women who did not have young children in the home showed a statistically significant increase from 2006 to 2009.

When we separately compared hand washing scores of women with young children to those without, no statistically significant difference (p=0.3585) existed between the two groups. This comparison also looked at the number of women who received training after 2006, but the sample size for this subset was too small for a meaningful comparison to be made.

Percentage of population using hygienic sanitation facilities
This indicator includes several variables. First, the household must have a sanitation facility. Second, the facility must be hygienic, meaning appearing clean with few flies present. Third, the facility must have signs of use. Signs of use include the existence of a path to the facility and appearance of the structure as in good condition for use (doors, walls, seat intact). Each variable is combined to calculate this indicator.

The FANTA goal is for 75% of a population to use a latrine or sanitation facility. This goal was met in 2002 (87%) and then it declined in 2006 (76%) but remained at greater than 75% use. Regional results in 2009 did not change, and the percent of the population using a hygienic sanitation facility remained at 75%. Again, most hygiene education programs had ceased in 2002. This indicator may not capture certain sanitation facilities that meet all criteria but are at their fill capacity. Future evaluators should inquire further about latrine use when estimating this particular indicator.

5.4 Qualitative Water Samples

Most water samples from households, the community sources, and the taps were positive for total coliform bacteria. Water systems that used chlorine treatment had a greater number of water samples with negative results for *E. coli* and total coliforms. However, 2% (2/133) of these household water samples (both with and without chlorination) were positive for *E. coli*. These results show that although the water system is treating the water, recontamination could be occurring in the distribution system after treatment or through defective management of water in the home.

Nine percent of the respondents in 2006 reported treating their drinking water that day, compared to 22% in 2009. In 2002, 30% of respondents treated their drinking water on the day of the survey. Reliance on the community water system to treat drinking water adequately is a reason that many households no longer treat their water. However, those results can be influenced by the fact that during the survey period, the respondents take special care to chlorinate the household water. Chlorine residual tests were not done on any of the household water samples to confirm these responses. These results indicate the need for chlorination in the home to improve household water quality, as well as for proper storage, handling, and treatment of household water in order to prevent recontamination.

5.5 Community Questionnaires and Infrastructure Evaluation Results

The goal of the community questionnaire was to obtain the opinion of the community leaders and/or water committee members on their water system and sanitation infrastructure. The infrastructure evaluation is completed by CDC and ARC personnel; the evaluation is an objective description of the water system and sanitation infrastructure. Review of the community questionnaire results and the infrastructure evaluation provides a better picture of what is occurring in each community. The findings of the community interview and infrastructure evaluation highlight other issues not fully captured by the household surveys.

The 2006 survey revealed four issues that can affect sustainability. These specific issues were re-visited in the 2009 survey to determine if any changes had occurred in the three years since the last site visit. The specific issues are local demographic trends, water source and water system problems, sanitation facility function, and follow-up support.

Local demographic trends

Results in 2006 showed that populations in the rural communities served by the ARC projects changed over time. Whether it be an increase or decrease in population size, these changes can affect infrastructure. Las Pozas, El Salvador had a significant decrease in population due to a lack of economic opportunities in the area. Because the water system relies on pumping from a deep drilled well, this water system had significant operating costs, and the projected decrease in population size threatened the financial viability of the water system. The water committee was not able to collect sufficient water fees to cover the operating costs. It was expected that the water system would either cease to function or provide only limited service. The large investment in infrastructure made by the ARC could have been lost.

Review of the system in 2009 showed that this community increased its water fees slightly and was able to continue to maintain its water system. This community continues to have seasonal damage to the water distribution system, and it has just enough funds to continue water service. Water service is cut to homes that do not pay for three consecutive months, and the population has generally stabilized.

In contrast, Las Lomas, Honduras is a growing community. In 2002, there were 220 homes, with 190 of them connected to the water system. In 2006, there were more than 400 houses, with 348 connected to water. By 2009, there were 500 homes with 3000 residents. Although the water system originally was designed to serve the entire future population of Las Lomas (500 houses), the original spring source did not have the capacity to serve the present number of homes. The community therefore has had to ration water, providing water for two days at a time to each sector of the community. The catchment structure had also already been rebuilt to capture more water, and the rebuilding resulted in the catchment's no longer being a sealed spring box but a surface impoundment that is subject to contamination. The water system has continuous chlorination at the storage tank. This method of chlorination provides an additional barrier to any contamination reaching users.

Overall, most communities have increased in size and population, and the original ARC projects no longer cover all the water needs of the communities.

Water source—water system

There are two issues with regard to the water source—water system and design and cost. Water systems were designed to chlorinate water prior to delivery to households. The systems in Honduras (Marcovia and Las Lomas) and El Salvador (Las Pozas and La Ceiba) were using chlorine and able to secure supplies in 2009. The water systems that chlorinate continue to deliver better quality water to users. In Guatemala and Nicaragua, chlorine was not readily available to communities, so that disinfection of water supplies was not a sustainable option without external technical assistance. The water system in Dipilto Viejo, Nicaragua received government funds to expand the water system to include two more communities; however, water was not being chlorinated due to lack of chlorine availability. In addition, the filter system was not being properly maintained, negating some of the benefits of an improved, expanded water system.

Another finding of the infrastructure evaluation was that severe storm events significantly impacted drinking water systems in many cases. Storm events such as hurricanes or even the typical annual rainy season can cause disruptions in a water system. These findings also indicate that project design needs to better account for such storm events, especially to avoid potential washouts from high flows in rivers and streams.

The 2009 survey showed that the overall cost of water in most communities had not changed much since 2006. Communities reported that the funds they collect are enough to cover only some of the expenses for water system repair. For example, in 2006 in Las Pozas, El Salvador, the storage tank was leaking and the water committee did not have sufficient funds to pay for repairs. During the 2009 survey, the water system was offline for needed repairs and system water testing could not be done. These results may indicate that initial water fees were set too low to pay for the actual cost of service or that due to constant damage to the system, money cannot be saved for improvements. Also, non-payment of fees continues, resulting in water's being discontinued to homes that do not pay. In addition, new homes are built in these communities and water service is needed but not provided to all homes.

Consideration should also be given in all communities to the design of water fees. Over time, water fees should be projected so that the level of service that communities request can be supported into the future. Communities may have unrealistic expectations about the level of service they are able to support, given what residents are willing and able to pay. Water fees should be sufficient to cover the cost of repairs in addition to normal operating expenses.

The 2006 and 2009 sustainability evaluations showed that only three of the eight study areas could still cover their monthly operating costs, although even those three did not all have enough funds to cover needed repairs or to make improvements. Monthly water fees in Guayabo, Guatemala do not always cover costs, and in such cases, the water committee asks for additional contributions from community members. The water committee in Plan Shalagua, Guatemala had disbanded, but due to recent problems, it was recently re-established to address the problem with the water system.

