Evaluation of the Health Impact of the American Red Cross-Sponsored Water and Sanitation Infrastructure Reconstruction Program in Communities Affected by Hurricane Mitch

Honduras, Nicaragua, El Salvador, and Guatemala

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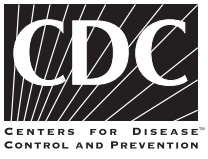

Evaluation of the Health Impact of the American Red Cross-Sponsored Water and Sanitation Infrastructure Reconstruction Programs in Communities Affected by Hurricane Mitch: Hondruas, Nicaragua, El Salvador, and Guatemala, 2002

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Executive Summary

The American Red Cross (ARC) and the Centers for Disease Control and Prevention (CDC) collaborated on a 3-year evaluation of the public health impact of ARC's water, sanitation, and hygiene education activities in eight study areas (two in each country) from the four countries where ARC implemented water and/or sanitation interventions after Hurricane Mitch. The purpose of the evaluation was to compare 1) access to and use of water and sanitation facilities, 2) the use of hygienic behaviors, and 3) diarrheal prevalence in children less than 3 years of age before (baseline survey), during (mid-term survey) and after (final survey) the interventions had been implemented. The baseline, mid-term and final surveys were conducted in the same communities in February of 2000, 2001, and 2002. In addition, an infrastructure evaluation was conducted in February 2002. The infrastructure evaluation provided a review of the design, construction, and current operation and maintenance of the water systems and latrines.

This report summarizes the activities of the three surveys and evaluates the effectiveness of the interventions in meeting the public health goals of increased access to water and sanitation, and decreased the rate of diarrheal disease. The results of the evaluation demonstrate the contributions that the ARC interventions have made to improve community health, access to water and sanitation, and promote the use of proper hygiene behaviors in these communities. However, this evaluation was somewhat limited in its ability to address longer-term sustainability of the interventions because of the time frame in which it took place. At the time of the final survey, approximately three years after Hurricane Mitch, some of these projects had been operating for about one year, while others had been online for only a couple of weeks. Therefore, evaluating long-term sustainability is not yet possible.

Our comparison of the final survey results with the results of the baseline and mid-term surveys found that the ARC post-Hurricane Mitch water and sanitation interventions generally were quite successful in meeting both programmatic and impact goals. Additionally, the water quality improved in every community from the time of the baseline survey to the final survey. The data indicate that the overall impact of the water and sanitation infrastructure interventions and the hygiene education programs was to effectively reduce the spread of fecal contamination, improve water quality, and decrease diarrhea prevalence. However, there were infrastructure and promotional issues that remained to be addressed in some communities. Not every community had a properly functioning drinking water chlorination system, and gray-water disposal was a significant problem in some communities. Although ARC had integrated a promotional and educational component into the projects, some difficulties related to the economic and educational components of the project, such as payment of monthly water fees and proper latrine use, were apparent during the evaluation.

CDC recommends that ARC address project-specific infrastructure issues including 1) upgrading the chlorination systems, 2) conducting regular routine monitoring for microbial indicators of fecal contamination, and 3) addressing gray-water pooling in certain beneficiary communities. In the area of promotion, CDC recommends that ARC provide additional follow up-promotion and education to the water committees and to community members to address community-specific issues such as nonpayment of water fees and maintenance of infrastructure, and to reinforce the benefits of using proper personal hygiene behaviors such as proper latrine use and hand washing. CDC recommends that ARC provide more institutional continuity within the

ARC country delegations for the water and sanitation program in order to provide ongoing support to the communities where infrastructure projects are undertaken. Finally, when working with partner organizations (i.e., Ministries of Health, international or local nongovernmental organizations) to perform interventions in disaster-response and development situations, CDC recommends that ARC ensure that roles within such partnerships are well defined and that mechanisms exist to ensure that all aspects of the projects are integrated.

Introduction

From October 26 to November 1, 1998, Hurricane Mitch struck Central America, killing an estimated 10,000 people, leaving approximately 500,000 people homeless, and causing regional damage to infrastructure. The American Red Cross (ARC) developed water and sanitation interventions for several communities in Honduras, Nicaragua, El Salvador, and Guatemala. The water and sanitation program benefited 110 communities populated by 75,765 people. Individualized water and sanitation interventions were developed for the communities that ARC assisted based on the communities' existing resources and needs, and consisted of drinking water supply systems, latrines, and health education. ARC took a participatory approach, in which the costs and benefits of all feasible options were presented to the communities, and the communities then decided the level of services they were willing and able to support.

People affected by disasters are more likely to become ill and to die from diarrhea and other diseases related to inadequate sanitation and water supplies than from any other single cause (The Sphere Project, 1998). The goal of the interventions planned by ARC as part of the post-Hurricane Mitch reconstruction program was to sustainably improve the health of the people living in the affected areas by focusing on three objectives: 1) establish sustainable access to water, 2) provide sustainable access to sanitation services, and 3) provide community education in basic sanitation and hygiene practices. Providing barriers to the spread of fecal pathogens by improving water supply, sanitation facilities, and hygiene behavior has been shown to decrease the transmission of diarrhea, reduce the overall burden of disease, and result in higher child survival rates (Esry et al., 1990).

ARC and the Centers for Disease Control and Prevention (CDC) collaborated on an evaluation of the public health impact of ARC's post-hurricane water, sanitation and hygiene education activities in eight study areas from the four countries where ARC implemented water and sanitation interventions. CDC and ARC planned three evaluations: 1) a survey of baseline water and sanitation resources and health indicators, conducted in February 2000, before the water and sanitation interventions were in place; 2) a mid-term survey, performed in February 2001, to evaluate the initial effectiveness of the interventions while they were ongoing; and 3) a final

survey, conducted in February 2002, to evaluate the initial health impact on the communities served.

Purpose

The purpose of the surveys was to compare the prevalence of diarrhea in children less than 3 years of age, and conditions of water, sanitation, and hygiene before the interventions were initiated (baseline survey) with the conditions in the same communities after the interventions had been completed (final survey). A mid-term survey was also conducted to inform the ARC of progress toward the goals, and to help them make decisions about how to refine the interventions to best meet the public health needs of the communities. The results of the three surveys were compared to evaluate the health impact of ARC's intervention program for water and sanitation in these communities. An infrastructure evaluation was also included in the final survey not only to determine if the water and sanitation interventions were appropriate and were well designed and well constructed, but also determine, to the extent possible, if the communities were operating and maintaining them properly.

Methods

Study Site Selection

Two study areas were evaluated in each of the four countries. A study area was a single community or several communities with similar demographics in the same geographical region that were selected by ARC to receive water and sanitation interventions. The study areas were selected to represent the range of intervention technologies used, and the range of geographical regions, types of communities (peri-urban vs. rural, existing vs. resettlement), and sizes of communities that ARC worked in. Selection was also based on the timing of the intervention process in each community. Communities where ARC had already completed infrastructure improvements or were providing hygiene education were not included in the study. Table 3.1.1 lists the study areas and describes the planned interventions and their status at the time of the

final survey in February 2002. ARC had completed all interventions in the eight study areas prior to the final survey. In one study site, Huitzitzil, in Guatemala, only 2 years of survey data were collected due to logistical constraints that precluded data collection in this study area during February 2000. Baseline data in Huitzitzil were therefore collected in February 2001.

Evaluation Teams

The evaluation teams for each study area varied somewhat from year-to-year. Generally, the evaluation teams comprised one CDC investigator, the ARC country water and sanitation (wat-san) and/or health delegate, one or more representatives of the national Red Cross societies from each country, locally hired health promoters, and local Red Cross volunteers. Local ARC staff also participated in some countries. In addition, during the final survey, an environmental engineer from the CDC visited most of the communities and worked with the ARC country wat-san delegates to evaluate the infrastructure that ARC provided.

Before going to the field, the evaluation teams participated in a 2-day training program to gain interviewing skills, practice data entry into Epi Info 6 (Dean et al., 1994), and become familiar with the interview documents and procedures specific to the evaluation.

Evaluation Components

The study documents are given in Appendices 2-8. In each study area, the evaluation included:

- A cross-sectional household survey, including a questionnaire and visual inspection to evaluate availability of water and sanitation services and related hygiene behaviors;
- A community survey conducted with the water committee and the ARC wat-san and/or health delegate to assess the functioning, maintenance and sustainability of the water intervention;
- 4 weeks of active diarrheal surveillance (conducted only in the two study areas in Nicaragua) to assess the health impact of the water and sanitation interventions;
- Analysis of a subset of community and household water sources for microbial indicators of fecal contamination; and
- An infrastructure evaluation, including a questionnaire for the ARC wat-san delegate and visual inspection of the infrastructure and community records.

Household Survey

During the three surveys, the United States Agency for International Development (USAID) Food and Nutrition Technical Assistance (FANTA) Project "Water and Sanitation Indicator Measurement Guide" (Guide) provided the primary basis for the household survey (Billig et al., 1999). ARC requested that CDC use the Guide as the basis for the evaluation because the water and sanitation interventions were done as part of a larger health and nutrition campaign that was conducted under the USAID Title II program. The indicators, therefore, represented a consistent set of performance indicators for assessing and reporting the effect of water and sanitation interventions in developing countries done under this program.

The performance indicators include impact indicators and monitoring indicators shown in Table 3.3.1. The impact indicators assess the effect of the interventions on the behaviors and health status of the beneficiaries, and include measures of disease burden, hygiene behavior, and maintenance and use of water supply and sanitation facilities. The monitoring indicators are used to evaluate the progress of the interventions in achieving programmatic goals. The ability of each community to meet each of the performance indicators was evaluated during the baseline, mid-term and final surveys.

Limitations in the approach of the Guide in measuring many of the parameters were noted and are discussed in the Limitations section (Section 5). To decrease the effect of the known limitations, questions developed for the household survey to measure changes in the indicators outlined in the Guide were supplemented with 1) additional questions to broaden the scope of the household survey, 2) interviews with the community leaders and/or water and sanitation committee, 3) active diarrhea surveillance in the two study areas in Nicaragua, 4) measurement of indicators of fecal contamination in water sources and stored household water, and, 5) during the final survey, an infrastructure survey to determine if the infrastructure that was installed was designed and built properly and was being adequately operated and maintained.

Sample Size Calculations

To choose a sample that was representative of the conditions in the entire Central America Region, we planned to conduct the evaluation in one or more study areas in each of the four countries. The sample sizes required to detect an expected difference in each of the USAID indicators were calculated and compared to determine the sample size necessary for the cross-sectional household survey.

The sample size needed to detect a 25% decrease in diarrhea in children less than 3 years of age after a water-sanitation intervention was 717 households. The diarrhea rate in this population was assumed to be 25% prior to the intervention (Billig et al., 1999), and was calculated using a power of 80% and a confidence interval (CI) of 95%. To account for refusals, a required sample size of 800 households was estimated. This sample size was too large to feasibly cover in one study area. Therefore, this indicator was used as a global indicator, pooling all household data from all study areas to reach the required 800 households. Consequently, changes in the diarrhea prevalence indicator among the three years can be compared statistically only when all of the study areas are pooled to give the required 800 households.

The sample size for the household survey was based on the indicator of hand washing behaviors before and after interventions, which required the largest sample size of the remaining indicators. The sample size was calculated by assuming that the practice of proper hand washing behaviors would occur in 20% of households before the intervention (Billig et al., 1999). Following the intervention, the percentage of households practicing proper hand washing behaviors was predicted to increase to 40% (Billig et al., 1999). A sample size of 91 households was calculated using Epi Info 6.01 (Dean et al., 1994), based on a power of 80% and a confidence interval (CI) of 95%. To account for refusals, a systematic sample (every Xth household, based on the size of the community) of 100 households was selected for each study area.

Active Diarrhea Surveillance

The active diarrhea surveillance that was conducted each year in both study areas in Nicaragua consisted of a questionnaire administered to each household that participated in the household survey. A census of each household provided information on the age and sex of all household

members. The incidence of diarrhea in the previous week was recorded for each household member. Active surveillance of the incidence of diarrhea among members of these households continued with weekly follow-up visits for four weeks. A trained in-country interviewer with a health background conducted the follow-up visits with the ARC health delegate providing oversight during this data collection.

Water Sampling and Analysis

Each community water source and stored water from a subset of households in all communities in each study area was sampled for indicators of fecal contamination. A sample size of 10 households was calculated based on a CI of 95%; a power of 80%; and the assumption that water, sanitation, and educational interventions would decrease the contamination of stored household water by 67% (Pinfold, 1990). To account for refusals, the CDC targeted a representative sample of 12 households from the 100 households participating in the survey in each community.

The actual number of household samples and community water samples taken was adjusted so that all community water sources would be sampled. In some communities, both the source(s) and other points along the distribution network were sampled (e.g., a sample was taken from the source such as a spring, the tank effluent, and at one or more taps in the distribution system). In this report, all of these points are termed "community water sources" and are analyzed with the community water sources. The CDC investigators collected and analyzed the water samples to quantify total coliform bacteria and *Escerichia coli* using portable DelAgua Water Testing Kits (Oxfam, 2000). The presence of total coliforms indicates that water may be contaminated with human or animal waste. The presence of *E. coli* is a positive indication of fecal contamination. Hach test kits (Hach Company, Loveland, CO) were used to qualitatively confirm the results obtained using the DelAgua kits.

Infrastructure Evaluation

Infrastructure was evaluated using a systems analysis approach, which assessed whether the entire infrastructure system (from water source to user) was protecting public health and preventing the spread of disease or disease-causing agents. Such an approach has been utilized

by WHO (1994) in the management of water supply and sanitation programs, as well as by other organizations in approaching both health and environmental issues (DHS Victoria, 2001; IDRC, 1999; McGranahan et al., 2001; WHO, 2002). The existence and effectiveness of barriers put into place at each step (water collection, storage, distribution) to prevent or eliminate contaminants in the water were also analyzed using this method. The infrastructure evaluation using the systems approach also considered institutional factors associated with the physical facilities that may have influenced public health. For example, the existence of organizations to effectively manage the infrastructure and to ensure that the public health benefits derived from it are sustained over the long term was also assessed. Any social or educational components of the infrastructure development program were also evaluated to the degree that such elements appeared to have influenced the construction or use of the physical facilities.

The CDC engineer performed the infrastructure evaluation of the systems in Guatemala, Honduras and El Salvador. The CDC investigator leading the evaluation in that community and the country ARC water-sanitation delegate evaluated the infrastructure in the 2 communities in Nicaragua.

Results

Table 4.1.1 summarizes the number of surveys and samples collected during the baseline, mid-term, and final surveys in each study area. During the final survey in February 2002, the teams completed questionnaires for 770 households, 11 community surveys, and collected and analyzed 128 household and community water samples. One hundred ninety-three households in the study areas in Nicaragua participated in 4 weeks of active diarrheal surveillance.

The final survey results were compared statistically to the baseline results to determine if the USAID goal was met using Epi Info 6.01 (Statcalc module) and SAS 8.02. The final results for the water quality indicators (total coliform bacteria and *E. coli*) were compared to the mid-term results because the same analytical method was used to enumerate these organisms during only the mid-term and final surveys.

Sections 4.1 and 4.3 summarize the results of the monitoring and impact indicators from the baseline, mid-term and final surveys for each study area. Section 4.2 summarizes the results of the water quality analyses from the mid-term and final surveys. The results for each study area are discussed in more detail in Appendix 1. Section 4.4 summarizes the general results of the infrastructure evaluation, including the community survey.

Monitoring Indicators

Table 4.1.2 summarizes the results of the four monitoring indicators from the baseline, mid-term and final surveys. The final survey evaluated the short-term impact of the interventions in comparison to the baseline and mid-term surveys. Monitoring indicator #4, "Percentage of constructed water supply facilities adequately maintained by the communities served," does not apply to individual communities, but to the program as a whole.

Monitoring Indicator #1: Households with Year-Round Access to Improved Water

At the time of the final survey, five of eight study areas met the ARC goal of 100% of households having year-round access to an improved water source within 200 meters of the home, compared to zero of eight during the baseline and mid-term surveys. In the five study areas that met the goal, ARC had constructed or repaired water systems with household taps or shared taps. Four of the five study areas that achieved this goal had reported coverage less than 100% at the time of the final survey, but the low reported coverage was due to growth in the community; 100% of homes that were counted at the time of the baseline survey had access to water at the time of the final survey or had refused to participate in the intervention. Two of the study areas that did not meet the indicator goal, Andres in Waspam, Nicaragua and Huitzitzil, Guatemala did not have water projects in part or all of the study area. The third study area that did not meet the goal, Nueva Segovia, Nicaragua, was not built by ARC and had difficulty supplying water continuously.

Monitoring Indicator #2: Households with Access to a Sanitation Facility

To be sensitive to physical constraints, and the needs and wishes of the communities, ARC used a variety of latrine designs to provide sanitation service to the communities they served. The latrine program was very successful; seven of eight study areas met the USAID goal of 100% of households having access to improved sanitation during the final survey. The study area that did not meet the goal included a community that did not have a latrine project; in Andres (Waspam, Nicaragua) the ARC donated materials for latrines to another nongovernmental agency, but the latrines were not built. As with the goal for access to water, five of the seven study areas that achieved the goal for access to sanitation had reported coverage less than 100% at the time of the final survey. However, the low reported coverage was due to growth in these communities or refusal to participate.

