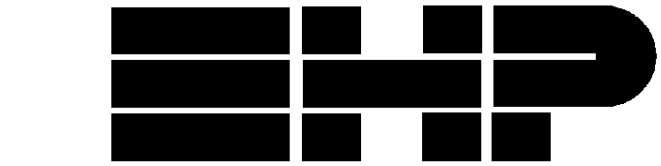

ACTIVITY REPORT

No. 70

Dominican Republic: Evaluation of Rural Water
and Sanitation Infrastructure Construction

June 1999

by

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and
Janelle Daane

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ABOUT THE AUTHORS

Andrew Karp is a consulting engineer with 25 years of experience with water supply and basic sanitation, in both rural and marginal urban areas. He has worked throughout the world, with emphasis in Latin America. This includes experience with project management, design, construction, and evaluation as well as experience with institutional, economic, and social issues. Of relevance to this evaluation, he has spent several years as an employee of both private sector entities and NGOs, as well as five years as a project officer of the World Bank. He served as team leader for this evaluation.

Janelle Daane, an environmental, civil, and construction engineer, has over 15 years of experience in developing water supply and sanitation services, primarily for indigenous people. She has performed water and sanitation work in the former Soviet Union, Central America and the Caribbean, Central and Eastern Europe, Africa, and the Middle East. From 1992-1996, she worked as a water and sanitation engineer for USAID on projects ranging from rural water and sanitation to municipal water utility reform. As a 1994 American Association for the Advancement of Science Overseas Engineering Fellow, she lived in Ukraine where she co-managed the USAID environment program. From 1984-1991 she worked for the U.S. Public Health Service primarily as a construction engineer on water and sanitation systems in native Alaskan villages. In addition to rural and small-scale water supply and engineering construction experience, Dr. Daane is versed in municipal water utility reform and in providing water and sanitation services to the urban poor.

ACRONYMS

CARE	US PVO
EHP	Environmental Health Project
ENTRENA	a private-sector firm which provides training
GODR	Government of the Dominican Republic
IDB	Inter-American Development Bank
INAPA	Instituto Nacional de Agua Potable y Alcantarillado
NGO	nongovernmental organization
PAHO	Pan American Health Organization
PVO	Private Voluntary Organization
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development
VIP	ventilated improved pit

EXECUTIVE SUMMARY

In April 1999, the Environmental Health Project (EHP) undertook an evaluation to compare the quality of work done by nongovernmental organizations (NGOs) and the private sector for technical aspects of rural water supply and sanitation infrastructure constructed in the Dominican Republic. The evaluation focused on technology choices, design, construction, and relative cost. This was undertaken for, and financed by, USAID, at the request of the National Water and Sewerage Institute – INAPA (Spanish name: *Instituto Nacional de Agua Potable y Alcantarillado*).

The two key findings of the evaluation were as follows:

- In the Dominican Republic, on average, the design and construction work performed by NGOs and the private sector is approximately the same.
- The range in the quality of work completed by both NGOs and the private sector requires careful selection of which NGO or private sector entity is awarded the work for a particular project.

Among other findings, the following are of particular interest:

- An evaluation focusing on field inspections of completed projects cannot make a meaningful and comparative cost analysis because of differences in the nature of the projects inspected. Such a comparative cost analysis would require a larger pool of comparable projects, with cost breakdowns for the components of each project.
- No design and construction standards are being applied consistently across-the-board to NGO, Pro-Comunidad (the Social Investment Fund of the government of the
- Dominican Republic), and INAPA-contracted projects.
- The projects inspected did not cause significant environmental degradation. This applied equally to projects constructed by NGOs and the private sector.
- Among the factors evaluated, the least variation was in the appropriateness of the technology selected, which was always either the only option available or the only reasonable option given funding, siting, and water resource constraints.
- Deficiencies in the siting, design, and construction of latrines constituted a particularly weak set of results, both for NGOs and private sector projects.

The above findings were concluded by a team of four engineers, including two employees of INAPA and two from EHP (the latter two wrote the present report). Between 8 April and 17 April 1999, this team spent eight days visiting 20 communities with a total of 22 rural water system and latrine projects, distributed over eight provinces of the country. These field inspections were the main source of information for the evaluation, although they were supplemented by interviews with personnel from funding agencies and implementing entities.

Various factors limit the precision of the evaluation results, although the data collected were sufficient to support the broad findings and recommendations. The most important limitation is statistical, which was due to the limited number of projects inspected. Also, variations in local conditions often made it impossible to compare all aspects of the various projects (e.g., the quality of work related to a drilled well and pumping system is not directly comparable to a spring using gravity-flow to conduct the water).

The following are recommendations based on the findings:

- Neither NGOs nor private sector entities as a group should be disqualified based on technical considerations.
- It is imperative to make decisions to award water and sanitation projects based on the qualifications of each specific NGO or private sector entity.
- In addition to design and construction, deciding who should undertake water and sanitation projects should be based on their ability to facilitate future operation and maintenance through community training, education, and organization.
- Standardized design and construction norms and guidelines are greatly needed.
- A national consensus needs to be reached on appropriate latrine design and the various soil and groundwater situations in which various types of latrines should be used.

It is hoped that the findings and recommendations of this evaluation will contribute to improving the coverage of rural communities with reliable potable water supplies and sanitation facilities.

1 INTRODUCTION

According to the Pan American Health Organization, UNICEF, and the Inter-American Development Bank, the water supply and sanitation problem in the Dominican Republic, and especially in the rural areas, is one of the most serious in the hemisphere. While 20 to 25% of urban populations are not served with water supply and sanitation facilities, 54% of the rural population does not have access to potable water and 63% does not have adequate sanitation.

For many years USAID/Dominican Republic has financed a number of water and sanitation activities in urban and rural communities through various nongovernmental organization (NGO) partners. Examples include grants to CARE through the PL-480 Program and grants to NGOs from the PVO Co-Financing Project. In addition to constructing water supply and sanitation infrastructure, community organizations were established to operate and maintain systems. USAID supported this theme by promoting acceptance and use of the "Total Community Participation" model of water and sanitation programs.

Over the past few years, the Government of the Dominican Republic (GODR), with support from external support agencies, recognized the importance of participatory community-based approaches in operating and maintaining sustainable rural water supply and sanitation facilities. As a result, GODR decided to transfer the administration, operation, and maintenance of rural water supply systems directly to beneficiary communities. To further strengthen the effectiveness and health impacts of rural water supply and sanitation programs, USAID contracted with EHP to develop a strategy and to assist in implementing the new program charged with transferring responsibility for rural systems from the National Institute of Potable Water and Aqueducts (INAPA) to rural communities. Part of this decentralization strategy included involving NGOs in the design and construction of GODR-sponsored rural water and sanitation projects. As part of the EHP effort, in June 1998, EHP began the development of technical norms and standards for water supply and sanitation facility construction, operation, and maintenance. Unfortunately, the occurrence of Hurricane Georges delayed the norms and standards initiative.