Proper source selection and location are also important factors. Disinfection of a water supply is an excellent public health intervention, but consideration should be given to identifying a consistent chlorine supply. In addition, disinfection needs should not obviate the selection of a high quality, well protected water source, especially in areas where chlorine supplies are not readily available.

Sanitation facilities
The survey in 2009 revealed that many more latrines were reaching their fill capacity and that information was needed at the household level on what to do once the latrines are filled. Pit latrines were filling up, and some households were digging new pits and moving the latrine housing, while other households just stopped using a filled latrine and returned to the practice of open defecation. In the Honduran communities where pour-flush latrines were used, no repairs or improvements had been made since 2006, and sewage leaking onto the streets continued to be a problem in these communities. Connection to a sewer system is one option, but it may not be financially feasible. These communities expressed an interest in connecting to the sewer system of a larger community nearby, but the initial analysis by ARC in 2000 indicated that the community would not be able to financially support that level of infrastructure.

Composting latrines are a good technical option in some areas, but they require intense hygiene education. Huitzitzil, Gutemala had composting latrines installed, and the installation included a strong hygiene education component. Review of this community in 2009 showed that a good portion of the composting latrines were still in working condition. However, some latrines were damaged from recent storms and were not repaired due the inability of the household to purchase the materials for repair.

In general, as communities increase in population, new homes are built that do not have latrines. Such home additions will be reflected in a decrease in the indicator regarding the community's access to a sanitary facility.

Follow-up support
All communities visited in 2006 had received very little follow-up from ARC regarding infrastructure after 2002. In the 2009 survey, all of them needed additional hygiene education or technical assistance with either water or sanitation facilities installed by ARC.

Follow-up work may involve dealing with major problems (such as a landslide's reducing the water source in Plan Shalagua, Guatemala), but it also may be as simple as periodic visits with a community to provide a referral to a source of information. Some of the water committees indicated that simply knowing that such external support was available could help to keep up their motivation to operate the water system. Most of these small rural communities in Central America had been in need of some outside technical assistance at some point, even the ones that had dealt successfully with major problems or repairs. The better-operated systems were able to pay private contractors for some of that assistance because they had diligently collected monthly water fees from users. However, systems that started off with inadequate designs and/or weak local water committees were unable to sustain a level of service that users were willing to pay for, and such committees did not have funds available to pay for outside assistance.

These results indicate the need for ARC's programs to be designed to provide long-term follow-up. The sustainability of these particular projects, as well as of future ones, would be enhanced by such follow-up, and large investments in infrastructure would be better protected. Many of the above issues are elements of good project and program design, and proper design promotes sustainability. Effective designs should take these issues into account. However, these elements are often not taken into account in emergency response programs. These results show that over the long term, a follow-up program should be established at the beginning of every project, including emergency response projects, so that the investment made can be sustained over many years.

6. Conclusions and Recommendations

The goal of this evaluation was to return to the same communities and re-visit the issues identified in the 2006 survey. Overall, no improvements were made to correct any of the problems identified in 2006. The ARC post-Hurricane Mitch water and sanitation projects continue to struggle with certain water system problems since project completion. Sanitation facilities also were not improved nor repaired; many were reaching their fill capacity, and there were reports of a return to the practice of open defecation. Results from the 2009 survey showed that although the water and sanitation projects are sustainable after seven years, there continue to be problems that these communities cannot address on their own.

Previous work and experience in Central America (e.g., Gelting 1998) indicate that even well-organized rural communities eventually need external institutional support to ensure sustainability of water and sanitation infrastructure. Guyabo, Guatemala, for example, had to turn to the local government for assistance to get its water system working again. Dipilto Viejo, Nicaragua was fortunate to have government support for water system expansion, but proper maintenance of the filters and lack of chlorine for disinfection caused this water system to fall short of providing an adequate and safe water supply. Physical infrastructure interventions continue to generally be more sustainable than hygiene behavior interventions, as demonstrated by the 2009 results.

Communities in which there was an active water committee with long-standing members continued to have functioning water systems. However, no significant improvements could be made when repairs were needed every year due to flooding from seasonal rain events. All of the communities could benefit greatly from follow-up by authorities or local organizations with water and sanitation skills. All communities, especially the more isolated ones, could also benefit from knowing where and how to seek support (financial, materials, technical assistance) for maintaining systems.

CDC's recommendations are generalizable to all water, sanitation, and hygiene interventions that ARC undertakes worldwide. Recommendations from the Final Survey in 2002 and the sustainability evaluations of 2006 and 2009 support the need for local ongoing support in several areas.

Project Design

- Ensure that adequate attention is given to estimating a water fee that will allow sustainable operation of infrastructure. Projections should be made of financial implications for future expansion of the water system.
- Ensure that site selection and project designs effectively take into account local demographic trends and employment opportunities to ensure community sustainability.
- Design considerations should address seasonal changes (dry vs. rainy seasons) and water source capacity to ensure intervention sustainability and to address growth in population.

Partnerships

- Work with local partner organizations and establish well-defined roles within these partnerships so that all aspects of the projects are supported once they are completed by ARC.
    - Include Ministries of Health and Environment and host-country Red Cross societies to develop effective mechanisms to provide continued support in water and sanitation after the completion of the active phase of ARC involvement.
- Ensure that adequate attention is given to forming, training, and providing ongoing support to local administrative structures (like water committees) to operate water and sanitation infrastructure. The local administrative structure in turn will ensure the proper ongoing use of water systems and sanitation facilities in the community.

Hygiene education.

- Identify a local partner to help provide hygiene education to communities. Strong community-wide hygiene education programs should be provided in beneficiary communities before, during, and after physical water and sanitation interventions are implemented.

Water quality monitoring

- Water quality monitoring is important to ensure adequate levels of chlorine in water distribution systems. A periodic testing program should be established for water systems where chlorine is used.
- A mechanism should be investigated for additional water testing to monitor water quality of water sources.

In addition, the ARC should consider the following:

- Institutional continuity for ARC's country-level water and sanitation programs in order to provide continuous, effective support to the communities where infrastructure projects are undertaken. This will require investment of time and qualified personnel on behalf of the local National Red Cross societies.
- Develop tools by which communities can collect information on the water and sanitation systems on a periodic basis. The information could be used to help these communities seek out local support for maintaining their interventions.
- Develop more focused and effective indicators for water/sanitation/hygiene education programs. For example, this sustainability evaluation suggested that continuity of water service is an important indicator, whereas per capita water use did not turn out to be as useful. Questions developed for the survey can be improved to obtain this kind of information. The World Health Organization's (WHO) quantitative service factors (quality, coverage, quantity, continuity, and cost) are a good basis for evaluating community water supplies and for developing better indicators (WHO 1997).

The intent of this evaluation beginning in 2000 was to measure the health impact of the interventions provided by the ARC after natural disasters. This project then developed into one in which we could evaluate the sustainability of the interventions. The outcomes of this exercise

should be applied to all ARC projects so that even in an emergency response, the investments made in these projects would be sustainable over time.