Monitoring Indicator #3: Recurrent Costs for Water Supply Services Provided by the Community Served

At the time of the final survey, six of eight water systems had been operating for sufficient time to make adequate assessments of the percentage of recurrent costs for operating and maintaining the water system that were provided by the community. Three of six communities where the water system had been operating for sufficient time to conduct the evaluation were providing 100% of their operating costs. Of the three communities that were not covering their recurrent costs at the time of the final survey, Waspam (Nicaragua) was not charging a fee, Nueva Segovia (Nicaragua) was providing substandard service and charging accordingly, and in Las Lomas (Honduras), the water committee was collecting tariffs that only covered approximately 90% of their operating expenses.

Monitoring Indicator # 4: Percentage of Constructed Water Supply Facilities Adequately Maintained by the Communities Served

This indicator applies to the water/sanitation program as a whole (as opposed to individual communities). Eleven separate rural communities were included within the eight study areas included in this final evaluation, but only seven communities had water systems that were designed and constructed by ARC and/or its partner organizations. No water projects took place in Andres (Waspam, Nicaragua) and Huitzitzil (Guatemala), and the two systems in Nueva

Segovia (Nicaragua) were designed and constructed by the local municipality without ARC involvement. These two systems in Nueva Segovia did not provide a level of service that was considered adequate, but that result had more to do with design and construction than community level operation and maintenance at the time of the evaluation.

In the six study areas where ARC had water projects (excluding Huitzitzil and Nueva Segovia), all but one of the water systems with direct ARC involvement were being adequately operated and maintained by the community served at the time of the final survey (although some had only been online for very short periods of time). The exception was Waspam (Kum), where two of the 16 new ARC wells were out of service at the time of the evaluation because the rope pumps were broken. These pumps had not been repaired despite the fact that ARC (according to the information provided by ARC staff) had provided a local distributor in Waspam with rope pump accessories and had an agreement with that distributor that those materials would be made available at cost to the community. In addition, the community had previously decided not to collect fees from users of the wells, but to collect funds on an as-needed basis to cover maintenance and repair costs. Because the procedures for accomplishing repairs had evidently not been successful (i.e., the pumps had not been fixed), this community cannot be considered to have adequate community-level operation and maintenance of the water supply facilities.

In summary, for the study areas that had direct ARC involvement in the water infrastructure, the overall percentage of constructed water supply facilities adequately maintained by the communities served was 5 out of 6, or 86%. The same indicator for all of the study areas with water infrastructure interventions was 5 out of 7 (excluding Huitzitzil where no water project took place) or 71%. No target values for this indicator are discussed by USAID, but the ARC goal of 100% for this indicator was not achieved by either measure.

Water Quality

Figures 4.2.1.a and 4.2.1.b summarize the percentage of samples taken from community water sources and stored household water that were contaminated with total coliforms and *E. coli* during the mid-term and final surveys. In comparison to the mid-term survey, the percentage of community water samples and samples of stored household water that were contaminated with

total coliform bacteria and *E. coli* decreased in every community where ARC was involved with the water intervention at the time of the final survey. This result suggests that the water, sanitation, and hygiene education programs that ARC implemented were effective in reducing the spread of fecal contamination in these communities.

Impact Indicators

Table 4.3.1 summarizes the results of the four impact indicators from the baseline, mid-term and final surveys. The final survey evaluated the short-term impact of the interventions in comparison to the baseline and mid-term surveys.

Impact Indicator #1: Regional Diarrhea Prevalence

The health impact of the interventions was directly measured by determining the percentage of children < 36 months of age (the most vulnerable population) with diarrhea in the two weeks preceding the evaluation. For this study, diarrhea was defined as three or more loose stools in a 24-hour period. This indicator was evaluated statistically on a regional basis (see Section 3.3.2, Sample Size Calculations, for a discussion of the sample size calculation for this indicator). However, the results are summarized for each study area in Table 4.3.1, and are discussed qualitatively in the country-specific results sections in Appendix 1.

As seen in Table 4.3.2, the prevalence of diarrhea decreased regionally from 35 per 100 children to 26 per 100 children. This was a 26% decrease in prevalence between the baseline and the final survey, which met the impact indicator goal of a 25% decrease. If the community of Andres, which ultimately received no water or sanitation intervention through the ARC, is removed from the analysis, the regional decrease in diarrhea prevalence decreases from 34 per 100 children to 24 per 100 children, a 29% decrease in prevalence.

The prevalence of diarrhea decreased from the baseline to the final survey for both children who were breastfeeding and children who were not breastfeeding. Among breastfeeding children, the prevalence rate of diarrhea decreased from 36 per 100 to 27 per 100. Of the children who were not breastfeeding, the prevalence rate of diarrhea decreased from 33 per 100 to 24 per 100 in the final year.

Impact Indicator #2: Per Capita Daily Water Use

None of the eight study areas met the USAID goal of collecting 50 liters of water per person per day (Lpd) during the baseline, mid-term, or final surveys. This goal is inappropriate for many of the study areas because of the proximity of the communities to rivers that provide much of the communities' nonpotable water needs (bathing, washing clothes). However, even those communities capable of collecting 50 Lpd (according to the USAID guidelines) were unable to accomplish the goal of 100% of households collecting 50 Lpd. In some of these communities (e.g., Marcovia, Honduras), the major source of water is household taps. Water use in communities where household taps are prevalent may be under-reported, because water that is used directly from the tap is not accounted for. The same situation may be true for communities with an abundance of private wells (e.g., Huitzitzil). Finally, people may not accurately recall of how much water they collect and store for home use when water is readily accessible.

Impact Indicator #3: Hygiene Knowledge and Behavior - Food Preparer and Child Caregiver

At the time of the final survey, six of eight study areas met the USAID target of a 50% increase in the number of food preparers and child caregivers demonstrating knowledge and practice of appropriate hand-washing behaviors after a hygiene education program. During the mid-term survey, only three communities had met the USAID goal. The hygiene education programs in the two communities that did not meet the target for improved hand washing at the time of the final survey (Las Pozas and La Ceiba, El Salvador) ended between five and eleven months prior to the final survey. No further education programs had been given in those two communities. Most of the communities that met the goal had ongoing hygiene education programs offered either by ARC or their partners.

Impact Indicator #4: Population Using Hygienic Sanitation Facilities

Seven of the eight study areas met the goal for this indicator – namely, that at least 75% of the population use hygienic sanitation facilities. In Waspam, one of the two communities that made up the study area (Andres) did not receive a latrine intervention by ARC. The success of most study areas in reaching this goal is related to the fact that household latrines were provided

throughout the study area, enabling nearly universal access to a latrine. This was not the case in Waspam, where only 59% of households reported access to a latrine. Another factor that contributed to most of the study areas reaching the goal of 75% percent of the population using hygienic latrines is that privately owned latrines are more likely to be properly maintained than shared latrines. The hygiene education that focused on care and maintenance of latrines also played a critical role in the ability of the communities to successfully achieve the goal of this indicator, particularly in the study areas that received composting latrines, which require intensive education to ensure their proper maintenance and use.

Infrastructure Survey Results

Tables 4.4.1 and 4.4.2 summarize the results of the infrastructure surveys by indicating which of the elements that were included in the infrastructure surveys were problematic. (the infrastructure survey instruments are included in Appendix 3.) These tables represent a consolidation of a large amount of information, and do not capture all of the details that were observed during the infrastructure surveys.

For example, in Waspam, Niacaragua, three of 18 water supply wells were not functioning during the infrastructure evaluation. Because a large majority of the wells were functioning, element # 3 of Table 4.4.1 indicates that the system of wells was functional. On the other hand, of the 18 community sources tested for water quality in Waspam, six had *E. coli* and 12 were contaminated with total coliforms. Because these results showed that a large proportion of the water sources tested were contaminated, item # 9 of Table 4.4.1 indicates that there was a problem with the quality of the water being delivered in Waspam. Despite this consolidation of information, these tables do present a useful and concise summary of the infrastructure survey results showing which study areas had more or fewer problems with the infrastructure interventions.

Water Interventions

As can be seen in Table 4.4.1, water infrastructure interventions ranged from facilities that had no major problems (Las Pozas) to ones that had problems in virtually all of the areas included within the infrastructure surveys (Nueva Segovia). Table 4.4.1 also highlights problematic issues

that were common to many study areas in the evaluation. The table shows that the two most common problematic elements for water infrastructure were # 6 (treatment system) and # 9 (quality of water delivered), two elements that are obviously closely related. Disinfection of drinking water in small rural water systems is often problematic, especially in lower income countries where both supplies and trained personnel may be limited, and these systems were no exception.

Another problematic element across several study areas was the payment of monthly water fees. Although three of six study areas that had been operating for sufficient time during the final survey to be evaluated were doing extremely well collecting fees, other study areas were experiencing problems and were not collecting enough fees to cover even basic operating expenses, nor were they accumulating funds for future repairs.

Sanitation Interventions

Table 4.4.2 presents the results for the sanitation portion of the infrastructure survey. As can be seen in this table, there were fewer problems in this area, which is expected because the sanitation facilities were generally quite simple in design, particularly when compared to the design of the water interventions. In two of the three study areas where composting latrines were installed, however, many of the latrines inspected were not being properly operated. This is discussed further in Appendix 1 (Impact indicator discussions for Las Pozas and La Ceiba in El Salvador and Huitzitzil, Guatemala).

In keeping with the systems approach, the infrastructure survey was not strictly limited to the elements contained in the infrastructure survey, but went beyond those when other issues were apparent. An example of this was the problems caused by gray water (water used for washing and bathing) disposal in several study areas. Installation of piped water systems in communities that previously did not have that service typically results in a marked increase in water use, with a consequent increase in the production of wastewater. However, since all of the systems included in this evaluation utilized latrines of various types for human waste disposal, the wastewater in the study areas did not include raw sewage. Nonetheless, there were significant problems with gray-water in several communities, with water pooling in ditches and streets,

creating potential public health problems. Pooling of water in ditches and streets was especially true in larger communities, such as Las Pozas, El Salvador and Las Lomas and Marcovia in Honduras.

ARC Involvement in Interventions

Another result that was apparent from the infrastructure and community surveys was that the degree of direct ARC involvement in the water/sanitation and hygiene education interventions varied across the study areas, as shown in Table 4.4.3. In addition, the level of ARC involvement influenced the outcomes of the interventions; in those communities in which ARC worked in conjunction with other partners, and the infrastructure was not as well integrated with other project components, the interventions were generally not as effective.

For example, in Nueva Segovia, Nicaragua, where the local municipality moved forward with constructing a water system without an adequate design and without the involvement of ARC, this intervention lead to a very low level of coverage and service and was not considered successful by the community. In another example, the hygiene education in Las Pozas, El Salvador, was undertaken primarily by a local NGO, and was less effective than the hygiene education in other study areas. This was apparent in the results from the hand washing indicators in Las Pozas, where there was actually a decrease in appropriate hand washing behavior.

In contrast, the interventions in which ARC undertook the primary role in implementing an infrastructure development program integrated with a hygiene education campaign were more effective than those where ARC worked in conjunction with other partners. Some examples include Chiquimula, Guatemala and the two study areas in Honduras, Las Lomas and Marcovia.

Institutional Continuity

Another factor that became apparent during the infrastructure evaluation was the existence of some institutional limitations within the ARC water and sanitation program. ARC has traditionally been involved in, and known for, disaster relief work. Although these water and sanitation interventions took place in the context of responding to Hurricane Mitch, the nature of the projects was somewhat different from typical disaster responses, because they took

substantial time to plan, design, and construct. The projects were, in essence, infrastructure development projects, rather than traditional disaster response projects. However, allocation of resources for these programs was still based on a system of funding and short-term personnel contracts tied to disaster responses. For example, because of the recent earthquake, there are funds available in El Salvador for additional work for water and sanitation projects. In contrast, in Guatemala, now that the concern surrounding Hurricane Mitch has largely subsided, there are no financial resources to continue with water and sanitation interventions at present.

Previous work and experience in Central America (e.g., Gelting, 1995) indicates that even the best organized small rural communities will eventually need some intermittent external, institutional support to ensure the sustainability of their drinking water and sanitation systems. However, the current system of resources tied to short term disaster responses is not able to provide such ongoing support to the communities where ARC water/sanitation projects have been undertaken, or develop new projects based on the capacity acquired by ARC.

Limitations

Limitations in the methodology used to perform the evaluation and in the indicators chosen to measure the inputs and outputs may have affected the results of the evaluation. Some of the major limitations identified during the evaluation are discussed below.

Use of Self-Reported Data

The household surveys were conducted as administered interviews with the person in each household who was responsible for the storage and handling of water and for the preparation of the food. Self-reported data are subjective in that each person responding to the question will interpret it in their own way. We attempted to reduce the variability in the interpretation of the questions by having each interviewer be from the country or region where the surveys were being conducted, and having the interviewers participate in a thorough training on the goals of the study, the methodology to be used, and the specific way to ask each question in the questionnaire. There were also places in the questionnaire where the interviewers recorded their observations, such as on the cleanliness of the sanitary facilities, which provided a more

objective point of view. The interviewers received training to standardize the methods used to arrive at answers for these questions and decrease interviewer bias. In addition, water samples were collected from randomly selected households and the analysis of the water samples provided objective data on the quality of the stored household water.

Timing of the Surveys with Respect to the Completion of the Interventions

The time frame of the evaluation was too short to adequately assess the long-standing benefits of the interventions to the communities served. The evaluation had been designed with the plan that all of the interventions would be completed before the second year of the study. However, this did not happen and, although all interventions were completed prior to the third and final year of evaluation, some of the interventions, such as the water interventions in Chiquimula, Guatemala, had been completed only a few weeks to a few months before the final survey. We did not modify our study design when we realized that the scheduling of the interventions was not on the original time line. Instead we conducted the 1-year follow-up to the baseline survey as a mid-term survey, that could be used to inform the ARC of their progress toward meeting their project goals, and areas that needed extra attention as they were completing the interventions.

Use of Diarrhea as a Health Impact Indicator

Although water and sanitation interventions decreased rates of diarrheal disease by about 25% (Billig et al., 1999), the usefulness of measuring diarrheal prevalence as an indicator may be limited because of the difficulty in causally linking the decrease in diarrheal disease to the intervention because some changes in diarrhea prevalence are likely to be unrelated to the effect of the water and sanitation intervention (Esry, 1991). Also, the study participants have little incentive to report a socially stigmatizing illness such as diarrhea to the interviewers.

Evaluating Hand Washing Knowledge and Practice

The knowledge of appropriate hand washing behavior was evaluated using the USAID guidelines for the child caregivers and the food preparers in each household. Proper hand

washing is one of the most effective ways to break the oral-fecal route of disease transmission. The ARC interventions include a health education component designed to increase knowledge about and practice of proper hand washing skills. The evaluation assessed the percentage of childcare givers and food preparers with appropriate hand washing behavior at the time of the interview on the basis of the interviewees' ability to recite critical times at which they wash their hands and to demonstrate specific hand washing techniques. These responses were self-reported and observed by the interviewer who scored the responses (Billig et al., 1999). The interviewer first asked each participant at what times they washed their hands and then asked each participant to demonstrate how they washed their hands.

The effectiveness of this evaluation was limited because participants may find it difficult to remember the fine points of the hand-washing technique when a stranger (the interviewer) is in their house asking them questions. Additionally, respondents may report and/or modify their hand washing techniques because they are being evaluated.

Another limitation to this method is the assumption that people who have children and those who do not will have the same likelihood of reciting hand washing behavior at times related to childcare activities. These activities may not come to the mind of a person who did not have young children in the household. However, the USAID Guide does not specify that the hand washing section of the survey be asked only for respondents who have young children (Billig et al., 1999). Our analysis of this indicator includes all respondents to these questions, regardless of whether they reported having young children.

To further explore the issue of possible differences between the respondents in households with or without young children, we compared the hand washing scores of the childcare givers and the food preparers between households that had young children with the households that did not have young children. Comparisons were made between 48 groups: food handlers and child care givers in eight communities over three study periods. For most comparisons (43 of 48 or 90%), no significant differences were observed between the two groups. However some minor differences were observed. The percentage of food preparers with passing scores was significantly greater among those who had children compared to those who did not have children

for four of the community-study period combinations (Table 5.4.1). In addition, for two community-study period combinations the percentage of child caregivers with passing scores was significantly greater among those who had children, compared to those who did not have children. Conversely, for one community-study period combination, the percentage of child caregivers with passing scores was significantly less than those who had children (Table 5.4.2). We reanalyzed the data, excluding the households that did not have children. The conclusions drawn for these indicators remained the same.

Estimation of Per Capita Daily Water Use

For this study, the quantity of water used per person per day was measured as the volume of water collected for each household and stored in culturally specific water containers divided by the number of people in the household. The volume of water collected and stored in each household was estimated by asking the study participants to recall how much water they had collected in the 24-hour period before the survey. Limitations to this method include the assumption that the amount of water collected was the amount used, the risk of recall bias, daily changes in water needs as household chores change, and the proximity and types of water sources available (Billig et al., 1999).

There was also a shift in the availability of water from the baseline to the final study, which was reflected in people's difficulty in reporting their daily water use. At the time of the baseline survey, the water interventions had not been installed and people were collecting or carrying a good deal of their water in containers. The need to actively search out the water made it easier for people to remember the quantities they collected. In the second year, many of the water interventions had been started and people's habits of collecting water changed. If people had a household spigot, they were not always able to estimate how much water they had used. The difficulty reporting continued into the final year of the survey, when most of the communities had received water interventions. In El Salvador, where all of the households in the two communities had household meters, there was a discrepancy in one of the two communities (Las Pozas) between reported water use and records from the community about household water use (See Appendix 1, Section A1.3.1.3).

