THESIS

COMMUNITY WATER SUPPLY:

PROJECT EFFECTIVENESS AND SUSTAINABILITY

Submitted by

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WE HERBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY CHRISTOPER DALE PELTZ AND ENTITLED COMMUNITY WATER SUPPLY: PROJECT EFFECTIVENESS AND SUSTAINABILITY BE ACCEPTED AS FULFILLING IN PART THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT OF THESIS

COMMUNITY WATER SUPPLY: PROJECT AND EFFECTIVENESS

Clean water is a necessity for all humans. However, there are more than 1 billion people in the developing world that are unable to access, on a daily basis, a reliable source of clean, freshwater. This problem is particularly acute in rural areas and small communities, where water collection may require hours of physical effort, water sources may be contaminated, or must be purchased at rates too expensive to allow for proper health and hygiene. Rural areas are also typically where water resources are managed by the end users, i.e., community management. Community managed water systems are some of the oldest forms of social organization, however, due to a number of post-colonial issues, such as dynamic political change, rapid population growth, environmental degradation, climate change, misguided development policies, and the shift from agrarian economies to market economies, these systems are in jeopardy of losing their resilience and effectiveness.

These issues cause development practitioners to ask two questions: (1) what are the circumstances that contribute to the sustainability of rural water supply systems; and (2) what are the best ways to support rural communities in meeting their water supply needs?

These two questions are explored by summarizing the major theoretical concepts and methodological practices of rural water supply development, and examining a case study of an ongoing water supply project in La Laguneta, El Salvador.

The investigation of the theoretical underpinnings of current development thought and practice, and the application of those concepts during the preliminary phases of the project in El Salvador are then combined into a framework for assessing system effectiveness and sustainability: the Water Project Assessment Framework (WPF).

The results of this research indicate that there are four major topic areas that contribute to water system sustainability and effectiveness, including the physical environment, the financial conditions, the socio-political context of the country and community, and a community's ability to access some form of outside development assistance, be it private, public, or non-governmental. Furthermore, this research found that participatory methods, when used during the assessment phase of a water supply project, support better information collection and communication, ultimately leading to more effective and sustainable water supply systems.

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Dedicated

In Memory of

Donna Carol Peltz

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Acronyms

ADB	Asian Development Bank
ADESCO	Asociación de Desarrollo Comunal (Community Development Association)
AfDB	African Development Bank
ANDA	Administracion Nacional de Acueductos y Alcnatarillado (National Administration of Aqueducts and Sewage Systems)
CAFTA	Central American Free Trade Agreement
CARE	Cooperative for Assistance and Relief Everywhere
CRS	Catholic Relief Services
CBO	Community-Based Organization
DEM	Digital Elevation Model
EWB-CSU	Engineers Without Borders – Colorado State University (student chapter)
EWB-USA	Engineers Without Borders – United States of America (national office)
GDP	Gross Domestic Product
GNI	Gross National Income
GTZ	Gesellschaft fur Technische Zusammenarbeit (German Agency for Technical Cooperation
IADB	Inter-American Development Bank
IMF	International Monetary Fund
IRC	International Water and Sanitation Center
JICA	Japan International Cooperation Agency
MGD	Millennium Development Goals
MSPAS	Ministerio de Salud Publica y Social (Ministry of Public Health and Social Attendance)
NGO	Non-Governmental Organization
PCI	Project Concern International
PCV	Peace Corps Volunteers
PPP	Purchasing Power Parity

PRA	Participatory Rural Appraisal
PRSP	Poverty Reduction Strategy Paper
RRA	Rapid Rural Appraisal
RWS	Rural Water Supply
SIDA	Swedish International Development Cooperation Agency
SNET	Servicio Nacional de Estudios Terriroriales (National Service of Territorial Studies)
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
USACE	United States Army Corps of Engineers
USAID	United States Agency for International Development
VLOM	Village Level Operation and Maintenance
WASH	Water, Sanitation and Hygiene Program
WPF	Water Project assessment Framework
WHO	World Health Organization
WWAP	World Water Assessment Program

Conversions

Centimeter (cm)	Divide by 2.54	Inch (in)
Meter (m)	Divide by 0.034	Foot (ft)
Kilometer (km)	Divide by 1.61	Mile (mi)
Liter (l)	Divide by 3.78	Gallon (gal)
Cubic meters-second (CMS)	Multiply by 35.31	Cubic feet-second (CFS)
Kilogram (kilo)	Multiply by 2.2	Pounds (lb)
Celsius	Multiply by 1.8 + 32	Fahrenheit

1 Liter of water = 1 Kilogram

1 Cantaro = 25 Liters

Chapter I

Introduction

Water supply: A Global Challenge

> *"The centrality of freshwater in our lives cannot be overestimated. Water has been a major factor in the rise and fall of civilizations. It has been the source of tensions and fierce competition between nations that could become even worse if the present trends continue. Lack of access to water for meeting basic needs such as health, hygiene and food security undermines development and inflicts enormous hardship on more than a billion members of the human family. And its quality reveals everything, right or wrong, that we do in safeguarding the global environment."*
> (Annan 2003)

The quote from Koffi Annan's introduction to "Water for People, Water for Life" (UNESCO 2003) speaks of the central importance of water in improving the human condition as well as the environmental conditions of landscapes increasingly dominated by humanity. The challenge of water for all is one that has taken on renewed interest through the declaration of the Millennium Development Goals (MDG), which has, the specific target, of reducing by half the proportion of people without sustainable access to safe drinking water by 2015 (United Nations 2000). Estimates from the World Health Organization (WHO) suggest that to provide water to all those who currently lack it, may cost as little as $\$50^{-\text{person-year}}$ or approximately $11.3 billion (WHO 2000; WHO/UNICEF 2005). Additionally, the causes and sources of water borne diseases have been widely understood for ~150 years (Johnson 2006). Furthermore, following the post WWII era, the proliferation of international, national and supra-national agencies dedicated to the goal of 'human development' has steadily increased to where there are now over 53,000

Non-Governmental Organizations (NGO's) (www.devdir.org) , more than 1,200 microfinance banks (Sengupta and Aubuchon 2008; www.mixmarket.org), and numerous other national and international organizations, trusts and foundations, who specialize in everything from financial services, health and welfare, and technical consulting, all with the goal of human social and economic development.

So, it seems improbable that over a billion people currently do not have adequate access to one of the most basic human needs – water. The current "water crisis" where nearly 1.1 billion people or 20% of the world's population lacks access to safe drinking water and over 4,500 children die each day as the result of polluted water, exists not simply due to a lack of effort (UNICEF/WHO 2005). Examples of this effort are reflected in the high profile given to water at the international level, for example, beginning in 1970 and continuing to the present there has been a numerous international meetings, conferences, and declarations, with various strategies, plans and goals proposed to solve the water supply problem at each one (see for example; World Water Assessment Programme 2006, www.unesco.org). Additionally, it has been estimated that over 2.3 trillion dollars spent on development by the West during the post WWII era (Easterly 2006, p. 4). However, the condition persists, and approximately 1/3 of humanity does not have access to basic water needs. Why is this? And what can be done about it?

This research sought to explore these questions by focusing specifically on what makes rural water supply projects effective and sustainable, and applying that understanding to an ongoing water supply and development project in a small community in El Salvador.

Meeting Basic Needs

It is widely accepted that in order to achieve a basic level of health and dignity an adequate amount of clean water is a daily necessity. There is also wide international consensus that the sustainable provision of basic water needs for populations in the developing world is both a global priority and global responsibility (Rosengrant 1997; Gleick 1998; 1999; 2000; 2002; World Water Assessment Program 2003). The World Health Organization (WHO) recommends that a minimum of fifty liters of clean freshwater be available to each person, every day in order to maintain basic health and cleanliness (Table 1.1).

Table 1.1 World Health Organization minimum daily water requirements

Direct Uses	**Recommended minimum (liters $^{-person - day}$)**
Drinking	5
Cooking	10
Indirect Uses	
Sanitation	20
Bathing	15
Total	50

(WWAP 2003)

Progress has been made towards meeting the water supply needs for the world's poor, for example, in 2002, 79% of the population in developing countries had access to improved water supplies, bringing up the total world coverage to 83%. This is an increase of 8% from 1990 to 2002 (WHO/UNICEF 2006). These increases have resulted in more than 1 billion additional people gaining access to improved water supplies over the past two decades. However, due to population growth and increasing rural-to-urban migration, there continues to be a large proportion of people in the rural and peri-urban areas of the

developing world that do not have access to adequate water supplies (United Nations 2006, p.18). With over 75% of the world's poor living in rural areas the need to expand sustainable water service to these areas is imperative (De Regt 2005).

Recent research supports the notion that meeting the water needs for those living in rural areas and the urban periphery will require a renewed emphasis in extending technology, infrastructure, financial investment, and capacity building support to those countries and regions that face imminent and future water shortages (Figures et al. 2003; WWAP 2003). Unfortunately, there is lack of consensus regarding how to do this in an effective and self-perpetuating way. Traditional approaches to water supply development require large financial commitments and centralized infrastructure (i.e., supply-side development) (Camdessus 2003). This approach has come under increased scrutiny and has been critically reviewed with an interest toward quantifying impact on livelihoods, health, and poverty reduction as opposed to simply reporting the numbers of wells drilled or latrines built (Nicol 2000). The problems identified by many of these reviews suggest that when projects had failed or were not sustained it was primarily due to a lack of understanding of the specific context of the community or a lack of effective support structures (Reif et al. 1996; Baker 2000; Schouten and Moriarty 2003; Gleick 2005; Fewtrell et al. 2005; WWAP 2006).

Moreover, when development projects were reviewed months or years after the initial construction a common theme emerged, namely, that when infrastructure improvements did not adequately involve the community during the design and implementation phases, the projects were more likely to be dysfunctional, thereby negating or diminishing the impact of the improvements (Ostrom 1993; Chambers 1994;

Hulme 1995; Nicol 2000). In offering an alternative model of development, others have shown that participatory community-based approaches for developing and managing rural water supply systems, when adequately supported and sustained may be more effective, less expensive, and more likely to sustain the service benefits (Narayan 1995; Lammerink 1998; Schouten and Moriarty 2003; Alfaro 2005; Gleick 2005, p. 12; Melo 2005). For example, field experience suggests that a safe and reliable water supply and sanitation service can be provided in rural areas for less than $50 annually, when local communities are involved in the planning and construction, and appropriate technologies are used (WHO 2000; 2003). Furthermore, when participatory processes are employed to engage and support communities in designing and managing water supply systems those systems tend to be more durable and equitable (Narayan 1995; Reiff et al. 1996; Melo 2005, p.16)

Millennium Development Goals

In September of 2000, the United Nations General Assembly adopted resolution 55/2, the Millennium Declaration. This declaration signified a major reinvestment by the world community into improving the environment and living conditions of the world's poor (U.N. General Assembly 2000). The Millennium Declaration specified eight Millennium Development Goals (MDG's):

1. Eradication of extreme poverty and hunger
2. Achieving universal primary education
3. Promoting gender equality and empowering women
4. Reducing child mortality
5. Improving maternal health
6. Combating HIV/AIDS, malaria and other diseases
7. Ensuring environmental sustainability
8. Developing a global partnership for development

These goals have particular relevance to the problem of inadequate water supply in the developing world, in that the MDG's have as a specific target the reduction by half, the proportion of people without sustainable access to safe drinking water and adequate sanitation (Goal 7, Target 10).

> *"Halve by 2015 the proportion of people without sustainable access to safe drinking water"* (UNDP 2005, p. 33)

The primary difference between "improved" and "unimproved" drinking water and sanitation sources is the implementation of physical and management infrastructure for improved sources (Table 1.2). The distinction is important in the context of the MDG's in that, by elucidating specific goals the success of the program has definable and measurable endpoints.

Table 1.2 Improved vs. Unimproved Water Sources and Sanitation Facilities

Improved Drinking Water Sources	**Unimproved Drinking Water Sources**
Household connection	Unprotected well
Public standpipe	Unprotected spring
Protected dug well	Rivers and ponds
Protected spring	Vendor-provided water
Rainwater collection	Bottled or tanker truck
Improved Sanitation Facilities	**Unimproved Sanitation Facilities**
Connection to pubic sewer	Public or shared latrine
Connection to a septic system	Open pit latrine
Pour-flush latrine	Bucket latrine
Ventilated improved pit latrine	

(WHO/UNICEF 2004)

Research Objectives

The primary objective of this research is the development of a series of best practices for conducting the assessment and monitoring phases of community water supply projects for rural areas in developing countries. To achieve this objective, the study plan included the analysis of participatory methodologies and a case study of an ongoing water supply project in La Laguneta, El Salvador. The case study focuses on the actions taken by Engineers Without Borders-Colorado State University (EWB-CSU), community members in La Laguneta, and other outside entities, (Peace Corps, Rotary International, El Salvadoran agencies and engineering firms) during the assessment and preliminary implementation phases of the project. The development of recommendations for the project specifically required the:

1. Identification of key concepts and methods important to development projects and linking those to an assessment methodology;
2. Analysis of the tools and techniques currently used by communities, agencies, and development practitioners to identify, design, and implement community water development projects;
3. The application of those tools and techniques to the case study

Identification of key elements necessary for the sustainability and effectiveness of a Rural Water supply System (RWS) was recognized as a crucial step for the development of effective recommendations for the case study project. These key elements (Table 1.3) include the aspects of a RWS that relate to the physical environment; the socio-political context of the country or region; the specific economic opportunities and constraints of the community members; the nature of development aid

the community can access; as well as the degree that community members participate in project identification, design, implementation and operation.

Table 1.3 RWS project effectiveness and sustainability factors

Key Element	Affects Water supply by:
Physical Environment	Constraining the amount, timing, and duration of precipitation that falls within the watershed where a community is located.
Social and Political Conditions	Defining the character of local and regional governance as well as limiting the amount, character and duration of government support for social goods (e.g., roads, power generation, laws, health programs, schools etc.).
Economics	Limiting the amount of financial capital a community or regional government has the ability to access to pay for public good activities, such as water supply.
Access to Development Aid	Expanding the financial and technical base from which individual communities can draw on to meet their water supply needs.
Community Participation	Identifying demand and the most direct and locally relevant options for meeting it.

El Salvador Case Study

The case study examined an ongoing Rural Water Supply (RWS) project facilitated by EWB-CSU. This project is located in the small village of La Laguneta in the La Paz department of El Salvador. The community of La Laguneta with the assistance of a Peace Corps volunteer (PCV) solicited EWB-USA in the fall of 2005 for assistance with the design and implementation of a RWS improvement project. The project was reviewed by EWB-USA and sent to EWB-CSU during the fall of 2004. Project activities for the EWB-CSU team commenced during January of 2005, continuing up to, and through the time of this writing.

The case study outlines the efforts of EWB-CSU, in terms of the assessment, collaboration, and implementation phases of the La Laguneta project, including the

techniques employed to establish baseline data and implement the communities preferred alternative - - improve existing infrastructure and dig additional shallow wells. This case study tracks the project over the course of two and a half years, from project identification to the assessment, design, and preliminary implementation phases.

The main conclusions derived from this study are the result of the information gleaned from the literature as well as the experience gained working with the community in El Salvador.

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Chapter II

Literature Review

Introduction

Chapter two summarizes the key concepts and methods utilized by development agencies to engage communities with the identification, implementation, and monitoring of improved rural water supply systems. The first section of this chapter will address some of the key concepts of Rural Water Supply (RWS) and the various definitions of Community, Sustainability, and Project Effectiveness. The second section reviews the current tools and techniques that have been, and currently are, used for water supply development projects.

Rural Water Supply Key Concepts

The topic of water development is broad and includes disjunct and potentially contradictory, disciplinary and professional foci (Cairncross 1992; Kumar 2002; Swartz and Ralo 2004). These different disciplines range from health care to engineering to anthropology. Furthermore, the push by many in the development sector toward 'multi-disciplinary' teams has the potential to create confusion among team members when communicating the details of RWS systems or methods used to assess rural conditions. Therefore, in order to establish a common basis of understanding a set of synthesis definitions of the key terms related to RWS development was developed. The following

sections examine these definitions by exploring their origins and current application as associated with RWS development.

Rural Water Supply

RWS systems are commonly defined as those water supply systems that operate independently of other formal services (Schouten and Moriarty 2003, p. 10). These systems may be rural or otherwise independent of a municipal supply network or, simply, a RWS may be a water system established where the regional water management agency does not have authority or the ability to extend infrastructure (Deverill et al. 2004; Swartz and Ralo 2004).

Some of the infrastructure features of a RWS system include boreholes, hand pumps, raw water mains, elevated tanks, roof rain-water catch tanks, small diversion dams, and gravity powered pumps (e.g., hydraulic rams) (Wagner and Lanoix 1959; Jordan 1980; WASH 1990; Younger 2007). RWS systems are also defined by a type of management and governance, which is often community based and derived from social rules and socially agreed upon modes of operation (Brooks 2002).

Rural water supply projects differ from municipal water development, large-scale irrigation works, or hydropower development in that a RWS project is focused primarily on the management of land and water resources for human consumption in rural areas, through the utilization of local institutions (Cairncross 1992; Narayan 1995; Paudel and Gopal 2004; Swartz and Ralo 2004). Moreover, a RWS improvement project is generally an action, by a community and any collaborators to materially improve the access individuals have to a clean and reliable water source (Lammerink 1998; MacDonald 2005, p. 32). Typically, the main objectives of a RWS initiative are to increase and

improve the quantity and quality of water used by a group of people on a continuous basis (Wagner and Lanoix 1959, p. 18; Schouten and Moriarty 2003, p. 18). Some of the general features of rural water supply projects include:

1. Rural location (Schouten and Moriarty 2003, p.11)
2. Operation independent of a municipal infrastructure network (McCommon el al. 1990; WHO 2000, p. 4)
3. Responsibility for operation and management falls to the end-users of the system -- Direct Management (Lammerink 1998; Brikke 2000; WHO 2000, p. 6)

Drawing on the commonalities of RWS definitions, this research has utilized a definition of RWS projects that includes: those *water projects that seek to materially improve a water supply service from unimproved sources to an improved source, managed and maintained by a local, community-based organization (CBO) who take the primary responsibility for decisions relating to the technology used, system layout, and financing of the operation, management, and repair of the infrastructure.*

Community

Identifying what constitutes the 'community' is complicated by the various forms that communities may take (Black, 1998; Carter, 1999; Guijt, 1998). However, Rickson et al. (1995) and the Agricultural Resource Management Council of Australia and New Zealand ARMCANZ (1995) offer two relevant and practical definitions of what a community is:

> *A community is a set of social relations based on shared values, a sense of mutual destiny, common bonds and obligations, and the primary ties to a local area and its biophysical environment*. (Rickson et al. 1995 250)
>
> *A community should be the smallest possible jurisdiction that encompasses all the costs and benefits of a decision.* (ARMCANZ 1995 20)

There are several basic elements regarding what can or should be defined as a community. These elements primarily consist of a population subset that is distinct in some way, be it geographically, administratively, or socially. A community must also be able to share, define, and in some way enforce social rules regarding resource use, and have a mechanism to institute management decisions regarding that resource.

An alternative view of community is offered by Guijt and Shaw (1998, p. 45), who suggest that defining a community is inappropriate due to the multiplicity of social, political, and economic forces which instead, tend to create populations of heterogeneous individuals with competing needs and goals rather than a community of people with co-dependent needs and desires.

This research has chosen to utilize a definition of a community that is primarily location specific and reflects rural conditions, as opposed to those definitions of community that emphasize political affiliation, philosophic predilection, or ideological similarity. The definition of community this research utilized is: *A community is comprised of a group of individuals, who share a common set of needs and goals, and have a mechanism for making collective decisions and taking action.*

This definition fits well with the case study in El Salvador due to the relative geographic isolation of the community and the small size and relatively uniform desire to improve the water supply system in the village.

Project Effectiveness

Project effectiveness can be considered a proxy for project impact. Project effectiveness is a measure of the beneficial impact on communities, from the

improvements in water service and other project outputs – improved quality, taps closer to homes, improved community organization, etc. (Carter et al. 1999). Project effectiveness is defined by Narayan (1995, p. 21), as a global measure of all project costs and benefits in the areas of construction, operation and maintenance, health and sanitation, education, institutional development, and income generation.

There are numerous citations that treat the subject methods for impact assessment (Carter et al. 1999, Baker 2000, Hubbard 2000). Generally though, these methods suggest that to determine the ultimate impact of a RWS project, one must be able to:

- Track the incidence of water related diseases (Brentlinger et al. 1999)
- Quantify the reliability[1] of the RWS system (Hoko and Hertle 2006)
- Gather opinions from users of system about usability and service provision (Narayan 1995).
- Utilize participatory assessments of project outcomes (Kumar 2002)
- Quantify the social or economic benefit of less time spent hauling water (R. Tinsley pers. comm.)

In synthesizing the range of metrics used to define project impact I choose to utilize a definition of project effectiveness that focuses closely on water system infrastructure improvements and the management capacity needed to sustain those improvements. Thus, project effectiveness is defined here, as: *Effectiveness is, if the water service provides the intended population with the quantity and quality of water specified by their needs and the capability of the management organization is matched to the size and complexity of the system.* The specific ways in which project effectiveness may be measured for the case study in El Salvador is by comparing time spent hauling water

[1] Reliability of water supply systems typically refers to the occurrence of service stoppages due to malfunctioning equipment, lack of repair materials (Hoko and Hertle 2006)

before and after the infrastructure improvements and by the degree reduction in water rationing during the dry season (November – April)

Sustainability

Sustainability has been called one of the most used and abused words in the development vocabulary (Sugden 2003, p. 1). Regardless, sustainability and sustainable development are the cornerstone goals, of development in general, and water supply specifically (WWAP 2003). And though there are widely ranging applications for the term sustainability, a number of common themes often emerge, namely, that resources are limited; humans are interdependent upon each other and the natural environment; these dependences are through time and between generations; and, that there must be equity in the distribution of goods and services if the ideals of justice are to be adhered to (Lockwood et al. 2003).

What is sustainability and how it manifests into development actions is the subject of much debate, with arguments for using the concept broadly, as in across generations, contrasted with the narrower view of sustainability that focuses on very specific aspects - as in availability of spare parts or financial solvency. Two definitions, one offered by the Brundtland Commission (1987) and the other by Kaliba and Norman (2004) provide a small example of the range with which the concept is applied.

> *Sustainability is....Development which meets the needs of the present without compromising the ability of future generations to meet their needs and aspirations*
> (WCED 1987 54).

> *Sustainability is when projects produce a continuous flow of outputs/goods, benefits or services throughout their intended economic life cycle*
> (Kaliba and Norman 2004, p. 76)

The definition offered by the Brundtland Report (WCED 1987) is focused primarily on the inter-generational aspects of sustainability, while Kaliba and Norman's (2004) intra-generational definition focuses on the specific elements of a development project. The contemporary definition of sustainability offered by Kaliba and Norman (2004) is comprised of five different aspects (Table 2.1) which describe the reliability of a water system; human institutional capacity and investment in its development; the cost of operation and maintenance; and the collaboration with and between various agencies, government entities and national and international NGO's.

The broader concept of sustainable development as a multi-scale, multi-disciplinary, multi-perspective definition was produced for the Brundtland Report in an effort to represent the most recent theories of development, economics, sociology and the environment. As Michaels and Laituri (1999) note, the Brundtland Commission combined three different streams of thought into a single statement and vision for how to balance the needs of today's population, with the needs of future populations. These streams include the idea that localized environmental degradation has global effects; human development and environmental conservation are the same cause; and that sustainable development will never be achieved if the disparity of wealth between the poor and the rich is not drastically reduced (Michaels and Laituri 1999).