7. Next Steps

Shortly after the 2009 survey in February–early March, a follow-up workshop was held to bring together key water committee members and community leaders from these communities. The goal was to discuss the main problems that their communities confront and the best ways to resolve these issues. One representative from six of the communities was invited to the three-day workshop. Other invited guests included mayors of the local towns, local Red Cross societies, and representatives from the Ministry of Health. Waspam, Nicaragua and Huitzitzil, Guatemala were not included because these study areas did not receive complete interventions from the ARC.

The results from the workshop provided a guide to implement a sustainable follow-up model for water and sanitation interventions. Three factors were highlighted:

- Ensure quality infrastructure is in place
- Ensure that proper administration, operation, and maintenance of systems are being practiced
- Solidify good hygienic practices

The outcomes of this workshop focused on these three factors identified by the community representatives. Follow-up water, sanitation, and hygiene promotion activities work will be done to address these community-based issues. This work is expected to be completed over a 12-month period. The components will include:

- Infrastructure rehabilitation in cases where the infrastructure is prone to damage or has been damaged due to natural disasters, seasonal floods, or other causes
- Committee trainings in administration, operation, and maintenance, including review of water and sanitation regulations

Hygiene education and promotion, including gray water disposal and mosquito breeding ground elimination

Assistance to these communities will focus on the above three factors in order to ensure that improvements are made. It is expected that the work will be completed before February 2012, when a final sustainability evaluation will take place.

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Appendix A Performance Indicators

Impact Indicators	Monitoring Indicators
1. Percentage of children under <36 months with diarrhea in the last 2 weeks	**1. Percentage of households with year-round access to improved water source**
2. Quantity of water used per capita per day	**2. Percentage of households with access to a sanitation facility**
3. Percentage in household with appropriate hand washing behavior ---Child caregivers ---Food preparers	3. Percentage of recurrent costs for water supply services provided by the community served
4. **Percentage of population using hygienic sanitation facilities**	4. Percentage of constructed water supply systems operated and maintained by the communities served

Billig et al., 1999.

Bold indicates indicators that are quantified in the sustainability evaluation.

Appendix B Household questionnaire

ID de dom _____

Reconstrucción de la Comunidad Después del Huracán Mitch Evaluación de Sustentabilidad: Encuesta del Hogar (Feb 2009)
América Central - El Salvador, Guatemala, Honduras, Nicaragua

País: ☐El Salvador ☐Guatemala ☐Honduras ☐Nicaragua
Comunidad: _____
Entrevistador: _____ Fecha: _____(mes/día/año) Hora de entrevista: _____

¿Puedo hablar con la persona en el domicilio que tiene la responsabilidad de preparar la comida y tiene la responsabilidad de recoletar el agua?

A. Información del domicilio
¿Participó usted en este estudio antes? ☐Sí ☐No ☐No sé
Si "Sí", (1a) ¿En qué año? (*marque todos los que apliquen*):
☐2000 ☐2001 ☐2002 ☐2006 ☐No sé

¿Esta casa es… (*Lea todas las respuestas posibles e indique una*)
☐ ***A. casa propia***
☐ B. amistades/familia
☐ ***C. alquilada***
☐ ***D. otro_____***

¿Cuántas personas duermen normalmente en este hogar? _____ (incluiendo el entrevistado)

Entre las personas que duermen aquí, ¿cuántos niños hay menores de 36 meses (<3 años)? _____

¿Cuál es el nivel de educación más alto que ha completado usted?
☐0 años ☐primaria (1-6) ☐secundaria (7-9) ☐bachillerato (10-12) ☐universidad

B. Uso y recolección de agua
¿Dónde consigue usted la MAYORIA del agua que usan en este domicilio **para beber y para preparar comida**? (*Lea todas las respuestas posibles e indique una*)
☐ ***A. llave pública*** ☐ ***D. pozo privado*** ☐ ***G. comprada de pipa/camión***
☐ B. llave privada ☐ E. comprada en botellas ☐ H. otro: _____
☐ C. pozo compartido ☐ F. río/arroyo

¿El agua que usted recoleta, es suficiente para todos sus usos diarios en la casa? ☐Sí ☐No

¿Qué tan lejos tiene que ir usted para recolectar el agua?_____varas _____metros _____km
(aproximación del entrevistador de la distancia: _____varas _____metros _____km)

¿Su fuente de agua le da agua durante todo el día? ☐ Sí ☐ No ☐ No sé
Si "No", (10a) ¿Cuántas horas por día hay agua? _____
(10b) ¿En qué parte del día? _____(por la mañana, tarde, noche)

¿Su fuente de agua le da agua durante todo el año? ☐Sí ☐No ☐No sé
Si "No", (10a) ¿Dónde consigue usted el agua cuando la fuente está seca? (*Indique una*):
☐ ***A. llave pública*** ☐ ***D. pozo privado*** ☐ ***G. comprada de pipa/camión***
☐ B. llave privada ☐ E. comprada en botellas ☐ H. otro: _____
☐ C. pozo compartido ☐ F. río/arroyo

¿Tiene agua guardada en casa para todos los usos? ☐Sí ☐No
Si "Sí", (11a) ¿Dónde? A. pila ☐Sí ☐No
B. botellas o otro recipientes ☐Sí ☐No

¿En este momento tiene agua de beber guardada en casa? ☐Sí ☐No
Si "Sí",**¿Podría sacarme un vaso de agua como si fuera a ofrecerlo a alguien?***(recoleta muestra de agua)*
(12a) *¿Está tapado el contenedor donde guarda el agua*? ☐Sí ☐No
(12b) *¿Cómo sacan el agua?*
☐A. con un cucharón ☐B. con un vaso ☐C. de la llave (contenedor)
☐D. lo vacía ☐E. otro: _____

(a) ¿Con qué frecuencia trata usted el agua? ☐A. siempre ☐B. de vez en cuando ☐C. nunca
(13b) ¿Cómo trata usted el agua? (*No lea las respuestas. Indique todas los que apliquen*)
☐A. con cloro ☐B. con yodo ☐C. la hiervo ☐D. otro _____
(13c) ¿ Porque sí o no? Razón: _____

¿Trató usted el agua antes de beberla HOY? ☐Sí ☐No

¿Cuánto paga usted por mes por el servicio de agua? _____ (moneda/mes)

¿Está el sistema de agua operado y mantenido por la comunidad? ☐Sí ☐No ☐No sé

¿Ha tenido algún problema o tiene alguna sugerencia acerca del sistema de agua que tiene? _____
_____
_____

C. Normas de higiene
Vamos hablar sobre las prácticas de higiene.

¿Me puede decir las actividades antes o después de las cuales se lava usted las manos?
(*No les dé las respuestas indicadas, pero puede decir* **"¿Y hay otros momentos?")**

Después de defecar	☐Sí	☐No	
Después de limpiar las nalgas de los bebés	☐Sí	☐No	☐ No hay niños
Antes de preparar la comida	☐Sí	☐No	
Antes de comer	☐Sí	☐No	
Antes de dar de comer a los niños	☐Sí	☐No	☐ No hay niños

¿Puede mostrarme cómo se lava las manos?
(***No les dé las respuestas. Si no quiere entonces*** ¿Puede explicarme cómo se lava las manos?)