There was also possibly a difference in the motivation level of survey participants in the baseline survey to truthfully report their household water usage compared to the final survey. At the time of the baseline survey, people were anxious to report their water needs to demonstrate their need for a water intervention. By the time of the final survey, people expressed concern about the effect that reporting their water usage would have on how much they were charged for the water.

Original Goals for Access to Water and Sanitation

The USAID Title II guidelines do not give target values for the monitoring indicators and ARC decided to use 100% access or coverage as the goal for all of these indicators. This goal of 100% coverage appears useful and realistic for the 3rd (percentage of recurrent costs covered by the community) and 4th (percentage of constructed water facilities adequately maintained by communities) monitoring indicators. However, for the first two monitoring indicators (access to water and sanitation), 100% access did not appear feasible or realistic. A considerable amount of hand labor was required from each participating household to complete most of the water and sanitation facilities constructed under this program. In several communities, some residents were unable or unwilling to contribute the required labor, and therefore were not included in the project. These limitations to access were based on characteristics of the potential user, and were not limitations of the interventions. Further, these limitations prevented some study areas from achieving the goal of 100% access to water or sanitation. However, CDC accounted for these limitations when determining whether each study area achieved these goals. If the percentage of households with access was slightly lower than 100%, and was determined to be due to lack of participation of households that were unable or unwilling to contribute the required labor, the goal was considered to be met.

Discussion

Linking Inputs to Outputs

The overall goal of the ARC post-Mitch water/sanitation program was to reduce childhood diarrhea by at least 25% in all of the study areas combined. This goal was met in that the actual reduction over the entire study area was approximately 26% (see Table 4.3.2). This output was

achieved by ARC interventions consisting of water and sanitation infrastructure and hygiene education. There is ample evidence that these inputs of infrastructure and educational interventions are related to the measured health outcome of childhood diarrhea (e.g., Briscoe 1984; Okun, 1988; Esry, 1996; Root, 2001; Tumwine et al., 2002). Therefore, the ARC program of water/sanitation related interventions was successful in an overall sense as measured by the health impact indicator of childhood diarrhea.

However, examining the study results more closely also yields important and interesting insights into the water/sanitation program. Specifically, looking at the study area (or community) level results for both the inputs (water/sanitation infrastructure and hygiene education) and the health output (childhood diarrhea) can yield important insights into which interventions were more or less successful and what should be replicated or improved upon. Both the inputs and output were measured by several of the USAID indicators using the household surveys. This discussion will center on those indicators, with some additional information from the infrastructure and community survey results. The indicators used to measure the specific interventions (inputs) are shown in Table 6.1.1. Impact indicator # 1 measured the output of health outcomes, "Children younger than 36 months with diarrhea in the previous two weeks."

When considering this analysis of the inputs and outputs at the level of the study area, several points must be kept in mind. First, the overall sample size was designed to evaluate whether the interventions resulted in a statistically significant difference in childhood diarrhea over the entire study area. In contrast, the sample sizes for the household surveys within each individual study area were designed to detect expected differences in the USAID indicators. Therefore, the discussion of the inputs and output at the level of the study area examines the relationships between statistically significant differences in the inputs, but only trends in the output of childhood diarrhea at this level. Nonetheless, some of those trends are very interesting and yield important information about the success of the interventions at a community level.

At the study area level, five of the eight study areas met the health outcome goal of reducing childhood diarrhea by 25% or more, as shown in Table 6.1.2. Keeping in mind the above mentioned distinction between statistically significant results and trends, examining variations in

the water/sanitation and hygiene education inputs (as measured by the USAID indicators shown above) still helps to explain why this variation in health outcomes occurred. Specifically, we can look at whether the targeted goals for each of these input indicators were met at the community level, and what effect that appeared to have, both individually and in concert, on health outcomes.

The results of the inputs and output are summarized numerically in Tables 4.1.2 and 4.3.1, and qualitatively in Table 6.1.3, which shows each indicator under consideration in this discussion and whether the goal for that indicator was met at the study area level of analysis.

Looking first at Impact Indicator # 4, the use of hygienic sanitation facilities, the goal for this input was met in seven of eight study areas. This represents a substantial improvement over the baseline situation in which none of the study areas met the goal of 75% use of hygienic facilities, and helps to explain the overall reduction in childhood diarrhea over the course of the evaluation. The study area that did not meet this goal, Waspam, did not have a latrine project in one of its two component communities (Andres). A large majority (78%) of the homes in that one component community had no sanitation facilities and therefore were also considered to not have hygienic facilities1. This situation had a strong influence on this indicator in Waspam as a whole, contributing to the goal not being met. Nonetheless, the health goal of decreased diarrhea in young children was met in Waspam, indicating that other factors may have played a more important role in improving the health of the study population in Waspam.

Looking at other results from Table 6.1.3 helps to inform what those other more influential factors on health outcomes were. In two of the three study areas in which the health goal was not met (Las Pozas and La Ceiba), the hand washing goals were also not met (Impact Indicator #3), but objectives for access to water and sanitation were achieved (Monitoring Indicators #1 and 2, respectively). Looking deeper at the hand washing issue in Table 4.3.1, we can see that in these two communities, appropriate hand washing behavior improved only slightly or actually

1 The homes that did have latrines in Andres had those facilities from previous projects and were not the result of the ARC program.

decreased, while in all of the other study areas there were dramatic improvements in this indicator. This appears to have had a strong influence on health outcomes, as both Las Pozas and La Ceiba had well designed and constructed physical water and sanitation infrastructure interventions that met typical norms and standards for the region.

In contrast, access to water and sanitation did not meet the specified goals in Waspam, but hand-washing behavior did meet the goal. At the same time, the health outcome goal was also met, providing further evidence that improved personal hygiene and hygiene education had a strong impact on health outcomes in this evaluation. This is not to say that improved water and sanitation infrastructure did not play a role in Waspam, as there were also gains in these areas in this community. However, evidence from both Waspam and the communities of Las Pozas and La Ceiba indicates that hand washing behavior appears to have been a very strong element in meeting the health goal specified for this evaluation (diarrhea). Other researchers have also documented the importance of hand washing in reducing childhood diarrhea with and without improved water and sanitation in a variety of environments in the developing world (e.g., Henry and Rahim, 1990; Shahid et al., 1996; Oyemade et al., 1998).

The interactions between the inputs of water/sanitation infrastructure and hygiene education can be further explored in the case of Huitzitzil. In this community, there was no water infrastructure intervention, so no health gains would have been apparent from this input. In terms of the other inputs, the goal for increased appropriate hand washing behavior was met in this community. In addition, according to the household surveys, the goal for access to sanitation was also met. However, the health output goal for childhood diarrhea reduction was not met. This appears contradictory to the results from Waspam, where fewer input goals were met (only hand washing as opposed to hand washing and sanitation access in Huitzitzil), but the health output goal was met.

The infrastructure survey, however, further characterizes the case of Huitzitzil with more detailed information about the actual rate of access to sanitation. In this community, the sanitation intervention consisted of constructing composting latrines along with a strong education component about proper use of these facilities. One hundred and thirty one of these

latrines were constructed, but the community contains approximately 200 homes. Therefore, only about 65% of the homes received the sanitation intervention. The remainder of the households continued to use previously constructed latrines, had no sanitation facilities, or shared the use of the new composting latrines with nearby relatives or neighbors. Even allowing for this sharing, access to improved sanitation is probably lower than the 97% measured by the household survey, making the sanitation intervention less effective than it would appear to be from the household survey[2]. In addition, there were no gains in access to water, whereas in Waspam, significant gains in access to water occurred.

Another interesting case illustrating the interactions between the inputs is that of Nueva Segovia, Nicaragua. In this case, a water intervention was done, but it was not effective in providing better access to water and the goal for water access was not met[3]. However, the goals for hand washing behavior and access to sanitation were met. In this study area, the health output goal was also met. As with Waspam, this again illustrates that the health output goal of diarrhea reduction could be achieved without meeting all of the specified input goals.

Implications of the Links between Intervention Inputs and Health Outputs

There are several important implications of the above discussion about linking inputs of water and sanitation infrastructure and hygiene education to the health output of childhood diarrhea.

First, even high quality, well-operated infrastructure interventions like those installed in Las Pozas and La Ceiba, were not sufficient to meet the health goals specified for this evaluation when hand-washing behavior did not improve. This result highlights the importance of including hygiene education specifically targeted towards hand washing in all water/sanitation interventions. At the same time, as shown in the contrasts between Waspam (where health goals

2 The main reason for this discrepancy is likely selection bias that occurred during the household survey. Because the community is difficult to navigate, the homes interviewed during the final survey were selected with input from guides who lived in the community. These guides would naturally wish to direct the surveyors to homes that received the sanitation intervention.

3 The local municipality, not ARC, performed this intervention. See section 4.1.1 for further discussion.

were met) and Huitzitzil (where they were not), water and sanitation infrastructure are also important components of a successful water/sanitation intervention. An integrated program containing all of the elements of water and sanitation infrastructure and hygiene education was most successful, as illustrated by the three communities in which all of the input goals discussed in this section and the health output goal were met (Las Lomas, Marcovia, and Chiquimula).

Nonetheless, another implication of the fact that the health output goals were met in some communities in which all of the input goals were not met is that the input goals do not need to be at the levels specified for this evaluation in order to achieve the desired health outcomes. It is beyond the scope of this evaluation to specify exactly what input goals would be required to achieve the specified health output of a 25% reduction in childhood diarrhea. However, it appears that access to water and sanitation do not need to be at the levels of coverage specified for this evaluation to achieve that health outcome[4].

Building a Conceptual Model Linking the Inputs and Outputs

Figure 6.3.1 combines all of the information from the discussion above into a conceptual model of how the inputs and outputs are linked. This model represents a theory about how the different inputs such as hygiene education and infrastructure interact and also how they affect health outcomes. As such, it does not represent a result that is generalizable in a statistical sense, but rather, a generalization to a theory about how the inputs and outputs are linked and interact and can improve health outcomes.

As can be seen in Figure 6.3.1, any one of the inputs of water or sanitation infrastructure or hygiene education can individually improve health outcomes. However, in keeping with the results from this evaluation, hygiene education has the single greatest impact on health status. The evidence for this comes from several sources. First, in Waspam, the health outcome goal was met with only the hand washing input goal being met. On the other hand, in Las Pozas and La Ceiba, despite meeting the water and sanitation goals, the health output goal was not met, an

4 Additional discussion about the goals for the intervention inputs, and the viability of the goals used in this evaluation is contained in Section 5.

outcome that appeared to be at least partially related to poor hand washing behavior in both communities.

It is difficult to separate out the effects of the water and sanitation interventions within this evaluation, especially with a small number of cases. Nonetheless, for this evaluation, sanitation appeared to have been second in importance after hand washing. As was seen in Nueva Segovia, the health outcome goal could be met without meeting the access to water goal when both sanitation and hand washing goals were met. In addition, in Waspam, the health outcome goal was met with neither the water nor sanitation goals being achieved, but access to sanitation was much higher than access to water, and so likely contributed more to the positive health outcome. Therefore, the conceptual model indicates that sanitation is the more important of the two infrastructure interventions. This order of importance agrees with the results of several intervention studies done throughout the developing world. For example, a review by Esry (1996) of over 30 studies in eight countries demonstrated that improvements in sanitation impacted diarrhea at all levels of water supply, whereas improvements in water did not result in health impacts if no improvements were made in sanitation.

Despite this "hierarchy" of the intervention inputs, it is important to keep in mind that an integrated program where the goals for all three intervention inputs were met led to the most successful health outcomes, as illustrated in the cases where all of the goals for both inputs and outputs were met (Las Lomas, Marcovia, and Chiquimula).

Another element of the conceptual model is that it contains feedback loops from the health outcomes back to the intervention inputs. If improvements in health occur, they can lead to positive feedback to reinforce good hygiene practices. This was illustrated in Chiquimula, Guatemala in responses to the community survey. When asked about advantages or disadvantages of the sanitation interventions, water committee members stated that their community was more hygienic and that they noticed fewer episodes of diarrhea in children after the intervention.

Feedback to the infrastructure interventions can also occur. Infrastructure improvements can have tremendous convenience and economic benefits, as well as health impacts. For example, when it is no longer necessary to haul water every day, time is freed up for other activities (including wage-earning activities) (Briscoe, 1984; Okun, 1988; Esry, 1996). Such positive feedback can create demand for additional water/sanitation interventions among community members that don't have them and improve the operation and maintenance of existing interventions in order to sustain the benefits they bring. This was again illustrated in Chiquimula, where water committee members stated that the water intervention brought them a better quality, more reliable water source and they could see no disadvantage to the intervention. In addition, the women of the community no longer needed to go to springs or streams to haul water and bathe because the homes now had taps in their yards. Of course, feedback can also be negative if improvements do not occur or are not at the level expected by community members, leading to abandonment of hygiene practices or infrastructure maintenance activities.

Although this model is only a conceptual one containing a theory about how intervention inputs affect health outcome, it nevertheless summarizes much valuable information from this evaluation activity. Conclusions and recommendations based on the material discussed in this section and contained within the conceptual model are presented in the following sections.

Conclusions

This evaluation of water, sanitation, and health education interventions in communities affected by Hurricane Mitch in Central America was an ambitious project that assessed the effectiveness of different interventions in distinct communities in separate countries. The size and scope of the effort was temporally, spatially, and conceptually challenging. The evaluation addressed the following issues: 1) the physical infrastructure of the projects, 2) the ability of the projects to provide the intended service, 3) the social and educational components that enhance project continuity and successful achievement of public health goals, and 4) the theoretical differences between development work and disaster response.

The goal of improving the health of the communities receiving the water, sanitation and hygiene education interventions, measured as a greater than 25% decrease in the health impact indicator, diarrhea in children less than 36 months of age, was met on a regional basis. The evaluation highlighted the importance of implementing an effective community-based hygiene education program targeted at improving hand-washing behavior on decreasing the prevalence of childhood diarrhea. Improvements in access to sanitation and water also contributed to better health in the most of the communities evaluated, and those study areas where goals for improved water, sanitation, and hygiene were all met achieved the highest success rate in decreasing childhood diarrhea. However, it appears that access to water and sanitation do not need to be met at the levels of coverage specified for this evaluation to achieve the goal of a 25% reduction in diarrhea.

A conceptual model was developed to describe the interactions of the inputs of hygiene education, and water and sanitation infrastructure improvements, and the output of decreased childhood diarrhea. Any one of the inputs of water or sanitation infrastructure or hygiene education can individually improve health outcomes. However, in keeping with the results of this evaluation, hygiene education has the most individual impact, followed by improvements in sanitation, and finally, improvements in water infrastructure. The conceptual model contains feedback loops from the health outcomes back to the intervention inputs, such that improvements in health can lead to positive feedback to reinforce good hygiene practices, and increased demand for water and sanitation infrastructure improvements, while lack of perceived impact could lead to abandonment of good hygiene practices or maintenance of water and sanitation infrastructure.

Finally, the infrastructure and community surveys revealed that the degree of direct ARC involvement in the water/sanitation and hygiene education interventions dramatically influenced the outcomes of the interventions. The interventions in the communities in which ARC partnered with only the country Red Cross Societies were the most effective; in those communities in which ARC worked in conjunction with other partners, the infrastructure was not as well integrated with other project components, and the interventions were generally not as effective.

Recommendations

Based on the results of the three-year evaluation of the health impact of ARC's water and sanitation interventions on the health of the beneficiaries and the infrastructure survey conducted as part of the final survey, CDC recommends that ARC take the following actions in the study areas where the evaluation was performed and in the other water and sanitation projects in the Central America region, as appropriate:

- Inspect chlorination systems in all beneficiary communities and replace those systems that are not working with more effective systems.
- Facilitate the development of a regular routine monitoring program for microbial indicators of fecal contamination in all community water systems.
- Address the gray-water problem in certain beneficiary communities by installing soak-pits, reusing gray-water to water plants and trees, and conditioning the soil within soak-pits or latrine pits to increase absorption, as appropriate.
- Provide additional follow-up promotion and education to the water committees to address community-specific issues such as nonpayment of water fees and maintenance of infrastructure for provision of continuous high-quality service.
- Continue to provide assistance to develop and promote infrastructure in communities where existing infrastructure has not been sustainable, such as Nueva Segovia.
- Facilitate the provision of additional follow-up promotion and education to the beneficiary communities to reinforce the benefits of using proper personal hygiene behaviors such as proper latrine use and hand washing.
- Provide more institutional continuity for the country water and sanitation programs in order to provide ongoing support to the communities where infrastructure projects are undertaken.
- When working with partner organizations, ensure that roles within such partnerships are well defined and that mechanisms exist to ensure that all aspects of the projects are integrated.

Some of these recommendations may be generalizable to all of the water and sanitation interventions that ARC undertakes worldwide. Specifically, CDC recommends that the following recommendations be considered when implementing future water and sanitation projects in disaster recovery/reconstruction and development situations:

- Emphasize the provision of strong community-wide hygiene education programs in beneficiary communities before, during, and after physical water and sanitation interventions are implemented.
- Provide 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.
- When working with partner organizations, ensure that roles within such partnerships are well defined and that mechanisms exist to ensure that all aspects of the projects are integrated.
- Work with Ministries of Health and Environment and host-country Red Cross Societies to develop effective mechanisms to provide continued support in the areas of hygiene education and promotion, and infrastructure and water quality monitoring after the completion of the active phase of ARC involvement in water and sanitation intervention projects.