In October 1998, just before the hurricane, a new INAPA director was named. The new director expressed reservations about the ability of NGOs to design and construct high-quality water systems and sanitation facilities. As a result, the director asked USAID for assistance in evaluating rural water and sanitation infrastructure constructed by NGOs. It was expected that addressing this concern would contribute to the final approach decided upon for decentralization of water and sanitation facilities and would help clarify what type of entities can best undertake design and construction of rural water and sanitation systems.

In April 1999, EHP began an evaluation to compare rural water supply and sanitation infrastructure constructed by NGOs and the private sector in terms of technology choices, design, construction, and relative cost.

The core information used for the evaluation was observations made during site visits to 20 communities. Four engineers participated in the eight-day field activity, which took place in eight provinces of the Dominican Republic. This report documents their conclusions during that evaluation.

There were several limitations to this evaluation:

- A relatively short time frame to complete it, which affected the number of sites that could be visited
- Limited access to sources of written information including contract documents, plans, and as-built drawings
- Limited access to information affecting design decisions
- Provision of cost information that did not allow valid direct comparisons among projects

The report is organized into four sections: (1) background to the activity, (2) methodology employed in the evaluation, (3) findings, and (4) recommendations.

2 METHODOLOGY EMPLOYED

To accomplish the evaluation, 22 rural water systems and latrine projects were inspected in 20 communities from 8 April to 17 April 1999. Initial meetings with INAPA, ENTRENA, Pro-Communidad, USAID, and NGOs on 5-7 April helped determine the NGOs and private sector projects to be inspected. To include a variety of project conditions, sites were selected in the provinces of Barehona, Bahoruco, Azua, Peravia, San Juan, San Cristobal, Salcedo, and Puerto Plata (see Figure 1).

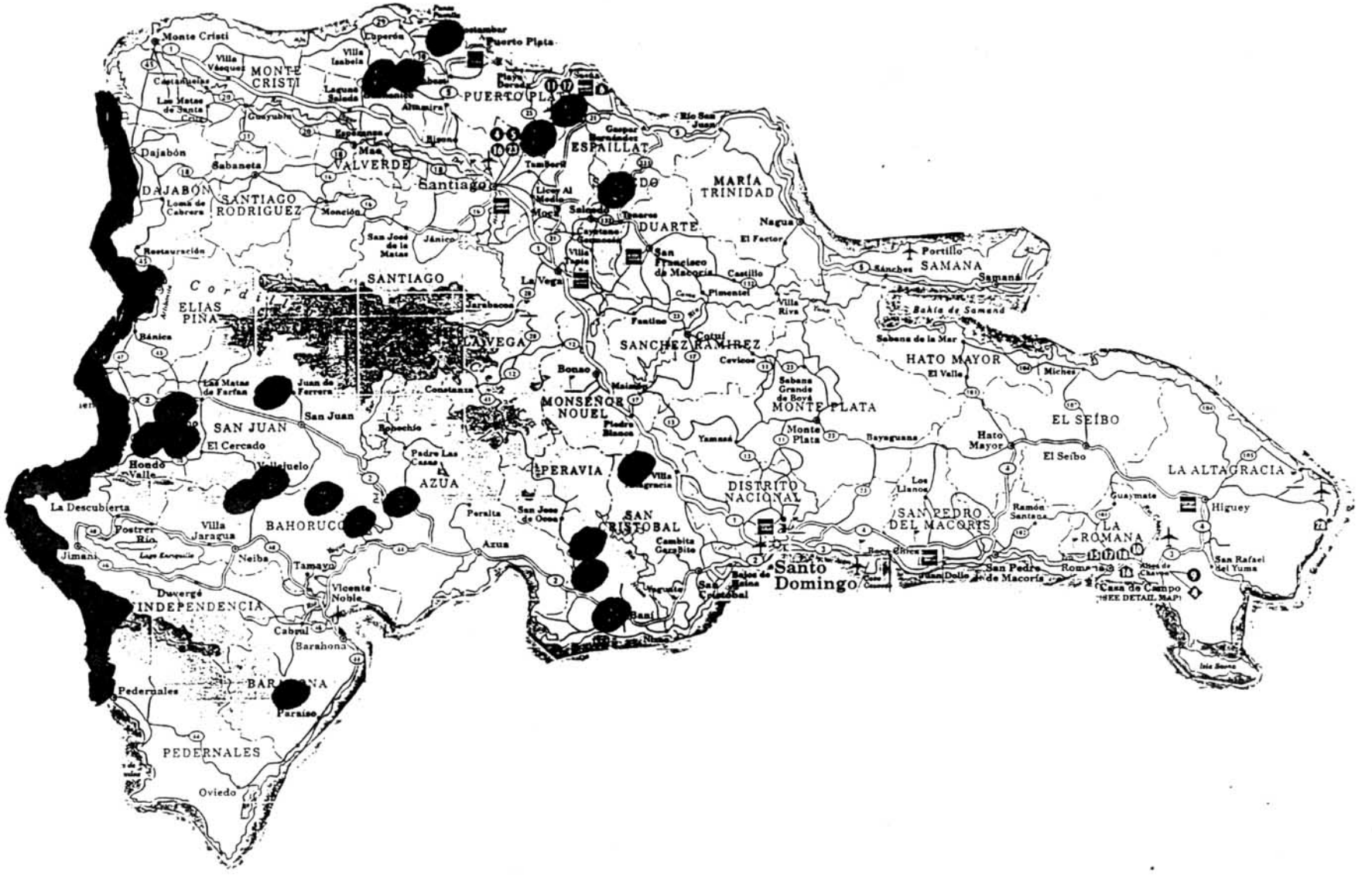
Of the 22 water system and latrine projects reviewed, four were latrine projects and 18 were water systems. The types of water systems reviewed included springs with gravity flow, solar pumping systems, surface water systems with only minimal "roughing" filtration at the source, surface water systems with slow sand filters, and a wind turbine system. During identification of the projects, an effort was made to select comparable types of water system technologies so that design and construction performed by NGOs and private sector entities could be reasonably compared. No hand pumps were evaluated because no projects involving private sector hand pumps could be identified and verified. Although only NGO-constructed solar systems were evaluated, most components of these systems, such as transmission line, storage tanks, and distribution systems, were comparable to those of gravity systems.