Table 2.1 Aspects of Sustainable Water Supply Systems[2]

Aspect	Link to Sustainable Water Supply Systems
Reliability	For community based water systems, the availability of spare parts and local skills to operate and maintain facilities play a critical role in ensuring that the system remains functional.
Human Capacity	Specialized training of project managers and staff is needed to build support and local capacity for operation and management. Since, in many cultures, women have a greater role than men in managing domestic water supplies, their involvement is crucial.
Local Institutional Capacity	Sustainability of participatory type projects requires a relatively autonomous institutional structure. Management of such projects needs to have the flexibility to implement any necessary remedial measures.
Operation and Management	In addition to expressing what they want, users of a system should contribute resources to make the project sustainable. Such projects are unlikely to be sustainable if the resources required for operation and management are beyond the capacity of the community to provide them.
Interagency Collaboration	Interagency collaboration requires that communities, governments, NGO's, the private sector, and research institutes and universities work together and share information and utilize the multiple skills and resources of each in a spirit of collaboration.

[2] Adapted from: Kaliba and Norman 2004

The Brundtland Commission offered a contemporary vision of what sustainability should be in terms of overall goals and vision however, the operational and pragmatic definition provided by Kaliba and Norman (2004) is also needed for the more practical purposes of identifying, designing and managing community water supply systems.

Expanding on the work of Kaliba and Norman, Carter et al. (1999, p. 4) provides a simple, easily verifiable definition, of sustainability for RWS:

> *'Sustainability in water and sanitation interventions can be achieved when the services continue to be provided, with relative autonomy, for successive generations*.'

By including both the inter and intra-generational aspects of sustainability Carter et al's (1999) definition succeeds in bridging between the Brundtland Commission's intra-generational and Kaliba and Norman's project-focused definition of sustainability. To discern the long-term sustainability of a project Carter et al (1999) proposed an assessment of the key components pertaining to the sustainability of water and sanitation projects, which includes:

- Understanding of the present water and sanitation problems faced by communities
- Identifying the potential benefits delivered by improving infrastructure
- Observing actual benefits experienced by users and consumers
- Quantifying the magnitude of beneficial impacts

This research utilizes a similar definition of sustainability in that sustainability for a RWS project is achieved when *a system operates effectively with minimal non-community financial support and that there are mechanisms in place that protect the community from extended periods of service stoppage*.

Participation

The idea that communities should be actively involved in the provision of water supply has become widely recognized as critical to the long-term sustainability of any water supply system (Narayan 1995; Wijk-Sijbesma 2001, p.28; Garande and Dagg; 2005). The primacy of community participation has become a central idea within contemporary development theory and practice (World Bank 1996; Rietbergen-McCracken and Narayan 1998; Kumar 2002). Moreover, the notion of participation has informed much of the current analysis of development practice (Mayoux and Chambers 2005; Annan 2005).

Community participation has been identified as a primary determinant of project sustainability and its relationship to project effectiveness has been estimated both qualitatively (Lund 1990; Lombardo 1998) and quantitatively (Narayan 1995; Mayoux 2005). Participation by community members in the identification, design, implementation and especially management stages can be understood in terms of the need and motivation of the community, as well as an indicator of community structure and cohesion. Various models of how communities participate in development projects are described by Arnstein, (1969), Chambers (2005), Vene Klasen and Miller (2002), and Kanji and Greenwood (2001) and include the full range and depth of community participation, from simple consultation by the community elite to the full and active participation of a representative cross-section of a village or set of villages.

The current emphasis on involving end-users in the assessment, design and implementation phases of development projects was not always the case, and the evolution of 'participation' has taken decades (Chambers 1994). For example, since the

early 1960's, development agencies have attempted to involve communities through the use of various participatory techniques and methods (Cohen and Uphoff 1977; Chambers 1994, Chambers 2005, p. 86). As Chambers (1994) notes, the modern version of community participation is derived at least in part from activist participatory research and Palo Freires' writings in *Pedagogy of the Oppressed* (1968), Gordon Conway and the systems, action-orientated thinking of agroecosystem analysis (Conway 1985), the early 1980's applied anthropology movements, particularly Robert Rhoades, *The Art of the Informal Agricultural Survey* (1982), as well as the use of Rapid Rural Appraisal (RRA), developed in the late 1970's, as response to the dissatisfaction practitioners were having with traditional surveys and other extractive methods of information gathering (Chambers 1994).

Kumar (2002) demonstrates how the typology of participation (Table 2.2) has evolved since the concept was first used, noting that in the 1970's participation typically meant that the people agreed with decisions made for them, while in the late 1990's participation evolved into the active involvement of people to analyze their situation and organize themselves to take actions to change it (DID 2000). Part of the rational for using participatory processes in development activities is that, it is now widely recognized that projects have a much greater chance of success, in addition to achieving a much higher level of effectiveness when participatory processes are used (Bell and Morse 2004; Garande and Dagg 2005).

Table 2.2 Typologies of Participation

Citation	Definition of Participation
ECLA 1973	Voluntary contribution by people in public programs designed to contribute to national development but people are not expected to take part in shaping the program or in criticizing its contents.
Cohen and Uphoff 1977	Includes people's involvement in decision-making processes program implementation benefit sharing and involvement in the evaluation of programs and interventions.
Conyers 1981, p. 103	Participation is means for obtaining information about local conditions needs and attitudes and eliciting beneficiary commitment to the process.
Paul 1982	Participation is an active process by which beneficiary or client groups influence the direction and execution of a development project with a view to enhance their well-being in terms of income, personal growth, self-reliance or other values they cherish.
Schneider and Libercier 1995	A 'people-centered process' demand-driven by being ultimately based on dynamics perception priorities capabilities and resources of the people.
Narayan 1995	A voluntary process, by which people including the disadvantaged (in income, education, gender, ethnicity, influence or control over the decisions that affect them) exercise voice and choice.
World Bank 1996	A process through which the public influences and shares control over development initiatives, decisions, and resources which affect them.
Guijt and Shah 1998	The broad aim of participatory development is to increase the involvement of socially and economically marginalized peoples in decision-making over their own lives.
Blackburn *et al.* 2000	Participation means enabling people to realize their rights to participate in and access information for the decision-making process.

Table adapted from: Kumar S. 2002

The participatory tools and methods developed since the 1980's all share the overall objective of the involvement of the project population in the identification, design, and management of projects outcomes (Bentley 2004; Bhatnagar et al. 1996). Participation, at its most fundamental implies two similar but distinct principles: efficiency and empowerment (Oakley et al. 1991; Nelson and Wright 1995). The empowerment aspect

of participation strives to create a condition where the right to determine ones destiny is achieved and decisions about resource use include the resource user (Kumar 2002, p. 22). Participation as empowerment seeks to develop the ability and capacity of people to improve their own lives irrespective of outside intervention (Freire 1970; Cleaver 2001). Alternatively, the efficiency component implies that participation is a means to implement development strategies using community participation as a tool for achieving the best possible project outcome (Paul 1982, p. 202; Cleaver 2001). The studies conducted by Paul (1982) and Ostrom (1993) suggest, that the success of interventions over the long term was dependant on nine specific strategies:

1. An initial focus on a single goal or service with clearly defined boundaries.
2. Sequential diversification of goals and explicit rules for achieving project goals.
3. Phased program implementation, including graduated options for involvement.
4. Organizational autonomy supported by sector programs and/or national goals.
5. The use of social network structures to identify and implement project outputs.
6. Monitoring with simple information systems with immediate or rapid feedback.
7. Flexible selection processes that employs collective choice arrangements.
8. Functional and vertical integration of project goals and inputs.
9. A method for conflict resolution.
   (Paul 1982; Ostrom 1993)

Recognizing that the notion of participation is a complicated and value laden term, this research choose a definition of participation that could be applied to the case study in El Salvador, and which generally follows the definitions developed by Narayan (1995), Guijt and Shah (1998) and Chambers (1994, b). *Participation is a means to engage, empower, and move to action, individuals who choose to elicit some control over local natural resources, water in particular*.

Rural Water Supply Key Methods

Since the late 1980's a shift has occurred in development practice. The move has been away from command and control modes of operation and toward empowerment of

local organizations (WASH 1990; Picciotto and Weaving 1994; Stieglitz 1998). This contemporary paradigm of development spawned a range of techniques and methods (Kumar 2002, Mukherjee 2002, Nelson and Wright 1995). These methods sought to achieve several objectives; acquiring information for assessment, matching technical assistance to a specific context, and empowering people to make informed decisions about natural resources (Lombardo 1998, Rall 1998, Pearson 2002, Matthew 2005).

The current suite of tools development practitioners now use to engage communities in the identification and development of improved water and sanitation initiatives, grew out of the rural appraisals and participatory action research of the late 1970's and early 1980's (Lutz 1994, Chambers 1994 c Rietbergen-McCracken and Narayan 1998). These "tools" include group interviews, transect walks, mapping and ranking exercises (Table 2.3). These tools and methods may be used as part of a development team's strategy to assess the community demand and how individuals conceptualize current and potential future water use.

The central focus of these techniques is to provide local individuals with the means to communicate their understanding of conditions and to discover locally relevant options for addressing those conditions. Furthermore, participatory methods can be used in sequence - - mapping exercises, timelines, and ranking - -to increase both the development teams understanding of the problem as well as the community's conception of the problem. In the context of water supply development the overall goal of using participatory methods is to identify the specific water supply issues and to discover all potential locally relevant solutions, and then to communicate those solutions among the communities population and to the development team involved in the assessment.

Table 2.3 Participatory Methods

Type	Methods	Elements
Space Related Methods (McCracken et al 1988, Mascarenhas and Kumar 1991)	Social and Resource Map Mobility Map Services and Opportunities Map Transect Walk Census Map	Local reality of space. Scale less important. Locally important landscape features. Identification of locally important natural/social resources. Maps created by local people using available materials. Visualization of key changes in landscape pattern, use and management.
Temporal Methods (Guijt and Pretty 1992)	Time Line Trend Analysis Historical Transect Seasonal Diagram Daily Activity Schedule Dream Map	Sequential aggregation of past events. Identification of important historical events. Depiction of daily, monthly, yearly activities of importance. Evaluating changes to landscape, infrastructure, or policies. Future preferred condition.
Relational Methods (Drinkwater 1993, Meams et al. 1992)	Flow Diagrams Process Map Well-being Ranking Method Process Map Venn Diagram Pair-wise Ranking Method Matrix Scoring	Visually depicting cause and effects. Focuses on causes not symptoms. Identifying linkages between causes and conditions. Assessing the impact of an action(s). Allows grouping of households-individuals based on locally relevant criteria. Explore inter-household disparities in wealth and well-being. Depiction of the step-by-step operation of a process.

The above table is not exhaustive; there are numerous alternatives to the methods mentioned above, including social and cost benefit analysis. However, table 2.3 represents the main methodological actions that current participatory development follows (Chambers 1994c; World Bank 1996; Axnin and Axnin 1997; Kumar 2002;

Mukherjee 2002). The evolution of these methods mirrors the evolution of the demand response concepts and the move toward community management of resources.

Presented below are three of the other major families of methods used by development practitioners to assist communities in the development of improved RWS; and include the Logical Framework Analysis, Rapid Rural Appraisal (RRA), and Participatory Rural Appraisal (PRA).

Logical Framework Analysis

The Logical Framework Analysis or Log Frame is a stepwise process to assess, plan and implement development activities (Coleman 1987). The main innovation of the Log Frame is the planning matrix (Table 2.4) which, is typically used to establish the 'logical' links between project goals and project inputs (Gasper 2000). The benefit of using the Log Frame planning model for RWS development is that there has been considerable research, (Coleman 1987; Mikkelsen 1995; Aune 2000; Gasper 2000; Dale 2003) and much actual practice with these methods, for instance the USAID and the World Bank has utilized the Log Frame to organize development projects since the late 1960's (Coleman 1987; Middleton 2005).

The utility of the Log Frame within the context of project planning is that all aspects of the project as well as the assumptions and necessary inputs can be discussed, summarized, and organized in a causal format. Critiques of the Log Frame point out that the utility of the technique is lost if deference is not given to any underlying social problems or the management capacity of the project beneficiaries (Dale 2003). Other concerns about the use of the Log Frame include the rigidity of the outcomes, the avoidance of problems concerning policy, income distribution, employment

opportunities, local participation, or environmental effects. In addition, the Log Frame has been criticized as a tool that overlooks some of the 'intangible results of development work' and that it focuses the energy of development agencies on the 'counting of beans for publicity's sake'[3].

Table 2.4 Logical Framework Planning Matrix

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Goal Long-term impact	Measurement of goal achievement	Sources of information. Methods used.	Assumptions affecting Purpose – Goal Linkages
Purpose Near-term impact	End of project status	Sources of information. Methods used	Assumptions affecting Output – Purpose Linkage.
Outputs Deliverables	Magnitudes of outputs. Planned completion date.	Sources of information. Methods used	Assumptions affecting Inputs – Outputs linkage.
Inputs Work done for each output	Nature and level of resources necessary. Cost.	Sources of information. Methods used	Initial assumption(s) about the project.

(Coleman 1987)

Others have argued that the Log Frame, which grew out of an era where assumptions were 'relatively understood' and change was considered controllable (Gasper 2000), is not suitable for the dynamic environment of current development (Chambers 1996; 1997). Aune (2000) however, has suggested that the LogFrame can overcome its implicit shortfalls if used in conjunction with participatory methods. Specifically, Aune (2000) suggests that participatory methods should be used to identify

[3] R. Tinsley personal communication 2008

vulnerable groups, their problems and endemic efforts to overcome those problems and then to identify the external factors that relate to the local problems with the structured thinking of the LogFrame.

Rapid Rural Appraisal

As development practice progressed during the 1970's, the notion that questionnaire surveys were not collecting accurate or useful information became more widely accepted (Chambers 1994). Nor, were the ostensibly logical and rigid planning frameworks effective in accounting for the myriad of factors and issues that need to be addressed for RWS projects (Younger 2007). As the criticism of rigid planning and evaluation techniques increased, movements within the development community to began to switch practice toward a more inclusive and locally focused type of development mentality (Harwood 1979; Ellman 1981; GTZ 1990). This switch comprised of a moving away from the rigidity of planning frameworks and the promotion of outside (Etic) knowledge systems towards a more devolved, indigenous (Emic), and location specific method(s) of data collection and synthesis (Chambers 1994 b; c).

Rapid Rural Appraisal (RRA) emerged in the late 1970's as a result of the dissatisfaction with the anti-poverty and rural biases often formed during the brief rural visit by an urban-based professional (Chambers 1994). RRA evolved in response to the realization that the questionnaire survey process did not provide results that were consistent with the realities of rural life (Chambers 1994). RRA consists of a series of techniques for rapid and 'optimally ignorant' research that generate results of less apparent precision, but greater practical value, than quantitative survey techniques (Khon Kaen 1985). RRA draws upon the insights of field social anthropology of the 1930s-

1950s, where the emphasis was on the importance and relevance of *in-situ* local knowledge, and the importance of getting things generally correct, rather than achieving some measure of statistical accuracy.

The practice of RRA developed into a style of 'listening research,' and a creative combination of iterative methods and verification, including 'triangulation' of data from different sources by using different methods to obtain similar information. The chief techniques typically employed for RRA type assessments include:

- Review of secondary sources, including aerial photos
- Direct interviews with key informants, group interviews, workshops
- Mapping, diagramming
- Biographies, local histories, case studies
- Ranking and scoring exercises
- Time lines
- Short, simple questionnaires
- Rapid report writing in the field

(Chambers 1994)

The drawbacks of using the RRA model for rural development work stem primarily from biases about rural living conditions and rural people (Chambers 1983). By not recognizing these biases and actively working to overcome them, RRA loses its effectiveness to fully address the physical and social problems experienced in rural areas. Chambers (1983) identified and listed some of the most common types of biases including: Spatial, Project, Person, Dry Season, Diplomatic, and Professional Biases.

Participatory Rural Appraisal

The direction that rural development began to take during the late 1980's and early 1990's was toward utilizing local knowledge and understanding about the problems and opportunities available in rural settings (Schouten and Moriarty 2003, p. 13). The importance of the movement toward participatory approaches to meeting the challenges

of the rural world is that as the methods of participation became more widely understood and used, the nature of development changed.

Participatory Rural Appraisal (PRA) is distinguished from RRA in that PRA is a 'body of methods to enable local people to share, enhance, and analyze their knowledge of life and the conditions to plan, act, monitor and evaluate' (Kumar 2002, p. 31). The origins of participatory rural appraisal (Table 2.5) grew out of the practices and efforts initially being conducted in Kenya and India (Chambers 1994). However the lineage of PRA is broader and includes poverty analysis through seeking out and dialoging with sectors of the population that had been typically excluded from decision making, namely, the very poor and women. Additionally, PRA is contrasted with RRA in that the focus is less on extractive information gathering and more on problem analysis and options discovery by the affected population, shifting the decision making roles away from the external entity (development team or technical expert) and toward the community. The main role for the development team in PRA is that of the facilitator, convener, and arbitrator.

Table 2.5 Origins of Participatory Rural Appraisal

Title	Major Elements	Focus	Key Citations
Activist Participatory Research	Poverty analysis. Outsiders as conveners, catalysts, and facilitators. Empowerment of the weak and marginalized.	Applying dialogue to enhance awareness and confidence to empower action.	P. Freire 1968 Kassam and Mustafa 1982 Rahman 1984
Agro-ecosystem Analysis	Ranking and scoring. Diagramming and systematic walks. Pattern, temporal, and relational analysis.	Understanding causal links between population pressure and ecosystem function in rural agricultural areas.	Gypmantasiri, et al., 1980 G. Conway 1985
Applied Anthropology	Field learning. Emphasis on attitude and behavior. The emic-etic distinction. Indigenous knowledge.	Farming systems particularly small-holders. Encouraging farmers to do their own analyses.	D. Norman 1975 R. Harwood 1979 P. Richards 1985 C. Lightfoot 1991 J. Ashby 1990 -
Rapid Rural Appraisal	Learning about rural life. Overcoming biases. Non-verbal methods.	Poverty reduction. Cost effectiveness. Rural empowerment.	R. Chambers 1980, 1990, 1994 M. Collinson 1981 University of Khon Kaen 1985

As PRA, became the more accepted mode of rural assessment, the realization became more widely accepted that for interventions to achieve sustainability local people must be allowed to take a larger role during the planning and implementation phases of a project (Chambers 1994 a). For water resources development projects this was a fundamental shift. Requiring development teams and technical consultants move away from the idea that rural people could only be relied upon to identify the problem (RRA) and toward the notion that rural people must be a part of the solution to the problem (PRA). The PRA approach required a shift from ‘dictation to facilitation’ (WASH 1990, p. 17) where collaboration would be used to both design and operate the systems and that the end users of a system had a major voice on all aspects of the project, from technology selection to tariff structure.

The techniques used in PRA to do this are similar to those proposed by RRA in that in PRA development teams strive to engage, encourage and support the efforts of local people to take an active (as opposed to a passive in RRA) role in the design, implementation and management of the water service. The core difference between RRA and PRA is that in RRA outside knowledge and understanding are 'given' to communities during development projects, while in PRA, insider knowledge (i.e., local knowledge) is privileged and the learning is reversed so that the outsider learns about the local realities, problems and opportunities. Ultimately, using the understanding gained thorough the PRA process to provide options that are both locally appropriate and affordable.

Summary and Discussion

There are four key elements to ensuring a sustainable and effective RWS project. First, to be effective and sustainable, RWS initiatives must be managed at the lowest possible level, i.e., at the community level. For this to happen there must be in place an engaged and informed community organization that has access to resources and is legitimized by national and regional governments. Estimating the capacity of a community organization to be able to adequately manage a RWS initiative is directly related to the Socio-Political condition of the community in question, in that the legal and administrative constructs within a country represent the management framework within which a community organization may operate. One clarification is required for point one; that being, that there is a distinction between managing a water supply system and operating it. To be effective and sustainable, a water supply system does not necessarily have to be operated by community members, as this is a service that in some instances

might be best contracted out to a private entity which may be more capable than the community organization to maintain infrastructure works.

The second major point is that for development assistance to be most effective, supporting agencies should adopt participatory approaches to broadly engage water supply users with the identification of needs and the management of infrastructure. Participation as it is defined for this research (a means to engage, empower, and move to action, individuals who choose to elicit some control over local water resources and infrastructure) is a necessary component of sustainable RWS initiatives. As the large body of evidence demonstrates, when individuals do not actively participate in the development of water supply, the benefits of that water supply often do not reach those who need them most, nor is it likely that any benefits realized during the project phase will be sustained over the long term. In addition, participation is necessary in order to select the best and most appropriate options for each context. Participation is essentially a way to customize a water development initiative to the expressed needs of a community.

The third point, that for rural water supply (RWS) initiatives to be successful over the long term i.e., sustainable, communities must have access to a support structure that provides technical assistance and training, social capital development, and financial backstopping. This point is analogous to the level and continuity of development aid a community has access to.

The last point is related to the expected benefits of an improved water supply. It is a recurring theme of the RWS related literature that simply increasing access to water may not provide a direct improvement in the physical health of individuals unless a broad program of environmental protection, sanitation, and lifestyle improvements are

instituted and supported over the long term (10+ years). This relates to the specific economic challenges a community faces. For project outcomes to have an impact on the health and well-being of individuals those outcomes need to be financially sustained and expanded into education, hygiene improvement and natural resource protection. None of these expansions will be possible if people are hindered by extreme poverty.

The techniques used to improve and extend water service in rural areas, that have been developed and refined over the past thirty years reflect a growing understanding that the complex nature of community managed water supply requires that local knowledge and indigenous methods be integrated with modern techniques if the goal is lasting benefits of the target population. The more traditional strategies of development assistance stressed rigid power relations, top-down management, the primacy of technical solutions and engineered infrastructure, and the notion that local scale development can be 'provided' by some outside entity have become largely discredited. This does not suggest that this type of development is not still practiced, rather, it shows that the effect of the combined knowledge of field practitioners, universities, aid agencies, and civil society has coalesced into the guiding 'best practices' espoused by and supported through, the high level international meetings of water and development professionals, for example:

1. Effective and sustainable, rural water supply initiatives must be managed at the lowest possible level, i.e., at the community level. (Dublin Principles 1992)

2. To be most effective, development agencies should adopt participatory approaches in order to, as broadly as possible, engage end users of a RWS system in the identification of needs and opportunities, and the management of infrastructure. (Schouten and Moriarty 2003)

3. Sustainable outcomes require that communities must have access to support structures which provide the technical assistance and training, social capital development, and financial backstopping. (Narayan 1995; Lockwood et al 2003)

4. The full benefit of an improved RWS system requires contingent improvements in the environmental conditions, sanitation practices, and livelihood strategies. (WASH 1990)

These 'best practices' should be understood as a guiding template for development. As each community is unique and while certain technologies and practices may be transferable, care should be taken to customize an intervention to the community in question by using integrative and participatory methods for information gathering, dissemination and action taking.

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Chapter III

Water Project Framework (WPF)

Introduction

This chapter introduces the Water Project Assessment Framework (WPF). This framework depicts the relationship between a set of external factors, the level of community participation, and a RWS initiative's ability to satisfy the needs of a community over the long term i.e., project effectiveness and sustainability. The WPF is applied as an organizational tool and conceptual framework during the assessment and monitoring phases of a RWS initiative; however, because the assessment strategy suggested for the WPF, its application is independent of a particular sector or project. The intended audiences for this framework are NGO's, engineers, financial advisors, and health and sanitation workers involved with the assessment and monitoring phases of a RWS improvement project.