Incorporate these recommendations into national disaster recovery and reconstruction plans.

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Table 3.1.1. Study Areas and Interventions

Country/ Study Area	**Type of Community**	**Intervention**	**Status of Intervention During Final Survey (February 2002)**
Honduras			
Las Lomas	Peri-urban Existing community in hilly region	• Upgrade water system – new tank and source, additional connections (spring-fed, gravity flow system to household taps)	• Completed – water available 24 hours per day
		• Household pour/flush latrines	• Completed – improved coverage
		• Education on hygiene, water use, and sanitation	• Completed and on-going
Marcovia	Peri-urban Resettlement community in flood plain	• New water system (deep drilled well, pump to tank, gravity flow to household taps)	• Completed – water available for 2 to 3 hours per day
		• Household pour/flush latrines	• Completed – improved coverage
		• Education on hygiene, water use, and sanitation	• Completed and on-going
Nicaragua			
Nueva Segovia	Peri-urban Existing community	• Municipal water system installed (not by ARC) – household taps	• In need of improvement – water available 2 to 3 hours per day
		• Household dry pit latrines	• Completed – improved coverage
		• Education on hygiene, water use, and sanitation	• Completed and on-going

Waspam Kum/Andres	Rural Existing community in flood plain	• 16 deep bored wells in Kum and 3 wells in Andres	• Kum: Completed - 2 wells broken, some wells go dry Andres: No wells constructed by ARC
		• Household ventilated improved pit latrines	• Kum: Completed – improved coverage Andres: No latrine project by ARC
		• Education program on hygiene and sanitation in Kum by ARC. No education by ARC for Andres (provided by other NGOs).	• Kum: Completed Andres: Other NGOs provided education
El Salvador			
Las Pozas	Peri-urban Resettlement community	• New water system (deep drilled well, water pumped to tank, gravity flow to household taps)	• Household water system complete-improved quality, quantity, and continuity, water committee
		• Household composting latrines	• Completed
		• Education program on hygiene	• Completed
La Ceiba	Peri-urban Resettlement community	• New water system (spring source, pumped to tank, gravity flow to household taps)	• Completed
		• Additional household composting latrines	• Completed
		• Education program on water, sanitation, and hygiene	• Completed

Guatemala			
Chiquimula -Plan Shalagua -Guayabo	Rural Existing community in mountains	• Upgrade water system (spring-fed, gravity flow system to household taps) • Household VIP latrines • Education program on hygiene, water use and sanitation	• Completed • Completed • Completed and on-going
	Rural Existing community in mountains	• New water system (spring-fed gravity flow system to household taps) • Household VIP latrines • Education program on hygiene, water use, and sanitation	• Completed • Completed • Completed and on-going
Huitzitzil	Rural Existing community on coast	• No water intervention planned	• Interested in drinking water project, some use bottled water
		• Household composting latrines	• Completed

Table 3.3.1. Water and Sanitation Performance Indicators

Impact Indicators	**Monitoring Indicators**
1. Percentage of children aged < 36 months who had diarrhea in the past 2 weeks 2. Per capita daily water use 3. Percentage in household with appropriate hand washing behavior Food preparers Child caregivers 4. Percentage of population using hygienic sanitation facilities	1. Percentage of households with year-round access to an improved water source 2. Percentage of households with access to sanitation facility 3. Percentage of recurrent costs for water supply services provided by the community served 4. Percentage of constructed water supply facilities adequately maintained by the communities served

Billig et al., 1999

Table 4.1.1. Completed Surveys and Water Samples Collected in Each Community During the Baseline, Mid-Term and Final Surveys

Community	Number of Household Surveys			Number of Community Surveys			Number of Participants in Active Diarrhea Surveillance			Community Water Samples Collected			Household Water Samples Collected		
Year	2000	2001	**2002**	2000	2001	**2002**	2000	2001	**2002**	2000	2001	**2002**	2000	2001	**2002**
Honduras-Las Lomas	105	94	**97**	1	1	**1**	N/A	N/A	**N/A**	1	1	**3**	13	12	**11**
Honduras-Marcovia	92	102	**100**	1	1	**1**	N/A	N/A	**N/A**	1	3	**4**	13	9	**10**
Nicaragua-Nueva Segovia	101	104	**93**	2*	2*	**2***	101	104	**93**	9	4	**7**	23	11	**7**
Nicaragua-Waspam	112	103	**100**	2*	2*	**2***	112	103	**100**	7	8	**18**	14	12	**11**
El Salvador-Las Pozas	98	102	**103**	1	1	**1**	N/A	N/A	**N/A**	4	4	**3**	13	9	**10**
El Salvador-La Ceiba	73	63	**68**	1	1	**1**	N/A	N/A	**N/A**	5	5	**3**	14	10	**9**
Guatemala-Chiquimula	191[1]	96	**108**	6[1]	2*	**2***	N/A	N/A	**N/A**	12	6	**7**	17	9	**9**
*Guatemala-Huitzitzil***	N/A	101	**103**	N/A	1	**1**	N/A	N/A	**N/A**	N/A	5	**4**	N/A	9	**10**
Total Number of Samples in the Region	772	765	**772**	14	11	**11**	213	207	**193**	39	36	**49**	107	81	**77**

N/A – not applicable

*Two communities make up one study area

**Baseline survey completed in 2001

[1] Household and community surveys done in six communities during the baseline survey because ARC had not yet chosen the communities where they would perform water-sanitation project. In 2000, 57 household surveys were collected in the two communities where ARC chose to work.

Table 4.1.2. Summary of Monitoring Indicators as Reported in the Household Surveys During the Baseline, Mid-term, and Final Surveys, 2000-2002

Performance Indicator	USAID Guide[1]	Year	Honduras		Nicaragua		El Salvador		Guatemala	
			Las Lomas	Marcovia	Nueva Segovia	Waspam	Las Pozas	La Ceiba	Chiquimula	Huitzitzil[2]
Monitoring Indicators										
#1 Households with year-round access to improved water[3]	100%[4]	Baseline 2000	59%	59%	38%	15%	36%	6%	23%	N/A
		Mid-term 2001	64%	72%	62%	18%	63%	2%	4%	15%
		Goal for 2002	100%	100%	100%	100%	100%	100%	100%	100%
		Final	**80%*†**	**100%*†**	41%	35%†	**90%*†**	**96%*†**	**97%*†**	7%[5]
#2 Households with access to sanitation facility	100%[4]	Baseline 2000	64%	27%	96%	21%	55%	18%	43%	N/A
		Mid-term 2001	96%	95%	99%	26%	**100%**	51%	29%	58%
		Goal for 2002	100%	100%	100%	100%	100%	100%	100%	100%
		Final	**94%*†**	**97%*†**	**100%**	59%†	**100%†**	**96%*†**	**97%*†**	**97%*†**
#3 Recurrent costs for water supply services provided by the community served	100%[4]	Final 2002	90%	**100%**	0%	0%	**100%**	**100%**	Water system not operating long enough to measure	N/A (no water project)

#4 Constructed water supply facilities adequately maintained by the communities served	100%[4]	7/9 water systems evaluated = 78% 6/7 water systems with direct ARC involvement = 86% Of the eleven separate rural communities included in this final evaluation, only seven had water systems that were designed and constructed by ARC and/or its partner organizations. No water projects were undertaken in Andres (Waspam) and Huitzitzil. Two systems in Nueva Segovia were designed and constructed by the local municipality. Of the seven water systems with direct ARC involvement, six them were being adequately operated and maintained by the community served at this early stage (some have only been online for very short periods of time), with the exception being Waspam. The two systems in Nueva Segovia do not provide a level of service that is considered adequate, but this is due more to design and construction than community operation (see text for discussion).

1 USAID Guide is either a goal or the necessary change in percentage in the population for a specific indicator.

2 The baseline survey in Huitzitzil was performed in 2001; a mid-term survey was not performed in this study area.

3 Water source is less than 200 meters away from the household and there is access to water year-round.

4 Goal in not defined in the USAID guide. Goal established by the American Red Cross.

5 Reflects the percentage of households that had access to an improved water source that they used for most household water needs; 40% of households reported buying bottled water for drinking and/or cooking.

* ARC Goal of 100% coverage of baseline homes was achieved. This percentage reflects the actual reported coverage from the household surveys at the time of the final survey, and is lower than 100% because conditions changed in the community. See further discussion in text.

† Statistical significance of Chi-square statistic < 0.05 for difference between baseline survey and final survey

N/A not available

Bolding indicates that the goal was met.

Table 4.3.1. Summary of Impact Indicators as Reported in the Household Surveys During the Baseline, Mid-term, and Final Surveys, 2000 – 2002

Performance Indicator	USAID Guide[1]	Year	Honduras		Nicaragua		El Salvador		Guatemala	
			Las Lomas	Marcovia	Nueva Segovia	Waspam	Las Pozas	La Ceiba	Chiquimula	Huitzitzil[2]
Impact Indicators										
#1 Children <36 months w/diarrhea in past 2 weeks[3]	25% decrease in no. of cases	Baseline 2000	27	29	27	48	40	25	33	N/A
		Midterm 2001	**15**	29	**13**	**31**	46	**16**	**28**	30
		Goal for 2002	≤20	≤22	≤20	≤36	≤30	≤19	≤25	≤23
		Final	**19**	**11**	**12**	**36**	44	24	**22**	31
#2 Per capita daily water use (50 Lpd)[4]	100% using 50 Lpd	Baseline 2000	27%	29%	16%	0%	23%	6%	4%	N/A
		Mid-term 2001	27%	51%	21%	1%	16%	6%	1%	57%
		Goal for 2002	100%	100%	100%	100%	100%	100%	100%	
		Final	25%	71%†	13%	0%	29%	21%†	12%	88%†
#3a Food preparer with appropriate hand washing behavior	50% increase	Baseline 2000	18%	20%	33%	15%	20%	31%	11%	N/A
		Mid-term 2001	**39%**	**34%**	28%	**37%**	21%	30%	6%	29%
		Goal for 2002	≥27%	≥30 %	≥50%	≥23%	≥30%	≥47%	≥17%	≥44%
		Final	**54%**†	**63%**†	**60%**†	**59%**†	18%	29%	**92%**†	**79%**†
#3b Child caregiver with appropriate hand washing behavior	50% increase	Baseline 2000	19%	20%	32%	17%	20%	32%	11%	N/A
		Mid-term 2001	**44%**	**50%**	28%	**45%**	29%	35%	9%	28%
		Goal for 2002	≥29%	≥30%	≥48%	≥26%	≥30%	≥48%	≥17%	≥42%
		Final	**59%**†	**79%**†	**61%**†	**58%**	18%	30%	**92%**†	**82%**†

#4 Population using hygienic sanitation facilities[5]	75% usage	Baseline 2000	23%	16%	72%	14%	6%	11%	15%	N/A
		Mid-term 2001	**86%**	**81%**	83%	17%	78%	44%	18%	37%
		Goal for 2002	≥75%	≥75 %	≥75%	≥75%	≥75%	≥75%	≥75%	≥75%
		Final	**88%**†	**86%**†	**85%**†	39%†	**90%**†	**77%**†	**91%**†	**90%**†

1 USAID Guide is either a goal or the necessary change in percentage in the population for a specific indicator.

2 The baseline survey in Huitzitzil was performed in 2001; a mid-term survey was not performed in this study area.

3 Goal is a 25% reduction in the number of cases of diarrhea per 100 children in the study population.

4 Percentage of people that can obtain 50 L/person/day of water.

5 A facility is hygienic if there are less than 3 flies present and no excreta are found outside the latrine. A latrine is IN USE if one or more of the following conditions are met: recently cleaned with water, presence of a path to the latrine, signs of recently being swept, signs of recent repair and no spider webs.

† Statistical significance of Chi-square statistic < 0.05 for difference between baseline survey and final survey

N/A not available

Bolding indicates that the goal was met.

Table 4.3.2 . Diarrhea prevalence per 100 children in the region and in separate communities: the Baseline, Mid-Term and Final Surveys, 2000-2002

Country	Community	Sectors of Communities	2000	2001	2002
All	All communities		35 (138/396)	26 (118/449)	26 (118/453)
	All except Waspam-Andres		34 (114/335)	26 (108/412)	24 (97/408)
Honduras	Las Lomas		27 (13/49)	15 (8/55)	19 (10/52)
	Marcovia		29 (13/45)	29 (13/45)	11 (5/47)
Nicaragua	Nueva Segovia		27 (18/68)	13 (8/63)	12 (7/57)
	Waspam		48 (53/111)	31 (24/77)	36 (34/94)
		Kum	58 (29/50)	35 (14/40)	27 (13/49)
		Andres	39 (24/61)	27 (10/37)	47 (21/45)
El Salvador	Las Pozas		40 (19/47)	46 (22/48)	44 (21/48)
	La Ceiba		25 (9/36)	16 (4/25)	24 (9/37)
Guatemala	Chiquimula		33 (13/40)	28 (21/76)	22 (18/81)
	Huitzitzil		---	30 (18/60)	31 (16/51)

Table 4.4.1. Performance of Water Infrastructure Interventions by Study Areas

Study Area	Item # on Water Infrastructure Sanitary Survey Problematic?									
	1	2	3	4	5	6	7	8	9	10
Las Pozas, El Salvador	N	N	N	*	N	N	N	N	N	N
La Ceiba, El Salvador	N	N	N	N	N	N	N	Y	N	N
Chiquimula, Guatemala	N	N	N	N	Y	Y	N	N	N	N
Marcovia, Honduras	N	Y	N	N	N	Y	N	N	N	N
Las Lomas, Honduras	N	N	Y	N	N	Y	N	N	Y	Y
Waspam, Nicaragua	N	*	N	*	*	*	*	*	Y	Y
Nueva Segovia, Nicaragua	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Huizitzil, Guatemala	*	*	*	*	*	*	*	*	Y	*

Table entries are as follows:
N = No
Y = Yes
***** = systems lacks this component or does not apply to this study area

Item #s from Infrastructure Sanitary Survey:
1. Problems with water system working (i.e., water coming out of taps)?
2. Problems working all day?
3. Problems with catchment structure (including watershed) or well?
4. Problems with conduction line from source to tank?
5. Problems with storage tank?
6. Problems with treatment system?
7. Problems with distribution network?
8. Problems with water arriving to all taps?
9. Problems with quality of water being delivered?
10. Problems with users paying water fees?

Table 4.4.2. Performance of Sanitation Infrastructure Interventions by Study Area

Study Area	Item # on Sanitation Infrastructure Sanitary Survey Problematic?			
	1	2	3	4
Chiquimula, Guatemala	N	N	N	*
Huizitzil, Guatemala	N	N	N	N
Waspam, Nicaragua	N	N	N	*
Nueva Segovia, Nicaragua	N	N	N	*
Las Lomas, Honduras	N	N	N	*
Marcovia, Honduras	Y	N	N	*
Las Pozas, El Salvador	N	N	Y	Y
La Ceiba, El Salvador	N	N	Y	Y

Table entries are as follows:
N = No
Y = Yes
***** = does not apply to this study area (not composting latrines)

Item #s from Infrastructure Sanitary Survey:
1. Problems with latrine suitability to environmental conditions?
2. Problems with latrine construction?
3. Problems with latrine operation?
4. Composting latrines only: Problems with ashes or other drying materials being used?