Information for the evaluation was primarily obtained from direct observation. Supplemental information on NGO systems was obtained from NGO engineers and staff, community water committees, system operators, and community members. In only one of the 13 NGO cases was the team unable to meet with the NGO to obtain information.

Supplemental information on private sector systems was obtained from INAPA engineers in field offices, INAPA engineers located in the central INAPA office in Santo Domingo, a Pro-Communidad engineer and staff member, private sector design/ construction engineers, and local water system operators.

The field evaluation was performed by EHP's Andrew Karp and Janelle Daane, and Freddy Poche and Oswaldo Muñoz of INAPA, all of whom are engineers. This report was prepared by Andy Karp and Janelle Daane with analysis and input from Freddy Poche and Oswaldo Muñoz.

Figure 1
Locations Of The Systems That Were Evaluated,
On The Map Of The Dominican Republic


Monte Cristi
Villa Vásquez
MONTE CRISTI
Castañuelas
Las Matas de Santa Cruz
Guayubín
Esperón
Villa Isabela
Laguna Salada
Maimón
Altamira
Puerto Plata
PUERTO PLATA
Río San Juan
Gaspar Hernández
ESPAILLAT
Dajabón
Sabaneta
Mao
VALVERDE
Santiago
Tamboril
Licey Al Medio
Moca
Salcedo
Tenares
DUARTE
MARÍA TRINIDAD
Nagua
El Factor
Loma de Cabrera
SANTIAGO RODRIGUEZ
Monción
San José de las Matas
Jánico
Restauración
Cordillera Central
SANTIAGO
La Vega
Jarabacoa
San Francisco de Macorís
Castillo
Pimentel
Villa Riva
Portillo
SAMANA
Sánchez
Samaná
Bahía de Samaná
ELIAS PIÑA
Bánica
Las Matas de Farfán
Juan de Herrera
San Juan
Constanza
LA VEGA
Fantino
Cotuí
SANCHEZ RAMIREZ
Cevicos
Sabana Grande de Boyá
Sabana de la Mar
HATO MAYOR
El Valle
Miches
Bonao
Maimón
MONSEÑOR NOUEL
Piedra Blanca
MONTE PLATA
Yamasá
Monte Plata
Bayaguana
Hato Mayor
El Seíbo
EL SEÍBO
SAN JUAN
El Cercado
Rancho Arriba
Padre Las Casas
AZUA
PERAVIA
Villa Altagracia
DISTRITO NACIONAL
Los Llanos
Guayacanes
Ramón Santana
SAN PEDRO DEL MACORIS
LA ROMANA
Higuey
LA ALTAGRACIA
Hondo Valle
La Descubierta
Postrer Río
Villa Jaragua
BAHORUCO
Jimaní
Lago Enriquillo
Neiba
Tamayo
Vicente Noble
Duvergé
INDEPENDENCIA
Cabral
Barahona
Pedernales
BARAHONA
Paraíso
PEDERNALES
Oviedo
Persita
San José de Ocoa
Azua
SAN CRISTOBAL
Cambita Garabito
Bajos de Haina
San Cristóbal
Santo Domingo
Boca Chica
San Pedro de Macorís
Romana
Casa de Campo
(SEE DETAIL MAP)
San Rafael del Yuma
Isla Saona

3 FINDINGS

3.1 Summary

A summary of the primary findings of the evaluation is presented below. Supporting observations and discussion follow the summary.

- In the Dominican Republic, on average, the design and construction work performed by NGOs and the private sector is approximately the same.
- The range in the quality of work completed by both NGOs and the private sector requires a careful selection of which NGO or private sector entity is awarded the work for a particular project.
- The differences in the nature of existing projects prevented a comparative cost analysis of work undertaken by NGOs and private sector entities. These differences include the following:
  - Systems constructed by private sector entities tend to serve much larger populations, often resulting in economies of scale.
  - Despite the limited quantity of water available from a source, NGOs will sometimes construct a system on the rationale that it will improve the living conditions of the beneficiaries, whereas private sector entities will generally avoid working in such locations. Such decisions distort costs because lower per capita flows will usually result in decreased costs, but with a corresponding decrease in benefits.
  - Most systems constructed by private sector entities in the Dominican Republic were designed by INAPA, whereas most systems constructed by NGOs were either designed by the NGO or by an engineer NGO contracted for this purpose. Thus, to the extent that the design affects the cost, the private sector entities may have less control than the NGOs.
- Most NGOs evaluated have engineers on their staff. In addition, NGOs are contracting out some engineering work. The majority of rural water systems constructed by the private sector were designed by INAPA engineers and constructed by private engineers or contractors.
- No design and construction standards are being applied consistently across-the-board to NGO, Pro-Communidad, and INAPA projects.
- The projects inspected by the evaluation team did not cause significant environmental degradation. This applied equally to projects constructed by NGOs and the private sector.
- In all NGO, Pro-Communidad, and INAPA water projects inspected, the team defined the choice of technology used as excellent. In many cases the technology was the only option available or the only reasonable option given funding, siting, and water resource constraints.
- Based on observations of latrines built by some private sector entities and NGOs, it is apparent that there are deficiencies in siting, design, and construction.
- NGOs were found to be doing a very good job in the design and construction of solar pumping systems. (The team did not have an opportunity to evaluate solar systems constructed by the private sector.)

3.2 Supporting Observations and Discussion

The following offers observations and some discussion supporting the findings.

In the Dominican Republic, on average, the design and construction work performed by NGOs and the private sector is approximately the same.

During the evaluation it was determined that three general implementors (NGOs, INAPA, Pro-Communidad) are responsible for various design and construction arrangements:

1. Design by NGO — Construction by an NGO
(or) Design by private sector engineer for an NGO — Construction by an NGO

2. Design by INAPA — Construction by private contractor
(or) Design by private sector engineer for INAPA — Construction by private contractor

3. Design by Pro-Communidad (applies to latrines) — Construction by private contractor
Design by private sector for Pro-Communidad — Construction by private contractor

(or) Design by NGO for Pro-Communidad — Construction by NGO

The team inspected 22 systems —13 NGO projects and nine private sector projects. A list of these projects is provided in Table 1. A list of the community names, municipalities, and provinces is included in Appendix A.