Prácticas de lavarse las manos:

Con agua	☐Sí	☐No
Con jabón	☐Sí	☐No
Con las dos manos	☐Sí	☐No
Restregar las manos juntas al menos 3 veces	☐Sí	☐No

Prácticas de secarse las manos:

En una toalla limpia/ trapo	☐Sí	☐No
Al aire	☐Sí	☐No
En la ropa	☐Sí	☐No
Otro _____	☐Sí	☐No

Número total _____

¿Hay un lugar dónde las personas de esta casa pueden lavarse las manos? ☐Sí ☐No
Si "Sí", (32a) ¿Hay jabón? ☐Sí ☐No
(32b) ¿Hay una toalla o un trapo limpio para secarse las manos? ☐Sí ☐No

D. Servicio sanitario

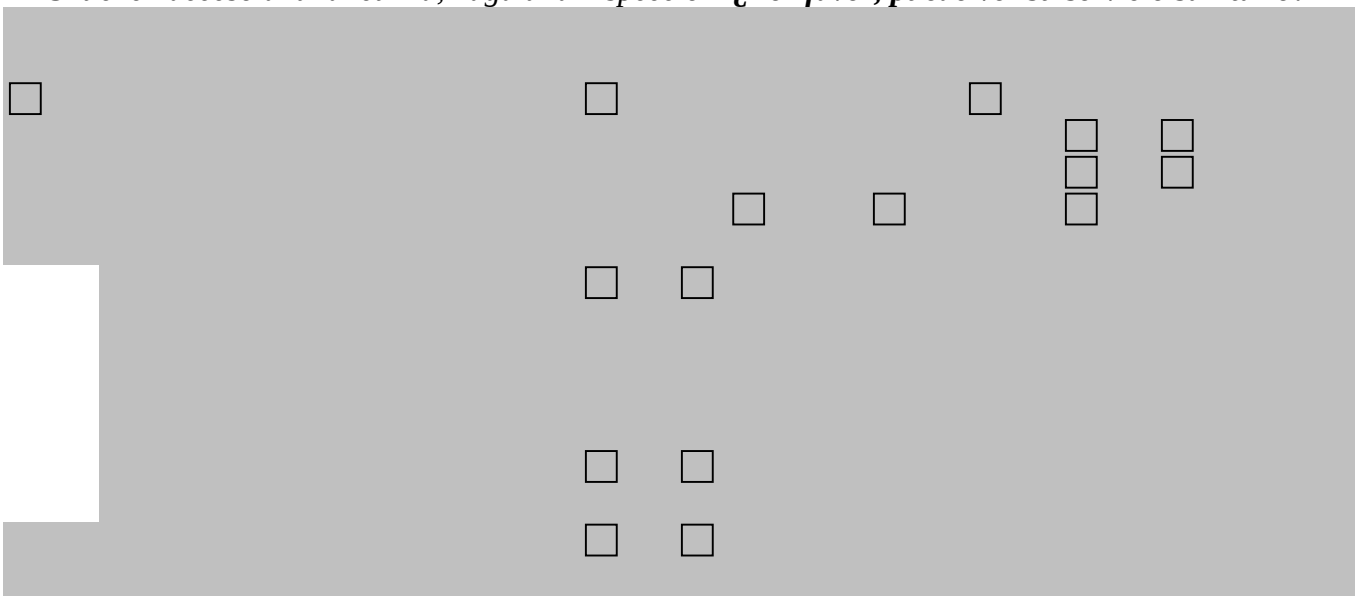
Después del Huracán Mitch, había muchos proyectos de letrinización.

(a) ¿Recibió usted una letrina después del Huracán Mitch? ☐Sí ☐No ☐ No sé
Pasar a #34 si "No o No sé" recibieron una letrina después del Huracan Mitch
Si "Si", (33b) ¿Hace cuantos años se la recibió? _____ años
(33c) ¿Quién se la proporcionó? _____
(33d) ¿Tiene usted esa misma letrina en la actualidad? ☐Sí ☐No
Si "Sí", (33e) La letrina es: ☐ propia ☐ comunal
Si "No", (33f) ¿Que le paso a la letrina anterior? _____

(a) ¿Tiene una letrina en la actualidad? ☐Sí ☐No (*Si "No", pasar a #34d*)
Si "Sí", (34b) ¿Quién se la proporcionó? _____
(34c) ¿Hace cuantos años? _____ años
(34d) La letrina es: ☐ propia ☐ comunal
Si "No", (34e) ¿Dónde hace sus necesidades? ☐letrina de otro (vecino/familiar) ☐afuera/aire libre

1. ¿Ha tenido algún problema o tiene alguna sugerencia acerca el sistema sanitario? _____
_____
_____

Si tienen acceso a una letrina, haga una inspección ***¿Por favor, puedo ver su servicio sanitario?***



E. Educación de salud

¿Ha recibido una charla despues del Huracán Mitch (Oct-Nov 1998) en……

8. …cómo tratar el agua para su uso en casa? ☐Sí ☐No (*Pasar a #47*)

Si "Sí", ¿Agencia/persona? ¿Cuándo le habló? ¿Dónde le habló? ¿Con quién (*com/grp/ind*)?

43. a._____ b._____ c._____ d._____
44. a._____ b._____ c._____ d._____
45. a._____ b._____ c._____ d._____
46. ¿Le ha enseñado usted a otra persona cómo tratar el agua? ☐Sí ☐No

Si "Sí", (46a) ¿A quien? _____

47… el uso y el cuidado de su servicio sanitario? ☐Sí ☐No (*Pasar a #52*)

Si "Sí", ¿Agencia/persona? ¿Cuándo le habló? ¿Dónde le habló? ¿Con quién (*com/grp/ind*)?

48. a._____ b._____ c._____ d._____
49. a._____ b._____ c._____ d._____
50. a._____ b._____ c._____ d._____
51. ¿Le ha enseñado usted a otra persona cómo usar y cuidar el servicio? ☐Sí ☐No

Si "Sí", (51a) ¿A quién? _____

52… prácticas de lavarse las manos? ☐Sí ☐No (*Pasar a #57*)

Si "Sí", ¿Agencia/persona? ¿Cuándo le habló? ¿Dónde le habló? ¿Con quién (*com/grp/ind*)?