Water Project Assessment Framework

The complexity of predicting the long-term success of a water supply project in a developing country is well documented (Paul 1982; McCommon et al. 1990; Getling 1995; Narayan 1995; Black 1998; Baker 2000; Ahmed 2003; Lockwood et al. 2003; ADB 2004; Kaliba and Norman 2004). There is however, some consensus that there are a number of common attributes related to the project site and community that can, in many cases, generally predict the success (effectiveness) a water project will have over the

long-term (sustainability) (Wijk-Sijbesma 1981; WASH 1990; Biswas 1988; Bender 1998; Carter et al. 1999; Schouten and Moriarty 2003; Swartz and Ralo 2004). These common attributes of successful and sustainable RWS systems include but are not limited to:

- An adequate and equitable tariff collection system
- Long-term support
- Spare parts and supplies
- Community management capacity
- Continued promotion and education of health and sanitation practices
- Adequate source protection i.e., preserving the water source

(Lockwood et al. 2003; Schouten and Moriarty 2003)

Understanding the conditions and information needed to assess what is the character and trajectory of these common sustainability attributes is an important part of the assessment and design process. It is during this process that numerous decisions are made both by the community and any assisting organizations regarding technology choice, the placement of the new facilities, the cost of construction and management, the adequate level of source protection, management rules, and numerous other decisions. This process, of identifying issues and formulating a plan of actions has been described as a 'decision maze,' where *priorities are set* and *actions to meet those priorities are taken in a timely fashion* (McNeil 1985). Moreover, the need for methods to prioritize development efforts is necessary so that resources are not directed towards actions that do not significantly contribute to the project meeting its.

The central concept, visualized through the WPF (Figure 3.1) is a continuum of project effectiveness and sustainability with each factor existing as a point along a continuum, where the potential future as well as current conditions are assessed and incorporated into the planning of the project.

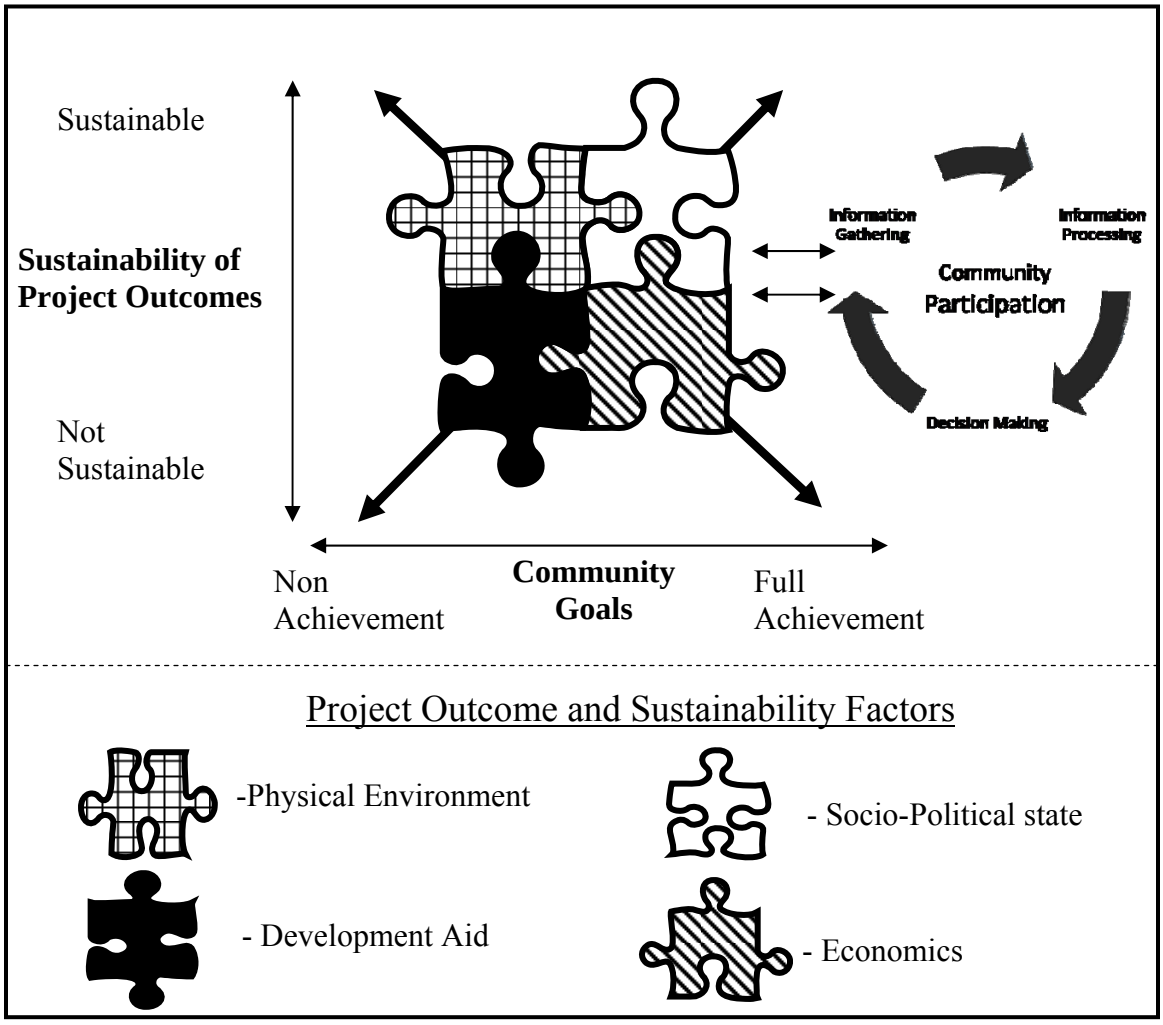

Figure 3.1 Water Project Framework (WPF)

The four project outcome and sustainability factors (Physical Environment, Socio-Political state, Development Aid, and Economics) represent various states and trajectories on the continuum of expected states for each factor. For example, the physical environment may range from severely degraded to pristine; the socio-political state could range from a crisis situation (active armed conflict) to well developed and resilient social and legal systems; economic challenges describe the access to financial capital and the explicit costs associated with improving water related infrastructure and management; and development aid describes the ability of a community to garner assistance (technical,

financial, managerial) from institutions outside of the community. These factors interact as the external elements, with the level of community participation acting internally as both a means toward gathering information and as an end, through the process of decision making. Considered together, project outcomes and sustainability factors with the level of community participation all combine to place RWS projects on the continuum of project sustainability and effectiveness.

The WPF provides an organizational tool for development teams to investigate the various factors that affect water supply project outcomes, and how to organize and integrate each of the factors into the assessment and monitoring phases of a RWS projects. The goal of developing the model was to provide a structured methodology for assessment teams working in the water and sanitation sector to quickly and consistently assess the numerous issues that contribute to the sustainability and effectiveness water project works and the human management of those works.

Project outcome and sustainability factors represent groupings of individual elements related to the four topic factors. The factors (Physical Environment, Socio-Political State, Development Aid, and Economics) are conceptualized as pieces of a puzzle, where the cumulative effect of all factors together may predict which trajectory the water supply project may follow. The preferred trajectory is where the community goals are satisfied (effectiveness) and the physical project works and management organizations persist (sustainability) after the 'project' phase of the initiative is over and the community has transitioned into operating and managing the system (management phase). Community participation is placed on a different axis, because it is recognized that while not implicitly necessary for project effectiveness and sustainability, when

individuals in a community are involved in identification, implementation, and management of project works, water supply initiatives tend to continue to provide services (water) over the long term (Narayan 1995; Nicol 2000; Mathew 2005).

The WPF loosely follows the model of sustainable RWS systems offered by Lockwood et al. (2003), in that it seeks to predict sustainability by assessing some 'qualifying list of key determinants' and that these determinants are essentially the 'factors' of sustainability that need to be satisfied in order for the RWS projects to achieve long-term success.

This framework can provide the organizational structure for which a project assessment and design team can focus their *information gathering efforts* and *near-term activities* towards. However, for the framework to be useful each factor must be understood in terms of its individual contribution to the end result of the project.

WPF Factor Physical Environment

The sustainability and effectiveness of any water project is often closely linked to the in-situ availability of water, as well as the climatic regime for the area (Roche 1993). As indicated in Figure 3.2, the continuum of the environmental variable spans a range of conditions - from not conducive (i.e., desert environment with either polluted or no access to ground water) to fully supporting the success of a water project, (i.e., humid environment with ample precipitation during all months of the year and easy access to high quality groundwater).

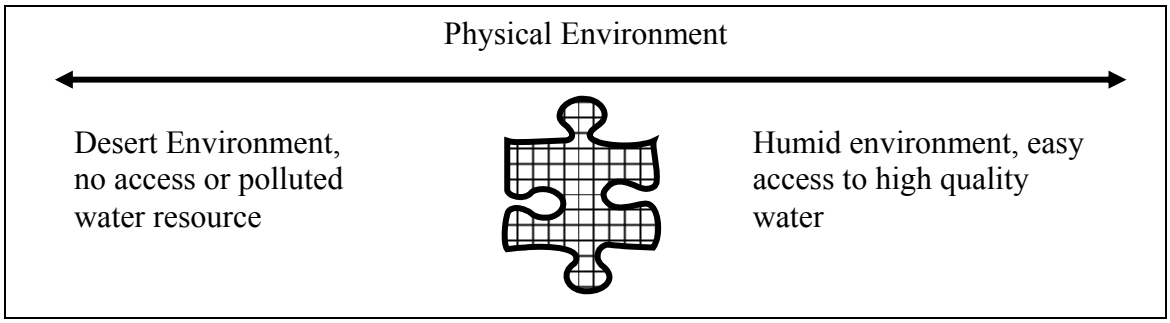

Figure 3.2 WPF Physical Environment

A number of information pieces, relevant at different scales, may be collected by an assessment team in order to estimate the condition of the physical environment and existing water resources (Table 3.1). Through the collection and assimilation of the information in this table, an assessment team may be able to assess the current state and trajectory of the physical environment as it concerns the water resource available to a community (Salati 1983).

In addition to collecting as much quantitative data on these various climate and environmental elements, participatory analysis tools can be used to verify or crosscheck the analytical data with locally relevant environmental information (Flanagan and Laituri 2004). This is an important step, as it may be rare that an assessment team will be able to collect enough quantitative physical environmental information about a site to give anything more than a 'snapshot' view (Ravenborg 2002).

Table 3.1 Physical Environment Data Needs

Information Need	Elements	Physical Environment Condition	
		Positive	Negative
Water Quantity	Monthly precipitation totals (mm) Rates (mm/hour) Timing - Duration (seasonal cycles)	High (150 – 250 mm) Moderate (10-20) Moderate (precipitation every month)	Low (-10mm) Very High (100+) High (precipitation only for part of year)
Water Quality[4]	Physical Chemical Biological	<5 NTU[5] <10 ppm N[6], <0.001Metals[7] <2.0 cols/100ml[8]	>500 NTU >20 ppm N, >1 Metals >5.0 cols/100ml
Soil and Bedrock Properties	Local geology Soil type (infiltration/erosion rates)	Confined shallow karst Mollisols (30-40 cm/hour, low)	Shallow alluvial Entisols (<10 cm/hour, high)
Topography	Drainage area Slope Significant features	Large (>100 km^2) Moderate (2%) Perennial streams	Small (<10 km^2) High (>20%) Active landslides
Vegetation	Forest Cover Agricultural intensity (type, extent, cropping system)	High (>60% canopy cover) Moderate (30-50% total cover, rotating fallow)	Low (<10%) High (>70% total cover, continuous cropping)

[4] The World Health Organization has compiled a manual with guidelines and assessment methods for water quality, this manual can be found online at (www.who.int/water_sanitation_health/dwq/gdwq0506.pdf)
[5] Nephelolmetric turbidity unit (NTU) is a measurement of light scatter through medium, low values indicates higher transparency clear water, high values indicate high translucence cloudy water. EPA drinking water standards require that 95% of samples fall below 1 NTU within a single month (EPA, 2001)
[6] 10 ppm N (Nitrate measured as Nitrogen) is the standard for drinking water in the U.S. Exposure to values above this range could result in cyanotic conditions in small children (methemoglobinemia or Blue Baby Syndrome) (Knobeloch et al. 2000)
[7] Metals including lead, aluminum, mercury, and other metalloids such as arsenic all have different values for exposure rates, regardless if high values are present then the source of water may not be usable without extensive treatment.
[8] Raw water supplies (surface waters) may contain up to 1000 cols/100ml and be considered safe, however drinking water supplies that contain > 2.0 cols/per 100ml have been shown to adversely affect children and those with weakened immune systems through dramatically increased rates of gastrointestinal disease (WHO, 2006).

WPF Factor Socio-Political State

At a broad scale, the socio-political state is a description of the interactions between local communities and the regional and national governments. At a finer scale, and in the context of RWS development, the socio-political state is an indicator of the *capacity of the local community to engage in, and sustain improvements* to a water supply system (Hofkes 1983; Getling 1995). The continuum of socio-political states (Figure 3.3) may range from degraded, where the capacity of the national/regional/local governing institutions is severely compromised (e.g. armed conflict), to optimal, where all levels of government are functioning at a high level and there are well-developed social structures to support the financing and operation of improved infrastructure projects.

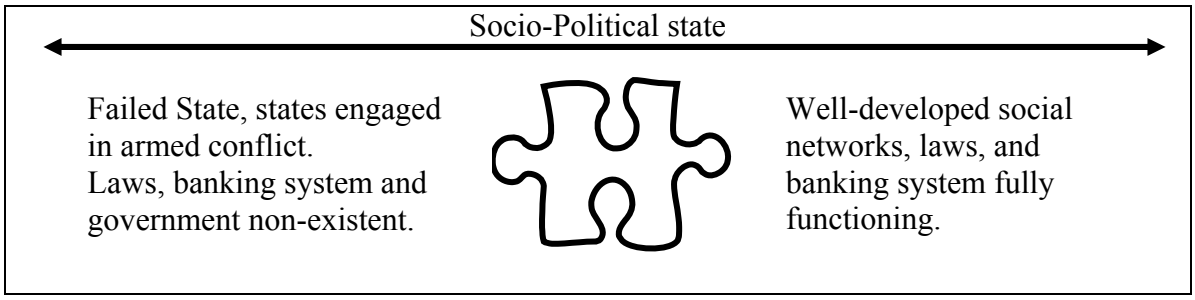

Figure 3.3 WPF Socio-Political state

In countries that have well developed social and legal networks with strong social contract laws and the means to implement those laws, communities with a need for infrastructure improvements to their water systems will often be able to count on some, if not extensive assistance from the government, e.g. Rural Electrification Project – USA (Brown 1980). However in many developing countries the state of the national government is such that there is little that can be provided in terms of direct financial or infrastructure support for rural or remote communities (Tinsley 2004).

There are two major avenues that an assessment team can explore in order to place a community within the socio-political state continuum. The first avenue is to review the various annual reports produced by the World Bank, United Nations Development Program (UNDP), and the World Health Organization (WHO) in order to assess what are the current and recent past conditions of the government and country in question. The other, is by reviewing local periodicals and daily newspapers. Reviewing newspapers may provide major insights in terms of local events and issues and how those may contribute or detract from water development projects. Both of these methods can provide a coarse scale of understanding of the current and recent history in terms of the political conditions in a country, providing the understanding of the general context and political environment. This information allows an assessment team to incorporate the relevant regional or national goals relating to water supply improvement and local capacity building. Conversely, by conducting an overview of the socio-political conditions of a country, an assessment team may potentially be able to identify, prior to a site visit, what some of the major hurdles or opportunities there might be to bolstering local governance capacity, entering into contracts, or fitting the goals of the project within the development or water sector goals of the country.

On a local scale, assessing the socio-political state of the community is more complex. This complexity is derived primarily from the diversity of conditions found in rural settings (Axnin and Axnin 1997; Brikke 2000). Regardless, gaining an understanding of the ability of community members/organizations to manage the proposed infrastructure improvements and the financial obligations that go along with them is an important task, and contributes to making better decisions regarding the level

and extent of training that may be needed. Assessment teams should at the minimum ask both individuals and local institutions (e.g., water committees) the following questions:

- Is there an organization that will take responsibility for the system?
- Are there legal impediments to expanding or improving the current system (land tenure)?
- What is the range of technical, administrative, and financial capacity of the community?
- Are there social or cultural taboos regarding water provision that may inhibit the effectiveness of improved infrastructure?

Participatory techniques may be used in order to investigate these questions at the local level, with careful attention paid to triangulating the responses in order to reflect the range of responses, rather than the average response (Chambers 1994b, Bentley 2004).

WPF Factor Economics

The economic constraints and opportunities a particular community is limited by, is mentioned consistently in the literature as a strong indicator of the sustainability of development projects (Narayan 1995; World Bank 1995; Rodrik 1999; Nicol 2000; Paudel and Gopal 2004). Moreover, understanding the financial capabilities of most rural communities are different than those of their urban counterparts has lead to an alternate paradigm for estimating the optimal cost structure and financing of RWS initiatives. Beginning in the mid 1990s there was a large effort by major international funding agencies (World Bank, International Monetary Fund) to require 'full cost accounting', and to develop the political and institutional capacity of partner lending institutions to better administer existing and future debt (Yaron et al 1998; Camdessus 2003; WWAP 2006, p.414). This new paradigm is contrasted with the more 'traditional' approach where national(ist) financial institutions would provide direct subsidies to agriculturalist or create state-owned agricultural credit unions to loan directly to rural residents;

ostensibly for modernization or expansion of agricultural production (Yaron et. al. 1998). Alternatively, the more contemporary approach for financing water related development focuses on investment in infrastructure, human development and in the creation of favorable policy environments and applicable regulations regarding lending practices to meet the goal of poverty reduction and livelihood improvement (Yaron et al 1998; UNESCO 2006).

Currently, there are numerous institutions and mechanisms for funding development projects. These institutions and mechanisms range from official development assistance from governments (e.g., Swedish International Development Agency and United States Agency for International Development) to person-to-person lending (e.g., Kiva). Multilateral development banks are also major contributors to development funding though they differ from the multilateral funding agencies in that they tend to focus on specific geographic regions; African Development Bank (AfDB) and the Inter-American Development Bank (IADB) for example. More recently, microfinance institutions like the Grameen Bank (www.grameenfoundation.org), Kiva (www.kiva.org), BancoSol (www.bancosol.com.bo), and ProCredit (www.procredit-holding.com) and the many others listed on the Microfinance Information Exchange have begun to overtake the more traditional, institutionalized forms of financial assistance (Sengupta and Aubuchon 2008). These organizations, have, in many cases changed the paradigm of development finance by creating credit products that are more accessible to the poor, more flexible in both terms of minimizing risk to creditors and maximizing potential impact by utilizing joint liability contracts, expanding the concept of collateral,

progressive lending based on previous repayment success, and an emphasis on extending credit services to women (Sengupta and Aubuchon 2008)

As the understanding has proliferated that the specific challenges facing rural communities and rural economies necessitates de-coupling credit access to agricultural output and the re-coupling of rural infrastructure improvement to overall economic well-being of communities numerous entities have emerged to facilitate this need. For example in 2006 there were 3,316 microcredit institutions, serving more than 130 million customers, with 60% of those being women earning less than a dollar a day (Daly-Harris 2007)

Though there has been improvement in the understanding of the financial needs of the poor and substantial success in developing appropriate financial vehicles for rural development, the specific economic aspects of rural communities make it difficult to reduce poverty and increase basic services like potable water. These aspects are numerous but can be generally traced to four of specific attributes of rural living:

1. Diminished reliance on a cash based economy
2. Greater reliance on in-kind labor trades
3. Bartering
4. Temporary migration

(Chambers 2005, p. 47)

Rural families may not receive regular cash payments, and may only have access to cash during a small period of the year (such as when crops are harvested). Rural families may also carry debt if they have access to it, throughout much of the year in order to purchase basic needs (food, fuel, seed, and fertilizer) with the resulting situation that household savings are low or non-existent. In addition to the community-wide levels of fluctuating wealth, there may be large intra-community variability in wealth due to

differential access to land or if remittances are being sent back to families from members living overseas or in the larger urban centers. Moreover, the economic condition of a community is not static, there may be in- and out-migration of people and wealth from a community, and the macro- and meso-economic forces (e.g. NAFTA[9]), and other events such as natural disasters or political upheaval (Pinochet rising to power in Chile 9/11/1973) may cause already highly volatile economies to become even more unstable.

All of these elements make it complex to assess both the ability and willingness-to-pay for improved water services over the course of the projects time horizon (~20 years). There are however, a number of techniques and information sources that can allow development teams to rapidly discern and incorporate the current macro- and micro-economic issues and their trajectories, and by doing so, be able to place the community somewhere on the continuum of economic capacity visualized by the WPF Economics factor (Figure 3.4)

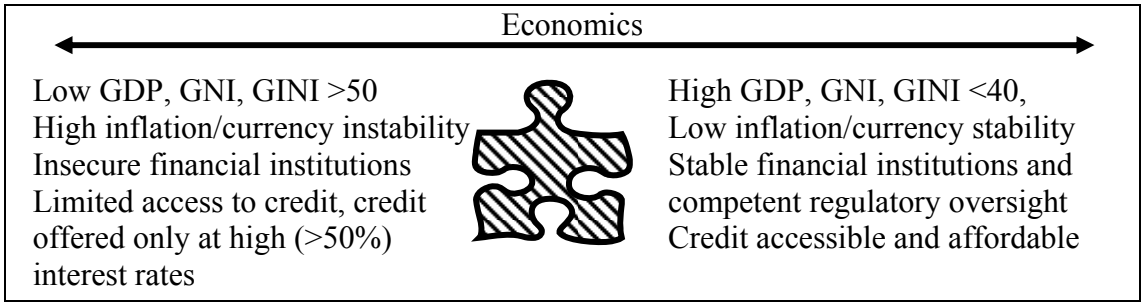

Figure 3.4 WPF Economics

Because the costs associated with water supply and infrastructure improvement projects can be large, $500,000 to $250 million dollars (Narayan 1995, p. 16) and most

[9] North American Free Trade Agreement (NAFTA) first implemented 1/1/1994 with the final provision fully implemented on1/1/2008 as an international agreement which eliminated or dramatically reduced tariffs on products traded among signatory nations with an emphasis on agricultural goods (USDA Foreign Agricultural Service 2008)

likely out of the ability of the community to self finance, an understanding of the macro-level economic condition of the country can be used to place the community into an economic frame of reference. One option for doing this is to review secondary sources of information (UNEP, WHO, World Bank), and compare standard international economic indicators such as Gross Domestic Product (GDP), Gross National Income (GNI), the international Purchasing Power Parity index (PPP)[10], and the Gini coefficient (GINI)[11] to place that community into the country's economic frame. Another option is to review country's Poverty Reduction Strategy Paper (PRSP).

A number of the major development funding entities such as the World Bank and the IADB use the unit cost of water supplied, to devolve total projects costs down to the per-capita scale. This method is reported widely as an example of project cost accounting and effectiveness monitoring; unit cost accounting may also be used to compare different regions and service levels to assess parity of costs (Table 3.2).

Table 3.2 Typical Per-capita water project costs

Agency/Organization	Annual Per capita cost/volume
World Bank	$3/m^3$[12]
USAID	$1.17/m^3$[13]
Inter-American Development Bank	$1/m^3$[14]

By calculating the unit costs of water, an assessment team can investigate the relative costs of varying levels of service that would potentially be available under

[10] The Purchasing Power Parity index (PPP) calculates the relative cost of a 'basket of goods."
[11] The Gini coefficient (GINI) measures the dispersion or relationship between the largest and smallest values of a distribution along a curve (Lorenz curve) e.g. income distribution (Xu 2004).
[12] Annual total water volume estimate based on 50 lpcd (World Bank 2007).
[13] US Agency for International Development Clean Water Revolving Fund (USAID 2003).
[14] Inter-American Development Bank (IADB 2007)

improved infrastructure conditions. Unit costs, when assessed using countrywide (GINI, GNI) and community wide information can be useful for the development of plans for levels or scales of infrastructure improvement, and also to project the ability of the community to sustain infrastructure improvements over the planning horizon of the project. One approach toward incorporating both macro- and micro-level economic information is to estimate project sustainability by using fuzzy set theory to examine cost recovery as a mechanism to predict the sustainability of improved water supply projects, with the result being that water projects which recovered costs were more likely to be sustainable (Virjee and Gaskin 2005). This result reflects the similar conclusions from Narayan's (1995) and Melo's (2005) research which sought to examine the reasons for individual's participation in improved water infrastructure projects.