Table 1
Systems Evaluated and Summary of Observations

Community	Type of System	Design by	Construc-tion by	Year Completed	Families Served	Population Served*	Total Cost (U.S.$)**	Cost Per Capita (U.S.$)	Appropriate Overall Choice of Technology	Quality of Design	Quality of Construc-tion	Overall Rating
Guzmancito	Wind turbine, well, and pump, with one public tap and one house connection	Winrock and Enersol	Adesol	1998	11	55	2852.46	51.86289	Appropriate for an experiment, questionable for replicability	Good	Mostly good but with some problems, such as poor battery protection, elec. Wires lack conduit protection, and leaking public tap	**3**
Bellavista	Solar system, pump and 7 public taps	Adesol	Adesol	1997	48	240	22000	91.66667	Very good	Good water tap design; good well seal; panels protected fairly well; should install valve at each public tap	Poorly suspended galvanized pipe from well; well located close to potentially contaminated ravine	**4.5**

Table 1 (Cont.)

Community	Type of System	Design by	Construc-tion by	Year Completed	Families Served	Population Served*	Total Cost (U.S.$)**	Cost Per Capita (U.S.$)	Appropriate Overall Choice of Technology	Quality of Design	Quality of Construc-tion	Overall Rating
Monteado	Solar system, pump and 4 public taps	Adesol	Adesol	1997	58	290	22000	75.86207	Very good	Good water tap design; need more valves in line next to public taps	Well poorly located in the center of pasture at a low point with cattle manure next to well head	**3.5**
La Flor	Spring with gravity flow and public taps	Fudeco	Fudeco	1992	60	300	38000	126.6667	Excellent	Oversized pipe and storage tank	Good drainage, excellent	**4**

											public taps	
Los Arroyones	Surface water intake with public taps	Fundeva (for Pro-Comuni-dad)	Fundeva	1998	75	375	58888.5	157.0361	Good, but could have included more filtration	Overall good, but could have improved the location of the storage tank	Some pipeline leaks; valve boxes located at low points; good drainage around public taps; good protection around storage tank and intake	**3.5**
San Jose	Spring with gravity flow and public taps	Fudeco	Fudeco	1985	80	400	not available	not available	Excellent	Oversized pipe and storage tank	Poor drainage	**4**
Vuelta Grande	Latrines	Fundasur	Fundasur	1998	85	425	14620	$172/latrine	Excellent	Excellent	Excellent	**5**
Vuelta Grande	Solar system, pump, 22 public taps, and 20 house connections	Dr. Edmundo Socrates Barinas Sone	Fundasur	Under construction	85	425	37974.7	89.3522	Excellent	Very good	Need a switch to manually shut off pump; some leakage around bottom of water storage tank; some erosion around the base of the tank	**4**
Granado	Solar system, pump, 11 public taps	Dr. Edmundo Socrates Barinas Sone	Fundasur	1999	92	460	50632.6	110.0709	Excellent	Panels should have been placed in different location	Excellent	**4**
La Jagua	Spring with gravity flow and 16 public taps	Fundeco	Fundeco	1996	239	1195	48427.2	40.52485	Excellent	Excellent use of valves downstream of storage tank, and a valve near spring box	Excellent	**4.5**
Rincon Caliente	Latrines	Forosocial	Forosocial	1998	250	1250	8250	$33/latrine	Should have been VIPs	Poor, used 2" ventilation pipe on one latrine, others had no pipes, too much light to function as a VIP	Fair to good	**2.5**
Apolinar Perdomo	Spring with gravity flow and public taps+C19	World Vision	World Vision	1992	400	2000	Not available	Not available	Excellent	Oversized spring box; catchment area is located below houses and no diversions exist for surface runoff; storage tank located in poor location w/ erosion; people are using a 4" pipe from the tank as a water tap; should have just constructed a public tap	Solid spring box and tank construction; good water tap location	**2.5**

Table 1 (Cont.)

Community	Type of System	Design by	Construc-tion by	Year Completed	Families Served	Population Served*	Total Cost (U.S.$)**	Cost Per Capita (U.S.$)	Appropriate Overall Choice of Technology	Quality of Design	Quality of Construc-tion	Overall Rating
Charco Prieto & Leonardo	Solar system, pump from spring, and public taps	Fundasur	Fundasur	1998	420	2100	87868.9	41.84231	Excellent	Includes valve boxes near public taps, unneeded pressure breaker boxes, hard to manipulate pressure	Buried valves in concrete; panels located in good site and survived the cyclone; a few leaks at public taps	**4**
Honduras & Matadero	Surface water source with slow sand filter and 130 household connections	INAPA	Ing. Maria del Carmen Rivera	1998	123	615	25664.3	41.73051	Good, but should have divided one filter into two to facilitate maintenance	Overall good, but no redundancy in filtration system; system must be taken off line or by-passed to clean sand; no individual household valves	Very good	**3.5 for design, 5 for cons-truction**
Maximo Gomez	Latrines	Pro-Commun-idad	Private contractor	Not available	172	860	45408	$264/latrin e	Bad: should have been ventilated improved pit latrines	Very bad: In addition to the same design problems as above, it has problem of latrines located less than 100 feet from water wells	Good	**1.5**
Villa Pando	Latrines	Pro-Commun-idad	Private contractor	Not available	250	1250	62000	$248/latrin e	Should have been VIPs	Some design problems: ventilation pipes all too short, no screens and not constucted through roof, durable block and good throne design	Excellent	**3**
Rincon Caliente	Two spring boxes, originally with public taps, extended to include house connections	Ing. Ramon Francisco (for Pro-Comuni-dad)	Ing. Ramon Francisco	1997	380	1900	174723	91.95937	Excellent	Excellent	Excellent	**5**
Fundacion, Rancho Viejo, Agua Larga	Spring with gravity flow and household connections	Ing. Ramon Francisco (for Pro-Comuni-dad)	Ing. Ramon Francisco	1997	390	1950	200413	102.776	Excellent	Storage tank could have been sited a little better to reduce erosion	Excellent	**4**
Palma Sola	Spring with gravity flow and public taps	INAPA	Ing. Adolfo Franco Brito	1993	289	1445	118471	81.9866	Excellent	Storage tank should have had an overflow, captation could have been improved, drainage could have been improved	Exposed plastic water line household connections crossing drainage ditches can be easily broken and difficult to repair if no individual household valves exist; household taps not robust	**3**

Galion	Spring with gravity and household connections	INAPA	Private contractor	1997	350	1750	Not available	Not available	Reasonable (issue: upstream community not providing water to downstream community, thus new wells being drilled)	Good road drainage diversion canal	Small cracks in tank concrete work	**4**

Table 1 (Cont.)