53. a._____ b._____ c._____ d._____
54. a._____ b._____ c._____ d._____
55. a._____ b._____ c._____ d._____
56. ¿Le ha enseñado usted a otra persona prácticas de lavarse las manos? ☐Sí ☐No

Si "Sí", (56a) ¿A quien? _____

57. ¿Esta casa ha sido afectada por algún otro desastre natural o evento desde el Huracán Mitch que ha afectado el sistema de agua o de saneamiento? ☐Sí ☐No

Si "Sí", (57a) Describa por favor: _____

_____

Comentarios del entrevistado: _____

_____

_____

Comentarios del entrevistador: _____

_____

_____

Appendix C Community Questionnaire

Post-Mitch Community Reconstruction Sustainability Evaluation:
Community Survey (Feb 2009)
Central America-El Salvador, Guatemala, Honduras, Nicaragua
(Present interviewer and qualifications)

Country: a. El Salvador b. Guatemala c. Honduras d. Nicaragua
Community: _____
Interviewer: _____ Date: _____ (day/month/year)
Interviewees: _____

1. How many households are in your community? _____

2. How many people are in your community? _____

3. What kind of water system do you have now? _____

4. (4a) Since when have you had a functioning and completed water system? _____ (day/mo/yr)
   (4b) Who installed/provided the system? _____
   (4c) Is the system still functioning? Yes No
   If "No": (4d) When did it stop functioning? _____ (day/mo/yr)
   (4e) Why did it stop functioning? _____

5. (5a) Have there been any problems with the system since 2002/2006? Yes No
   If yes, please describe: _____
   (5b) How is it repaired? _____
   (5c) Is this person paid? Yes No
   (5d) How is this funded? _____

6. (6a) Have you received help for taking care of the water system from outside of the community since 2002/2006? Yes No
   If "Yes": (6b) from whom?
   A. Red Cross C. NGO
   B. Local municipality D. Government E. Other _____

7. What is the monthly cost of water to the households receiving water? _____ (per household)

8. (8a) Are the monthly fees collected from the households enough to pay for the operation and maintenance of the water system? Yes No
   If no: (8b) Where do the necessary funds come from for maintenance or repair?
   _____

9. Is there still a functioning water committee? Yes No

10. Does the water committee have a savings account? Yes No

11. (11a) Are there households in your community that do not receive this water supply? Yes No
    If "Yes": (11b) How do these households get water? _____
    (11c)Why don't these households receive water? _____

12.(12a) Is the water treated at a community level? Yes No
If "Yes": (12b) What kind of treatment? _____
(12c) When was the last time that it was treated? _____ (day/mo/yr)

13. (13a) Has your water been tested for contamination? Yes No
If "Yes": (13b) When was the last time it was tested? _____
(13c) Who tested it? _____
(13d) What did they find? A. contaminated B. not contaminated
(13e) Type of contamination A. chemicals B. microorganisms
(13f) If known, could you please provide more information about the type of contamination?
Specify type(s) of contamination (chemical/microbial):
_____

14. (14a) Given the choice today, would you choose the same water system option? Yes No
If "No", (14b) Why not? _____
(14c) Which would you choose? _____
(14d) Why? _____

15. What kind of sanitation system does your community have? _____

16. What year did this sanitation become available to the community? _____

17.(17a) Are there households in your community that do not receive this sanitation? Yes No
If "Yes": (17b) What do these households use for sanitation?_____
_____
If "Yes": (17c) Why don't these households receive these facilities? _____
_____

18. (18a) Given the choice today, would you choose the same sanitation system option for your community? Yes No
If "No", (18b) Why not? _____
(18c) Which would you choose? _____
(18d) Why? _____

19. (19a) Has there been any type of training about sanitation, hygiene or use of water? Yes No D K
If "Yes": (19b) When? _____ (day/mo/yr)
(19c) Where? _____
(19d) Who was the program geared to? _____
(19e) Who provided the training? _____

20. Is your community receiving any assistance with food, such as Food Aid? Yes No DK

21. (21a) Has this community been affected by any natural disasters or other events since 2002 that have affected the water and sanitation systems? Yes No
If "Yes", (21b), please describe: _____

Comments_____

_____

Appendix D Infrastructure evaluation

Infrastructure Sanitary Survey

Water System Performance/Design

1. Is the system working? (i.e., water coming out of taps or pump?) YES NO

2. If working, how many hours per day is water delivered to taps:
   - o 16 - 24 hours
   - o 8 –16 hours
   - o less than 8 hours
   - o NA (on demand hand pump system)

3. Functionality of components:

a. Catchment structure or well:

All valves function well? (test them)	YES	NO	NA
Cracks or leaks in structures?	YES	NO	NA
Clean inside spring box or behind dam?	YES	NO	NA
Catchment or well structures fenced in?	YES	NO	NA
Are there latrines or other sources of contamination (livestock, cesspools, etc.) within 100 feet of the catchment or well?	YES	NO	NA

If so, what and how far away?

For springs and dams:
what is upstream of the catchment structure? (forest, grazing land, houses, roads, etc.)

For wells:

Hand pump function well? (test it)	YES	NO	NA
Well casing extend 18" above ground or normal flood level?	YES	NO	NA
Top of well casing sealed from surface water, rain water, or contaminants?	YES	NO	NA
Is the well sealed at the ground surface? (i.e, can surface water, rain water, or contaminants enter the well at the ground surface?	YES	NO	NA

b. Conduction line from source to tank:

Leaks in pipes or joints?	YES	NO	NA
Exposed PVC pipe in line?	YES	NO	NA
Clean out valves and air valves working?	YES	NO	NA

c. Storage Tank:

All valves function well?	YES	NO	NA
Cracks or leaks in structure?	YES	NO	NA
Clean inside?	YES	NO	NA
Hatch covers in good shape?	YES	NO	NA
Covers locked?	YES	NO	NA
Tank fenced in?	YES	NO	NA

d. Treatment System:

Is there any treatment system? YES NO NA

If yes, what type:

- sedimentation tank
- chlorination
- other (specify): _____

Is it working? YES NO

e. Distribution Network:

Are there leaks in distribution network?	YES	NO	NA
Are there leaks in domestic connections?	YES	NO	NA
Does water arrive at all taps?	YES	NO	NA

4. Does the design of the system match the design information given to you by the watsan delegate?

YES NO

If no, describe the differences and their significance.

Sanitation Facility Performance/Design

(to be answered by visiting a sample of the latrines constructed in each community)

5. Given the type of latrine constructed, was it built properly? YES NO

Type_____

comments (especially if improperly constructed):

6. Is it being operated properly? YES NO

comments (especially if improperly operated):

7. Does the design match the design information given to you by the watsan delegate? YES NO

If no, describe the differences and their significance.