Beyond the macro scale indices of financial condition (e.g., GDP, GNI, PPP, and GINI) the tools and techniques that an assessment team can utilize to assess the demand, and Willingness-To-Pay (WTP) at the local level fall under four broad categories: Revealed Preference Methods, Avertive Expenditures, Replacement Cost, and Cost Benefit Analysis (Virjee and Gaskin 2005, Briol et al 2006). Within those topics are a number of assessment methodologies (Table 3.3) that can be used to discern the net present value (NPV)[15] or demand and the WTP for improved water supplies.

[15] Net Present Value of an investment is the difference between the sum of the discounted cash flows expected from the investment and the amount initially invested.

Table 3.3 Methods of assessing Willingness to Pay (WTP) for improved water service.

Methodologies	Description
Hedonistic Pricing Method (HDM) (Lancaster 1966, Griliches 1971)	The cost of a good is reflective of the characteristics of that good and its respective level in relation to other goods.
Travel Cost Method (TCM) (Hotelling 1931, Briol et al. 2006)	The time and travel costs associated with a good represent the "price" associated with that good.
Choice Modeling (Blamey et al. 1999)	Alternative policy options are presented and pair wise comparisons are made between policy options.
Contingent Valuation (CV) (Randall et al. 1974, Briscoe et al. 1990)	Single hypothetical policy options are presented to respondents who indicate whether they would participate at varying levels of cost.

Demand responsiveness also falls within the analysis of the economic factor, and is a concept that broadly focuses on the ability of users to make decisions regarding the level of water service and the costs associated with that service (WASH 1990) or, as Deverill et al (2001, p. 5) defined it, demand is the "*informed* expression of desire for a particular service, measured by the contribution people are willing and able to make to receive a service."

Demand responsiveness is reflected in the concepts outlined in the Dublin Principles (1992) which treats water as both an economic and social good (Principle #4) and encourages managing water resources at the lowest appropriate level (Principle #2) (ICWE Dublin Principles 1992).

Taken in sum, an examination of the economic component of the WPF requires the analysis of the demand for improved water service, the willingness of individuals and groups to pay for improved service, and the ability to pay for improved service at both

the household and village level. Moreover, there a number of macro- and micro-economic indicators of ability and WTP as well as multiple methodologies for assess them. However, in order to place a community at a position along the continuum of economic conditions, a major focus for the assessment team should be on the *current and potential future ability* to secure, and maintain adequate funds for the ongoing operation and maintenance and future replacement of the infrastructure works.

WPF Factor Access to Development Aid

Development aid has been defined as assistance or influence generated by epistemic[16] communities to influence an issue or further a cause (Michaels and Laituri 1999). Examples of this include both international (exogenous) and local (indigenous) knowledge and influence and its effect on a specific issue, sector, or political goal.

Exogenous thought and support often originates from International Non-governmental Organizations (NGO's) (e.g., Red-Green Cross, Rotary International) foundations and trusts (e.g., Ford Foundation, Bill and Melinda Gates Foundation, The Pew Charitable Trusts etc.), official support provided by an external government(s) (e.g., United States Agency for International Development (USAID), African Development Bank (AfDB), Centre on Integrated Rural Development for Asia and the Pacific (CIRDAP), or religious groups (e.g., Catholic Relief Services (CRS), and Living Water). The forms of support these groups can provide include, but are not limited to direct

[16] Epistemic communities are: knowledge-based transnational networks of specialists whose members share common views about the causes of a problem and the policies that should be adopted to manage it. Such groups are defined by their shared beliefs in cause-and-effect relations, truth tests, underlying values and a common policy enterprise (Hass 1991; Michaels and Laituri 1999).

investment, technology transfer, the provision of materials and tools, and technical support and training. Though crucial to achieving broad, international development goals (e.g., MGD's), in order to assess development aid at a project scale the access and character to assistance a community may have access to, a more locally focused and in some ways less specific definition of development aid is required.

In terms of the WPF development aid factor (Figure 3.5), understanding the community's access to development aid is comprised of two main components. The first component is access to internal aid; this can include the current and past relationships the community has developed with national agricultural extension programs, local or regional NGO's, skilled labor pools, local consulting agencies, micro-credit financial institutions, and even local materials suppliers. The second component is broader and is concerned primarily with the historic and current form that international NGO's are interacting in the countries national development strategies.

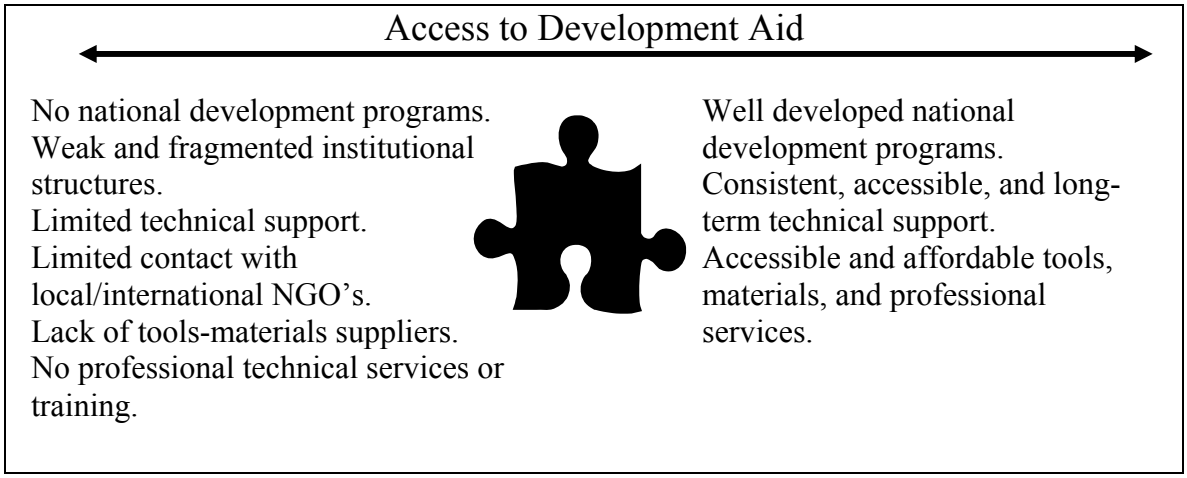

Figure 3.5 WPF Development Aid

Conditions that may hinder community access and therefore place the community lower along the continuum of access to development aid may include recent political upheavals that have dramatically altered national goals or priorities for water and

sanitation, a weakened civil service, lack of professional services or simply inadequate transportation infrastructure which inhibits both the travel of people to provide support but also tools and materials. Alternatively, when a country has well-defined and widely understood water and sanitation programs and those programs are funded and staffed for an extended period of time, and there are strong and well defined public-private partnerships the potential for development assistance to positively affect communities may be greatly increased.

An effective PRA technique for assessing the access to development aid including markets and financial services is the use of institutional or Venn diagrams (Figure 3.6) (Kumar 2002).

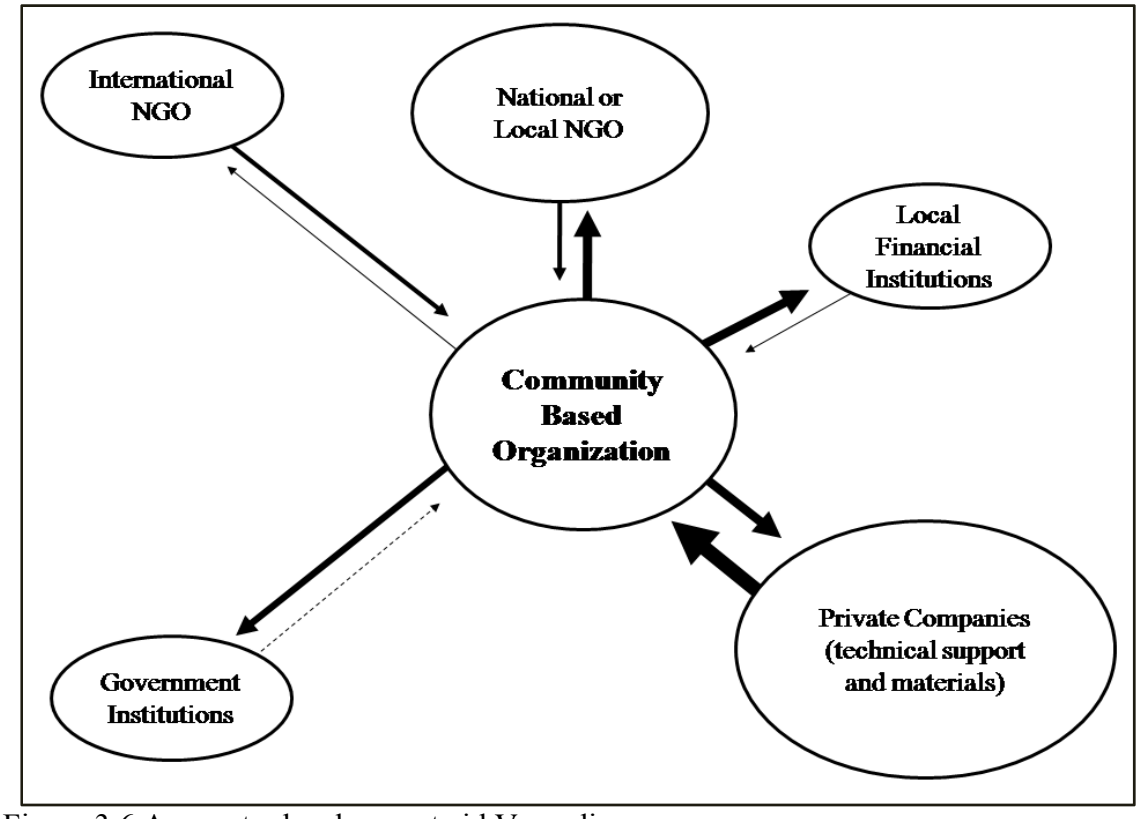

Figure 3.6 Access to development aid Venn diagram
Size of oval relates to the importance of the organization to the CBO, length and width of line between ovals depicts the accessibility of the service provided (outward arrows) and the value (inward arrows) the CBO places on the service provided by the institution.

The example Venn diagram depicts the relationship and access a CBO may have or need to rely upon to support efforts to improve and maintain an improved water supply system. When used in conjunction with other PRA methods, such as pair-wise ranking, a development team may be able to quickly assess the relative importance, accessibility, and character to ongoing assistance the community may access.

Alternatively, the linkages between international civil society institutions and rural communities may also be explored in order to understand where the major opportunities or impediments may lie to improving rural water supply service (Figure3.7)

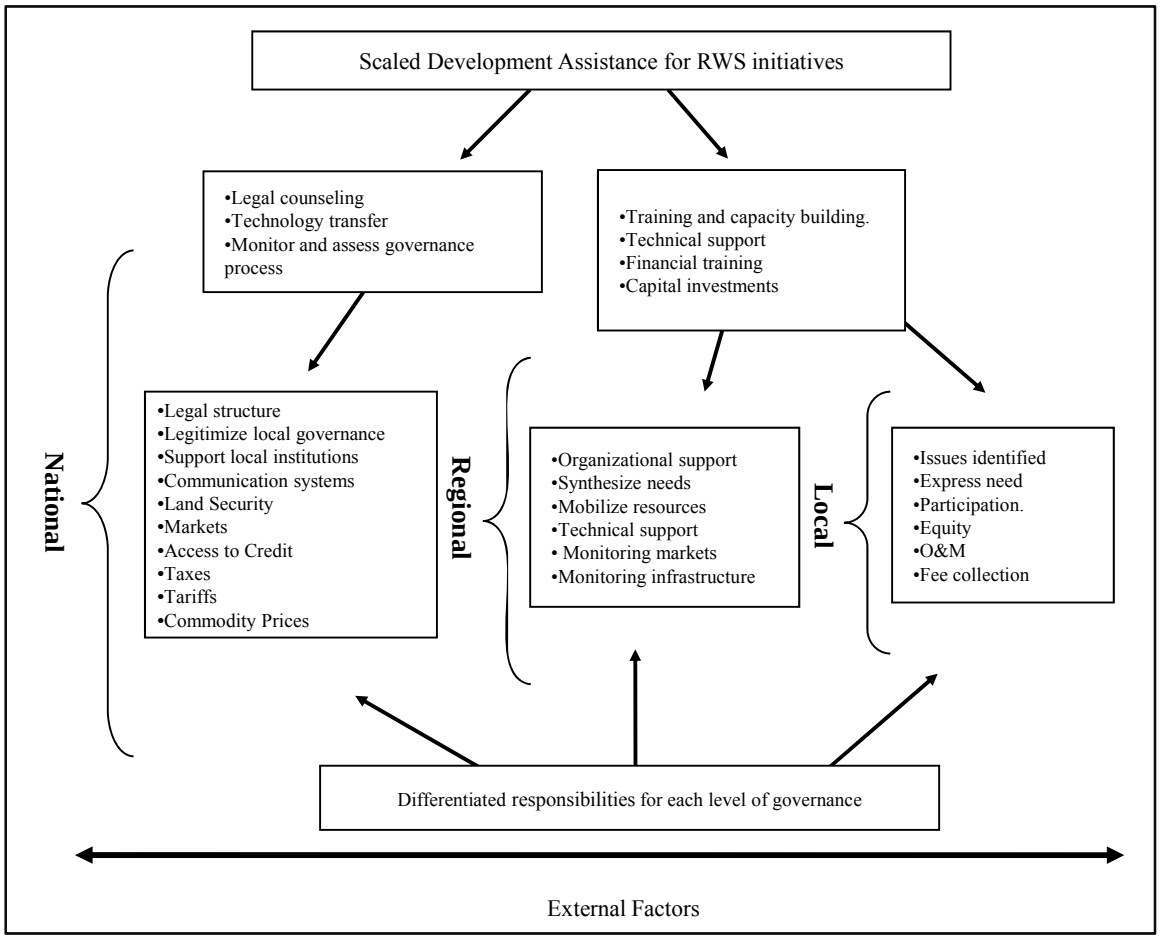

Figure 3.7 International NGO and Community Based Organizations (CBO) Linkages

Unlike the Venn diagram, which focuses on how CBO's view support systems available to them, figure 3.7 visualizes from the NGO's perspective, the differing levels of institutional oversight containing communities, and how those communities are nested in both the regional and national governance institutions. For development teams, understanding both the local and national linkages between and importance of to support structures is a fundamental aspect of assessing the Development Aid WPF factor.

Summary

The Water Project Assessment Framework (WPF) is offered as a tool to organize information collected during the assessment and monitoring phases of a RWS improvement project. Each factor of the WPF was described and suggestions were made concerning what information is necessary to identify the current status and potential future trend of that factor. Community participation is also depicted in the WPF as a process of information collection, information processing and decision making.

The first major point emphasized by the WPF is that, in order to make the timely decisions needed for rural water supply development, knowledge of the specific context and conditions should be the first concern. The second point is that the process of community participation during problem identification and decision making should be supported by the development team, who can assist the process through the guided discovery techniques of PRA and by the quantitative techniques outlined in the assessment of the physical environment. A third major point of the WPF is that the factors fall along a continuum of states which will change through time.

Limitations of the applying the WPF include problems with quantifying and incorporating the uncertainty with the future trajectories of each factor. For example,

countries current socio-political circumstances may indicate the legal and policy environment are conducive to rural water development at a site. Regardless, political trajectories can be highly dynamic and predicting what the future political circumstances in a country, much less a small community will be over a 20 year planning horizon is at the least impractical, if not entirely impossible. Another limitation of the WPF is that the process of information decomposition into the four factors may lead to an oversimplification of the circumstances of a community.

The WPF described is a new tool, though it is not new concept and has drawn largely upon the extensive work by, McNeil (1985), Chambers (1994), Narayan (1995), Lockwood et al (2003), and Bentley (2004). The WPF is also a result of the understanding gained by the experiences working with the community in La Laguneta, and the lessons learned there, particularly the complexity of issues and the amount of energy and time needed to acquire actionable information. The WPF is offered as a tool that can make this process more effective and, in turn support better decision making by development teams and communities during a RWS improvement project.

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Chapter IV

EL Salvador Case Study

Project Background

The case study presented in this chapter outlines the assessment and preliminary implementation phases of a RWS initiative in the community of La Laguneta, El Salvador. La Laguneta is a small, rural village located on the north-west side of the San Vicente volcano in the La Paz department. During the five month dry season, (October through May), the availability of well water diminishes, causing severe water shortages. As the wells in the community begin to go dry in late March, families (average 4-6 individuals, max 10) are limited to between 1 and 4 cantarro s (25 and 100 liters) of water each day, reducing individual water use to less than half the UN recommended minimum. The seasonal lack of adequate water supplies along with high levels of biological contamination of existing sources contributes to decreased health, especially for older women and small children. In addition to the dry season shortages and poor quality of water, the amount of time required to collect water was identified as major obstacles to improving the livelihood conditions in the community.

The RWS improvement project in La Laguneta is a collaborative development project, involving the local community, PCV's, and EWB-CSU. The original objectives, of the project, established during the March 2005 site assessment trip are related to expanding access to the local unconfined aquifer and improving the usability of the

existing infrastructure. These objectives are part of the overall goal of the project, which is to improve the health and well-being of the community members (Table 4.1).

Table 4.1 La Laguneta RWS project Objectives

Project Objectives	Relationship to Livelihood
Increase access to clean water.	Lack of water, especially during the dry season identified as the major community health issue.
Reduce time spent queuing for and hauling water.	Hauling water (30 minutes to >1 hour) identified as a physically demanding and dangerous constraint on individuals time, especially women and young girls.
Reduce the biological contamination of water supply.	Contaminated water (*F. Coliforms)* identified as the major cause of gastrointestinal disease.

Beginning in 2005, EWB-CSU has traveled to the La Laguneta site on six separate occasions. These visits have included two assessment, and three implementation trips, as well as a trip to apply geophysical methods for groundwater exploration. The major events that have occurred during these site trips are listed in Table 4.2, and an analysis of the information collected, relating this information to the four elements of the WPF are discussed in the last section of this chapter.

As of August 2007, two additional wells were drilled and completed, and an electric pump and chlorination system has been installed on the main village tank. However, the additional wells do not produce the desired volume of water needed to satisfy community demand ($250^{l/person/day}$). Other avenues are being pursued, including digging other shallow wells, and constructing an additional tank to increase water storage.

Table 4.2 El Salvador Site Trips - Goals and Major Outcomes

Date	Trip Goals	Outcomes
March 2005	1. Site assessment (physical setting, water quality, existing infrastructure). 2. Develop relationship with community members. 3. Understand the state and process of water deprivation. 4. Develop options for alleviating water supply shortages.	1. Three alternatives developed for alleviating water shortages (Table 4.1). 2. Established good relationship with members of community and PCV stationed there. 3. Contacted and interviewed individuals with other El Salvadoran agencies dealing with water.
August 2005	1. Assess groundwater potential in community. 2. Investigate costs associated with materials and drilling. 3. Reinforce existing in-country contacts. 4. Develop new in-country funding and technical support contacts.	1. Hydrogeologic study completed. 2. Pumping test suggests that underlying aquifer may provided necessary water yield if sufficient thickness is penetrated. 3. Identification of four potential locations for new borehole wells.
July 2006	1. Drill small diameter wells. 2. Test aquifer properties at new borehole sites. 3. Present community with possible options for a water distribution system. 4. Contract with materials suppliers for distribution and tank materials. 5. Install precipitation gages and institute a climate monitoring program. 6. Install pressure transducer in main community well to measure change in water depths as related to precipitation.	1. Two wells dug, cased and pump tested by El Salvador based drilling company, Perfotec http://www.perfotec.com.sv/. 2. Tap locations identified for future distribution system. 3. Existing tank evaluated and plan developed for improvement (additional taps and chlorination system). 4. Repair of an existing submersible pump. 5. Relationship established with San Miguel Rotary Club. 6. Two precipitation gages installed and pressure transducer placed in main community well.

Table 4.2 continued

Date	Trip Goals	Outcomes
January 2007	1. Improve existing tank in La Laguneta (cement roof, chlorination system, and additional taps). 2. Increase flow into main community well, using drive points. 3. Develop relationship with new PCV's.	1. New roof, chlorination system, and taps installed. 2. Tank painted and drainage improved 3. Drive points installed in main well, flow unchanged. 4. New PCV's in introduction phase in community and water project.
March 2007	1. Use geophysical equipment to quantitatively assess the success of additional borehole wells. 2. Install chlorination system.	1. Six electromagnetic resistivity tests run. 2. Chlorination system installed and community tank improved by adding 4 additional taps.
August 2007	1. Install pipeline, pump and new water taps in El Chile (community near La Laguneta). 2. Assess installed project infrastructure in La Laguneta. 3. Assess impact of infrastructure improvements in La Laguneta. 4. Train PCV's in management and trouble shooting of installed systems in La Laguneta and El Chile. 5. Initiate a home gardening project.	1. El Chile pipeline and taps installed, pump not connected (PCV was going to take lead on assisting community with task). 2. Installed infrastructure in La Laguneta not operating in optimum fashion (automatic shutoff not connected, chlorination system not being used). 3. PCV's provided with a laptop, water quality measuring equipment, and explanation on how to use. 4. Seminar (charla) held for utilizing old plastic bottles as planters for vegetable seeds.

El Salvador County Background

El Salvador is a small, densely populated country located on the Pacific side of Central America. El Salvador shares borders with Guatemala to the North and Honduras to the East (Figure 4.1). El Salvador's land area is ~21,041 km^2 (8124 mi^2) – comparable

to the U.S. state of Massachusetts - with a 2006 estimated total population of 6,990,657[17] (Gammage 2006, World Bank 2007).

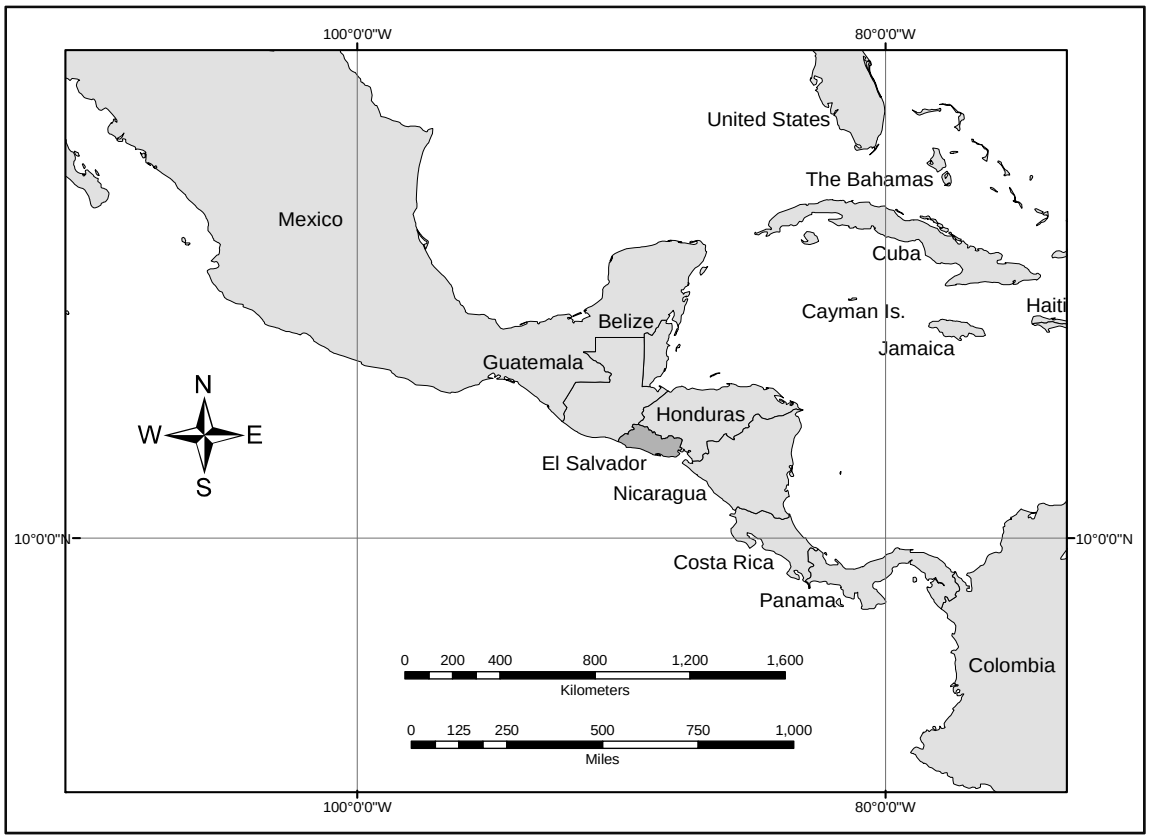

Figure 4.1 El Salvador Location Map

The World Bank (2007) estimated Gross Domestic Product (GDP) for El Salvador is ~$15.2 Billion with an estimated annual growth of 2.8 %. Average annual income for El Salvadoran families is approximately $4,900; however this statistic is an inaccurate representation of the income disparity in the country, as more than 35% of the population is living below the poverty line (OECD 2006). Generally, El Salvador has

[17] The estimated figure of 6,990,657 was developed from data collected by the Direccion General de Estadistica y Censos (http://www.digestyc.gob.sv/) and is based on census data collected in 2003. More recent data has been published from the Ministerio de Salud Publica y Asistencia Social (2007) which suggests that the current population is approximately 7.1 million. Both population figures are presented in this text due to the complex nature of census taking in El Salvador and that both numbers and in general agreement.

suffered from many of the same problems of other developing countries, for example in due to the large proportion of land put into agriculture, year 2000 forest cover is estimated at ~15%, making El Salvador the least forested country in Central America (Honduras - 48%, Guatemala - 38%, Nicaragua - 47%, Panama - 58%) (Hecht 2006; WBDDO 2006).