Table 4.4.3. Degree of ARC Involvement in Interventions

	Entity Responsible for Primary Implementation of Intervention		
Study Area	Water	Sanitation	Hygiene Education
Las Lomas	ARC	ARC	ARC
Marcovia	ARC	ARC	ARC
Chiquimula	ARC	ARC	ARC
Nueva Segovia	Municipality	ARC	ARC
Waspam	Kum: ARC Andres: no project	Kum: ARC Andres: no project	Kum: ARC Andres: local NGO
Huitzitzil	No project	ARC	ARC
Las Pozas	CARE	ARC	Local NGO
La Ceiba	ARC	ARC	ARC

Table 5.4.1. Comparison of percentage of passing handwashing scores in food preparers between households that have children vs. those that do not have children

		2000			2001			2002		
Country	Community	Children	No Children	p value	Children	No Children	p value	Children	No Children	p value
All		21% (65/304)	19% (57/308)	0.37	33% (113/344)	24% (100/414)	**0.00***	65% (238/367)	52% (210/404)	0.00*
Honduras	Las Lomas	24% (9/38)	11% (7/64)	0.09	49% (21/43)	31% (16/51)	0.08	61% (28/46)	47% (24/51)	0.17
	Marcovia	24% (9/37)	13% (7/53)	0.17	53% (20/38)	23% (15/64)	0.00*	80% (32/40)	52% (13/60)	0.00*
Nicaragua	Nueva Segovia	33% (18/54)	35% (15/43)	0.87	26% (13/50)	30% (16/53)	0.64	58% (21/36)	61% (34/56)	0.82
	Waspam	15% (11/74)	17% (6/35)	0.76	39% (20/52)	35% (18/51)	0.74	68% (46/68)	41% (13/32)	0.01*
El Salvador	Las Pozas	18% (7/40)	13% (6/47)	0.54	32% (12/38)	15% (9/62)	0.04*	18% (7/38)	19% (12/65)	0.99
	La Ceiba	29% (8/28)	31% (13/42)	0.83	40% (8/20)	24% (10/41)	0.21	29% (9/31)	30% (11/37)	0.95

Guatemala	Chiquimula	9% (3/33)	13% (3/24)	0.68	9% (5/56)	3% (1/39)	0.21	92% (58/63)	91% (41/45)	0.86
	Huitzitzil	----------	----------	----------	30% (14/47)	28% (15/53)	0.87	82% (37/45)	76% (44/58)	0.43

* statistically significant ($p < 0.05$) based on Chi squared test

Table 5.4.2. Comparison of percentage of passing handwashing scores in child caregivers between households that have children vs. those that do not have children

		2000			2001			2002		
Country	Community	Children	No Children	p value	Children	No Children	p value	Children	No Children	p value
All		22% (68/304)	19% (53/292)	0.20	32% (110/340)	36% (32/89)	0.52	65% (236/366)	37% (69/186)	0.00*
Honduras	Las Lomas	29% (11/38)	9% (6/64)	0.01*	47% (20/43)	39% (7/18)	0.59	59% (27/46)	----- (0/0)	------
	Marcovia	24% (9/37)	13% (7/53)	0.18	53% (20/38)	0% (0/2)	**0.15**	78% (31/40)	100% (2/2)	**0.45**
Nicaragua	Nueva Segovia	33% (18/55)	33% (14/42)	0.95	23% (11/48)	37% (11/30)	0.19	60% (21/35)	62% (34/55)	0.86
	Waspam	19% (5/27)	16% (12/73)	0.81	39% (20/52)	67% (10/15)	0.05*	68% (46/68)	36% (10/28)	0.00*
El Salvador	Las Pozas	18% (7/40)	13% (6/46)	0.57	32% (12/38)	20% (2/10)	**0.47**	18% (7/38)	19% (12/65)	0.99
	La Ceiba	29% (8/28)	33% (12/36)	0.68	40% (8/20)	17% (1/6)	0.29	29% (9/31)	31% (11/36)	0.89

Guatemala	Chiquimula	9% (3/33)	13% (3/24)	0.68	9% (5/56)	0% (0/1)	0.75	92% (58/63)	--- (0/0)	-----
	Huitzitzil	----------	----------	------	31% (14/45)	14% (1/7)	0.36	82% (37/45)	------ (0/0)	------

* statistically significant ($p < 0.05$) based on Chi squared test

Table 6.1.1. Indicators Used to Measure Interventions

Intervention (input)	USAID Indicator	Description of Indicator
Water Infrastructure	Monitoring Indicator # 1	Households with year-round access to improved water source
Sanitation Infrastructure	Monitoring Indicator # 2	Households with access to sanitation facility
Hygiene Education	Impact Indicator # 3 Impact Indicator # 4	Appropriate hand washing behavior Population using hygienic sanitation facilities

Table 6.1.2. Status of Each Study Area in Reducing Childhood Diarrhea

Communities meeting the health goal	Communities not meeting the health goal
Las Lomas, Honduras	Huitzitzil, Guatemala
Marcovia, Honduras	Las Pozas, El Salvador
Nueva Segovia, Nicaragua	La Ceiba, El Salvador
Waspam, Nicaragua	
Chiquimula, Guatemala	

Table 6.1.3. Goal Achievement by Study Area

	Output: Goal Met?	**Inputs: Goal met?**			
Community	Impact Indicator # 1 (childhood diarrhea)	Monitoring Indicator # 1 (water access)	Monitoring Indicator # 2 (sanitation access)	Impact Indicator # 3 (hand washing)	Impact Indicator # 4 (hygienic facilities)
Las Lomas	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Marcovia	**Yes**	**Yes**	***Yes***	**Yes**	**Yes**
Chiquimula	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Nueva Segovia	**Yes**	**No**	**Yes**	**Yes**	**Yes**
Waspam	**Yes**	**No**	**No**	**Yes**	**No**
Huitzitzil	**No**	**No**	***Yes***	**Yes**	**Yes**
Las Pozas	**No**	**Yes**	**Yes**	**No**	***Yes***
La Ceiba	**No**	**Yes**	**Yes**	**No**	**Yes**

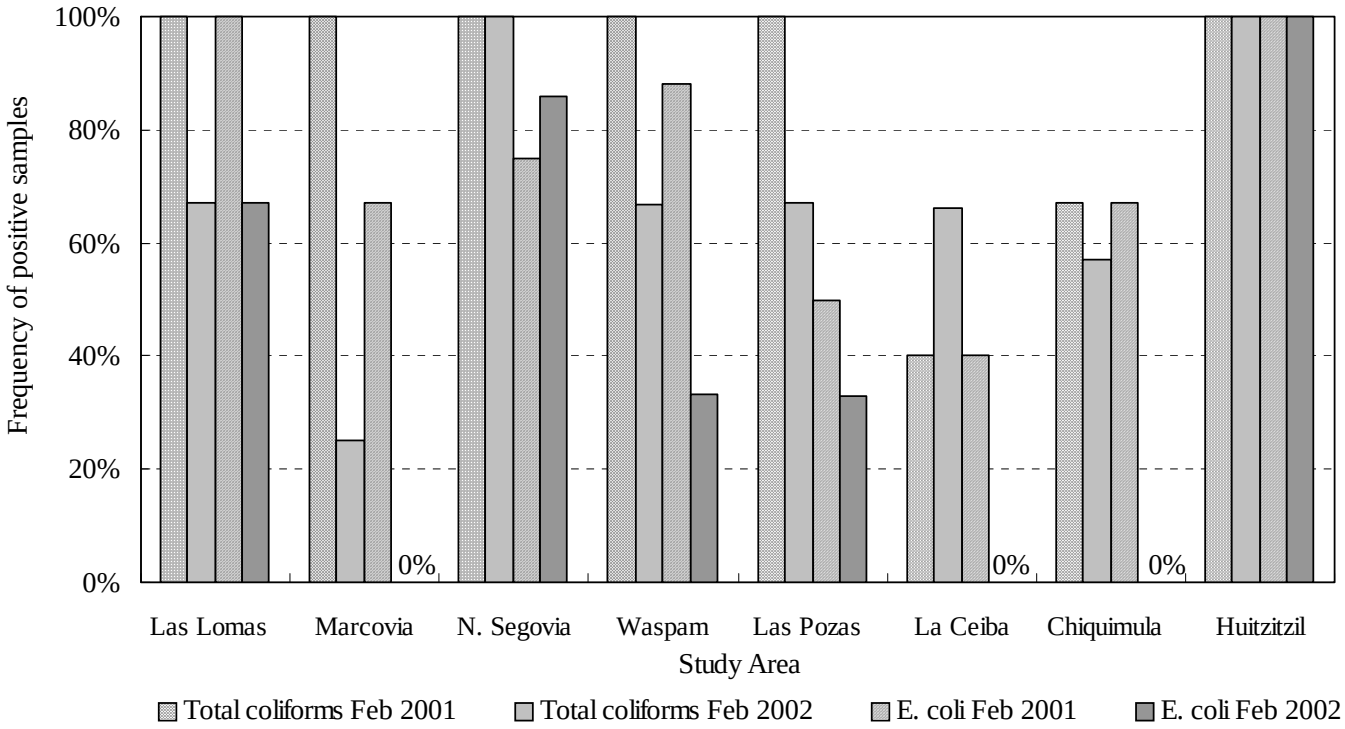

Figure 4.2.1.a. Comparison of Percentage of Water Samples Positive for Total Coliform Bacteria or *E. coli* from community water sources: February 2001 and February 2002

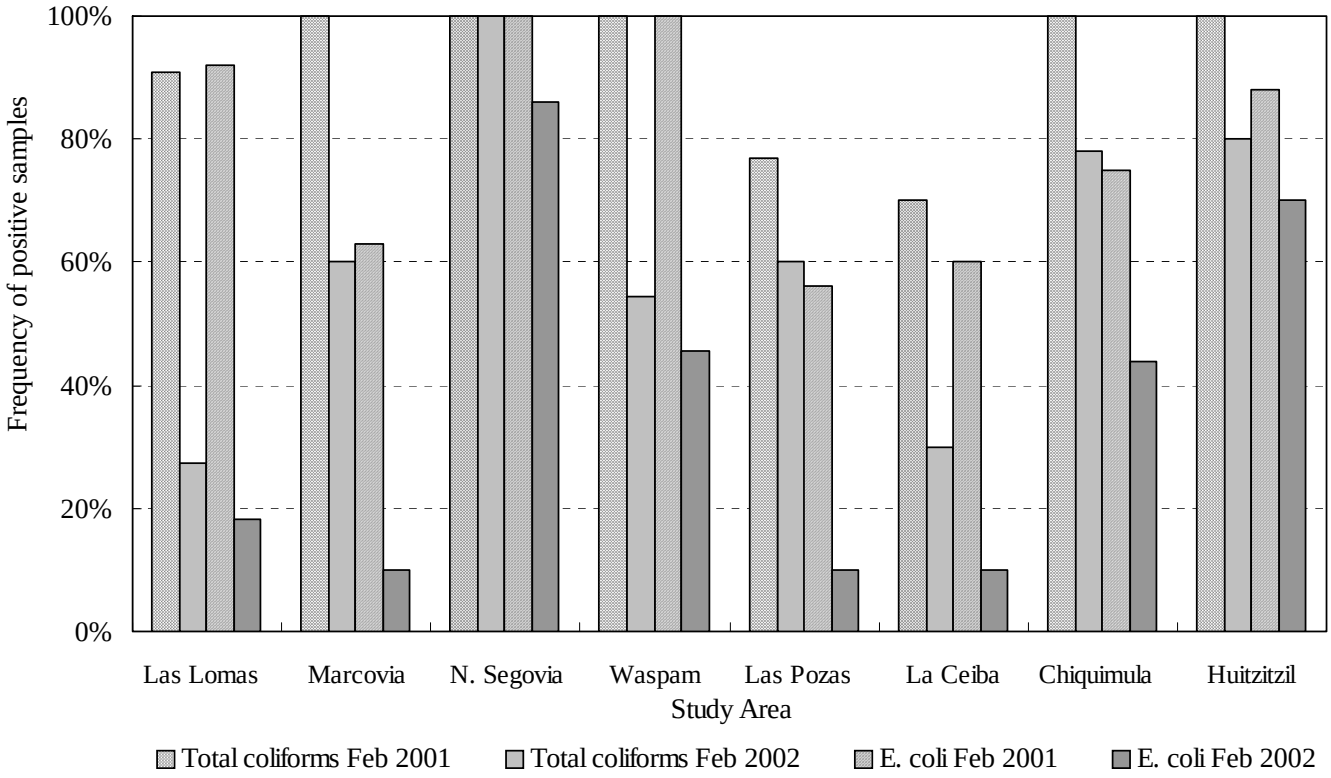

Figure 4.2.1.b. Comparison of Percentage of Water Samples Positive for Total Coliform Bacteria or *E. coli* from Stored Household Water: February 2001 and February 2002

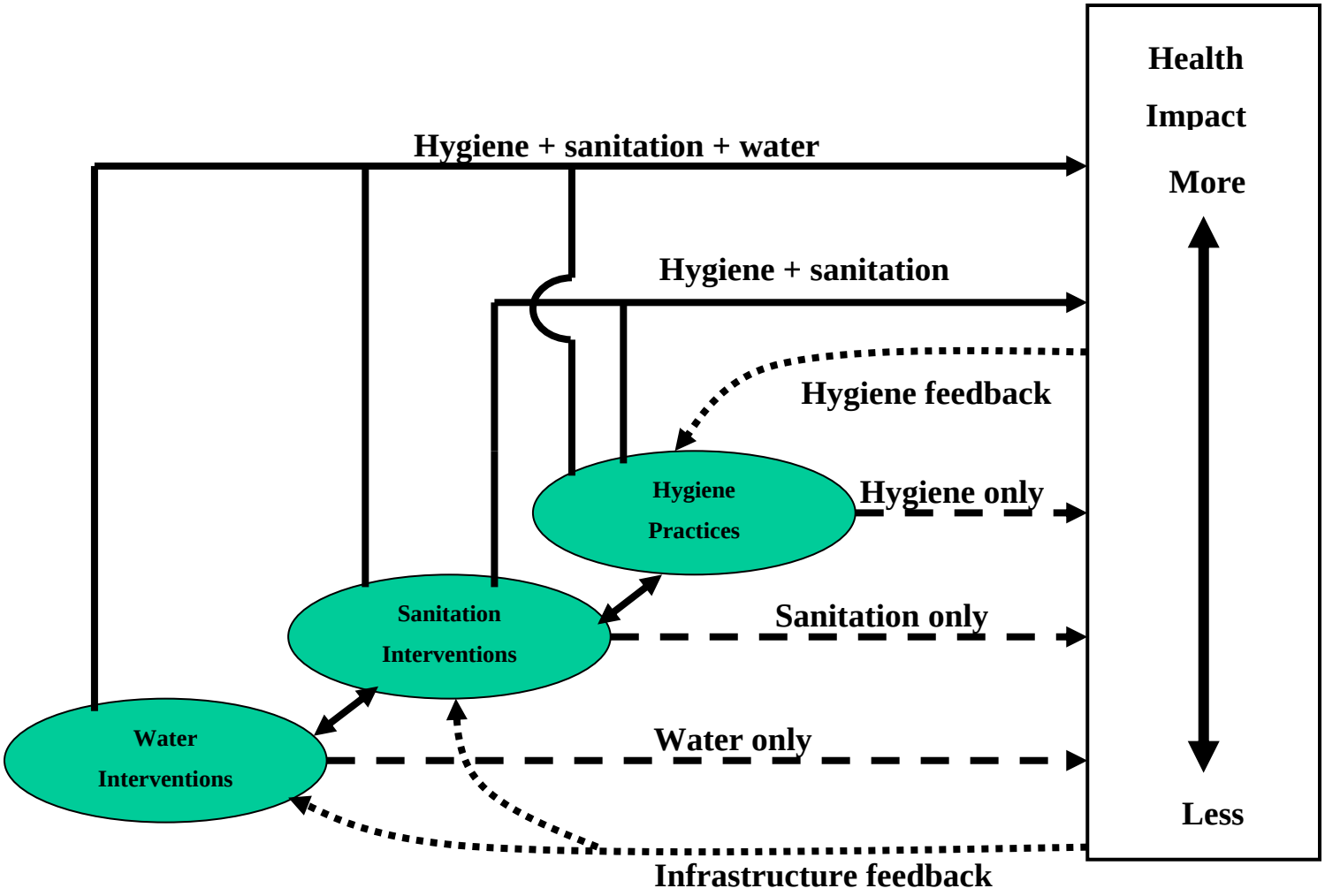

Figure 6.3.1. Model of Intervention Inputs/Health Output Relationship

Appendix 1: Study Area-Specific Discussion of Results

Appendix 1 provides a detailed discussion of the results of the household survey and infrastructure survey (as they pertain to the monitoring indicators and impact indicators), and water quality analyses for each study area.

A1.1. Honduras

The two study areas in Honduras were Las Lomas and Marcovia. The approximate locations of these communities are shown in Figure A1.1.1.

A1.1.1. Las Lomas

Las Lomas is a mountainous peri-urban community in central Honduras. The community consists of 220 houses (172 inhabited), and approximately 1300 people. The water project in this community consisted of an upgrade to an already existing water system and included construction of a new water tank and more household connections. Household pour/flush latrines were constructed in this community, and the education program addressed hygiene and latrine and water use.

Data collection for the household surveys took place from February 9-10, 2000 (baseline), February 14 and 15, 2001 (mid-term), and February 16-17, 2002 (final). See Table 4.1.1 for the number of household surveys, and community surveys conducted each year, and the number of water samples taken. During the final survey, the sanitary survey was conducted in Las Lomas on February 16-17, 2002.

A1.1.1.1 Monitoring indicators

1. Percentage of households with year-round access to water.

At the time of the baseline survey there were 130 homes, and at the time of the final survey 138 homes were connected to the water system. Because the number of homes covered by the updated water system is greater than the original 130 homes identified in the baseline survey, the original goal of 100% coverage of the baseline homes was achieved. Due to the growth of this community, however, not all homes had year-round access to an improved water source at the

time of the final survey; according to the community survey, the overall coverage in Las Lomas was 63%. It is likely that Las Lomas will continue its rapid growth, which will continue to affect water coverage in this community.

Fifty-nine percent (61/103) of the households participating in the baseline household survey in Las Lomas had year-round access to an improved water source (based on the USAID definition of the water source being a protected well, spring or piped water source located within 200 m of the home). The results of the mid-term survey indicated a slight increase in coverage, to 64% (57/89). Access to an improved water source increased further by the time of the final survey, when 80% (78/97) of the households participating in the final survey had year-round access to an improved water source.

2. Percentage of households with access to a sanitation facility.

The ARC's goal of 100% access to a sanitation facility was aimed at providing latrines to the 130 homes identified in the baseline survey. At the time that latrine project was completed, this goal had been achieved; however, because there has been continued rapid growth in Las Lomas, actual access to latrines has been less than 100%. During the community survey, the water committee indicated that the overall access to a sanitation facility was 86%. As with water coverage, the continued growth of this community will continue to affect the latrine coverage in this community.