Appendix E Household questionnaire with frequencies

Regional Results **Feb-Mar 2009**

Household ID#_____

Post-Mitch Community Reconstruction Sustainability Evaluation:
Household survey (Feb 2009)
Central America—El Salvador, Guatemala, Honduras, Nicaragua

Country: ☐El Salvador ☐Guatemala ☐Honduras ☐Nicaragua
Community: _____
Interviewer: _____ Date:_____ day/month/year Time: _____

A. Household information

1. Did you participate in this study before? Yes No DK

1.	Yes (%)	No (%)	Don't Know (%)
2009	**25 (18.1)**	**101 (73.2)**	**12 (8.7)**
2006	43 (45.4)	43 (45.4)	7 (7.5)
2002	395 (69.7)	134 (23.6)	38 (6.7)

If "*yes*", in which year (*mark all that apply*)? 2000 2001 2002

	2000 (%)	2001 (%)	2002 (%)	2006 (%)	Don't Know (%)
2009	**1 (4.0)**	**3 (12.0)**	**5 (20.0)**	**4 (16.0)**	**12 (48.0)**
2006	6 (14.0)	13 (30.2)	14 (32.6)	0	10 (23.3)
2002	29 (7.3)	214 (54.0)	596	0	0

2. This house is ……..? (*indicate one*)
   A. Own house
   B. Friends/family
   C. Rental
   D. Other_____

2.	A (%)	B (%)	C (%)	D (%)
2009	**124 (89.9)**	**8 (5.8)**	**5 (3.6)**	**1 (0.7)**
2006	84 (89.4)	4 (4.3)	5 (5.3)	1 (1.1)
2002	511 (89.8)	34 (6.0)	14 (2.5)	8 (1.4)

3. How many people normally sleep in this home? _____

3.	Mean	Median	SD	Range
2009	**6.0**	**6.0**	**2.7**	**1 to 16**
2006	5.7	5.0	2.4	1 to 13
2002	5.1	5.0	2.3	0 to 17

4. Among the people who sleep here, how many are children < 36 months (3 yrs) old? _____

4.	0	1 (%)	2 (%)	>2 (%)
2009	**76 (55.1)**	**44 (31.9)**	**11 (8.0)**	**7 (5.1)**
2006	53 (56.4)	28 (29.8)	13 (13.8)	0
2002	315 (55.4)	200 (35.2)	51 (9.0)	3 (0.5)

5. What is the highest level of education that you have completed?

5.	0 (%)	1-6 (%)	7-9 (%)	10-12 (%)	Universidad
2009	**50 (36.2)**	**72 (52.2)**	**12 (8.7)**	**3 (2.2)**	**1 (0.7)**
2006	44 (47.8)	40 (43.5)	6 (6.5)	2 (2.2)	0
2002	258 (45.3)	280 (49.2)	27 (1.2)	4 (0.7)	0

B. Use and collection of household water

May I speak to the person who is responsible for the water for the household?

6. Where do you get MOST of your water for drinking and food preparation? (*Indicate one*)

A. shared spigot
B. private spigot
C. shared well
D. private well
E. bottled/purchased
F. river/stream
G. by truck (purchased)
H. other:_____

6.	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)	G (%)	H (%)
2009	**8 (5.8)**	**92 (66.7)**	**10 (7.2)**	**5 (3.6)**	**10 (7.2)**	**9 (6.5)**	**0**	**4 (2.9)**
2006	8 (8.5)	85 (90.4)	1 (1.1)	0	0	0	0	0
2002	87 (15.3)	459 (80.8)	17 (3.0)	2 (0.4)	0	2 (0.4)	1 (0.2)	0

7. Is the water that you collect sufficient for all of your family's domestic needs?

7.	Yes	%
2009	**111**	**80.4**
2006	91	96.8

8. How far do you have to go to collect your water? _____varas_____meters _____km

Distance in meters

8.	n	Mean	Median	SD	Range
2009	**133**	**26.1**	**5**	**73.5**	**0 to 600**
2006	49	98	3	376	1 to 2500
2002	566	38.6	4	132	0 to 999

(interviewer comments: _____varas_____meters _____km)

	n	Mean	Median	SD	Range
2009	**138**	**31.1**	**5**	**84.2**	**0 to 600**
2006	90	25	3	95	0 to 500
2002	565	39	5	132	0 to 999

9. Does your water source provide water throughout the day? Yes No DK

9.	Yes (%)	No (%)
2009	**93 (67.4)**	**45 (32.6)**
2006	65 (69.2)	39 (30.9)
2002	405 (71.2)	164 (28.8)

If "*no*", (a) for how many hours a day is there water? _____hours

9a.	n	Mean	Median	SD	Range
2009*	**45 [29]**	**19.1 [3.1]**	**4 [3]**	**21.7 [1.25]**	**1 to 48 [1 to 7]**
2006	28	2.8	2.0	2.4	0 to 12
2002	164	3.1	2.0	4.1	0 to 23

* In 2009, one community (Las Lomas, Honduras) had 16 households report receiving water all day, 2 times/week. This was recorded as 48 hours. Data without the 16 households from Las Lomas is recorded in the brackets.

If "no", (b) in what part of the day is there water? _____ morning, afternoon, evening

9b.	n	2 times/week	Morning	Afternoon	Evening
2009	**45**	**18 (40.0)**	**23 (51.1)**	**3 (6.7)**	**1 (2.2)**

10. Does your water source provide water throughout the year? Yes No DK

10.	Yes (%)	No (%)	Don't know (%)
2009	**109 (79.0)**	**29 (21.0)**	**0**
2006	71 (75.5)	23 (24.5)	0
2002	465 (81.7)	37 (6.5)	67 (11.8)

If "*no*", (10a) where do you get your water when the source is dry? (*choose one*)

A. shared spigot
B. private spigot
C. shared well
D. private well
E. bottled (purchased)
F. river/stream
G. by truck (purchased)
H. other:_____

10b.	n	A (%)	B (%)	C (%)	D (%)	E (%)	F (%)	G (%)	H (%)
2009	**29**	**3 (10.3)**	**2 (6.9)**	**0**	**1 (3.4)**	**0**	**11 (37.9)**	**1 (3.4)**	**11 (37.9)**
2006	22	6 (27.3)	5 (22.7)	1 (4.6)	1 (4.6)	0	6 (27.3)	1 (4.6)	2 (9.1)
2002	38	8 (21.1)	4 (10.5)	11 (29.0)	0	0	12 (31.6)	1 (2.6)	2 (5.3)

11. Do you have stored water in the house? Yes No

If "yes", (11a) Where?
A. pila Yes No
B. Bottles or other containers Yes No

	2009			2006			2002		
	Yes (%)	**No (%)**	**DK* (%)**	Yes (%)	No (%)	DK* (%)	Yes (%)	No (%)	DK* (%)
11. Stored water	**131 (94.9)**	**7 (5.1)**	**0**	88 (93.6)	6 (6.4)	N/A	527 (92.6)	42 (7.4)	N/A
11a. Pila	**65 (49.6)**	**66 (50.4)**	**0**	N/A	N/A	N/A	N/A	N/A	N/A
Bottles/containers	**113 (86.3)**	**18 (13.7)**	**0**	N/A	N/A	N/A	N/A	N/A	N/A

*DK= don't know N/A not applicable since this was a newly added sub-question

12. (a) At this moment, Do you have drinking water in this house? Yes No

If "*yes*", (b) Is the container where the water is kept covered? Yes No

	2009			2006			2002		
	Yes (%)	**No (%)**	**DK* (%)**	Yes (%)	No (%)	DK* (%)	Yes (%)	No (%)	DK* (%)
12a. Drinking water	**130 (94.2)**	**8 (5.8)**	**0**	87 (92.6)	7 (7.5)	0	548 (96.3)	21 (3.7)	0
12b. Covered water**	**101 (77.7)**	**22 (16.9)**	**7 (5.4)**	70 (80.5)	14 (16.1)	3 (3.5)	473 (86.3)	45 (8.2)	51 (9.3)

*DK= don't know

**Out of 130 households with drinking water stored in the home.

Could you get me a glass of water as if you would offer it to someone to drink?