Community	Type of System	Design by	Construc-tion by	Year Completed	Families Served	Population Served*	Total Cost (U.S.$)**	Cost Per Capita (U.S.$)	Appropriate Overall Choice of Technology	Quality of Design	Quality of Construc-tion	Overall Rating
Punto Cana-Arroyo Loro	Surface water intake, slow sand filter	INAPA	Private contractor	1993	434	2170	Not available	Not available	Good	Overall good, however, no fence protection at intake, overflow into valve box is a problem	Overall good construction, however, some weak concrete work at intake, valve-box covers too heavy	**4**
Capulin	Spring with gravity flow and household connections	INAPA	Private contractor	1984	650	3250	Not available	Not available	Excellent	Overall good, but no reducing valve at spring box	Concrete lids too heavy; cinder block valve boxes half gone; exposed plastic transmission pipe to community w/ hole punched in it; erosion near water storage tank; spring-box sealed so can't be cleaned	**3**
Average Rating for NGOs:												##
Average Rating for Private Sector:												**4**

* assumes an average of five people per family

** costs have been converted to U.S. dollars using the exchange rate for the year when construction was completed

Projects were evaluated for appropriate type of technology, overall quality of design, overall quality of construction, and general cost-effectiveness. An overall rating was determined for each project, and the average for NGO projects was compared to the average for private sector projects. Projects were evaluated on a scale of 1 to 5 with 5 being the best. A more complete description of the criteria used to determine the ratings for each project is included in Annex B.

The average for the NGO projects inspected was 3.77, and the average for the private sector projects inspected was 3.53. Because there is no significant difference, one must conclude that the results of this evaluation indicate that, on average, the design and construction work performed by NGOs and the private sector is approximately the same.

Interestingly, when only a subset of projects is considered (for example, gravity-fed systems), results indicate that the average score for NGO projects and private sector projects is still nearly the same. (Private sector scores 3.8, while NGOs score 3.75.)

Although costs per capita for the water systems inspected varied from $41 per person to $157 per person, it is misleading to compare specific projects by costs. Costs can only be reviewed in general terms for several reasons. For example, the distance to the source varies significantly from project to project, and some sources require pumping while others do not. Some projects require treatment while others do not, and the lack of electrical power may dictate the types of systems that can be constructed. In addition, some of the projects used wells constructed previously under other systems and/or rehabilitated systems as part of a post-hurricane reconstruction effort. Caution must

be applied in interpreting project costs.

The range in the quality of work completed by both NGOs and the private sector requires careful selection of which NGO or private sector entity is awarded the work for a particular project.

Note from Table 1 that there is a fair range in the quality of work completed by NGOs as well as the private sector. At the sites visited, NGO work ranged from 2.5 to 5, and private sector work ranged from 1.5 to 5. As a result, it is important to carefully select which NGO or which private sector entity is awarded the work for a particular project.

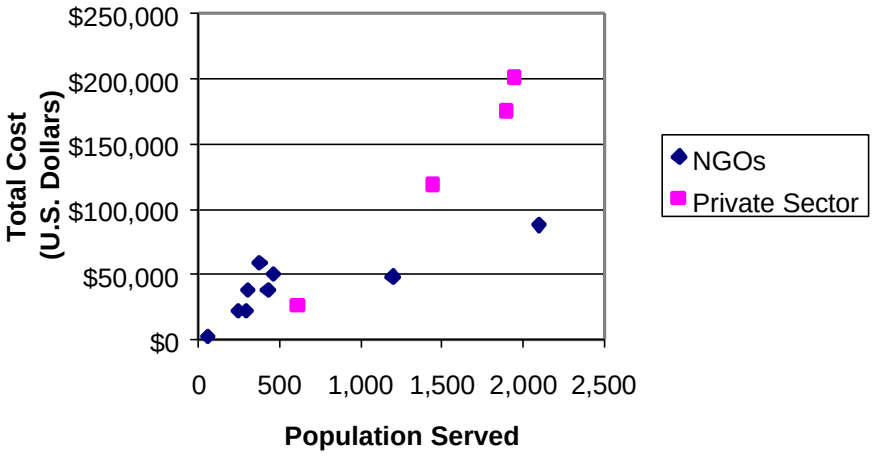
The differences in the nature of existing projects prevented a comparative cost analysis of work undertaken by NGOs and private sector entities.

Comparisons of NGO, Pro-Communidad, and INAPA projects must be carefully interpreted because NGO and Pro-Communidad often serve a different population than INAPA projects.

One of the questions that this evaluation attempted to address is, "With similar technologies, would it be more expensive to contract with the private sector or NGOs?" This question could not be satisfactorily answered based on a field evaluation because water systems contracted by NGO and Pro-Communidad often serve a different population than INAPA projects. NGO projects typically serve more rural areas, often those with smaller populations, at times located in areas without electrical power. This fact is illustrated in Figure 2.

In addition, systems provide different levels of service both in terms of household connections

Figure 2
Water System Costs



versus public taps and the amount of water provided per capita. INAPA usually provides household connections, and it sizes systems and bases flow on projections of household use. NGO and most Pro-Communidad typically serve only public taps.

Most NGOs evaluated have engineers on their staff. In addition, NGOs are contracting out some engineering work. The majority of rural water systems constructed by the private sector were designed by INAPA engineers and constructed by private engineers or contractors.

NGOs Adesol, Fundasur, and World Vision have engineers on their staff. Adesol has one engineer, Fundasur has two engineers, and World Vision recently hired a very experienced engineer away from Catholic Relief Services to improve its quality of water and sanitation design and construction. Fundeco has an individual on staff who completed half the course work for an engineering degree and has 16 years of experience working on water projects at Fundeco.

NGOs are using outside engineering assistance to help develop designs in wind and solar systems. Adesol is using expatriate engineering assistance provided through Winrock and Enersol. Fundasur is obtaining design assistance through a highly respected private sector engineer, Dr. Eduardo Socrates Barinas.

Some NGOs are subcontracting private sector contractors for certain aspects of construction. For example, Fundasur is currently on a waiting list to have well drilling accomplished by a local well driller. Adesol has its own well-drilling rig but subcontracts with an experienced well driller on an as-needed basis.

In addition, at least some of the NGOs are using private sector contractors to lead construction efforts. During the evaluation of one site that was under reconstruction, the team met with an engineering contractor under subcontract to Fundasur for construction of transmission and distribution systems. The contractor seemed well versed and experienced.

All NGOs receiving assistance through USAID indicate that an experienced ENTRENA engineer performs construction inspection at project sites.

Private sector systems overseen by INAPA involve engineers in both design and construction. Some systems are being designed and constructed by private sector engineers. However in the majority of cases reviewed, INAPA is designing systems and contracting out construction. INAPA engineers report that they provide monitoring during construction.