The FAO statistics division indicates that in 2000, 12% of El Salvador was in permanent crop and 38% in pasture, putting half of the countries land area into agricultural production (FAOSTAT 2007). In order of importance to the economy, the primary types of agriculture in El Salvador are coffee, sugar, corn, and pasture (FAOSTAT 2007).

Besides agriculture, the other major component of the landscape, and an important consideration for groundwater exploration, are El Salvador's volcanoes. Volcanoes dominant El Salvador's landscape, with twenty-two volcanic cones, eighteen of which are classified as active (Siebert and Simkin 2002).

Administrative Districts

El Salvador's internal boundaries are divided into 14 geographically defined departments (departmentos) (Figure 4.2) which function as administrative units with representation in the national legislative assembly (Grupos Parlamentarios). Each department is then sub-divided into a number of municipalities (municipos) where mayors administer to locally relevant issues. At the local level, people live in small communities or farming collaborative (cantons or campos) where community organizations are the primary legislative body.

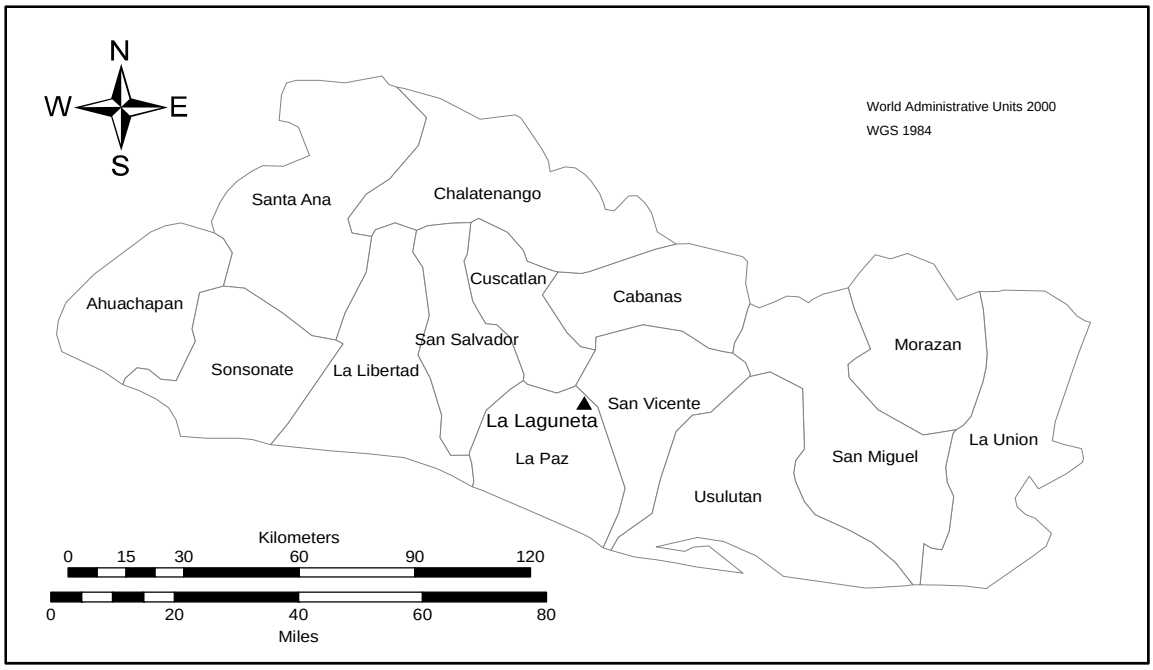

Figure 4.2 El Salvador Administrative Boundaries

Demographics

According to El Salvador's Ministry de Salud (Ministry of Health) 2007 provisional data, the current population is ~7.1 million with the most densely populated areas being the San Salvador, Santa Ana and La Libertad departments (Figure 4.2) (MSPAS 2007). Most of the population (90%) is of Amerindian and Spanish descent with a small proportion of indigenous Pipil Indians (<1%) (CIA Fact Book 2007). Median age is 21 (men) and 23 (women) with 36% of the population below 14 years, 59% between 14-64 years and 8.2% above 65 years of age (MSPAS 2007). El Salvador's population is divided between those living in the main urban centers of San Salvador, La Libertad, San Vincete, Puerto El Triunfo, and Acajutla, and those living in one of the many rural campos, cantons, or unaffiliated squatter settlements surrounding the larger cities. In 2006 the urban population constituted 60% (4,282,600) and the rural population comprising ~2,822,400 persons (MSPAS 2007; World Bank 2008).

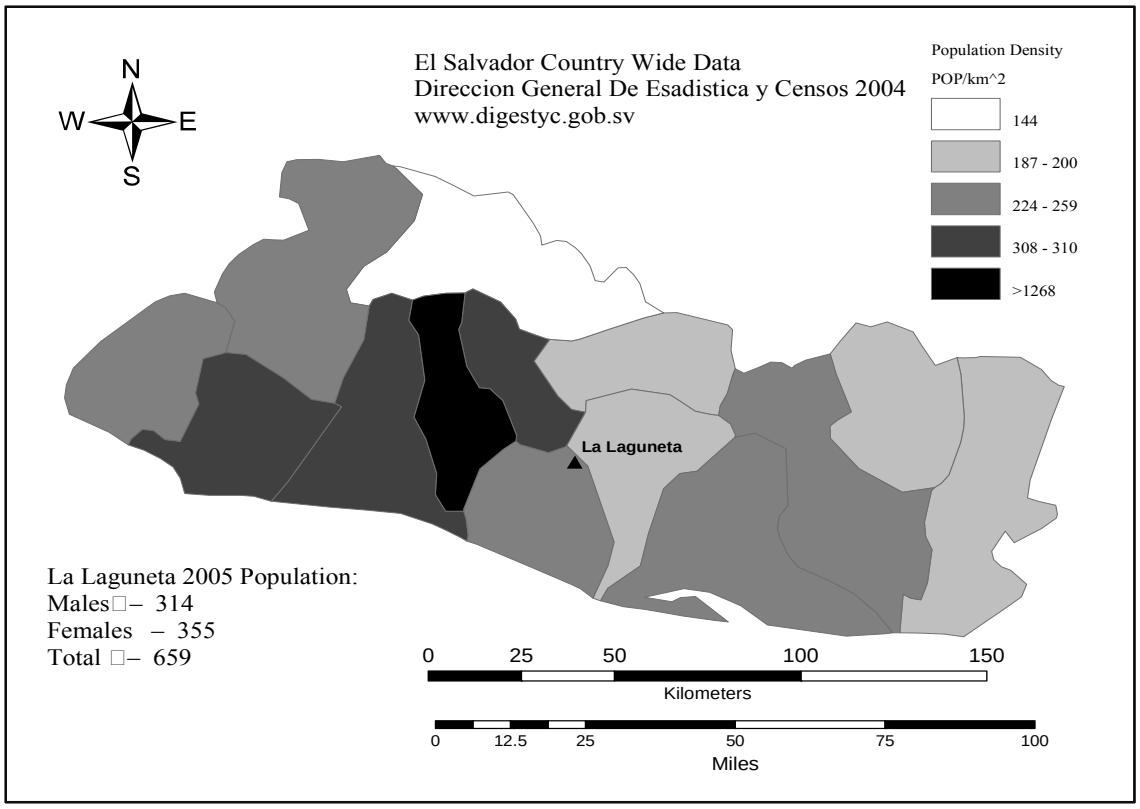

Figure 4.3 El Salvador Population densities (Individuals/km^2) in each department - El Salvador

El Salvador Water Supply Issues

For much of the year water is plentiful in El Salvador. Total renewable water resources in the country are approximately 17.8 billion cubic meters/year, equivalent to 3,761 m^3/person/year (FAO 2007). Other indicators of the state of water resources suggest that streamflow and groundwater is easily available (Table 4.3). However, as in many other developing countries, El Salvador faces problems in meeting its population's water supply needs. These problems range from pollution to inadequate and failing infrastructure to social equity issues regarding unequal distribution of services (Buckalew 1998).

Table 4.3 Water Resource Indicators

Indicator	1960 – 2007 (mean)
Average precipitation in depth (*mm/yr*)	1,724
Average precipitation in volume ($10^9 m^3/yr$)	36.3
Total internal renewable water resources ($10^9 m^3/yr$)	17.8
Total renewable water resources per capita ($m^3/inhab/yr$)	3,761
Total dam capacity (km^3)	3.2
Total water withdrawal (summed by sector) ($10^9 m^3/yr$)	1.27
Hydroelectric Capacity (*2003 mw*)	429.7

(FAO 2007)

The hydro-geography (Figure 4.4) of El Salvador is a function of the volcanic activity in the region and the large amounts of seasonal rainfall, which create a landscape that is rugged and particularly at risk to landslides (Bonell 1993). El Salvador's largest river is the Rio Lempa. The Lempa rises in Guatamela and flows for 320 km (250 km within El Salvador) through the Cerron Grande Reservoir, and a series of hydroelectric dams before it reaches the Pacific, near Zamoran. Two large lakes make up the other major significant hydrologic features of El Salvador, Lake Ilopango near San Salvador and the Lago de Coatepeque.

The condition of the Rio Lempa is reflective of many of the principle water related challenges facing El Salvador. These problems include high levels of industrial and municipal pollution, ageing, inadequate and localized infrastructure, and a lack of economic support for water infrastructure development. Moreover, as a legacy of the civil war (1980-1992) there is a shortage of trained individuals to develop and manage infrastructure projects (UNICEF/WHO JMP 2006).

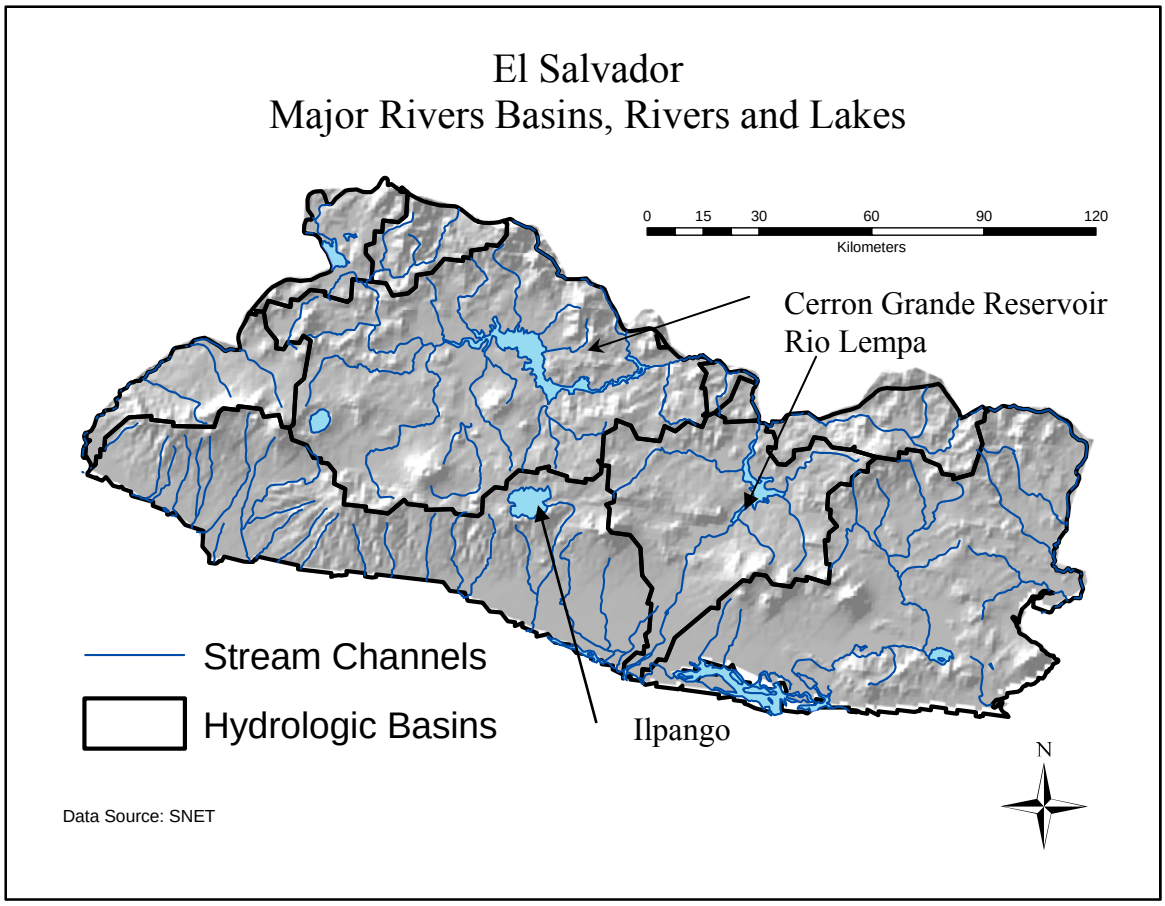

Figure 4.4 El Salvador major basins, rivers and lakes

These deficiencies in water supply and infrastructure development are manifest most explicitly in rural areas, where access to sustainable water supply approaches 68% and access to improved sanitation facilities is often less than 40% (Buckalew 1998; UNICEF/WHO JMP 2006).

For drinking water in rural areas most people in El Salvador rely on ground water (Buckalew 1998). This reliance on groundwater is due primarily to the heavy contamination of surface waters from industrial, domestic, and agricultural sources (Castillo et al. 1997; Buckalew 1998). Data collected in 2004 by the Czech Government (Novarkova 2007) indicated that most, if not all surface waters, including those in the Cerron Grande reservoir were highly contaminated by a combination of effluent from

sugar and chemical factories and untreated wastewater sewage. The primary water issue for the community in La Laguneta is directly related to the absence of a reliable supply during the November through March dry season, and a lack of the financial and technical capacity to expand or improve the existing system.

Administracion Nacional de Acueductos y Alcnatarillado (ANDA)

The government agency primarily responsible for developing and maintaining water systems in El Salvador is the Administracion Nacional de Acueductos y Alcnatarillado (ANDA). ANDA oversees water systems for most of the country, and is the primary ministerial entity responsible for water supply development. ANDA is an umbrella organization that provides water and sanitation services, and defines policies and regulations. ANDA provides direct water supply and sanitation services to approximately 50% of the population (ANDA 2006, p. 1). Costs associated with residential service range from $0.17 to $0.28 per cubic meter (ANDA 2006 10)[18].

Though ANDA is the major entity for water in El Salvador, it is not the only institution/organization involved with water supply as there are numerous other Salvadoran and international organizations that focus on water supply development in the country with the prominent ones listed in table 4.4. However, as the main ministerial entity for water and the branch that sets policy and develops plans, ANDA is the most important water related entity in the country.

[18] $0.20 per cubic meter is approximately 72% less than the base rate paid by Fort Collins citizens who access Fort Collins Utilities water at the base rate ($12.72 base charge, $1.97/1000 gallons up to 7000 gallons).

Table 4.4 El Salvador Water Supply Institutions and Agencies

Agency	Primary area of influence
Administracion Nacional de Acueductos y Alcnatarillado[19] (ANDA)	Municipal and industrial water supply and sewage treatment.
Minesterio de Salud[20] (MSPS)	Medical Statistics Urban sanitation Food hygiene in slaughterhouses and markets Sewers and sewage systems Mosquito control
Fondo de Inversión Social para el Desarrollo Local[21] (FISDL)	Finance and technical assistance programs (water and sanitation, schools) Expansion of basic social services Improving financial management skills for regional governments Rural Electrification projects
Japan International Cooperation Agency[22] (JICA)	Education Economic investment/Poverty reduction Social development Environmental conservation.
United States Agency for International Development[23]	Economic Growth and Education Water and Environment Democracy and Governance Health
Cooperative for Assistance and Relief Everywhere[24] (CARE)	Agriculture and Natural Resources Economic Development Education Emergency Relief Health, Nutrition, and Water

[19] National Administration of Aqueducts and Sewage Systems - http://www.anda.gob.sv
[20] Ministry of Health - http://www.mspas.gob.sv/
[21] Social Investment Fund for Local Development - http://www.fisdl.gob.sv/
[22] http://www.jica.go.jp/elsalvador/index.html
[23] http://www.usaid.gov/ locations/latin_america_caribbean/ country/el_salvador/
[24] http://www.care.org

La Laguneta

The community of La Laguneta is located in the La Paz district of El Salvador at an elevation of 1060 (m) on the north-western side of the San Vincente volcano (Chincontepeque). The center of the community is the church with dwellings surrounding the main square in front of the church, and an additional section of the community just north of the soccer field (figure 4.5)

The village was established in 1930 by five families (Chavez, Henriquez, Reyes, Crespin, Dominguez). These five main families still comprise ~80% of the local population[25]. Most families in La Laguneta rely on the cultivation and harvest of coffee as their primary source of income. During EWB-CSU's initial site assessment we found that average monthly incomes were ~$80.00.

The main source of water in the village is from five wells located near the Casa Comunial (Community Building). These wells provide adequate amounts of water during the wet period of the year (July-November) however; due to diminished well yields during the dry season (January-May) water rationing is instituted. Rationing typically begins in late January or early February and may extend through the end of the dry season (May). When rationing does occur, families are restricted to between two and four cantaros each day (50-100 liters).

As part of the effort to increase water access during the dry season EWB-CSU has assisted with include drilling two bore-hole wells (Figure 4.6, 4.7), improving the storage tank by funding an improved roof and installing additional taps, electrifying two of the existing pumps (which now pump directly to the tank), and installing a chlorination system on the main tank (Figure 4.8).

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[25] Pers. comm. M. Sugrue – Peace Corps Volunteer (April 2004 – May 2006)

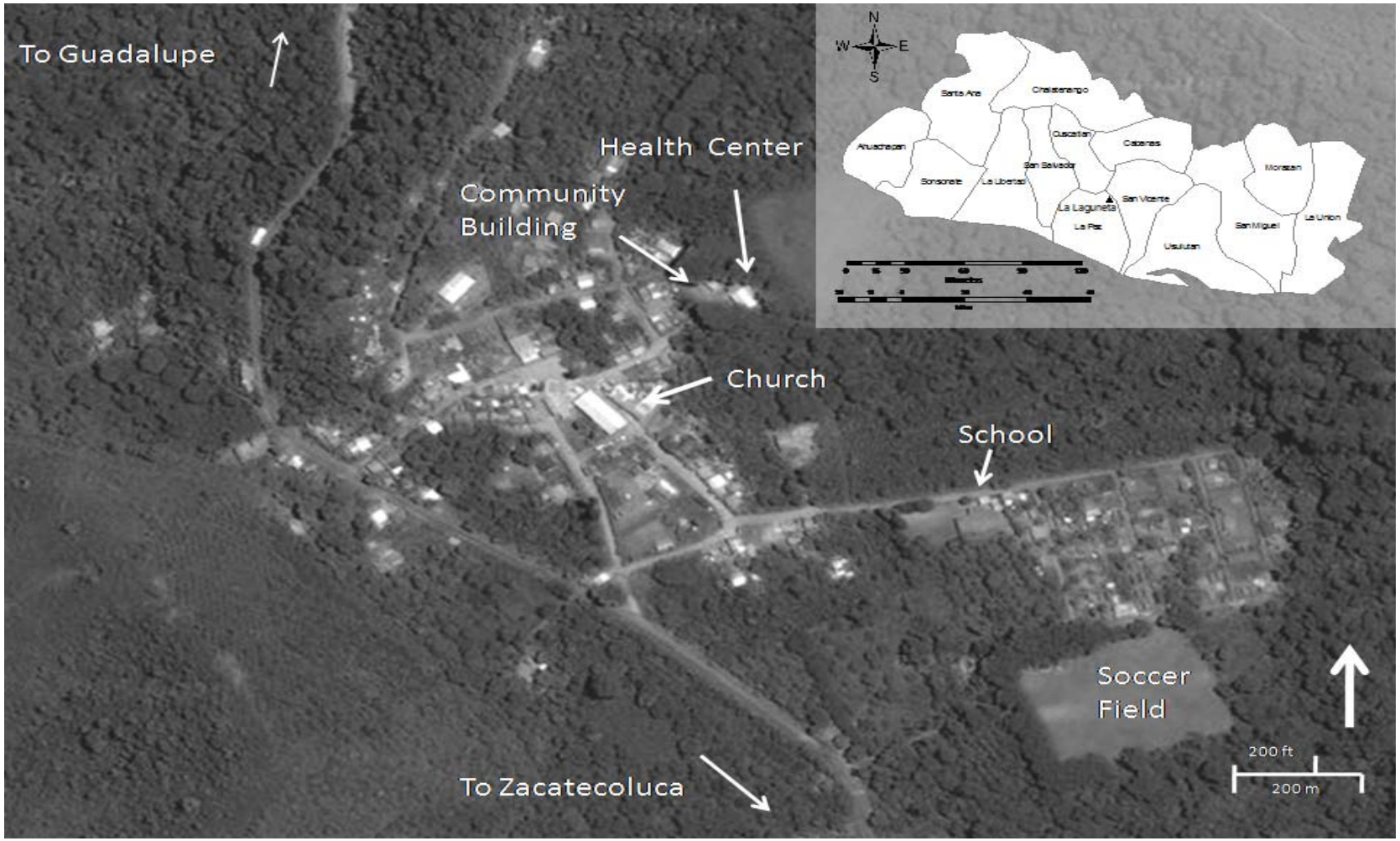

Figure 4.5 La Laguneta

The major buildings in the community are the Health Center (Casa de Salud), Church, School, Community Building (Casa Communial). The other major feature of the town is the soccer field with the newer neighborhoods (colonias) located directly north of the field. The older part of town and where the existing wells are located is north of the church and near the Health Center (Google Maps 2007).