The percentage of households participating in the household survey in Las Lomas with access to a sanitation facility improved from the baseline survey when only 64% (63/98) of the households reported access, to 94% (94/97) of households reporting access at the time of the final survey.

3. Percentage of recurrent costs for water supply services provided by the community served.

At the time of the final survey, the water committee in this community was having problems collecting water fees, even though they had cut service to a few residents. At that time, the committee was not collecting sufficient funds to cover routine operating costs and was discussing the possibility of raising the monthly water fee, which was 15 lempira ($0.92 USD).

A1.1.1.2. Water quality

Fourteen water samples were collected, three from community water sources and 11 from stored household water. Figures 4.2.1a and 4.2.1b summarize the percentage of samples taken from community water sources and stored household water that were contaminated with total coliforms and *E. coli* during the mid-term and final surveys. Community water samples were taken from the spring that feeds the water system, from the water tank clean out, and from a randomly selected household tap. The percentage of community water samples contaminated with total coliforms and *E. coli* decreased from 100% (1/1) during the mid-term survey to 67% (2/3) during the final survey (the spring and the tank clean out). Although there was no chlorine residual in the tank, chlorine was present at the sample taps and the sample taken there was not contaminated with total coliforms or *E. coli*.

The percentage of stored household water samples that were contaminated also decreased. Ninety-two percent (11/12) of the samples taken during the mid-term survey were contaminated with total coliforms versus only 27% (3/11) taken during the final survey, and 92% (11/12) of the samples taken during the mid-term survey were contaminated with *E. coli* versus only 18% (2/11) taken during the final survey. These results reflect the fact that there is a chlorination system at the community level even though the chlorinator does not appear to be working all the time. The hygiene education program also led to changes in behaviors, such as better storage, handling, and treatment of water in the home (data not shown) that contributed to the improvements in water quality at the household level.

A1.1.1.3. Impact indicators

1. Percentage of children aged < 36 months who had diarrhea in the past 2 weeks.

The prevalence of diarrhea in this community was 19 cases per 100 children (10/52) at the time of the final survey, a 27% decrease from the baseline survey of 27 cases per 100 children (13/49). The USAID goal of a 25% decrease in diarrhea prevalence from the baseline to final survey ([27 cases/100 children – (27 cases/100 children *0.25)]) was 20 cases per 100 children. This goal was reached at the time of the mid-term survey and at the time of the final survey. The availability of an improved water source, improved hand washing, and use of hygienic latrines led to the reduction in the prevalence of diarrhea in this community.

2. Per capita daily water use.

The USAID goal, that 100% of the population to have access to 50 liters of water per person per day (Lpd), was not met in this community. Although access to an improved water source increased in this community, only 25% (24/97) of the community reported using 50 Lpd, and the percentage of households using 50 Lpd did not change compared to the baseline survey, during which 27% (28/103) of the households used 50 Lpd. The average volume of water used in the final survey in Las Lomas was 40 Lpd. The majority of residents in this community reported having access to water from household spigots all day long, which may have reduced their need to store water in the home.

3. Percentage in household with appropriate hand washing behavior.

The USAID goal is to have a 50% increase in the number of household members capable of demonstrating appropriate hygiene and knowledge with regard to hand washing behavior. The primary food preparer and primary child caregiver (usually the same person) were asked about their knowledge of appropriate times to wash their hands and to demonstrate how they wash their hands. The interviewer, using a standard list of appropriate answers and behaviors, scored their responses and demonstration.

- Results for the food preparers show that 54% (52/97) had a passing hand washing score during the final survey. This was a 3-fold increase from the baseline level of 18% (19/105). The goal was to have greater than 27% of food preparers with a passing hand washing score after the interventions were completed. This goal was achieved during the mid-term survey and improved further at the time of the final survey.
- The final survey found that 59% (27/46) of the child caregivers had a passing hand washing score. Results showed an approximate 3-fold increase from the baseline survey (19%, 20/105). The goal was to have greater than 29% of child caregivers with a passing hand washing score. As with the food preparers, the goal was reached in the mid-term survey and continued to improve in the final survey.

Hygiene education in this community had been completed at the time of the final survey and contributed to the improvements in this indicator.

4. Percentage of population using hygienic sanitation facilities.

During the final survey, the percentage of the population in Las Lomas that used a hygienic sanitation facility was 88% (411/466) and was greater than the 75% USAID goal. The latrine construction and education programs were complete at the time of the final survey and contributed to the increase in the population meeting this indicator. Although Las Lomas is growing as a community, the community has shown a nearly 4-fold increase in the percentage of people that use hygienic sanitation facilities compared to the baseline level of 23% (133/570).

A1.1.2. Marcovia

Marcovia is a peri-urban community near the city of Choluteca in southern Honduras. There are a total of 240 households, but only 223 are occupied; the total population is an estimated 1300 people. The ARC water project for this community consisted of a new well from which water is pumped to a tank and gravity fed to new water distribution system that provides spigots to individual households. At the time of the final survey, the system had been in operation for about one year. Household pour/flush latrines were constructed in this community, and the education program addressed hygiene, care and use of latrines, and proper storage and treatment of water.

Data collection for the household surveys was conducted from February 7-8, 2000 (baseline), February 16-17, 2001 (mid-term), and February 19-20, 2002 (final). Table 4.1.1 shows the number of household surveys, and community surveys conducted each year, and the number of water samples taken. During the final survey, the sanitary survey was conducted in Marcovia on February 18, 2002.

A1.1.2.1. Monitoring indicators

1. Percentage of households with year-round access to water.

The ARC goal for the water project was to provide 100% coverage to the 240 homes in the community. The infrastructure survey revealed that only 223 homes were connected to the water system at the time of the final survey. The remaining 17 homes had also been connected to the system when it was built; however, these services were disconnected because the homes were uninhabited. Therefore, the ARC goal of 100% coverage has been met. However, the water

system for this community had been in operation for one year and provided daily access to water for only two to three hours per day. The percentage of households participating in the household survey that had year-round access to improved water increased to 100% (100/100) during the final survey from 59% (53/90) at the time of the baseline survey.

2. Percentage of households with access to a sanitation facility.

The infrastructure survey indicated that pour/flush latrines had been constructed at all of the baseline homes, so the original goal of 100% coverage of these 240 homes was met. However, at the time of the final survey, some of the latrines installed in this community were starting to have problems, primarily filling up, possibly due to the low permeability of the soils.

In the household survey, the percentage of households reporting that they had access to a sanitation facility increased from 27% (22/83) at the time of the baseline survey to 97% (97/100) at the time of the final survey. Although some of the latrines in the community were starting to fill up, in this resettlement community with a fairly new latrine (< 2 years old) at each household, it is unlikely that any household did not have access to either a private or shared latrine. One of the three households reporting lack of access reported that the latrine was being repaired. This household and the other two reporting lack of access to latrines may have misinterpreted the question about latrine access to mean only having access to a private latrine.

3. Percentage of recurrent costs for water supply services provided by the community served.

The tariff of 35 lempira ($2.15 USD), collected by the water committee, was covering all of the routine operating costs at the time of the final survey. The water committee had also been able to accumulate a significant fund for purchasing a spare pump and for future repairs.

A1.1.2.2. Water quality

Fourteen water samples were collected in Marcovia, four from community water sources and 10 from stored household water. The results of the mid-term and final survey water quality assessments are summarized in Figures 4.2.1a and 4.2.1b. The community sources included the community well, the water tank, and two taps. None of these community water source samples were contaminated with *E. coli* during the final survey, compared to 67% (2/3) during the mid-

term survey. The percentage of community water sources that were contaminated with total coliforms also decreased, from 100% (3/3) of the samples during the mid-term survey to 25% (1/4) during the final survey. The community well was contaminated with total coliforms. The improvements in water quality at the community level are due to the improved water system with a reliable source for the water and piped water delivery, so there is less recontamination. The community did not chlorinate their water supply at a community-level at the time of the mid-term survey. At the time of the final survey, the community batch-chlorinated the tank every morning when they filled the tank before distributing the water to the community.

During the final survey, 60% (6/10) of stored household water samples contained total coliforms and only 10% (1/10) were positive for *E. coli*. This was also a significant improvement from the mid-term survey that showed that 100% (8/8) of household water samples were contaminated with total coliforms and 63% (5/8) were contaminated with *E. coli*. Improvements to the community water system and the ARC education program on water storage and treatment contributed to these improvements at the household level. Many of the households disinfected their household water using chlorine at the time of the final survey. However, when asked if they treat their household water, some people said that they had run out of chlorine.

A1.1.2.3. Impact indicators

1. Percentage of children aged < 36 months who had diarrhea in the past 2 weeks.

The prevalence of diarrhea in this community at the time of the final survey was 11 cases per 100 children (5/45), a nearly 3-fold decrease in prevalence compared to the baseline survey (29 cases per 100 children). The goal, to have less than 22 cases per 100 children, was far exceeded during the final survey. The availability of an improved water source, education on appropriate hand washing behavior, and use of hygienic latrines contributed to reduce in the diarrhea rate of children in Marcovia.

2. Per capita daily water use.

The improved access to a water source in Marcovia led to an increase in the volume of water used from the baseline to the final survey. However, the USAID goal of 100% of the population with access to 50 L of water per person per day (Lpd) was not met. Seventy one percent

(71/100) of the community used 50 Lpd at the time of the final survey and the average usage rate was 114 Lpd. The residents store water in pilas because piped water is available for only 2-3 hours per day. Water is stored for several days, which may affect the ability of people to recall their daily water use.

3. Percentage in household with appropriate hand washing behavior.

The USAID goal of a 50% increase in the number of food preparers and child caregivers capable of demonstrating appropriate hygiene and knowledge with regard to hand washing behavior was met in Marcovia.

- Sixty three percent (63/100) of the food preparers had a passing hand washing score in the final survey, a 3-fold increase from the baseline survey (20%, (18/92). The goal was to have greater than 30% of the food preparers with a passing hand washing score. This goal was achieved at the time of the mid-term survey (34%, 37/94), and increased further at the time of the final survey.
- Seventy nine percent (33/42) of the child caregivers had passing hand washing scores in the final survey. This was also a 4-fold increase from the baseline survey (20%, 18/92). The goal, to have greater than 30% of the child caregivers with a passing hand washing score, was achieved at the time of the mid-term survey (50%, 20/40) and increased further at the time of the final survey.

These results indicate that the hygiene education program conducted in Marcovia by the ARC and its partners was effective in teaching appropriate hand washing behaviors.

4. Percentage of population using hygienic sanitation facilities.

The percentage of the population in Marcovia that used a hygienic sanitation facility during the final survey was 86% (385/447), greater than the USAID goal of 75%. There was a 5.5-fold increase in the use of hygienic facilities in this community from the time of the baseline survey to the time of the final survey. The latrine construction program and hygiene education program both contributed to the increase in the percentage of the population using hygienic latrines.

A1.2. Nicaragua

The two study areas in Nicaragua were Nueva Segovia and Waspam. The approximate locations of these communities are shown in Figure A1.2.1.

A1.2.1. Nueva Segovia

Two resettlement communities, Dipilto Nuevo and Dipilto Viejo, were evaluated to represent this region of Nicaragua. These communities together comprise 100 households and approximately 600 people. The municipality-supported water interventions in both communities were spring-fed, gravity-filled tanks with a distribution system to a household spigot in each household. The ARC sanitary interventions in both communities were dry pit latrines for 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.

Data collection for the household survey took place in February in each of the three years: Feb.7-8, 2000, Feb. 10-11, 2001, and Feb. 9-10, 2002. An average of 99 surveys were conducted each year. The sanitary survey was conducted two days before the household surveys in the final year.

A1.2.1.1. Monitoring indicators

1. Percentage of households with access to an improved water source.

ARC did not construct the water systems in the two communities in Nueva Segovia. Instead, the local municipality, which was supported by other agencies, opted to install facilities before an adequate design was available; thus, the two systems were built in 2000. Their haste, however, did not pay off; neither system worked effectively at the time of the final survey and water was supplied infrequently.

Before they moved to the resettlement communities, most residents lived in their own homes that had been damaged by Hurricane Mitch or stayed with relatives in homes that were served by a municipal water system that provided continuous service. Therefore, the water supply situation of the people living in these communities actually deteriorated from the time of the baseline

survey to the time of the final survey. The final household survey revealed that 41% (38/93) of the households had access to an improved water source. This was a slight increase from the baseline survey when 38% of households (38/101) had access to an improved water source. The goal of 100% access to an improved water source was not met due to a lack of planning and poor design and construction of the initial water intervention by the municipality without the involvement of ARC.

2. Percentage of households with access to improved sanitation.

ARC, in conjunction with the Nicaraguan Red Cross, built enough latrines in Nueva Segovia, to provide coverage for more than the number of baseline homes of 100. There were also several latrines still under construction in Dipilto Nuevo at the time of the final survey to provide latrine coverage for new arrivals in the community. Of the homes that participated in the final household survey, 100% (93/93) had access to either a private or shared latrine. This was a 4% increase from the baseline survey of 96% (95/99) (when most people were living with relatives in homes that had sanitation facilities) and met the monitoring indicator of 100% access to improved sanitation.

3. Percentage of recurrent costs for water supply services provided by the community served.

Based on the household survey, the average monthly tariff reported was a flat fee of 5 cordobas per month (approximately $0.35 USD) in Dipilto Nuevo and 6 cordobas per month (approximately $0.42 USD) in Dipilto Viejo. These tariffs were not sufficient to cover routine operating costs for either system. The tariffs for households connected to the water systems were intentionally low because of the poor service provided by the water system, and there is no penalty for failing to pay the tariff. This monitoring indicator was not met, because the monthly fees charged to each household were not adequate to support routine operation and maintenance of the system.

A1.2.1.2. Water Quality

Of the 14 water samples that were collected, 7 were collected from community water and 7 were collected from households. All of the community water samples (7/7) were contaminated with total coliforms and 86% (6/7) were contaminated with *E. coli* (Figure 4.2.1.a). This is an increase

in contamination from the mid-term survey when 100% (4/4) of the community samples were contaminated with total coliforms and 75% (3/4) were contaminated with *E. coli*.

All of the samples taken from stored household water were contaminated with total coliforms and 86% (6/7) were contaminated with *E. coli* (Figure 4.2.1.b). This is a decrease in contamination from the mid-term survey when 100% (11/11) of the household samples were contaminated with both total coliforms and *E. coli*. While only 18% (16/89) of the households reported having treated their water on the day of the survey, 69% (64/93) reported that they usually treat their water. Chlorination was the most commonly reported method of treatment.

The chlorine level was checked in one household and in one source water sample. Neither water sample had any detectable levels of chlorine. While conducting the household and community surveys, it became clear that the supply of chlorine that is normally distributed by the Ministry of Health for disinfecting water had run out, leaving many households without chlorine.

The decrease in water quality in the community samples between the mid-term and final surveys may reflect a deterioration in the water system in the one-year interval between the two surveys and the lack of funds available for maintenance at the community level. The increase in water quality in the household samples between the mid-term survey and the final survey may indicate that the health education campaign supported by the ARC between the mid-term and final surveys to provide the households information about proper techniques to treat household water was effective.

A1.2.1.3. Impact indictors

1. Percentage of children aged < 36 months who had diarrhea in the past 2 weeks.

Twelve children of 100 children (7/43) under the age of 36 months had diarrhea in the two weeks prior to the final survey. This was a 56% decrease from the baseline study when 27 children in 100 children had diarrhea (18/68). Because the final goal was 20% (a 25% decrease from the baseline), this impact indicator was met. The successful decrease in the prevalence of children with diarrhea may be an indication that the health education efforts of the ARC that were initiated between the mid-term and final survey were effective.

2. Per capita daily water use.

The mean water use in Dipilto was 25 Lpd. This impact indicator of per capita water use was not met due to the low quality of the water intervention, which only sporadically served the community with water from unprotected sources. Thirteen percent (12/92) of the households met the USAID guideline of 50 Lpd water use during the final survey, a decrease from the baseline survey, during which 16% (15/93) of the households met the guideline. Decreasing the USAID guideline to 25 Lpd for those households that washed and bathed in the river has very little effect on the percentage of households with passing scores; only 20% (18/92) of the households would meet the guideline.

It was difficult to assess household water usage in these communities because participants were wary of reporting their water use with the fear that it might affect how much they were asked to pay for their water. Additionally, some participants were not aware of how much water they used because they were no longer carrying water from the river although 98% of the households in the survey (91/93) reported storing some water in their homes and most homes reported a mean of only three hours of water service daily. There were no log sheets on the volume of water discharged from the community tanks to compare with the household data collected during the final survey.

3. Percentage in household with appropriate hand washing behavior:

- Sixty percent (55/92) of the food preparers demonstrated appropriate hand washing behavior. This was an 82% increase from the baseline survey in which 33% (33/100) had appropriate handwashing behavior. This increase met the goal of a 50% increase in the percentage of food preparers demonstrating appropriate hand washing behavior.
- The goal of a 50% increase in child caregivers demonstrating appropriate hand-washing behavior was also met. Sixty one percent (55/90) of the child caregivers demonstrated appropriate hand washing behavior, an 85% increase from the baseline survey in which 32% (32/100) demonstrated appropriate hand washing behavior.

The increases in appropriate hand washing behavior for food preparers and child caregivers, which exceeded the levels required to meet the impact indicator, may reflect the effectiveness of the health education campaign initiated between the mid-term and final surveys.