If "yes", (c) how does the interviewee get the water?

A. Dips in a ladle (has handle) B. Dips in a cup C. Turns a faucet (container)

D. Pours it out E. Other_____

Year	n	A (%)	B (%)	C (%)	D (%)	E (%)
2009	**124**	**3 (2.4)**	**67 (54.0)**	**18 (14.5)**	**35 (28.2)**	**1 (0.8)**
2006	92	2 (2.2)	36 (39.1)	10 (10.9)	44 (47.8)	--
2002	559	48 (8.6)	233 (41.7)	91 (16.3)	185 (33.1)	2 (0.4)

13. (a) How often do you treat your drinking water? A. Always B. Sometimes C. Never

13a.	N	A (%)	B (%)	C (%)
2009	**138**	**28 (20.3)**	**30 (21.7)**	**80 (58.0)**
2006	84	8 (9.5)	12 (14.3)	64 (76.2)
2002	565	171 (30.3)	394 (69.7)	0

If '*A*' or '*B*' (b), how do you treat your water? (D*o not read list of answers. Mark all that apply*)

A. Chlorine B. Iodine C. Boiling D. Other _____ E. Do not treat

13b.	n	A (%)	B (%)	C (%)	D (%)
2009	**58**	**47 (81.0)**	**0**	**8 (13.8)**	**3 (5.2)**
2006	21	11 (52.4)	0	6 (28.6)	4 (19.1)
2002	11	0	0	8 (72.7)	3 (27.3)

(c) Why or why not? _____

14. Did you treat your water for drinking **TODAY**? Yes No

14.	Yes (%)	No (%)
2009	**30 (21.7)**	**108 (78.3)**
2006	8 (8.5)	86 (91.5)
2002	171 (30.3)	394 (69.7)

15. How much do you pay per month for the water you receive? _____(currency/month)

n	Currency	Mean	Range	Exchange rate	USD
34	Cordobas	4.41	0 to 10	20.14:1	0.22
34	Lempiras	35.44	0 to 50	18.89:1	1.88
30	Quetzales*	16.42 (2.31)*	0 to 99 (0 to 5)*	8.10:1	2.03 (0.29)*
36	USD	5.63	0 to 16	1:1	5.63

*Without Huitzitzil in parenthesis. Huitzitzil used bottled water

Regional mean and median water cost in US dollars among respondents who reported paying for water

Year	n	Mean	Median	SD	Range
2009	**134 (122)***	**$2.50 (2.29)***	**$1.06 (1.06)***	**3.3 (3.0)***	**$0.00 to $16.00 (0-16)***
2006	80	$2.55	$1.86	2.26	$0.14 to $12.00
2002	567	$1.89	$0.90	1.66	$0.21 to $10.50

*Without Huitzitzil in parenthesis. Huitzitzil used bottled water

16. Is your water supply operated and maintained by the community? Yes No DK

16.	Yes (%)	No (%)	Don't know (%)
2009	**106 (76.8)**	**32 (23.2)**	**0**
2006	92 (97.9)	0	2 (2.1)
2002	534 (94.7)	5 (0.9)	25 (4.4)

17. Have you had any problem or do you have any suggestions regarding your water system?

_____

_____

C. Hygiene behaviors

May I speak with the person who makes the food for the household?

Could you tell me before or after which activities do you wash your hands?
(*Let them answer.* ***Do not read possible answers, but you can say "are they any other times?***)

18. After defecation Yes No
19. After cleaning baby's bottoms Yes No There are no children
20. Before food preparation Yes No
21. Before eating Yes No
22. Before feeding children Yes No There are no children

Handwashing Activities	**2009**		2006		2002	
	n	**%**	n	%	n	%
18. After defecation	**115**	**83.3**	72	76.6	494	87.0
19. After cleaning baby	**23**	**16.7 [37.1]***	15	16.0 [22.0]*	176	31.0 [46.9]*
20. Before food prep	**124**	**89.9**	85	90.4	505	88.9
21. Before eating	**113**	**81.9**	58	61.7	427	75.2
22. Before feeding children	**43**	**31.2 [60.6]****	27	28.7	248	43.7

*Out of those that have children ≤ 3 years of age.
**Out of those that answered that they have children of any age-question only asked in 2009.

Would you explain and show me what you do when you wash your hands? (***Do not prompt***)

Handwashing technique:

23. With water Yes No
24. With soap Yes No
25. With both hands Yes No
26. Rub hands together at least 3 times Yes No

Handwashing	**2009**	2006	2002

	n	**%**	n	%	n	%
23. Water	**138**	**100.0**	92	97.9	562	98.9
24. Soap	**115**	**83.3**	81	86.2	489	86.1
25. Both hands	**135**	**97.8**	88	93.6	557	98.1
26. Rub hands	**122**	**88.4**	83	88.3	521	91.7

Hand drying technique:

27. On a clean towel/cloth Yes No
28. Air dry Yes No
29. On clothing Yes No
30. Other _____

Hand drying	**2009**		2006		2002	
	n	**%**	n	%	n	%
27. Towel	**75**	**54.3**	55	55	175	30.8
28. Air	**55**	**39.9**	25	25	211	37.1
29. Clothing	**30**	**21.7**	15	15	215	37.8
30. Other	**3**	**2.2**	5	5	11	1.9

31. *Total score:* _____

Total Scores

Year	N	Mean	Median	Range
2009	**138**	**7.5**	**8.0**	**3 to 10**
2006	93	7.3	7.0	2 to 10
2002	306	8.2	9.0	2 to 10

	2009		2006		2002	
	n	**%**	n	%	n	%
32a. Place	**122**	**88.4**	90	95.7	537	94.4
32b. Soap	**112**	**91.8**	77	81.9	466	81.9
32c. Towel*	**45**	**37.2**	33	35.1	166	29.2

*one missing value

D. Sanitary facilities

33. (a) Did you receive a latrine after Hurricane Mitch? Yes No (No then go to 34.)
If "*yes*", (b) How many years ago? _____ years
(c) Who gave it to you? _____
(d) Do you now have that same latrine? Yes No
If "*yes*", (e) The latrine is: A. Private B. Shared

Sanitary facility	**2009**		2006		2002	
	n	**%**	n	%	n	%
33a. Post-Mitch latrine?						
Yes	**112**	**81.2**	76	80.9	N/A	
No	**21**	**15.2**	12	12.8	N/A	
Don't know	**5**	**3.6**	6	6.4	N/A	
33d. Same latrine?						