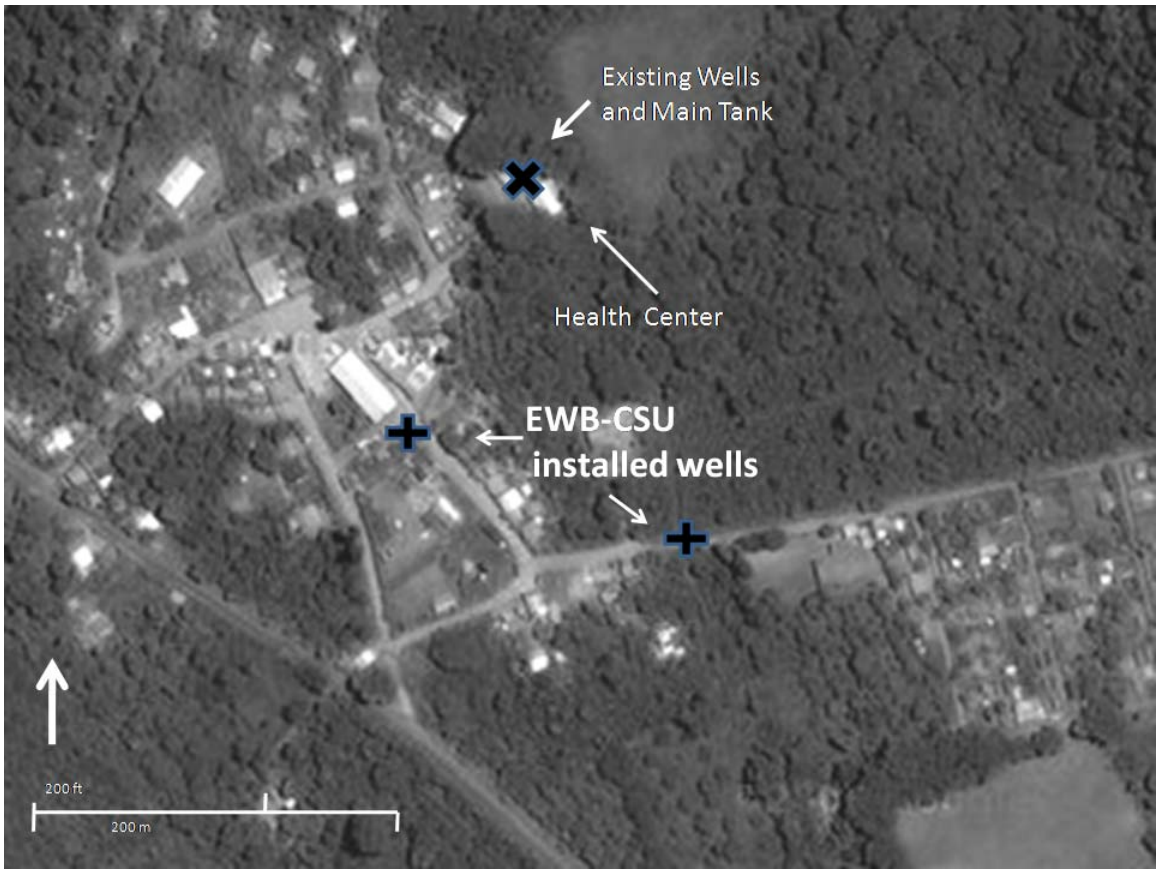

Figure 4.6 Air photo of La Laguneta showing existing and new wells
(Google Maps 2007)


Figure 4.7 EWB installed school well
The school well pictured above is the new well in the right portion of the air photo. This well was placed at the lowest topographic point in the community along a visible, but dry channel bed.

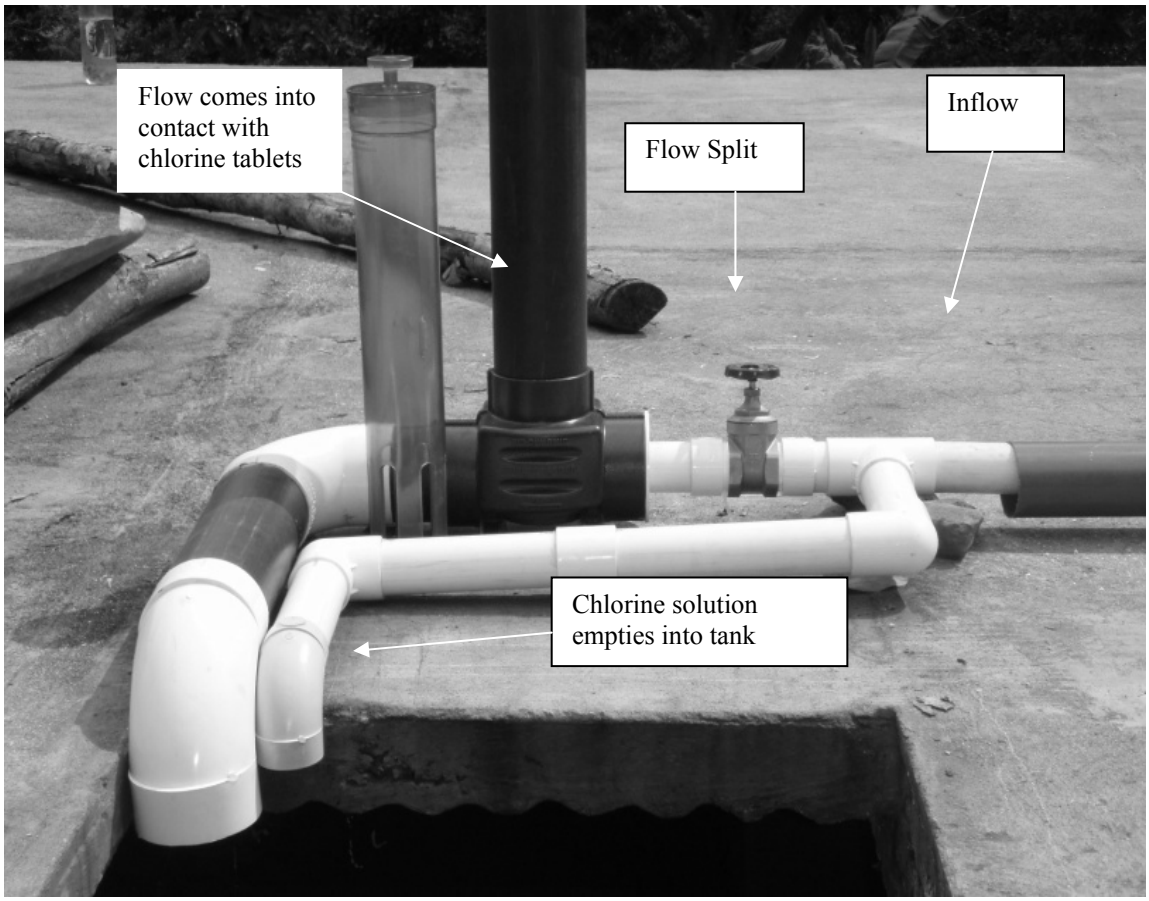

Figure 4.8 Chlorination System

Water flows into the apparatus from the right side of the image, half of the stream is then sent through the joint where it comes into contact with a chlorine cake. The chlorine cake is slowly dissolved into the flow creating a solution of chlorine which is then sent into the tank.

Applying Water Project Framework (WPF)

The key elements of the WPF for the project in La Laguneta relate directly to the seasonality of precipitation and the mitigating the biological contamination of existing supplies, the lack of in-hand cash funds and credit for engaging in large infrastructure, the legacy of a political system that is extremely hierarchal and dominated by the land owning class, and the intermittent and/or cursory access to development aid and technical assistance (Table 4.5).

Table 4.5 Relationship of Model Factors to Water Supply in La Laguneta

Key Element	Affects Water supply in La Laguneta by:
Physical/Environmental Context	Contributing to the variability and seasonality precipitation, and creating a complex geology due to the volcano and frequent seismic events.
Social and Political Environment	Defining the character of local and regional governance (Patron or 'Big Man' style of governance) as well as limiting the investment and support for social goods (e.g., water supply, roads, power, laws, health programs, schools, etc.).
Economics	At the macro-scale, El Salvador's economy is highly volatile, largely inequitable, and dependent on the U.S. economy and currency value. And at the micro-scale, the rural, agriculturally-based economy is cash poor, with limited access to credit and a high reliance on remittances to pay for basic needs.
Development Aid	Expanding the financial and technical base from which the community draws upon to meet their water supply needs.
Participation	Involvement of the water committee and the community at large is main point of contact between the other factors. Participation is conceptualized as a circular process of information gathering, information processing, and collective decision making.

Participation by the community in assessing these issues and translating the acquired information in actions had been hampered by a lack of capacity and training. However, as the project has transitioned through the initial phase, participation by community members has increased, potentially due to the visibility of project outputs and the enthusiasm generated by the EWB-CSU project team during site visits.

The WPF is an outgrowth of the lessons learned during the initial phases of project. Moreover, EWB-CSU's approach to gathering information evolved during the three years of involvement in La Laguneta. The analysis of the WPF factors provided below represent the most current understanding of the issues relevant to the project and how that information was obtained during the site visits.

Physical Environment – El Salvador and La Laguneta

The range of the physical and environmental context of the RWS for the project in La Laguneta (Figure 4.9) is framed by the influences relating to the seasonality of precipitation and the aquifer properties in the La Laguneta basin. This context is examined at both the micro (village) and macro (country) scales. The dual scales of investigation were important to understanding the major environmental issues facing the village: i.e., are the conditions facing La Laguneta an isolated problem, or are the problems of seasonality in water supply a country-wide issue. By following this scaled level of assessment the EWB-CSU team was able to compare different sources of information, and confirm, through triangulation, the major issues and opportunities concerning the physical environment and the ability to expand water supply infrastructure

in the community. Thus, the first section of assessing the physical environment consists of understand the macro-elements the physical environment of El Salvador.

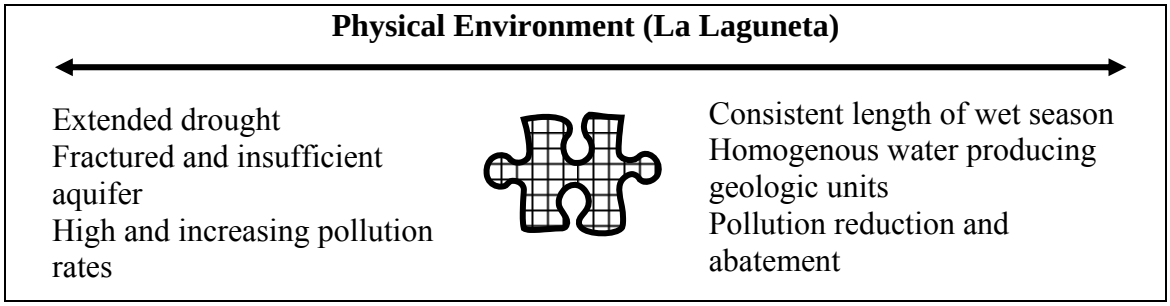

Figure 4.9 WPF Factor Physical Environment - La Laguneta

Geography and Topography

El Salvador is geographically divided into tropical lowlands along the coastal plain, a central valley consisting of plateaus and volcanoes, and a mountainous upland located in the North (Figure 4.10). The coastal regions width averages ~16 kilometers (10 miles), but widens to a maximum width of 32 kilometers (20 miles) near the Golfo de Fonseca. The central valley regions elevation approaches ~600 meters (2,000 feet), comprising the upland valley between the northern Sierra Madre and southern chain of volcanoes.

Approximately 40% of El Salvador's population is concentrated in the central valley region where the capital city of San Salvador as well as Santa Ana, San Miguel, Sonsonate, and San Vicente are located. One of the major geographic features of the northern region is the Rio Lempa valley and the Sierra Madre Mountains bordering Guatemala. The southern part of the country is comprised of five groups of volcanoes, including the Santa Ana volcano, El Salvador's highest point (2,365 m).

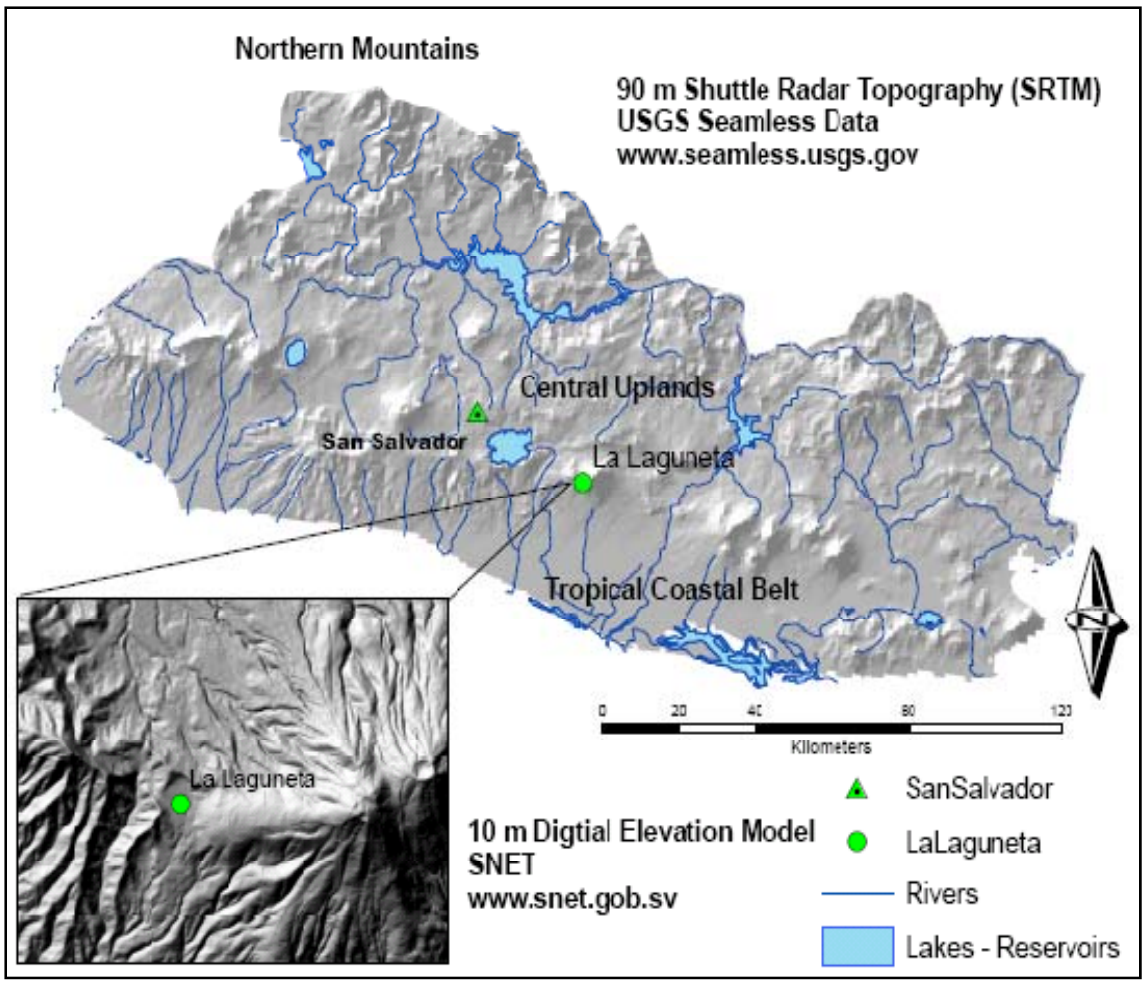

Figure 4.10 El Salvador Topography

La Laguneta is located in the southern part of the central uplands in a small depression between the San Vincente volcano and an older volcanic cone (Figure 4.10). The topography in La Laguneta reflects the effects of the San Vincente volcano (Figure 4.11). La Laguneta, literally means little lagoon, and when the community is viewed from the ridge north of the town, the topographic depression that lent it its name is visibly apparent (Figure 4.11, 4.12)

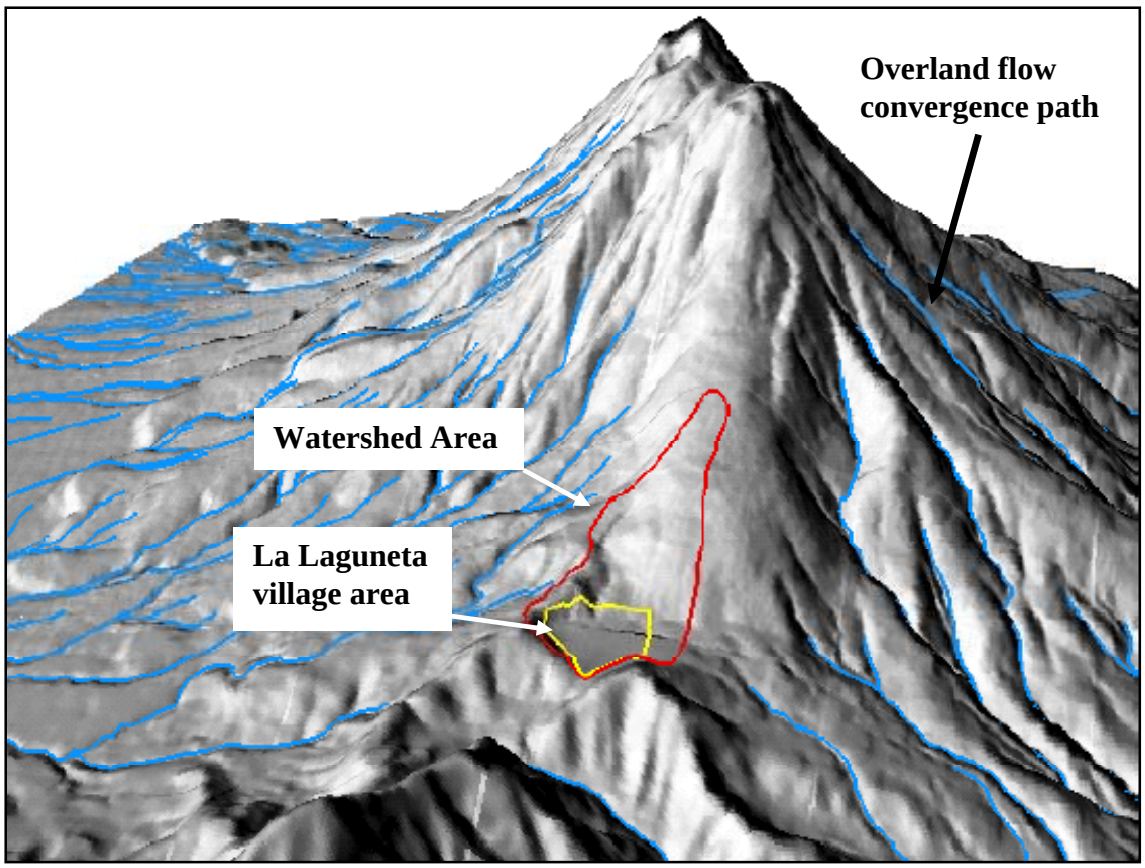

Figure 4.11 Topographic representation of the San Vincente Volcano

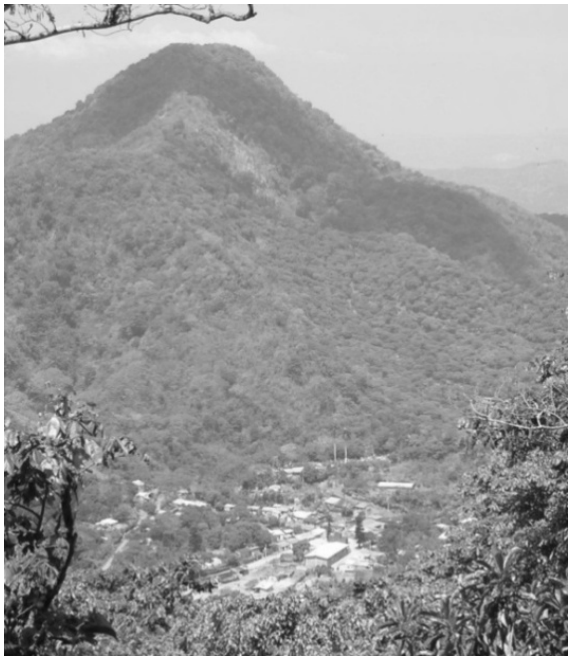
Figure 4.12 La Laguneta from West ridge

Climate

On a macro-scale, El Salvador's climate responds to the effect of the Northern Tropical Monsoon Cycle where the predominant rainfall season occurs between May and November with the rest of the year being relatively dry (Manton 1993). Average monthly precipitation amounts range from <10 mm during parts of the dry season (December – March) to more than 350 mm during the wettest months.

The precipitation regime in El Salvador is similar to other Central American countries in that precipitation amounts are elevated on southern facing aspects and at higher elevations, varying from about 1500 mm (59 inches) over the coastal plain to as much as 2300 mm (90 inches) in the mountain ranges (SNET 2005).

The seasonality and variability of precipitation has been identified as a contributing factor to rural water supply shortages in El Salvador (Buckalew 1998). This is particularly true for La Laguneta as dry season access and storage is one of the principle challenges for the community.

The amount and timing of precipitation is a key variable in assessing the potential yield for a water supply project. Because precipitation in tropical climates typically expresses high variability in annual and bi-annual cycles (Manton 1993) - wet (monsoon) and dry (summer), it is important to assess the variability of precipitation timing and amounts when developing water supply infrastructure in these areas (Jordan 1980).

For the La Laguneta site, precipitation was assessed by analyzing data provided by Riverside Technologies Inc (www.riverside.com) and the Servicio Nacional de Estudios Territoriales **(**SNET). Data from stations around El Salvador were used as La Laguneta does not have a climate station within close proximity. The nine stations

selected had data records longer than ten years, and were either geographically close to La Laguneta or were located at a similar elevation (Table 4.6).

Table 4.6 Annual Precipitation Totals for Five Sites in El Salvador

Santa Cruz Porillo (30)	Santiago Texacuangos (615)	Finca Santa Elena (699)	San Jacinto (840)	Finca El Carmen (1,320)	El Ayutepeque (1,770)	**La Laguneta (1,050)**
Precipitation (mm)						**Estimated**
1774	1714	1787	2104	2198	2279	**2144**

Values in (parentheses) indicate approximate elevation (m)

Using the estimated precipitation regime from other nearby or similar (in elevation) meteorological stations, a monthly precipitation estimate was constructed for La Laguneta by least-squares regression using elevation as the independent and precipitation as the response variable. Based on the mean of the regression equations ($y = 0.0629x + 284.26$), precipitation increases ~6 millimeters for every 100 meters of elevation. These estimates of precipitation changing with elevation are consistent with the estimates produced by SNET's meteorological division (http://www.snet.gob.sv). The modeled estimate of precipitation (Figure 4.14) was validated with field data by installing two, 8 inch, clear plastic rain gages and recording daily precipitation, beginning on August 15th of 2006 to present. Local contacts in the community collected daily precipitation data and periodically sent the data updates to the EWB-CSU team in Fort Collins. Figure 4.13 presents the measured total monthly precipitation at La Laguneta from August 2006 to March of 2008.