In at least two of the three Pro-Communidad water systems evaluated, Pro-Communidad is contracting out both design and construction components to an engineer. Pro-Communidad also has an engineer on staff who is providing some construction monitoring.

In conclusion, after reviewing 22 sites, results indicate that the relative complexity of a system does not inherently determine whether the private sector or NGOs would be best suited to implement the project. Rather, the complexity of the project requires that the entity that undertakes it either have its own qualified staff or subcontract others who have appropriate skills and experience.

No design and construction standards are being applied consistently across-the-board to NGO, Pro-Communidad, and INAPA projects.

Currently, NGOs and Pro-Communidad receive a letter from INAPA authorizing them to design and construct systems in a particular location. Specifically, the letter from INAPA states that INAPA "has no objection" to the NGO (or Pro-Communidad) providing assistance in a regional area that INAPA does not plan to serve.

Although this letter formally authorizes the NGO and Pro-Communidad to develop designs and implement construction, it does not reference any standards or guidelines, nor are any provided to the NGO and Pro-Communidad. Pro-Communidad reports using a few of its own design and construction norms. During the evaluation, at least one NGO reported that it would like to receive standardized national norms and guidelines for design and construction.

In addition to not having national norms or standards available, no formal design review of NGO- and Pro-Communidad-designed systems is being conducted by INAPA or any other government regulatory agency. To facilitate design, if possible, INAPA should make engineers available to provide advice on designs as requested by the NGO or Pro-Communidad.

Currently, no requirements exist for NGOs and Pro-Communidad to provide as-built information to INAPA or any other municipal or governmental organization for record-keeping when construction is complete. A repository for this type of engineering information would be very helpful, especially for later operation, maintenance, rehabilitation, and reconstruction.

During the evaluation, it was discovered that INAPA recorded incorrect as-built information on its projects. For the as-builts to be effective, an effort should be made to improve accuracy of information.

The projects inspected by the evaluation team did not cause significant environmental degradation. This applied equally to projects constructed by NGOs and the private sector.

A cursory environmental assessment of the projects inspected corresponds to suggestions in the "*Environmental Guidelines for PVOs and NGOs: Potable Water and Sanitation Projects*," which was prepared for the USAID Mission to the Dominican Republic in 1992 by the Water and Sanitation for Health Project. (One of the authors of the present report, Andrew Karp, assisted with the preparation of this document in 1992.) Although most of the projects visited were not constructed with USAID funds, the referenced document is suitable for the purposes of this evaluation. This document indicates that the relevant environmental concerns are as follows:

- Depletion of fresh water resources (surface and groundwater quality)
- Chemical degradation of the quality of potable water sources (surface and groundwater)
- Creation of stagnant (standing) water
- Degradation of terrestrial, aquatic, and coastal habitats
- Contamination of surface water, groundwater, soil, and food by excreta (chemicals and pathogens)
- Degradation of stream, lake, estuarine, and marine water quality and degradation of terrestrial habitats

The evaluation team found no problems with the projects relative to these concerns, with two exceptions. One area of concern was the creation of stagnant (standing) water. This was most prevalent around household taps that homeowners had constructed without assistance or guidelines. This also occurred in some Pro-Communidad projects where public taps were originally constructed by the contractor, and homeowners later constructed their own individual connections.

Another area of concern was contamination of groundwater and surface water. In one case, bathers were observed at the surface water intake at Punta Caña. In the neighborhood of Maximo Gomez, NGO-constructed latrines may be potentially contaminating local water wells.

In all NGO, Pro-Communidad, and INAPA water projects inspected, the team defined the choice of technology used as excellent. In many cases, the technology was the only option available or the only reasonable option, given funding, siting, and water resource constraints.

Despite the fact that the technology choice was always excellent, in several projects operational problems were observed. One operational problem resulted from poor design. In this case, lids on

valve boxes, pressure-breaker boxes, and storage tanks were constructed of concrete. Because the large concrete lids were too heavy to lift on a regular basis, they were sometimes left ajar, only partially covering the access openings and allowing contamination.

During the evaluation, it was also found that slow sand filter systems designed by INAPA and constructed by the private sector to filter surface water sources were being operated incorrectly. Slow sand filters work effectively by developing a biological layer on top of the sand that serves to remove turbidity and pathogens. Unfortunately, treatment operators reported that they were removing this layer before it had a chance to develop because its unsightly appearance caused community members to complain. While the design and construction of most filtration systems was very good, the suboptimal operation of the systems significantly reduced their effectiveness.

While most NGO and private sector systems have been designed and constructed to include chlorine for disinfection, none of the 18 water systems observed is currently using chlorine with the exception of one NGO and one private sector-constructed system that are only periodically chlorinating.

In addition, at least two storage tanks were overflowing a great deal of water. Although the overflow could have been easily adjusted by partially closing valves near the water source intake, operators were not doing so. This overflow is a problem particularly when water has been chlorinated, since chlorine is being wasted.

Several of the problems mentioned above could be addressed through improved operator training and community education and support.

Based on observations of latrines built by some private sector entities and NGOs in the field, it is apparent that there are deficiencies in siting, design, and construction.

Several problems existed in three of the four latrine projects reviewed. In at least one case, in the Barrio of Maximo Gomez in Bani, robustly constructed latrines were located too close to potable water wells, thereby significantly increasing the likelihood of well contamination. Unfortunately, the construction of a robust latrine usually creates demand for its use, further increasing the chances of well contamination.

In a second case, latrine construction was very consistent; however, it did not conform to the intended design. Even if the latrines had been built to design, problems existed in the design itself. In two of the three problem cases, robustly constructed block latrines (costing approximately $265 per latrine), which were very sustainable, hurricane resistant, and well liked by users, included minor design and construction errors that significantly reduced their effectiveness. These latrines could have been built correctly without any additional cost. Thus, an important opportunity exists to advance public health simply by improving latrine designs, standardizing their design within the NGO and private sector communities, and educating designers and constructors about proper construction. In addition, adequate construction supervision should be provided to ensure that latrines are built to design.

NGOs were found to be doing a very good job in the design and construction of solar pumping systems. (The team did not have an opportunity to evaluate solar systems constructed by the private sector.)

The design and construction of each of the five solar systems evaluated was found to be very good. The systems evaluated are currently being constructed by NGOs in areas that do not have electrical power. In determining where to construct the systems, NGOs have been careful to select only those areas that will not be provided with electricity from the national grid in the near future.

Solar systems typically have high installation costs, but low operational costs since there is no ongoing electricity charge. Given the high initial costs (which in some cases must be paid back to the NGO by the users), solar-pumping systems are being sized only to provide enough water for public taps.