Yes	**89**	**79.5**	62	81.6	N/A	
No	**23**	**20.5**	14	18.4	N/A	
33e. Latrine is:						
Private	**89**	**100.0**	60	96.8	N/A	
Shared	**0**	**0**	2	3.2	N/A	

If "*no*", (f) What happened to the previous latrine?_____

34. (a) Do you currently have a latrine? Yes No

If "yes", (b) Who gave it to you? _____

(c) How many years ago? _____ years

(d) The latrine is: A. Private B. Shared

If "no", (e) Where do you go to the bathroom? A. Other latrine (family/friend) B. Outside

	2009		2006	
	n	**%**	n	%
34a. Have latrine*				
Yes**	**42 [129]**	**82.4 [93.5]**	29*	30.9
No***	**9 [9]**	**17.6 [6.5]**	3	3.2
34d. Latrine is:				
Private	**42 [129]**	**82.4 [93.5]**	29	100
Shared	**0**	**0**	0	0
34e. Where do you go?****				
Other latrine	**2**	**22.2**	N/A	--
Outside	**7**	**77.8**	N/A	--

*two households had two latrines

**42 households have a latrine apart from ARC after Hurrican Mitch. In total, 129 households have access to a latrine. Numbers in parenthesis are based on total numbers with or without a latrine

***9 households do not have a latrine

****Out of 138 households, 18 households go to the bathroom outside and 7 households use another household's latrine, regardless of having a personal latrine.

Total number of people who have latrines in 2009 compared to 2006 and 2002

	2009		2006		2002	
Have latrines	**n**	**%**	n	%	n	%
Private	**129**	**93.5**	89	97.8	547	96.1
Shared	**0**	**0**	2	2.2	6	1.1
Don't have	**9**	**6.5**	0	--	16	2.8

35. Have you had any problem or do you have any suggestions regarding your sanitary facility?

_____

_____

If the house has PRIVATE OR SHARED sanitary facilities, ask or answer questions 35-38.
Inspection of sanitary services *(if the house has them)*

Latrines (126 observed)	**2009**		2006		2002	
36. Type of bathroom*	**Yes**	**%**	Yes	%	Yes	%
A. Dry pit	**30**	**23.8**	2	2.1	16	2.8
B. Dry pit ventilated	**24**	**19.0**	40	42.6	218	38.3
C. Compost	**38**	**30.2**	25	26.6	160	28.1
D. Flush	**32**	**25.4**	25	26.6	174	30.6
E. Other	**2**	**1.6**	2	2.1	1	0.2
37. Cleaned?	**110**	**87.3**	64	68.1	429	78.6
38. Feces outside?	**15**	**11.9**	12	12.8	37	6.7
39. Flies?						
None	**80**	**63.5**	68	75.6	429	77.7
Few	**30**	**23.8**	15	16.7	100	17.1
Many	**16**	**12.7**	7	7.8	23	4.2
40. Condition of bathroom						
A. Path	**115**	**91.3**	88	93.6	505	91.5
B. Swept	**106**	**84.1**	73	77.7	431	78.1
C. Good condition	**101**	**80.2**	79	84.0	22	4.0
D. Webs	**120**	**95.2**	88	93.6	39	7.1
E. Seat covered	**58**	**46.0**	32	34.0	N/A	N/A
F. Other	**10**	**7.9**	--	--	4	0.7
41. Toilet paper?	**72**	**57.1**	70	74.5	354	64.3

E. Health education

Have you heard a presentation on ….?

42…treating your water for household use? Yes No

If "*yes*", Agency/person? When did they speak? Where did they speak? With whom (*com/grp/ind*)?

43. a._____ b._____ c._____ d._____

44. a._____ b._____ c._____ d._____

45. a._____ b._____ c._____ d._____

46. (a) Have you shown anyone else how to treat the water? Yes No

If "*yes*", (b) to whom? _____

47… the use and care of your latrine or toilet? Yes No

If "*yes*", Agency/person? When did they speak? Where did they speak? With whom (*com/grp/ind*)?

48. a._____ b._____ c._____ d._____

49. a._____ b._____ c._____ d._____

50. a._____ b._____ c._____ d._____

51. (a) Have you shown anyone else how to use and care for your toilet? Yes No

If "*yes*", (b) to whom? _____

52… handwashing practices? Yes No

If "*yes*", Agency/person? When did they speak? Where did they speak? With whom (*com/grp/ind*)?

53. a._____ b._____ c._____ d._____

54. a._____ b._____ c._____ d._____

55. a._____ b._____ c._____ d._____

56. (a) Have you taught anyone else these handwashing practices? Yes No

If "*yes*", (b) to whom? _____

Received health education	**2009**		2006		2002	
	Yes	**%**	Yes	%	Yes	%
42. Water treatment	**87**	**63.0**	56	59.6	445	78.4
47. Latrine use/maintenance	**89**	**64.5**	60	63.8	457	80.7
52. Hand washing	**91**	**65.9**	64	68.1	445	78.4

57. (a) Has this house been affected by some other natural disaster or event that has affected your water and sanitation system? Yes No

Other event	**2009**		2006	
	Yes	**%**	Yes	%
57. Natural Disaster	**48**	**34.8**	12	12.9

(b) if "yes', please describe: _____

Interviewee comments: _____

_____

Interviewer comments: _____

_____

Appendix F Financial assessment of water system operations in Las Pozas, El Salvador

Financial Summary: Comparing January 2006 to January 2009

	2006 Cost	2009 Cost
Total Income	$2,351.40	$1976.00*
Expenses:		
Administration (salaries, electricity, etc.)	$1,110.27	--
Service (plumbers)	$779.56	--
Chlorine	$45.00	--
Total Expenses	$1,934.83	$2,361.57
Normal **monthly** operating expenses	**~$2,000**	**~$2,400**

Financial Assets on Hand	January 2006	January 2009
Cash	$197.63	$2,448.89
Bank accounts	$2,297.10	$933.02
Total	**$2,494.73**	**$3,381.91**

* total income is based on the number of paid accounts on the day of the site visit on February 26, 2009. There were 494 paid accounts out of 696 active accounts that day

-- not provided

Calculation of minimum number of customers to cover operating expenses:

Normal monthly water tariff†	$3.43	$4.00
Normal operating expenses	$2,000 / 583 connections	$2,400 / 600 connections

† water is metered and high-volume consumers pay more, but vast majority of consumers in this residential area pay the standard tariff