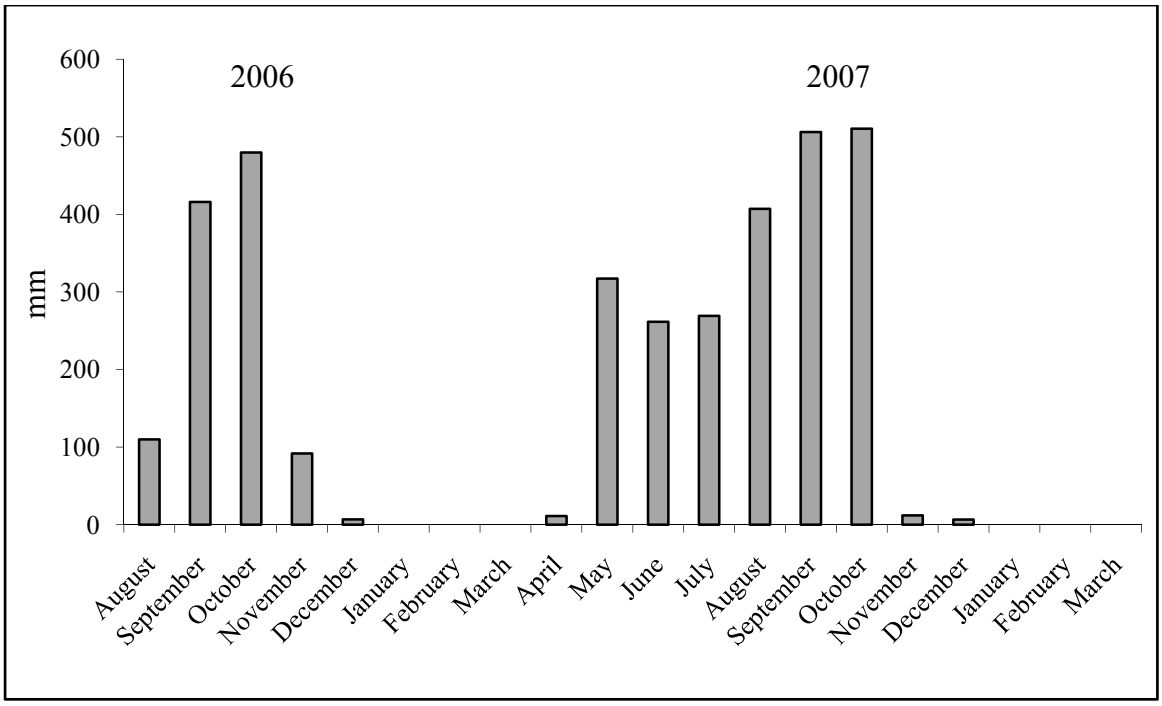

Figure 4.13 Measured precipitation at La Laguneta site
Precipitation measurements began on August 15th 2006.

Groundwater

Recharge to the local aquifer at La Laguneta occurs through direct infiltration of precipitation and as infiltration of runoff from the volcanic hills to the west of the village and from the slope of San Vicente volcano east of the village. The surface drainage basin contributing recharge to the La Laguneta aquifer was estimated by using a digital elevation model (DEM) and ArcMap © *v*9.1 (ESRI 2007) to compute a watershed area by flow path analysis, the method yielding a watershed area of 0.98 km^2.

Soil infiltration rates on the volcanic slopes of San Vicente Volcano are most likely quite high due to the high transmissivities of the unconsolidated volcanic alluvium[26]. The epiclastic deposits of the La Laguneta aquifer encompass an area of

[26] Dan Hart, Hydrogeologist, Natural Resource Consulting Engineers Fort Collins, CO

approximately 0.28 km^2 (Cullor 2006). The configuration of the bottom of the epiclastic deposits, and thus the total volume of the aquifer are uncertain. However, the examination of the drilling logs and visual inspection of the drilling cuttings indicated that there are three distinct layers in the La Laguneta Basin (Figure 4.14, 4.15).

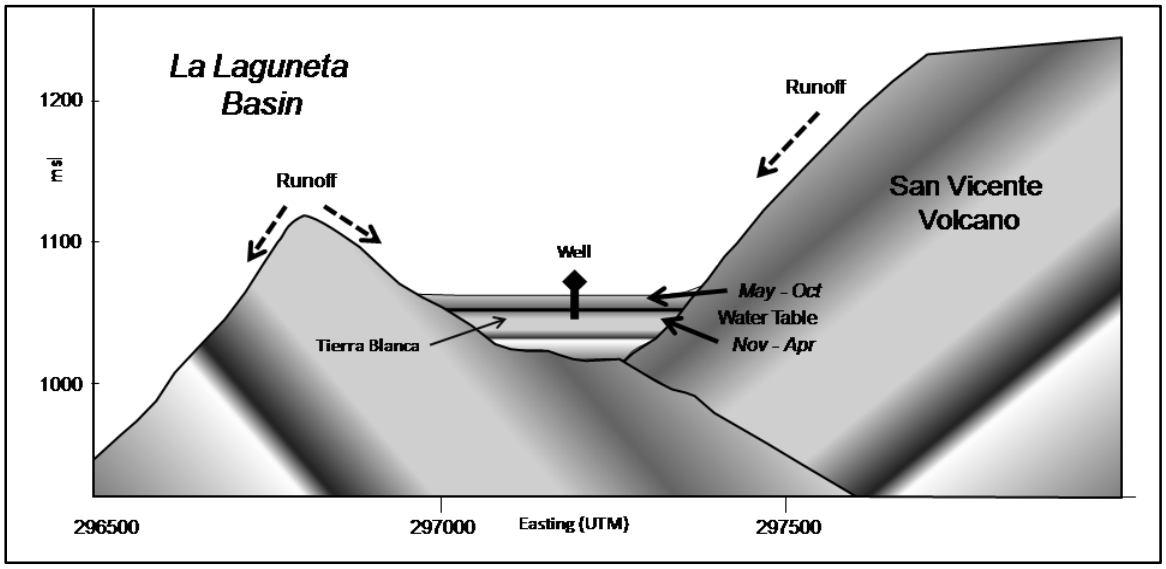

Figure 4.14 Cross section representation of the La Laguneta basin
(Adapted from Cullor 2006)

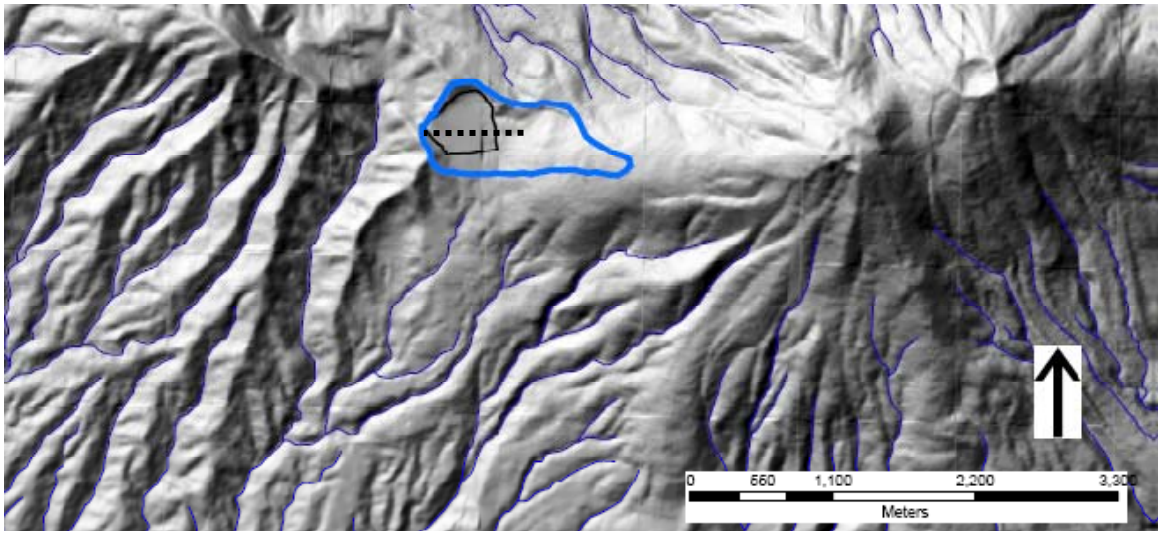

Figure 4.15 San Vincente volcano and La Laguneta watershed area
Dashed line represents the location of the cross-section view in figure 4.15

These layers, evaluated during the well drilling that occurred during August 2006, include the unconsolidated alluvium (0 – 14.5 m), then a layer of fine sand and white pumice (~15 – 16.5 m), and a deeper layer (16.5 – 32 m) which consisted of cobbles and angular and sub-angular epiclastic rock. The layer of white pumice is known locally as 'tierra blanca' (white soil) and consists of white to light grey acidic pyroclasitc and epiclastic rocks (Crosta 2005).

Details of nine existing wells and one exploration borehole in the basin are summarized in Table 4.7. Depths of the wells are all less than 18 meters and during the dry season, after 12 hours of recharge, depth of water averaged 3 meters (EWB-CSU March, 2005). Water level elevations for wells in the La Laguneta area were measured directly in 2005 using a modified well sounder allowing for 6 hours of recharge.

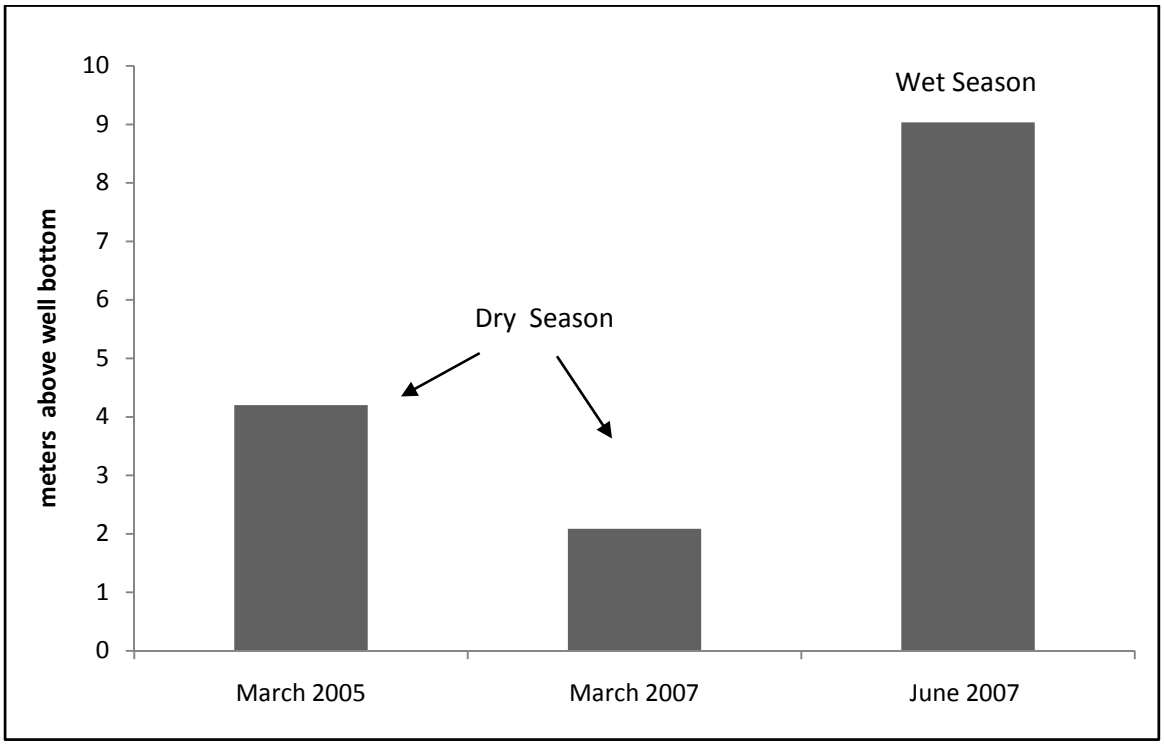

Figure 4.16 Average daily depths to water March 2005, June 2007

The 2007 data represents data collected from a pressure transducer (Baro TROLL) (In-Situ 206) which was installed in January of 2007. The depths presented in Figure 4.16 represent dry season volumes of ~4000 and 2000 liters respectively for the March measurements and ~9000 liters for the June 2007 measurements.

Table 4.7 La Laguneta Water Wells

Well ID	Name	Ownership	UTM X WGS84	UTM Y WGS84	Ground Elevation (m)	Lifting device	Well Diameter (m)	Well Depth (m)
1	NW-Casa de salud	Public	297048	1503644	1052	India Mark II	0.66	Na
2	NE-Casa de salud	Public	297050	1503660	1054	India Mark II	0.8	Na
3	South Public	Public	297048	1503650	1053	String Wheel with elec. pump	1.0	17.1
4	NE-storage tank	Public	297041	1503663	1055	Long handle	0.64	15.3
5	North Public	Public	297030	1503665	1056	String Wheel	1.0	16.5
6	Dora	Private	297013	1503662	1057	Bucket	1.0	16.5
7	Gladis	Private	297174	1503408	1046	Bucket	1.4	12.8
8	Christian Ricarma	Private	297224	1503519	1049	Bucket	0.82	4.0
9	School	School	297195	1503495	1047	String Wheel	0.9	13.1
10	Soccer field hole	NA	297192	1503372	1047	NA	2+	7.32
11	Deep well	Public	297030	1503664	1055.97	NA	0.20	103

An estimate of volume of the local aquifer of 868,000 m^3 was made assuming three meters of saturated thickness. Assuming a specific yield of 20% (derived from the well test results) the aquifer may potentially contain 170,000 m^3 of groundwater in

storage (Cullor 2006). This is slightly more than the estimated average annual recharge and implies that if the aquifer were fully developed, water shortages would be experienced only during periods of extended drought (more than 3 months after dry season). The full thickness of the aquifer is unknown but likely to be considerably thicker in the central part of the basin and therefore the potential volume of water in storage may be larger than the 170,000 m^3 estimate.

In 2002 the mayor of the San Juan Nonualco municipality, of which La Laguneta is a part, contracted with an engineering firm to drill an additional well in the community. A borehole well was drilled to a depth of 103 meters but failed to encounter sufficient groundwater to warrant further development and was subsequently abandoned. The mayor indicated the well contained 50 meters of screen (103-53m), though he was unsure and was not present during the casing of the well. Full details of the borehole are unavailable though inspection of the well showed that the portion of the well casing visible from the surface is not perforated to a depth of at least 17 meters (the total depth of several of the public wells). This may be the cause of the well not producing adequate water, as the case screen may be below the saturated zone of the aquifer, and the casing fill cap (most likely bentonite) prohibiting drainage to the screened section of the well.

The five other public wells are situated near the northeastern edge of the basin and thus information regarding the aquifer properties in the basin is limited. Based on the water rationing scheme currently utilized in the community during the dry periods (½ the community using the wells in the morning, ½ in the evening) and assuming all five wells have a similar volume of water and each family gets a equal amount, during the dry season, each person would only be able to have 26.5 liters per day (5 wells * ~3,500 liters

= 17,500 liters / 660 people = 26.5 liters). This is approximately half the WHO recommended daily minimum.

An attempt was made to apply geophysical methods to assess the groundwater potential in the area during January 2007. The results indicated that in some of the topographically lower portions of the basin, wells might produce adequate flow volumes, but the results were inconclusive and will require further physical measurements of water levels.

Rates of infiltration and hydraulic conductivity are the other major physical components identified as being particularly relevant to achieving community goals for the project. Infiltration rates and hydraulic conductivities are high, most likely due to the characteristics of the volcanic soils found in the basin and runoff is very low and most precipitation infiltrates into the unconfined portion of the local aquifer. The rapid infiltration could benefit water development in that there are numerous possibilities for additional shallow wells (10-16 m), however, the high rates of conductivity may also facilitate the contamination of groundwater from each families pit latrines.

Water Quality

All community members interviewed identified gastrointestinal disorder as the most significant health threat. When asked about water quality, people generally indicated that they did not link water quality to the illnesses they were experiencing. However, upon inspecting the well site, and viewing the proximity of latrines to the wells and the open tops, the EWB-CSU team hypothesized that there might be high biological contamination. Samples of water were collected from the main public well in August

2005 and subjected to field and laboratory analyses. The samples were tested for the presence of fecal coliform using a HACH coli-scan presence/absence test kit. In addition to field testing, samples were collected and submitted to a laboratory in San Salvador for a standard drinking water analysis. Both the field tests and the laboratory scans reveled that there was a high level of bacteriological contamination (Table 4.8).

Table 4.8 Summary of Water Quality Test Results

Parameter	Units	La Laguneta South Public Well	El Salvador Water Quality Limits	
			Recommended	Maximum
pH (lab)	SU	6.5	6.0	8.5
EC	µmhos/cm	165.7		
Alkalinity	mg/L	2.00		
Hardness	mg/L	51	100	400
Calcium	mg/L	42.78		75
Magnesium	mg/L	10.06		50
Chloride	mg/L	4.29	25	250
Iron (total)	mg/L	0.10	0.05	0.30
Iron	mg/L	0.10		
Manganese	mg/L	tr	0.05	0.10
Total Solids	mg/L	228		
TDSS	mg/L	224	300	600
Sulfate	mg/L	16.39	25	250
Nitrate	mg/L	0.25		45
Silica	mg/L	56.00	60	125
Fluoride	mg/L	0.50		1.5
Bicarbonate	mg/L	83.42		
Arsenic	mg/L	ND		0.01
E Coli		**Positive**	Negative	Negative
Total Coli form	NMP/100 mL	>23		<1.1
Total Fecal Coli form	NMP/100 mL	23		Negative

Efforts were made to isolate the causes of the contamination. Based on the results of the laboratory analysis of the water samples, the EWB-CSU team concluded that the latrines closest to the main community wells were potentially causing the contamination. The team has on several occasions suggested that the households near the main community wells discontinue their use of the latrines and move to developing a small-bore or condominial (Mello, 2005) sewer system. However, due to the cost, this option is not currently being pursued.

Overall, the physical environment at the La Laguneta site is conducive to expanding and improving the water supply system. Annual precipitation provides enough water for both current and future needs. Temperature and topography also work in favor for the La Laguneta site in that temperatures are cool reducing evaporative losses, and because of its location at the top of a watershed there is no possibility of upstream contamination from other communities. With regards to the existing contamination problems, simple disinfection practices (addition of sodium hypochlorite NaOCl) have been employed in the community with limited success[27].

The same positive elements of the physical environment are also the source of challenges in plans to expand the water system. The plentiful nature of precipitation during the rainy season has contributed to some apathy concerning developing expanded storage, as many of the people interviewed felt that the problem was acute for a limited part of the year. In addition, the lack of understanding between the biological quality of

[27] Puri Agua is a 2% Sodium Hypochlorite solution provided free of cost from the national government and is typically left at the wells for people to use in their cantaros. However use is sporadic and many people indicated they did not like the taste.

the water and rates of illness pose a challenge to garnering support for initiatives focused on reducing pollution and increasing the usage of disinfection techniques.

Socio-Political State – La Laguneta

The socio-political state (Figure 4.17) at the La Laguneta site is constrained by the remnants of the civil war which occurred in El Salvador during the 1980's and the move toward democratization and local governance derived from the Chapultepec Peace Accords in 1992.

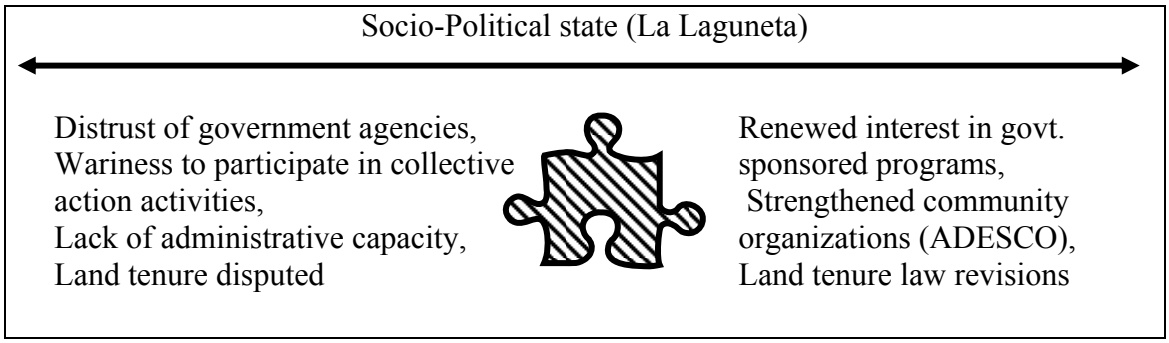

Figure 4.17 WPF Factor Socio-Political state - La Laguneta

EWB-CSU applied a modified form of Participatory Rural Appraisal (PRA) methods to assess the Socio-Political framework and Economic challenges/opportunities of the community. The hybrid approach EWB-CSU to assess the socio-political framework and economic challenges/opportunities utilized many of the PRA techniques as well as some of the more structured formal approaches.

PRA techniques utilized by EWB-CSU:

- Review of secondary sources, including aerial photos
- Direct observation, foot transects, familiarization, participation in local activities
- Interviews with key informants, group interviews, workshops
- Biographies, local histories, case studies
- Time lines
- Short simple questionnaires
- Rapid report writing in the field

In addition to these PRA techniques, EWB-CSU utilized formal interviewing techniques, consisting of the EWB-USA health survey and informational group meetings. These meetings were held with the community ADESCO and Water Committee and were conducted in Spanish with members of EWB-CSU translating for others in the group. Interviews and meetings were also conducted outside the village in order to better understand the larger socio-political framework of El Salvador. These meetings were held in Guadalupe and San Salvador and included contacts from three NGO's, the major El Salvadoran organization for water and sanitation, as well as some engineering firms familiar with shallow ground water development in the region (Table 4.9)

Table 4.9 El Salvador Collaborators

Organization	Person Contacted
Administracion Nacional de Acueductos y Alcnatarillado (ANDA)	Ingeniero Carlos Flores Chabarrilla
Ministerio de Salud Publica y Asistencia Social (MSPAS)	Dr. Santiago Ghiringhello
Ministerio de Medio Ambiente y Recursos Naturales (MARN)	Ivy Dora García de Romero
Cooperative Assistance for Relief Everywhere (CARE)	Jonathon Claros
Servicio National de Estudios Territoriales (SNET)	Roberto Cerón
United States Army Corps of Engineers (USACE)	Paul Reed
United States Agency for International Development (USAID)	Brad Carr

Community Health Issues

A semi-formal interview method was used to establish baseline information about the general health and well-being of individuals in the community. A set of questions was

adapted from the EWB-USA standard community survey (EWB-USA 2005) (Appendix A) and translated into Spanish by members of EWB-CSU. The interviews were carried out by two of the EWB-CSU team in collaboration with the Peace Corps volunteer. Participants to the community survey were chosen based on the suggestions by the Peace Corps volunteer. Individuals were asked to participate in answering the health-based and community history questions.

A census of the village concluded that there are 660 persons with approximately 51% of the population under the age of 20 years, and 54% women (Table 4.10)

Table 4.10 La Laguneta Population Structure

Population Group	La Laguneta
Males 12 and older	210
Females 12 and older	247
Males under 12	94
Females under 12	108
Total individuals	659
Total # of families	151
Individuals per family (average)	4.36

The original census and community survey were conducted by M. Sugrue a PCV stationed in the community. Ms. Sugrue began her service in April of 2004 as a Health and Sanitation specialist and conducted house visits and community survey during the first two months of her service. Through the community survey and house visits, Ms. Sugrue discerned that most important issue to the community was the improvement of the water supply situation. To facilitate this process, a project proposal was submitted to Project Concern International (PCI) in November of 2004. The proposal submitted to PCI included a description of the village and water supply problems, signatures from all adult

beneficiaries of the project (head of household) and letters of recommendation from both the mayors of the closest two large towns (Guadalupe and San Juan Nonualco). Sugrue is notified in January of 2005 that due to funding constraints, PCI will not be able to assist with the project. Upon receiving this information, Ms Sugrue continued to seek outside assistance and submited proposals to Engineers Without Borders, Red Cross and ANDA (Appendix B). EWB-CSU responds with the promise of technical assistance in February of 2005 and schedules a site visit for March.

Based on the efforts of Ms. Sugrue, EWB-CSU was able to prepare for the site assessment knowing some of the key elements of the community, including the general size of the project population and the level of desire for the project. EWB-CSU then followed up and confirmed the understanding of the water supply situation in the community by utilizing a questionnaire survey (Appendix A) which focused on health related issues associated with the existing water supply situation in the community. The major findings of the interviews were respiratory illness and gastrointestinal diseases are the primary health afflictions facing people in the community and influenza and diarrhea were most prevalent during the dry season (Table 4.11).

In addition to identifying influenza and diarrhea as the most common illnesses, the health survey contributed to EWB-CSU's understanding of the linkages individuals in the community ascribed to water and health: for example, all interviewees stated that, they expected health conditions to improve with better access to potable water.