4. Percentage of population using hygienic sanitation facilities:

Eighty five percent (408/482) of the population used hygienic sanitation facilities, a 18% increase from the coverage in the baseline study in which 72% (344/477) used hygienic facilities. The USAID goal that 75% of the population use hygienic sanitation facilities was met during the final survey. This goal was successfully met due to the construction of household latrines by the ARC and to the implementation of an effective education campaign between the mid-term and final surveys.

A1.2.2. Waspam

Waspam is a rural community made up of smaller communities located in the Gracias a Dios Region in the northeast of Nicaragua along the Rio Coco (Coco River) in the Miskito area. Two communities, Andres and Kum, make up the study area. Both communities were initially selected to receive interventions, however, only Kum received water and sanitation interventions. In Kum, 16 wells were installed (1 well/15 families) with 100% latrine coverage. The water and sanitation interventions in Andres were provided by other organizations. Baseline, mid-term, and final survey data for both of the communities are combined for analysis and comparison of the results for all three years. Separate analyses of data collected for the 6 indicators is also provided to compare the success of the interventions in Kum verus Andres which did not receive ARC interventions.

Data collection for the household surveys was conducted from February 8-9, 2000 (baseline), February 11-12, 2001 (mid-term), and February 10-12, 2002 (final). During the final survey, the sanitary survey was conducted in Waspam on February 10-12, 2002.

A1.2.2.1. Monitoring indicators

1. Percentage of households with access to improved water.

Overall access to improved water sources for the two communities in Waspam was 35% (35/100), an improvement over the baseline survey of 15% (17/112). Surface water (Rio Coco) and rainwater catchments were the alternative water sources used in these communities.

Although the goal for this indicator was not met at the time of the final survey, access to water was significantly improved in Kum where 16 wells were constructed with the intention that all existing homes would have access to an improved water source. At the time of the final survey only 70% (35/50) of households in Kum reported that they had access to improved water sources. This is because some of the wells in Kum go dry during the dry season, and, at the time of the final survey, two of the 16 new wells were not operating because some of the parts had broken.

The ARC did not support a water project in Andres. Household survey results from Andres indicated that none (0/50) of the homes had year-round access to improved water at the time of the final survey.

2. Percentage of households with access to a sanitation facility.

The percentage of households with access to a sanitation facility in Waspam was 59% (59/100) during the final survey, approximately twice the number of households that reported access to latrines during the baseline survey (21%, 23/112).

Although this indicator as a whole was not met in the final survey, access to sanitation facilities improved significantly in Kum. In Kum, latrines were constructed for 248 homes that provided all existing households access to improved sanitation, and met the goal of 100% access to all baseline households. Since the baseline survey, there has been some growth in Kum. The homes that were built after the completion of the ARC latrine project did not receive latrines. According to the household survey, 96% (48/50) of households in Kum had access to a sanitation facility at the time of the final survey, compared to only 18% (10/56) during the baseline survey.

Andres did not receive latrines as part of the ARC project. In Andres, where no latrine project took place, there was no improvement in latrine access. Only 22% (11/50) of the residents had

access to improved sanitation at the time of the final survey, compared 23% (13/56) during the baseline survey. The latrines in Andres had been constructed previously by other organizations.

3. Percentage of recurrent costs for water supply services provided by the community served.
Neither community was collecting water fees at the time of the final survey, so the communities were providing none of the recurrent costs. After discussions with ARC, both communities had decided that they would collect funds for repairs on an as-needed basis. However, the arrangement of collecting funds when needed does not appear to be an effective means for performing operation and maintenance activities, as demonstrated by the fact that two wells in Kum were out of service because of broken parts at the time of the final survey. Additionally, neither community had any materials, tools, or funds on hand to undertake any repair activities at the time of the final survey.

A1.2.2.2. Water quality

During the final survey, 29 water samples were collected in Waspam: 18 from community water sources, and 11 stored household water samples. The community sources sampled were 14 new ARC wells, 1 existing well at the health post, and 1 spring in Kum, and 2 existing wells in Andres. Two of the 16 ARC wells in Kum were broken and were therefore not sampled. Total coliform bacteria were detected in 67% (12/18) of the wells and *E. coli* was found in 33% (6/18) of the wells (Figure 4.2.1.a). The percentage of contaminated samples decreased from the mid-term survey, at which time 100% (8/8) of the samples were contaminated with total coliforms and 83% (7/8) were contaminated with *E. coli*. At the time of the final survey, some of the wells in Kum were being "shock chlorinated" (addition of a large dose of chlorine to a well for disinfection), as part of the well maintenance program. Ten of 14 wells in Kum were found to be free of *E. coli* contamination, indicating that the practice of shock chlorination and well construction that includes a sanitary seal likely contributed to the improved water quality.

Results for the household samples, which are summarized in Figure 4.2.1.b, showed that, at the time of the final survey, 55% (6/11) of the water samples contained total coliforms and 45% (5/11) contained *E. coli*. Contamination of the household water samples also decreased in comparison to the mid-term survey. Water analyses performed during the mid-term survey

showed the presence of total coliforms in 100% (12/12) and *E. coli* in 100% (12/12) of the household samples. Five of the 11 households in the final survey where stored water samples were taken (all in Kum) reported that they chlorinated their water the day of the survey. *E. coli* was not detected in water stored in any of these homes. These results indicate that at the household level, chlorination has effectively decreased contamination of stored household water.

A1.2.2.3. Impact indicators

1. Percentage of children aged < 36 months who had diarrhea in the past 2 weeks.

The percentage of cases of diarrhea decreased in the final survey and met the USAID goal of a 25% decrease in diarrhea prevalence in children < 36 months of age. There were 48 cases per 100 children reported in the baseline survey, and the goal was to have fewer than 36 cases per 100 children. Thirty-six cases of diarrhea per 100 children were reported in the final survey, meeting the goal for this indicator. There were 13 cases of diarrhea reported in Kum and 21 reported in Andres. Increases in the availability of an improved water source, hygienic latrines, and hygiene education contributed to the decrease in diarrhea prevalence in these communities.

2. Per capita daily water use.

None of the households in Waspam, met the USAID goal of 50 L of water used per person per day. This was expected because the two communities that make up the study area of Waspam (Kum and Andres) are located adjacent to the Rio Coco. Nearly all of the residents (99%, 99/100) in Waspam wash their clothes and dishes in the river, and bathe in the river. Each of these tasks diminishes the amount of water that the people in these communities need to collect and store in their households.

Since many of the households continue to use the river for washing and bathing the 50 Lpd value is an unrealistic goal for Waspam. Excluding 25 Lpd for washing and bathing from the 50 Lpd goal may be more appropriate; however, only 5% (5/100) of households reported using 25 Lpd. Alternatively, the USAID guide defines a drinking water minimum of 5 Lpd (Billig, et.al., 1999), and 85% (85/100) of the homes participating in the final survey reported using at least 5 Lpd.

3. Percentage in household with appropriate hand washing behavior.

- Passing hand washing scores for the food preparers increased to 59% (59/100) in the final survey from 15% (17/111) in the baseline survey, a 4-fold increase. The goal was to have greater than 23% of the food preparers with a passing hand washing score. This goal was surpassed during both the mid-term and final surveys.
- The percentage of child caregivers with a passing hand washing score increased to 58% (56/96) in the final survey, a 3-fold increase from the baseline percentage of 17% (17/102) of child caregivers with passing hand washing scores. The goal to have greater than 26% of child caregivers with a passing hand washing score was achieved during both the mid-term and final surveys.

4. Percentage of population using hygienic sanitation facilities.

In Waspam, the percentage of the population using a hygienic sanitation facility increased from 14% (124/893) in the baseline survey to 39% (289/747) in the final survey, but did not meet the USAID guideline goal of 75%. The results from Andres, which did not receive the benefits of the ARC project, have been included in the final results. In Kum, where the ARC provided household latrines and education on the care and use of latrines, there was nearly a 6-fold increase from the baseline survey (12% of the population (45/372)) to the final survey (67% of the population (230/343)).

A1.3. El Salvador

The two study areas in El Salvador were Las Pozas and La Ceiba. The approximate locations of these communities are shown in Figure A1.3.1.

A1.3.1. Las Pozas

Las Pozas is a large resettlement community for displaced families. Of the three parts of Las Pozas, parts II and III are for those families affected by Hurricane Mitch. There are 1004 families living in the three parts of Las Pozas with the majority living in Pozas I; there are 289 households in Pozas II, and 138 households in Pozas III. Las Pozas II and III, the resettlement communities for families affected by Hurricane Mitch, were the sections of Las Pozas where the ARC concentrated its sanitation and health education campaign. The water intervention in Las Pozas, installed primarily by CARE with support from ARC, was a deep drilled well pumped

into a central tank and fed by gravity to individual household taps. The ARC sanitation project for Pozas II and III included a composting latrine for each household. The health education intervention for Pozas II and III involved training the health committee about personal hygiene, proper use and maintenance of composting latrines, and methods to treat water in households. The health committee members in turn trained people in the community in community meetings and home visits.

The data collection for each three years of the study occurred in February: in 2000 on Feb.3, in 2001 on Feb. 14, and in 2002 on Feb. 14-15. Each year the study team conducted approximately 101 household surveys. The infrastructure survey was conducted on Feb. 13, 2002.

A1.3.1.1. Monitoring indicators

1. Percentage of households with access to an improved water source

At the time of the final survey 92% of all the households in the entire Las Pozas community (I, II and III) were served by the water system. However, 98% of the homes were registered with the system and eligible for service. It appeared that some of these eligible but unserved households had still not moved to Las Pozas from their previous locations. In the final household survey, 90% (93/103) of the households had access to an improved water source. This was a 2.5-fold increase over the baseline survey, which found that 36% (35/98) of the households had access to year-round water. The remaining homes not yet connected to the system were either not yet permanently residing in their home in Las Pozas, or were unwilling or unable to make the necessary contribution to get the water system connected. Although the ARC's goal was 100% coverage in the communities it served, 100% coverage is an unrealistic goal, given that there will always be some non-participating households, as discussed above. If we consider those who were not willing or able to work ineligible, the ARC goal of 100% coverage of households that were eligible at the time of the baseline survey was met.

2. Percentage of households with access to improved sanitation

Ninety eight percent of the homes in the entire Las Pozas community (I, II, and III) have new latrines. Some of the remaining houses already had pit latrines and elected not to participate in the ARC latrine project. According to the household survey, all of the households (103/103) had

access to a private or shared latrine, which met the goal of 100% latrine coverage. The level of accessed doubled from the baseline survey, which found that 55% (53/97) of households had access to sanitation facilities.

3. Percentage of recurrent costs for water supply services provided by the community served

This is a very large rural water system, and at the time of the final survey, the tariff charged by the water committee was covering 100% of their routine operating costs (including electricity, chlorine, and salaries for 6 employees) and the committee had accumulated some savings for future repairs. According to the household survey, the mean tariff paid by a household is 31 colones a month ($3.41 USD). The tariff is based on usage, and if a household fails to pay the tariff, their water service could be cut off. This indicator was successfully met, because the expenses for operating and maintaining the water system were covered by the tariffs collected and the water committee was able to save money for future, unexpected expenditures.

A1.3.1.2. Water quality

Of the 13 water samples that were collected, 3 were collected from community water sources and 10 were collected from water storage containers in participants' homes. In addition to these 10 household samples, two samples were collected in one randomly selected household with had both stored water and a household tap in order to provide a direct comparison of the quality of tap water and stored water in a household. The samples taken from community water sources included one sample from the inlet to the water tank, one from the water tank clean out, and one from a community well. All of the three samples (100%) from the community water samples (the samples from the well and the water tank inlet) were contaminated with total coliforms. Only the sample that was taken from the well (33%) was contaminated with *E. coli*. This was a decrease in contamination from the mid-term survey, which found that 100% (4/4) of the community water samples were contaminated with total coliforms and 50% (2/4) were contaminated with *E. coli* (Figure 4.2.1.a).

Six of 10 (60%) of the household water samples had total coliforms in them, and one of ten (10%) had *E. coli*. This was a decrease in contamination from the mid-term survey in which 77% (7/9) of the household water samples were contaminated with total coliforms and 56% (5/9)

were contaminated with *E. coli* (Figure 4.2.1.b). In the household where samples were taken from both the tap water and the stored water, the tap water had no detectable levels of total coliforms or *E. coli* but the stored water was contaminated with both total coliforms and *E. coli*.

Chlorine levels were tested at the tank clean out and a level of 0.3 mg/L was detected. Chlorine levels were tested at six randomly selected households and only one had a detectable level of chlorine (0.1 mg/L).

The completion of the water intervention, which included improvement of the water source and chlorination of the distributed water, led to significant improvement in water quality from the mid-term to the final survey.

A1.3.1.3. Impact indicators

1. Percentage of children aged < 36 months who had diarrhea in the past 2 weeks

The period prevalence of diarrhea in children less than 36 months of age increased from 40 per 100 children (19/47) during the baseline survey to 44 per 100 children (21/48) during the final survey. This increase did not meet the USAID goal for this impact indicator of a 25% decrease in the number of diarrhea cases, perhaps due to the fact that the health education intervention supported by the ARC was completed close to the time of the mid-term survey, and the community had received no further hygiene education to reinforce the messages taught during the ARC program.

2. Per capita daily water use

Twenty nine percent (26/90) of the households reached the USAID guideline of 50 Lpd. This was a 26% increase from the baseline survey at which time 23% (21/91) had 50 lpd. This was a substantial increase, but did not meet the impact indicator of 100% of the households having access to 50 Lpd.

If the standard is reduced to 25 Lpd for those households that did not wash their clothes or bathe in the home, 30% (27/90) of the households would reach the USAID guideline. The mean water use reported by household was 43 Lpd.

There was difficulty in determining how much water people were using because people were receiving piped water directly to their homes and were not storing all of the water they used domestically. The households reported a mean of 19 hours of water service per day. Although 71% (73/103) of the households reported having stored water in their household, this was often solely drinking water, and the water used for household activities was not included in this small amount of water. The participants were also cautious about reporting their water use because they thought it might affect their monthly payments. Therefore, the daily readings from the tank that serves the community were collected to get a more objective (if somewhat rough) estimate of how much water each household in the community was using. These data were collected from the daily records for the first two weeks of February. An average of 322 liters per household per day or, assuming an average of 4 people per household, 83 Lpd was estimated. In contrast, the reported water use in our questionnaire was 160 liters per household per day, on average, for the 91 households, or an average of 43 Lpd.

3. Percentage in household with appropriate hand washing behavior

- Eighteen percent (19/103) of the food preparers demonstrated appropriate hand washing behavior. This was a 10% decrease from the baseline survey at which time 20% (19/97) had appropriate hand washing behavior. This decrease did not meet the USAID goal for this impact indicator of a 50% increase in appropriate hand washing behavior.
- Eighteen percent (19/103) of the child caregivers demonstrated appropriate hand washing behavior. This was also a 10% decrease from the baseline survey at which time 20% (19/95) had appropriate hand washing behavior. This decrease did not meet the USAID goal for this impact indicator of a 50% increase in appropriate hand washing behavior.

The USAID impact indicators for an increase of appropriate hand washing behavior may not have been met because the health education campaign supported by the ARC was completed close to the time of the mid-term survey and no further health education programs were instituted to reinforce the health and hygiene messages.

4. Percentage of population using hygienic sanitation facilities.

Ninety percent (363/405) of the population used a hygienic sanitation facility at the time of the final survey, a 15-fold increase over the baseline survey, which found that 6% (203/348) of the population used hygienic sanitation facilities. The monitoring indicator of 75% coverage was met at the time of the final survey. The success of the community in meeting this USAID impact indicator was probably due to construction of household latrines by the ARC and the support provided by health education programs about correct usage of the latrines.

A1.3.2. La Ceiba

La Ceiba is a mountainous community that received assistance from ARC in reconstructing its water system, sanitation facilities, and dwellings after Hurricane Mitch. The water intervention there is a spring fed system that fills a gravity-fed cistern and is pumped uphill to the distribution tank. The water then flows downhill to the household spigots of the connected households. There are a total of 100 houses with a population of approximately 600 people in La Ceiba, with 65 houses participating in the water project and 73 houses participating in the latrine project at the time of the final survey. The 73 households that participated in the latrine project were targeted for participation in the evaluation. The health education intervention involved training the health committee about personal hygiene, proper use and maintenance of composting latrines, and methods to treat water in households. The health committee members in turn trained people in the community in community meetings and home visits.

Data collection occurred in February for the three years of the study: Feb. 4 in 2000, Feb. 15 in 2001, and Feb. 18-19, 2002. Each year the study team collected an average of 68 surveys. The sanitary survey was conducted on Feb. 13 in the final year.

A1.3.2.1. Monitoring indicators

1. Percentage of households with access to an improved water source.

Based on the infrastructure survey, 77% (65/84) of the homes included in the baseline project were served by the water system at the time of the final survey. A considerable amount of labor was required from each participating household to construct this system. Some residents were unable or unwilling to contribute the required labor, and therefore were not included in the

project. Other homes that were targeted to receive the intervention were still not occupied at the time of the final survey, so that the service had not been installed.

During the final survey, 96% (65/68) of the households surveyed had access to an improved water source. This is a dramatic increase from the baseline survey, which found that only 6% (4/73) of the households had access to an improved water source. The goal for this USAID monitoring indicator of 100% coverage was met, because all of the households in the community that were willing to be included in this project were included. The limitations to access to an improved water source were based on characteristics of the potential user and not on limitations of the water intervention. In addition, because of the success of the water project, many homes in the community that were not initially included in the project were seeking to connect to the water system at the time of the final survey.