4 RECOMMENDATIONS

In addition to the scope of work, the evaluation led to the following recommendations, which could improve implementation of rural water and sanitation projects:

- Neither NGOs nor private sector entities as a group should be disqualified based on technical considerations.
- Given that there is a range of quality among NGOs as well as private sector contractors, it is imperative to make decisions to award water and sanitation projects based on the qualifications of each specific NGO or private sector entity.
- Given that both NGOs and the private sector can do excellent design and construction work, the selection process should also consider their ability to provide other services that will facilitate future operation and maintenance such as community training, education, and organization.
- Consensus, documentation, and application of standardized design and construction norms and guidelines are greatly needed. The team identified the following norms and guidelines as critical to success:
  - a recommended specification for locating and including valves in water systems, especially those near public standposts;
  - a norm specifying appropriate well-head design, construction, and protection;
  - a guideline for appropriate design and construction of household connections (apparently such a guideline exists, but it is not being applied and this needs to be remedied); and
  - a well-drilling specification, which requires the contractor to provide a well log and description of pumping test.
- The letter INAPA gives to Pro-Communidad or an NGO indicating that they have no objection to the proposed project should be accompanied by national standardized norms and guidelines specific to the type of construction that the NGO or Pro-Communidad intends to provide. (For example, guidelines and specifications on locating and including valves in water systems should be provided to an NGO that will be providing public standposts.)
- National consensus needs to be reached on appropriate latrine design and the various soil and groundwater situations in which various types of latrines should be used. Similarly, a national standard should be developed for proper siting of latrines. To facilitate proper ventilated improved pit (VIP) design, an educational guideline should be developed that describes the theory behind VIP design and usage.
- To facilitate future operation, maintenance, rehabilitation, and reconstruction, as-built information should be developed by NGOs and Pro-Communidad. (INAPA already does this for its own projects.)
- A repository for water and sanitation system “as-built” drawings should be established in INAPA.
- Given the proximity of latrines to water wells in the Barrio of Maximo Gomez in Bani as well as the large number of recipients using these water sources, it is recommended that water

quality tests for coliform bacteria be performed on these water wells as soon as possible.

REFERENCES

1. Edwards, D. September 1997. *The process of transformation of rural water systems of INAPA to community organizations for potable water: strategic design.*

2. As-built drawings on INAPA projects. INAPA central office.

3. Project summary documents on various INAPA projects. INAPA central office.

4. Map indicating regions and boundaries on eight water and sanitation zones as designated by INAPA. INAPA central office.

5. List of urban and rural systems in each INAPA zone, showing communities served, type of systems, and water source. INAPA.

6. Latrine design drawings used by Pro-Communidad. Pro-Communidad.

7. Latrine cost information on various types of latrines. World Vision. 1999.

8. Pro-Communidad water and sanitation project summary report. Pro-Communidad. April 7, 1999.

APPENDIX A: Communities Inspected In Each Province

Twenty-two projects were inspected in 20 communities located in eight provinces. The names of the communities and municipalities are indicated below under each province. The municipalities are indicated in parentheses.

Barehona
Charco Prieto & Leonardo (Paraiso)

Bahoruco
Apolinar Perdomo (Neyba)
Vuelta Grande (Tamayo)
Granado (Tamayo)

Azua
Villa Pando (Padre Las Cases)

Peravia
Honduras & Matadero (Baní)
Galion (Baní)
Maximo Gomez (Baní)

San Juan
La Flor (Matas de Farfan)
San José (Matas de Farfan)
Capullin (Valle Juelo)
La Jagua (Last Matas)
Punta Caña (Pedro Corto)

San Cristobal
Los Arroyones (Villa Altagracia)

Salcedo
Palma Sola (Tenares)

Puerto Plata
Bellavista (Sosua)
Rincón Cliente (Guananico)
Guzmancito (Luperon)
Monteado (Sosua)
Fundacion (Guananico)

APPENDIX B: Criteria Used to Determine the Ratings for Each Project

As part of the evaluation process for each project that was inspected, the evaluation team gave ratings from 1 to 5, as defined below:

1 = Extremely poor and incapable of serving its intended function
2 = Poor
3 = Adequate: It can serve its intended function, although in less than an optimal manner
4 = Very good
5 = Excellent: Given the hydrogeological and financial constraints affecting the specific project, the best decisions were made in regard to technology choice, design, and construction.

The team was not looking for conformity to any specific design or construction practice. Rather, the technology choice, design, and construction were rated in terms of their ability to achieve their purpose, as follows:

- For water supply systems, the technology choice, design, and construction were rated in terms of their ability to contribute to a system that could reliably provide good quality water without unacceptable environmental degradation.
- Likewise, for latrines these factors were rated in terms of providing latrines that could lead to improved health in the community served, without unacceptable environmental degradation.

The subjectivity in determining the ratings was minimized by reaching a consensus among the evaluation team members that visited each site. More than half of the sites were visited by two INAPA engineers and two EHP engineers, and the remaining sites were visited by one INAPA engineer and one EHP engineer. To ensure consistency among the criteria used for the ratings given to all projects that were evaluated, the entire evaluation team met and discussed each project and its rating in detail.

APPENDIX C: Photos

The photos on the following pages show various aspects of technology selection, design, and construction, which were taken into account when rating the quality of work performed by the NGOs and private sector contractors. The evaluation team did not seek any specific designs, but rather rated projects in terms of their ability to achieve their purpose.

Photo No. 1: This is an excellent springbox (spring captation), and is one of two such adjacent springboxes that provide water to the INAPA project serving the community of Galion. In the foreground one can see diversion canals that help to protect the springboxes from contamination from surface runoff water.

Photo No. 2: This is another view of the excellent surface runoff water diversion canals above the springbox shown in the previous photo.

Photo No. 3: This springbox (spring captation), built by an NGO to serve the community of Apolinar Perdomo, has several deficiencies, although it does function to collect water for the system. One deficiency is the lack of a surface runoff water diversion canal above the springbox; this is particularly important because there are homes located uphill from it. Another deficiency is oversizing, which resulted in an unnecessarily high cost.

Photo No. 4: This is a surface water intake that is part of an INAPA project built by a private contractor in the community of Capulin. People bathe directly in front of the intake, and there is no fencing or other protection to discourage this.

Photo No. 5: Taken at the same location as in the previous photo, this one shows an open entrance to the intake structure, where the cover is made of concrete and is too heavy for a single person to lift and place in its correction position.

Photo No. 6: This photo shows a slow-sand filter that is part of an INAPA project built by a private contractor in the community of Capulin. It has a good design.