2. Percentage of households with access to improved sanitation.

Based on the infrastructure survey, 88% (73/84) of the homes included in the baseline project had an operating latrine at the time of the final survey. More households participated in latrine construction than in water system construction in this community. However, some households did not participate, again because they were unable or unwilling to contribute the necessary labor, or because of resistance to the use of composting latrines.

Ninety six percent (65/68) of the households in the final household survey had access to a shared or private latrine. This was a dramatic increase from 18% (13/71) of households with access to a latrine in the baseline survey. The goal for this USAID monitoring indicator of 100% coverage was met, because all of the households willing to be included in this project were included. The limitations to access to a latrine were based on characteristics of the potential user, as with the water project, and not with limitations with the sanitary intervention.

3. Percentage of recurrent costs for water supply services provided by the community served.

At the time of the final survey, the water committee was collecting tariffs sufficient to cover 100% of their routine operating costs (including electricity, chlorine, and salaries) and had accumulated some savings for future repairs. According to the household survey, at the time of

the final survey each household paid a usage-based water fee, and the average fee was 39 colones per month (approximately $4.46 USD). The goal for this USAID monitoring indicator was successfully met.

A1.3.2.2. Water quality

Three community water samples were collected: one from the spring, one from the cistern, and one from the distribution tank. Two of the three (67%) samples were contaminated with total coliforms and none were contaminated with *E. coli*. This is a decrease in contamination from the mid-term survey, which found that 40% (2/5) of the community water samples were contaminated with total coliforms and *E. coli* (Figure 4.2.1.a).

Stored household water samples were collected from 9 households. In one randomly selected household, two water samples were collected in order to provide a direct comparison of the quality of the tap and the stored water. Three of the 9 water household samples (33%) were contaminated with total coliforms and one of the 9 water samples (11%) was contaminated with *E. coli*. In the household where samples of both the stored and tap water were taken, neither sample was contaminated with total coliforms or *E. coli*. The percentage of household water samples that were contaminated decreased dramatically in the final survey compared to the mid-term survey. In the mid-term survey, 70% (7/10) of the household water samples were contaminated with total coliforms and 60% (6/10) were contaminated with *E. coli* (Figure 4.2.1.b). Only 3% (2/68) of the households reported having treated their water on the day of the survey and 4% (3/69) reported that they often treat their water. This dramatic decrease in contamination is due to the improvement in the water quality achieved upon the completion of the water project, the treatment of the water at a community level, and possibly the influence of the well informed and active health committee.

A1.3.2.3. Impact indicators

1. Percentage of children aged < 36 months who had diarrhea in the past 2 weeks.

The period prevalence of diarrhea in children less than 36 months of age decreased slightly from 25 per 100 children (9/36) during the baseline survey to 24 per 100 children (9/37) during the final survey.

This slight decrease did not meet the goal for the USAID impact indicator of a 25% decrease in diarrhea in children less than 36 months of age. The failure to meet this indicator may be due to the fact that the health education campaign supported by the ARC for this community was completed five months before the final survey, and no further education was offered in this community to reinforce the health and hygiene messages of the ARC program.

2. Per capita daily water use

Twenty one percent (14/64) of the households in the final household survey reached the USAID guideline of 50 Lpd. This was a 3.5-fold increase from the baseline survey, which found that only 6% (4/71) of the households met the guideline. However, the goal of 100% of the households having access to 50 Lpd was not met. If the standard is adjusted to 25 Lpd to account for those households where clothes were washed in the river and bathing was done in the river, 35% (24/68) of the households would meet the guideline.

The failure to meet this guideline underscored the difficulty we had in assessing the amount of water people used in their homes. Every household (68/68) reported that it had access to water all day long, and all households were obtaining water from the ARC-built water system and. Although 96% (65/68) reported storing water, this was usually drinking water. People were probably not storing water that they used for their household chores. However, the water usage rates calculated using the household water meter readings and the water use reported in our survey were comparable. The household meter readings for the 30 days prior to data collection indicated that the average water use was 254 liters per household per day. Assuming that six people live in an average household, an average usage rate of 42 Lpd was calculated. An average water use of 230 liters per household was reported during the final survey, or an average per capita use of 38 Lpd.

3. Percentage in household with appropriate hand washing behavior.

- Twenty nine percent (20/68) of food preparers had appropriate hand washing behavior, a 6% decrease from the baseline survey in which 31% (22/71) demonstrated appropriate

- Thirty percent (20/67) of child caregivers had appropriate hand washing behavior. This was also a 6% decrease from the baseline survey in which 32% (21/65) demonstrated appropriate hand washing behavior. This decrease did not meet the goal for this USAID impact indictor of a 50% increase in appropriate hand washing behavior.

The failure to meet the USAID impact indicators for appropriate hand washing behaviors for food preparers and child care givers may reflect the fact that the health education campaign supported by the ARC was completed five months before the final survey, and no further education was offered in this community to reinforce the health and hygiene messages of the ARC program.

4. Percentage of population using hygienic sanitation facilities.

Seventy seven percent (305/396) of the population was using a hygienic sanitation facility at the time of the final survey. This was a 7-fold increase from the 11% (42/393) in baseline survey, and exceeded the goal for this USAID impact indicator of 75% coverage. The community successfully met this indicator due to the construction of new household latrines and the knowledge acquired from the ARC-supported health education campaign on correct usage of the latrines.

A1.4. Guatemala

The two study areas in Guatemala were Chiquimula and Huitzitzil. The approximate locations of these communities are shown in Figure A1.4.1.

A1.4.1. Chiquimula

The study area of Chiquimula consists of two communities: Guayabo and Plan Shalagua, which are rural, mountainous communities located on the border between Guatemala and Honduras. There are 147 houses in Guayabo, and 767 people. Plan Shalagua has 78 houses and 450 people. Both communities received ventilated dry pit latrines as part of the ARC interventions. Guayabo received a new gravity fed piped water system that originates at a spring, feeds into a tank with a chlorinator, and then distributes to household taps. The existing gravity-fed piped water system

with public taps in Plan Shalagua was rehabilitated and a new tank with a chlorinator was built. Both communities also received training regarding proper care and use of latrines, collection and storage of water, and proper hand washing behavior.

Data collection for the household surveys took place from February 2-3, 2000 (baseline), on February 7-8, 2001 (mid-term), and February 7-8, 2002 (final). Table 4.1.1 shows the number of household surveys, and community conducted each year, and the number of water samples taken. During the final survey, the sanitary survey was conducted in Chiquimula on February 7-8, 2002.

A1.4.1.1. Monitoring Indicators

1. Percentage of households with access to an improved water source.

According to community survey, 90% of the homes in Chiquimula had access to an improved water source at the time of the final evaluation. The projects in these communities involved considerable hand labor, and the remaining homes were unwilling or unable to make that contribution. Although the ARC's goal was 100% coverage in the communities it served, 100% coverage is an unrealistic goal, given that there will always be some non-participating households, as discussed above. If we consider those who were not willing or able to work ineligible, the ARC goal of 100% coverage of households that were eligible at the time of the baseline survey was met.

The results of the household survey show that the water projects in these communities led to a 4-fold increase in the percentage of households who reported that they had access to an improved water source, from 23% (13/57) during the baseline survey to 97% (105/108) during the final survey.

2. Percentage of households with access to improved sanitation.

Overall, 90% of the homes in Chiquimula also had access to improved sanitation. The remaining households did not participate in the latrine project, either for the reasons discussed above or because extremely rocky soil made it impossible to complete the necessary excavations for the ventilated pit latrines constructed in these communities. The ARC goal of 100% sanitation coverage of eligible houses was also met, an excellent achievement in these communities.

The percentage of households participating in the household survey who reported that they had access to an improved sanitation facility increased from 43% (20/47) during the baseline survey to 97% (105/108) during the final survey.

3. Percentage of recurrent costs for water supply services provided by the community served

At the time of the final survey, the water systems in Chiquimula had not been operating for long enough to measure this indicator. The water system in Guayabo had only been operating for nine weeks and the system in Plan Shalagua had been operating for only two weeks.

A1.4.1.2. Water quality

During the final survey, seven community water sources and nine households were sampled and analyzed in Chiquimula. The seven community water sources included the springs in both Guayabo and Plan Shalagua, the tank overflows in both communities, and three community taps (one at the school in Guayabo and two in Plan Shalagua). The nine household samples included eight from stored household water and one from a household tap. As can be seen in Figure 4.2.1.a, the percentage of community water sources contaminated with total coliform bacteria and *E. coli* decreased from 83% (5/6) and 50% (3/6), respectively, during the mid-term survey to 57% (4/7) and 0% (0/7), respectively, respectively, during the final survey. Likewise, in Figure 4.2.1.b, the percentage of household water samples that tested positive for total coliform bacteria and *E. coli* decreased from 100% (9/9) and 67% (6/9), respectively, during the mid-term survey to 78% (7/9) and 44% (4/9), respectively, during the final survey.

The provision and upgrading of the water systems, and provision of latrines and hygiene education training have successfully decreased the level of contamination in the community water supplies and in stored household water. It is not surprising that some community water samples were contaminated with total coliform bacteria because some of the samples were taken directly from the springs, which are not fully protected, and there was no chlorine in the tank of one of the communities.

A1.4.1.3. Impact Indicators

1. Percentage of children aged < 36 months who had diarrhea in the past 2 weeks.

The period prevalence of diarrhea in children less than 36 months of age decreased from 33 cases per 100 children (13/40) during the baseline survey to 28 cases per 100 children (21/76) during the mid-term survey, and finally to 22 cases per 100 children (18/81) during the final survey. This decrease exceeded the USAID goal of a 25% decrease in diarrhea prevalence in children of this age group following provision of improved water and sanitation and hygiene education.

2. Per capita daily water use

The percentage of participants meeting the goal of 50 L per capita daily water use increased from 4% (2/57) during the baseline survey to 12% (13/107) during the final survey. The water distribution in the two communities that provided household or shared taps had recently come online (two weeks and nine weeks prior to the survey), which may have influenced the amount of water reported. Additionally, issues with reporting volume of water collected by people who have access to household taps make this indicator difficult to measure.

3. Percentage in household with appropriate hand washing behavior.

The USAID goal of a 50% increase in the number of food preparers and child caregivers capable of demonstrating appropriate hygiene and knowledge with regard to hand washing behavior was met in Chiquimula.

- The percentage of food preparers demonstrating appropriate hand washing knowledge and behavior increased from ≤ 11% in both the baseline and the mid-term surveys, to 92% (99/108) during the final survey.
- The percentage of child caregivers demonstrating appropriate hand washing knowledge and behavior increased also from ≤ 11% in both the baseline and the mid-term surveys, to 92% (58/63) during the final survey.

These gains in appropriate hand washing knowledge and practice far exceeded the USAID guideline of a 50% increase in the percentage of people who demonstrate appropriate hand washing technique. The hand washing education programs that had been implemented at the time of the mid-term survey appeared not to have had a positive on the study population's hand

washing behavior, and CDC recommended that ARC focus attention on the educational interventions in this study area during the remainder of the project.

The remarkable increase in the percentage of study participants who passed the hand washing test, and the reports of many of the participants that they had received numerous charlas during the past year, indicate that the ARC made a serious commitment to providing hygiene education to these communities. Because the water systems had just come online, the ARC was still active in the communities at the time of the final survey, which may have led to higher hand washing scores than in other communities where the physical infrastructure parts of the interventions had been completed for some time, and the ARC was no longer active.

4. Percentage of population using hygienic sanitation facilities.

The percentage of the population using hygienic sanitation facilities increased dramatically, from 15% (54/357) during the baseline survey, to 91% (379/415) during the final survey, and corresponds with the completion of the latrine projects in these two communities and of intensive hygiene education programs on care and maintenance of latrines.

A1.4.2. Huitzitzil

Huitzitzil is a rural community of 201 households and 1200 people located on the southeast coast of Guatemala. The ARC infrastructure project in this community consisted only of composting latrines, which were being operated extremely well at the time of the final survey. However, the community has also expressed an interest in a drinking water project. Treated bottled water is readily available in this area, and was being used by 40% of the residents for drinking and (some) cooking. However, some residents are not able to afford the bottled water. The community also received extensive hygiene education about care and use of the composting latrines and hand washing skills.

Data collection for the household surveys took place from February 9-10, 2001 (baseline), and February 9-10, 2002 (final). Table 4.1.1 shows the number of household surveys, and community conducted each year, and the number of water samples taken. During the final survey, the sanitary survey was conducted in Huitzitzil on February 9-10, 2002.

A1.4.2.1. Monitoring indicators

1. Percentage of households with access to an improved water source.

The ARC did not have a water project in this community. During the final survey, 7% (7/103) of participants in the household survey had access to an improved primary water source to meet the majority of their household water needs. However, 40% (41/103) of the residents reported that they buy bottled water to meet some of their domestic water needs, and so could be considered to have access to an improved source.

2. Percentage of households with access to improved sanitation

Composting latrines were constructed in this community. According to a map of the community that indicated the location of each house and composting latrine, 67% of the households have new composting latrines located on their property. However, access is probably somewhat higher, because some latrines appear to be shared by more than one household, and other households already had dry pit latrines. Although all households in the community were eligible to participate in the intervention, some residents were unable or unwilling to contribute the required labor, and therefore were not included in the project. Because all households that wished to take part in the intervention did participate, the ARC target of 100% access was met.

During the final household survey, 97% (100/103) of the households reported that they had access to a latrine, compared to only 58% (59/101) during the baseline survey. Ninety-eight percent of the households from the final survey reported they had had their own latrines and 2% reported shared use of latrines. Ninety-six of the latrines were composting latrines, and four were dry pit latrines.

Although the infrastructure evaluation indicated that only 67% of households had composting latrines, 97% of the households participating in the household survey reported that they had access to a latrine. This is likely due to a biased household selection toward households that participated in the latrine project in this community because guides from the community, who may have been motivated to direct interviewers only to households that participated in the latrine project, were used to help interviewers find houses.

3. Percentage of recurrent costs for water supply services provided by the community served.

This indicator is not applicable to this study area because no water supply services were constructed in this community.

A1.4.2.2. Water quality

Although ARC did not perform a water intervention in this study area, the microbial quality of some water sources and stored household water samples was analyzed because contamination of stored household water and water sources may impact other indicators. During the final survey, four "community" water source samples were taken, including three household wells and one sample from a bottle of purchased water. All "community" water sources sampled were contaminated with total coliforms and *E. coli* during both the baseline (6/6) and final (4/4) surveys (Figure 4.2.1.a). The percentage of household water samples contaminated with total coliforms and *E. coli* decreased from the baseline (2001) to the final survey, from 100% (6/6) to 80% (8/10) and 88% (7/8) to 70% (7/10), respectively, indicating some improvement that may have been associated with better sanitation and hygiene, and possibly chlorination of stored household water (Figure 4.2.1.b).

A1.4.2.3. Impact indicators

1. Percentage of children aged < 36 months who had diarrhea in the past 2 weeks.

The period prevalence of diarrhea in children less than 36 months of age remained relatively constant during the baseline and final surveys: 30 cases per 100 children (18/60) and 31 cases per 100 children (16/51), respectively. This may be due to the type of water that most people used for drinking and cooking. Although the households received composting latrines and hygiene education, the people living in Huitzitzil relied on dug wells and bottled water to meet their potable and non-potable water requirements, and only 40% (41/103) of the households reported using bottled water for drinking and sometimes for cooking. The remaining 60% (62/103) of households relied solely on private or shared wells for drinking and cooking water.

2. Per capita daily water use

The water sources in Huitzitzil remained the same during the baseline and final surveys. However, survey participants reported using more water during the final survey compared to the baseline survey. The percentage of participants meeting the goal of 50 L per capita daily water use increased from 57% (55/96) during the baseline survey to 88% (91/103) during the final survey.

3. Percentage in household with appropriate hand washing behavior

The USAID goal of a 50% increase in the number of food preparers and child caregivers capable of demonstrating appropriate hygiene and knowledge with regard to hand washing behavior was met in Huitzitzil.

- The percentage of food preparers demonstrating appropriate hand washing knowledge and behavior increased from 29% (29/101) during the baseline survey to 79% (81/103) during the final survey.
- The percentage of child caregivers with appropriate hand washing knowledge and behavior increased from 28% (15/53) during the baseline survey to 82% (37/45) during the final survey.

These increases were far greater than the USAID guideline of a 50% increase in demonstrated hand washing knowledge and behavior following water, sanitation, and hygiene education interventions. Because the composting latrines are relatively complex to use and maintain, ARC was still active in Huitzitzil at the time of the final survey, giving charlas on latrine care and use and on hygiene. The continued ARC presence may have led to higher hand washing scores than in other communities where the physical infrastructure parts of the interventions had been completed for some time, and the ARC was no longer active.

4. Percentage of population using hygienic sanitation facilities

The percentage of the population using hygienic sanitation facilities increased dramatically, from 37% (215/581) during the baseline survey, to 90% (454/506) during the final survey, and corresponds with the completion of the latrine projects in these two communities. This percentage far exceeds the USAID guideline of 75% of households using hygienic sanitation facilities, and corresponds to the completion of the ARC latrine intervention.