Photo No. 7: This photo shows

the chlorination system that follows the slow-sand filter shown in the previous photo, serving the community of Capulin. Unfortunately, at the time of the inspection, the regulator was out of service and the chlorine dose could not be adequately controlled.

Photo No. 8: A river intake serving the communities of Honduras and Matadero. The screen at this intake eliminates only the largest objects, and the water is in obvious need of treatment. This is an INAPA project built by a private contractor.

Photo No. 9: This is the treatment plant for the water captured at the intake shown in the previous photo, serving the communities of Honduras and Matadero.

Photo No. 10: This is another view of the treatment plant shown in the previous photo. Although it lacks redundancy that would have been desirable, it is designed adequately to achieve its purpose. However, it is not being properly operated.

Photo No. 11: This is an example of a well-designed and constructed entrance to a water storage tank, built by an NGO in the community of Los Arroyones.

Photo No. 12: This valve box has been very poorly constructed, with the valves embedded in concrete, and only their handles left exposed. If maintenance is eventually required for these valves, it will be necessary to construct a by-pass and install new valves to replace them. This was constructed by an NGO in the community of Charco Prieto-Leonardo.

Photo No. 14: This well head, in the community of Guzmancito, is inadequately sealed and is thus subject to contamination.

Photo No. 13: This is an example of an inadequately protected well, constructed by an NGO in the community of Monteado. The well is at a low point, and surface runoff water will tend to flow towards it. Because of the lack of fencing, animals are able to defecate close to the well and thereby expose it to contamination.

Photo No. 15: This is an example of a poorly supported suspended span of pipe in the community of Bella Vista.

Photo No. 16: This photo shows a well-supported suspended span of pipe in the system serving the communities of Charco Prieto and Leonardo.

Photo No. 17: This is an appropriately designed and constructed array of solar panels, which collect energy to operate a pump for the community of Monteado.

Photo No. 18: This is an excellent water storage tank built by a private-sector contractor for a Pro-Comunidad-funded project serving the community of Rincon Caliente.

Photo No. 19: This water storage tank, serving the community of Apolinar Perdomo, has several deficiencies, as illustrated in the following two photos.

Photo No. 20: The 4-inch diameter white PVC pipe in the foreground of this photo is used as a spigot to provide water to families that live uphill from the water storage tank. It is connected to an inlet pipe and is operated via a gate valve. It has two major shortcomings: (1) it provides excessive quantities of water, thereby wasting water that would otherwise enter the water storage tank and (2) the excess water is directed along the edge of the tank and is causing erosion that will eventually undermine the tank.

Photo No. 21: This photo was taken from the top of the water storage tank. It shows an overflow pipe that is improperly located and directed where it is causing erosion, which will eventually undermine the tank.

Photo No. 22: In contrast to what was shown in the previous photo, this overflow pipeline is approximately 200 ft. long and conducts excess water to a ravine where it will not cause unacceptable problems. This was constructed by an NGO in the community of La Flor.

Photo No. 23: This water storage tank was constructed by a private sector contractor for a Pro-Comunidad-funded project serving the community of Rancho Viejo. It has a serious defect, which is shown in the following photo.

Photo No. 24: The water storage tank shown in the previous photo is located on a steep hillside that is beginning to erode. There is a risk that this erosion will continue and will eventually undermine the tank. This could be prevented by soil stabilization actions, such as planting appropriate vegetation or constructing appropriate masonry structures.

Photo No. 25: PVC pipelines should not be left exposed, and such an error has resulted in this pipeline being punctured with a major leak. This is in the community of Capulin, served by an INAPA project that was constructed by a private sector contractor.

Photo No. 26: The community has provisionally resolved the problem of the leak shown in the previous photo by plugging it with a wooden peg. This is not a long-term solution, and would not have been needed if the use of PVC pipe had been avoided in this exposed area.

Photo No. 27: This pressure-breaker box was disconnected from the water system and bypassed because it was eliminating pressure needed for the water to reach a sector of the community of Charco Prieto. In fact, this box was not needed and its construction was a waste of money, as a result of a design error.

Photo No. 28: This public standpost has an excellent design and construction, with good drainage. It was built by an NGO for a Pro-Comunidad-funded project in the community of Los Arroyones.

Photo No. 29: This is another example of a public standpost with an excellent design and construction, including good drainage. It was built by an NGO in the community of La Flor.

Photo No. 30: The drainage at this public standpost is obviously inadequate, creating unsanitary puddles that can become breeding grounds for mosquitoes. It is in the community of San José, and was built several years earlier than the excellent standpost shown in the previous photo, which is in a different community but was built by the same NGO.

Photo No. 31: This public standpost, in the community of Apolinar Perdomo, has inadequate drainage similar to that of the standpost in the previous photo.

Photo No. 32: This nicely constructed public standpost was abandoned shortly after its completion. It was no longer needed because all of the homes in the community installed yard connections. It was built by a private sector contractor for a Pro-Comunidad-funded project in the community of Rincon Caliente.

Photo No. 33: This is one of the yard connections that superseded the public standpost shown in the previous photo.

Photo No. 34: This is a terribly constructed yard connection built by a private sector contractor for an INAPA project in the community of Palma Sola. The concrete base should have been imbedded below ground level, but is instead exposed, allowing the entire standpost to rock. It is likely that such rocking will eventually break the pipe below it.

Photo No. 35: This is another poorly designed and constructed yard connection in the same community as the previous photo.

Photo No. 36: Exacerbating the potential problems from the poor yard taps shown in the previous two photos, the pipelines connecting them to the main line are made of plastic and are exposed to tampering and abuse, as shown in this photo. Furthermore, there are no cock valves (llaves de paso) on these connecting lines, making it impossible to isolate them when repairs are needed.

Photo No. 37: This is a well-designed and constructed VIP latrine, built by an NGO in the community of Vuelta Grande.

Photo No. 38: This is a detail of a properly constructed VIP latrine, where fly-screen has been placed over the top of the ventilation pipe. Flies that are attracted by light to travel up the pipe from the latrine pit will die as they try to escape against the screen. This will eliminate the flies as disease vectors.

Photo No. 40: This is a closer view of the cut-off ventilation pipe shown in the previous photo.

Photo No. 39: This is an example of a foolishly constructed VIP latrine, where the ventilation pipe has been cut off within the latrine, thereby obviating its function. This was constructed in the community of Villa Pando, by a private contractor, for a Pro-Comunidad-funded project. It is obvious that the contractor did not understand the function of the ventilation pipe.

Photo No. 41: Three members of the evaluation team are seen inspecting a latrine.