Table 4.11 Summary of community well-being survey

Illness	Stated Causes	Treatments	Affected Annually
Pneumonia	Change of seasons	Home remedies, clinic in Guadalupe or hospital in San Vincente	10 - 20
Diarrhea	Water and inadequate hygiene practices	Re-hydration salts, education. Some go to hospital	15 - 30 Children 7 - 20 Adults
Influenza	Lack of water/lack of cleanliness; smoke	Acetaminophen (Aspirin) and antihistamines	70 – 160 Children 40 – 138 Adults
Hepatitis A	Hygiene practices	Large amounts of honey Education, hygiene education	3-4 Children
Arthritis	Old age	Elderly care education and ibuprofen	30
Vomiting	Undercooked food, lack of food and water	Amoxicillin when available	12 - 40 Children 10 + adults mostly elderly
Aches and Pains	Poverty, work, and constant worry	Pain relievers	30-50 % of population

Local Governance

The most important local administrative system operating in La Laguneta is the Asociación de Desarrollo Comunal (ADESCO) and the various boards that comprise the ADESCO. The concept of the ADESCO or community association grew out of the components of 1992 Chapultepec Peace Accords that dealt with the creation and strengthening of democratic institutions and the economic and social development for rural areas (Alverez-Basso et al. 2006)

ADESCOs are organizations typically formed by 25 or more members of the same community that have united forces to resolve common problems and meet community

needs. The ADESCO is recognized officially by the local government as personería jurídica (legal standing). The ADESCO is sub-divided into various boards (e.g., Water Board, Education Board, Health Board etc.) EWB-CSU interacted primarily with the members of the Health and Water Board. These sub-groups typically had memberships of less than ten individuals, with the water board having five members, including the community's health promoter and two women. The members of other ADESCO boards were similar, as all the members of the Health Board were also members of the water board. When inquiring about this we were told that due to the size of the community and because so many adults worked in San Salvador or in other towns, membership on committees was limited to a relatively few in the community. The main ADESCO committees would meet on a weekly basis to discuss issues related to community development. Full ADESCO meetings are open to the whole community and are held on a monthly basis, or as needed. Whenever the EWB-CSU team had visited the community, turnout for these meetings was high, with most adults in the community attending (Figure 4.18)

Generally, the interactions between the EWB-CSU teams and the ADESCO have been positive. There has always been a willingness to work together and to share information. However, the ADESCO's ability to function as an effective local governing body is hampered by three main issues:

1. The authority of the ADESCO to levy fees to support development projects or to provide for the continued maintenance of existing initiatives is limited;
2. ADESCO members are elected from the local populace at revolving intervals, creating a situation where institutional knowledge is not retained in a formalized way;

3. In addition to a lack of institutional memory and because many of the ADESCO members are small-holder agriculturalists, there is a paucity of technical, administrative, and financial skills.

Figure 4.18 Community Meeting La Laguneta
(photo JI Peltz, August/2007)

The challenges to effective management of the day-to-day operation of the installed infrastructure, has led to instances of misunderstanding over the roles and responsibilities by both EWB-CSU and the water committee. A major example of this was EWB-CSU's expectation that the water committee would collect fees in order to continue to purchase chlorine tablets for the disinfection system. The community water committee understood differently and once the tablets had all been used, and additional tablets were not sent to the community, the disinfection system was taken off-line.

Regional and National Governance

At the regional level the governance structure of El Salvador is organized by departments, with mayors acting as the intermediary between individual communities and the regional government. EWB-CSU met with two mayors (San Juan Nonualco and Guadalupe) in the region who have influence over La Laguneta. Both mayors expressed an interest in assisting La Laguneta and have in the past; for example, the Mayor of San Juan Nonualco has provided funds for a tanker truck to deliver water to La Laguneta during the dry season. However, community members indicated that the assistance they received from the mayors was closely related to election results and voting patterns in the community from previous elections.

In addition to meeting with local political figures, EWB-CSU also meet with local NGO's from CRS and the San Salvador Rotary Club. The meetings that were held spanned the entire range of formality, including informal pump-side conversations with local women, and very formal meetings in San Salvador, with officials from ANDA.

The main purposes of these meetings were to introduce the EWB-CSU organization to local entities that might provide assistance and guidance as well as to gain a better understanding of the local political situation. The outcomes of these meeting varied; many of the local political figures expressed a willingness to work with EWB-CSU on the La Laguneta water project, however, in each meeting, it was conveyed to us that financial support would not be possible.

In the larger national context of El Salvador the main forces affecting the socio-political state for water are the remaining tension from the war and the requirements of the Central American Free Trade Agreement (CAFTA). The tension from the war

manifests itself through polarizing national elections with the most recent election of Antonio Saca an ARENA party leader who has begun to implement many of the 'structural adjustment reforms' required of CAFTA. The most major of these reforms are termed "hydro-sector reform" which focuses on privatization of services, especially water supply.

Civil War

A major element of the socio-political state of El Salvador is the still visible effects of the 1980's civil war. This 12 year conflict caused of thousands of deaths with hundreds of thousands of individuals being displaced.

As with any strife, the causes are often multiple and confounding. However, Byrne (1996) outlines some of the major events that lead to the initiation of conflict and has attributed the root causes to "economic, political and strategic factors" (Byrne, 1996, p. 17). The economic causes lay in the transition of El Salvador into an export-crop economy (coffee) "dramatically worsening the conditions of life for most of the peasantry" when the price of coffee fell (Byrne 1996, p. 17). As the landless rural farmers lost wage based employment, their ability to feed their families was severely compromised. With governmental institutions backed by the agricultural elites, land tenure reform became impossible, leading many of the rural populace to turn to the Catholic clergy for support. These factors ultimately led to a sense of national tension that led to the events which triggered open conflict, the catalyst being the murder of Archbishop Oscar Romero, who was killed a few days after he had given a speech condemning the U.S. for providing military support to the junta that had taken over the

government (Byrne 1996, p. 54). The two major factions of the conflict were the conservative Alianza Republicana Nacionalista (ARENA) group and the leftist Farabundo Martí National Liberation Front (FLMN). The conflict ended with the signing of the Chapultepec Peace Accords in 1992. These agreements restructured the Salvadoran Army, created a civilian police force, created the FMLN political party, and allowed combatants amnesty (Byrne 1996, p. 205).

The war affected water supply development in El Salvador in a number of ways, most importantly the destruction of infrastructure and the inhibition of investment in public works projects. The war impacted the community of La Laguneta in complex and continued ways. The people in the community were the target of violence by both the ARENA soldiers and the FMLN fighters. Two members of the community were killed by the FMLN fighters when they refused to provide food to them. However, because the house compound of the Espinoza family was burned, there is continuing tension between the community members who are mostly farmers and rely on seasonal work in the coffee fincas (farms) and those who own the coffee fincas (Espinoza's). Due to lingering tension the Espinoza's have been unwilling to allow construction of wells, pumps, or pipelines on land that they own. This is problematic, because most of the land in the community belongs to the Espinoza family.

Economics – La Laguneta

Due to the rural nature of La Laguneta, the financial opportunities in the community are limited, though economic conditions for individuals in the community range from very poor relative to rural El Salvador standards to relatively wealthy by rural

El Salvador standards (Figure 4.19). The EWB-CSU team investigated the economic condition of the community through the use of semi-formal interviews, focus groups and through the collection of background material and interviews with individuals at various funding entities in the country.

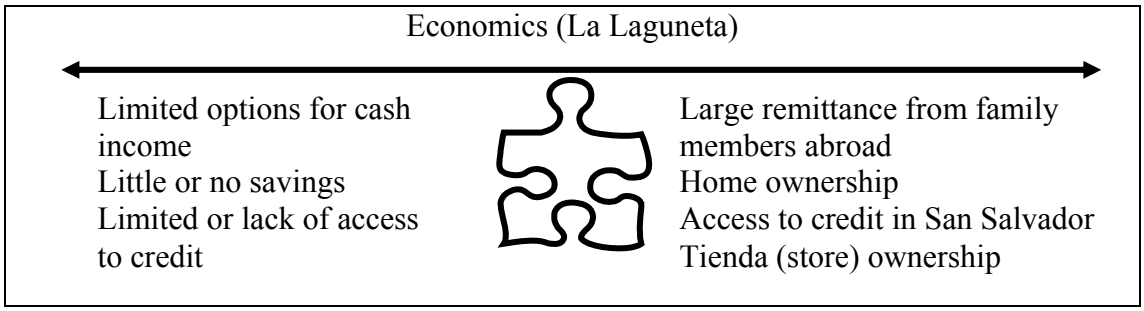

Figure 4.19 WPF Factor Economics - La Laguneta

At the largest scale the economy of El Salvador is considered a lower-to-middle income country by the World Bank's Atlas method[28]. The Gross National Income (GNI) for El Salvador ranges from $847 – $3,465. Using the international purchasing power parity (PPP) index[29] average annual per capita income is ~$4,700 (WBDDO 2006). The Gross Domestic Product[30] (GDP) in El Salvador is ~17 Billion, with much of the economy driven primarily by services (59% GDP) followed by industry (30 % GDP) and agriculture (10.7 % GDP) (WBDDO 2007).

One important element of El Salvador's complex economic condition is the 2.8 billion dollars of El Salvador's GNI derived from workers' remittances, primarily from

[28] Economies are divided according to 2005 GNI per capita, calculated using the World Bank Atlas method. The groups are: low income, $875 or less; lower middle income, $876 - $3,465; upper middle income, $3,466 - $10,725; and high income, $10,726 or more.
[29] Purchasing Power Parity (PPP) the law of one price; used to compare the standards of living between countries, and states that the cost of a comparable set of goods is the measure of currencies value within a country. e.g., the cost of an item and therefore the purchasing power of a currency is a function of a countries individual currency valuation (Rogoff 1996).
[30] GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products (WBDDO 2007).

the U.S. (Gammage 2006; WBDDO, 2007). Gammage (2006) asserts "remittances are now a critical source of national income and make up over half of export earnings and more than 16% of GDP." This is a growing phenomenon across Latin America, where in 2004 worker remittances equaled $40 billion, exceeding both foreign direct investment and net official development aid to the region (Gammage 2006).

El Salvadors, the economy was historically driven by coffee trade, which changed dramatically as world coffee prices declined. For example in 1998 coffee accounted for ~50% of El Salvador's total exports, but in 2004 it accounted for only 7% (Pearcy 2006). Textiles are now the dominant export, with 70% of the production going to the U.S. This may account for El Salvador's early ratification of the CAFTA.

In the community of La Laguneta, economic conditions were assessed through informal questionnaires and meetings with community members. Most families in the community derive income from farming in the local coffee plantations or from one or more members doing work in San Salvador or another of the larger cities. The average monthly income for families in the community is ~$80.00. There is a large amount of variation in this figure as some families receive remittances or maintain businesses either in the community or in San Salvador. From the community survey and meetings it was learned that families pay between ~$3.50 - $4.00 annually for water and that this payment occurs at the end of the coffee harvest season (December). Based on the estimate of $54m^3$/year ($36m^3$, wet season – 18 m^3, dry season) families pay approximately $\$0.074/m^3$ water. We investigated this further in August of 2007, by conducting household surveys to assess the feasibility of increasing the water tariff.

The 2007 survey was conducted by semi-formal interviews with both men and women. Our questions related to individuals satisfaction with the level of service improvement from the additional wells and the improvements to the main community tank, and what acceptance their might be toward increased water tariffs. The responses we collected ranged widely, with some individuals indicating that they would be willing to pay as much as $4.00 a month, but others saying that the current tariffs were too expensive and that they would be unable to pay any additional costs. An undertone we noticed with the responses were that people may be willing to pay increased costs, but they would want the tariff rate to be equal for all families (i.e., price increases should be uniform for all families).

Because the economic condition of the La Laguneta community is relatively worse off than those in other parts of the municipality, the ability to pay more for any type of services is severely limited. The reasons for the depressed economic condition are linked to the lack of local wage labor. In addition to a lack of local employment, the relatively isolated nature of the community makes it difficult for individuals to commute for work on a daily basis, requiring individuals to live away from La Laguneta for extended periods of time. Remittances are a source of income for some in the community, allowing some families to achieve a relative level of wealth in the community.

Development Aid – La Laguneta

Development aid in El Salvador has a relatively long and robust history. For example, the directory of development organizations (www.devdir.org) lists 396 different organizations actively working in El Salvador. Though expansive, the list is incomplete

and does not include EWB-USA, Rotary International, or the Peace Corps organization which has been actively involved in El Salvador since 1962 (Peace Corps 2007).

In La Laguneta, development support ranges from direct access to health care services (National Health Promoters visiting the community) to a complete lack of law enforcement (Figure 4.20).

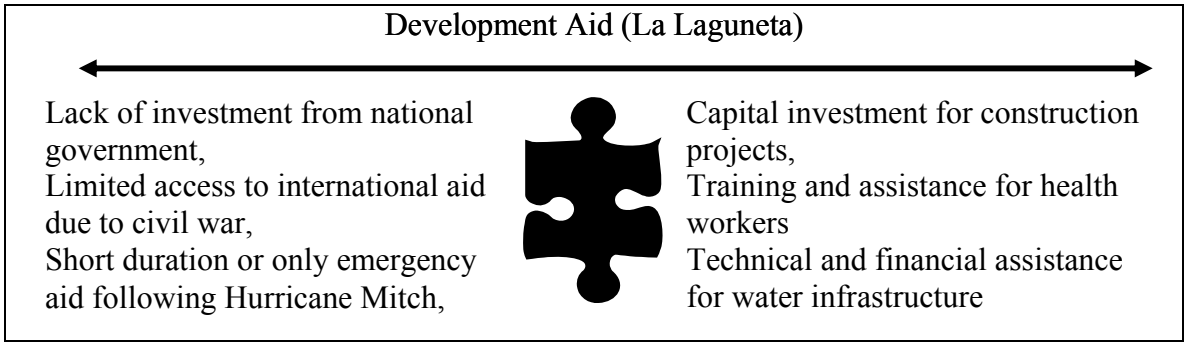

Figure 4.20 WPF Factor Development Aid - La Laguneta

The character of development support or what has been available includes the national health and school assistance programs, capital support from the regional government for the construction of the Casa Comunial (community building), and U.S. Peace Corps volunteers stationed in the community.

In terms of the continuum of access to development aid, the long term involvement of various aid agencies in the country (45 years for Peace Corps), the continued and improved cooperation between organizations, and the improved sophistication of community members to identify and communicate with outside aid organizations all contribute to placing the community towards the positive end of the development aid continuum. Aspects of the community that would have a negative effect on its ability to garner outside assistance includes the relatively isolated location of the community and a lack of an easy or economically viable way to access markets and

services in San Salvador. The prospects for increasing outside-of-the-community support are high due, largely to the experience gained by the ADESCO members successfully petitioning for PCV's and through the contacts that have been cultivated through the experiences with EWB-CSU.

Transition Phase and Next Steps

The project in La Laguneta is now entered a transitional phase. The tasks completed by EWB-CSU include the various assessments and the implementation of the additional bore-hole wells, chlorination system and improved taps. The community water board has taken the lead on improving the existing wells by adding an electric pump with an India Mark II hand-pump as a backup. Total capital costs associated with these improvements are ~$45,000, not including funds spent by EWB-CSU students and professional mentors to travel to the site. The community water board has increased tariffs slightly, hopefully ensuring that there will be funds available to maintain the existing improvements and expand the system with additional tanks and a distribution system.

Improvements planned for 2009 include an additional tank and a distribution system. However, these improvements are dependent on funding, some of which is already allocated by Rotary International and the desire of the community. Regardless of future construction plans, CSU-EWB has planned to continue its involvement with the community as technical support and collaboration partners. A major caveat to this is the ability of a student chapter, devoid of dedicated university funding to continue to partner

with the community, is compromised as students graduate and the institutional knowledge of project teams is not retained in a formalized way.

Through the initial process of assessing the community and collaborating with local NGO's in El Salvador, the web of relationships that the community can rely upon for support has been expanded, the San Miguel, El Salvador Rotary Club in collaboration with Rotary International and the Fort Collins Rotary has been taking an active role in project financing. Professors and students from the San Salvador University have committed to work on the project and to collaborate with EWB-CSU in supporting the community's efforts and in general, the visibility of the water supply problem in La Laguneta has been raised above simply a local issue.

Lessons Learned

1. The complexity of actions, fluidity of conditions, and continually evolving socio-political circumstances which contribute to the effectiveness and sustainability of a RWS system may be beyond the scope of a simple framework to conceptualize. Elements such as the changing inter-personal relationships with-in the community, rapidly changing energy costs, natural disasters, or major political shifts in the region or country are beyond the scope of this analysis to consider, though individually each of these external factors may have enormous impact on the effectiveness and sustainability of the water system in La Laguneta.

2. In order to avoid the traditional failings of the questionnaire survey, a clear strategy of participatory information gathering should be developed before an initial site assessment trip. The EWB-CSU team arrived in the community with little experience

conducting development work and therefore relied upon guidelines provided by EWB-USA to assess the community issues and demand for an improved system. For the EWB-CSU team, utilizing the survey (Appendix A) provided by EWB-USA appeared to be an adequate strategy to gather all of the relevant information regarding the health of individuals in the community. While the survey did supply us with important information regarding the dynamics of health and population in the community, because of the small sample of people interviewed (4) including the PCV we potentially missed important information regarding the range of circumstances families were experiencing. Another drawback of the questionnaire strategy we employed included the lack of a formalized way to communicate the results of our surveys back to the community members, limiting our ability to cross-check the information. For future assessments, it is recommended that PRA techniques are utilized, and that a broader cross-section of individuals are included in the exercises. Successive, field visits have filled in some of the gaps in EWB-CSU's understanding, and each trip has added a dimension of knowledge about the community and improved the communication flow between EWB-CSU and the ADESCO and water committee. However, because different groups of students have traveled to La Laguneta on successive trips, some re-learning of the basic attributes of the community has been necessary.

Ultimately, the project in El Salvador points to the conclusion that if a framework and methodology for conditions assessment and monitoring outcomes is used in a consistent fashion, successive teams of students (or development professionals) can build upon successes and avoid previous mistakes by utilizing a common frame of reference. Furthermore, if a *pre-defined strategy* of participatory issue identification and planning is

utilized by the development team prior to the initial site visit more efficient and effective problem identification and analysis can take place. The framework developed through this research may be put to this task by organizing information, visualizing how that information affects individuals, and then using that information to prioritize actions.

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Chapter V

Conclusions and Recommendations

Introduction

The goal of this research project was to evaluate the various techniques, concepts, and theories regarding how community-based water supply systems are developed, improved and managed in order to answer the question – What makes a rural water supply system effective and sustainable? Then taking the results of the investigation and applying it to the water supply project in El Salvador.

To do this a number of objectives first had to be met. 1. The key concepts of rural water development were explored and defined, with synthesis definitions developed for the specific application of the RWS project in El Salvador. 2. The methods with which rural water systems are designed, monitored and managed were identified and compared. 3. A framework for the assessment and monitoring phases of a rural water supply project was developed to provide strategic framework for the collection and prioritization of information.

Results

Key concepts

Because rural water supply development is complex and requires multi-disciplinary development teams comprising of engineers, health workers, natural resource

specialists, and economists, defining the key concepts of rural water development was considered a major objective of this research. This objective was met by reviewing the major policy papers from the World Bank, United Nations Development Program, the World Water Assessment program and other peer-reviewed journals.

The key concepts identified during this review include: Rural Water Supply project, defined as actions that seek to materially improve a water supply service from unimproved sources to an improved source, managed and maintained by a local, CBO who take the primary responsibility for decisions relating to the technology used, system layout, and financing of the operation, management, and repair of the infrastructure. Communities were described as a group of individuals, who share a common set of needs and goals, and have a mechanism for making collective decisions and taking action.

Project effectiveness was characterized as service provision that meets the intended population's water quantity and quality needs and is within the CBO's ability to manage. Sustainability was defined as effective water system operation, with minimal non-community financial support and mechanisms in place to protect the community from periodic service stoppages. And, Participation was offered as an action and process that seeks to engage, empower, and move to action, individuals who choose to elicit some control over local natural resources, water in particular.

Methods

Once the key concepts of rural water systems had been identified the next objective of this research was to compile and compare some of the methodological techniques development teams utilize to assist communities with water system

improvement. This research focused specifically on techniques used to identify, during the assessment and monitoring phases, the community demand and the conditions which affect project effectiveness and sustainability.

The most important conclusions regarding what types of methods development teams may use to assist rural communities with improving their water supply fall into three categories:

1. Assessing demand (pre-project)
2. Assessing circumstances (pre-project)
3. Quantifying impact (post-project)

Methods for assessing the ability to pay for improved services and the demand for them include the relational methods of PRA, and the economic analysis techniques of contingent valuation (Briscoe 1990), hedonistic pricing (Lancaster 1966), travel cost (Loomis 2000), and choice modeling (Blamey et al. 1990) methods for discerning willingness-to-pay.

In assessing the specific circumstances and conditions of the community and water resource, the space related and temporal analysis methods of PRA are suggested, especially the community mapping, Venn diagrams, seasonal timelines and daily timelines. The conditions related to the technical and environmental aspects of the project should be evaluated as holistically as possible using the geographic unit of the watershed to guide the analysis. A list of the minimum number of items included for this assessment is provided in Chapter 3, table 3.1.

Addressing the links to development assistance can be done by utilizing Venn diagrams and asking individuals to represent the major institutions they rely upon for water and health support. Development teams should also contact other organizations

who work in the country – with most the advent of the Development Directory (www.devdir.org) this has become much easier.

Analyzing the socio-political context and more importantly the capacity of the CBO to manage the water system may be completed through semi-structured interviews and transect walks with the CBO.

To quantify post-project impact the temporal, before/after methods of PRA are suggested, particularly timelines and time maps. Additionally, well-being maps that focus on the pre/post project conditions of the community.

Water Project Assessment Framework

The result of defining the key concepts and identifying the important methods of community water supply development lead to questions regarding how to combine this information into a usable form that would help development workers assist communities in reaching their water supply needs. What was clear from the literature review was the notion that many different factors can affect the conditions needed for a successful or water supply improvement project. However, there was less clarity in how to combine this understanding.

The impetus for developing an assessment framework of the factors important to rural water project effectiveness and sustainability was the realization that the information needs of a development team are many and cover topics ranging from engineering design, environmental assessment, organizational capacity, and services availability. And within each of these topic areas there are numerous resources espousing "best practices" for rural water supply development. However, there are fewer resources

that take a systematic, holistic, and integrative view of rural water supply development during the assessment and monitoring phases. The WPF developed through this research sought to fill this gap.

Because the focus of the WPF is on the organization of a process for information collection and prioritization, each factor represents a topic area of assessment or monitoring. The reasoning for depicting WPF factors as a continuum and the emphasis on assessing both current and future conditions is partly due to the recognition of the highly dynamic conditions found in developing countries in general and rural areas especially.

The major conclusions regarding the application of the WPF are that it should be used during the pre-project phase as a tool to guide the assessment of rural conditions, and then based on the results of that assessment be used to prioritize which of the factors most inhibits the projects effective and sustainable operation. Taking that understanding to focus energy or prioritize actions.

Conclusions

The contemporary paradigm of the community managed water supply and the tools and methods development teams may draw upon to assist communities in this endeavor was the primary focus of this research project with the case study in chapter four, highlighting some of the complex issues and conditions affecting a rural water supply development project.

Early on in this research it became clear that one of the most important concepts for development in general, but rural water supply specifically was community participation. Participation of the population in the decision making process was

universally emphasized as a crucial to the long-term success of any improved water supply system. Participation by community members however, was not the only factor relevant to the sustainability and effectiveness of a water system. Other factors, relating to the demand of individuals, their ability to pay for improved services, the environmental conditions, and socio-political circumstances, and the access communities have to outside support all were identified as important in terms of an effective and sustainable water supply system.

These conclusions re-affirm previous studies that suggest that there is a suite of issues that affect how successful an improved RWS may be. Moreover, because each community is unique, a narrow assessment methodology would fail as had previous attempts to develop some sort of cook-book technique for assessing and addressing rural water needs.

The lesson drawn from this realization was that successful water supply improvement actions were the result of a clear understanding of the issues and effective communication of this understanding to the community. The case study in El Salvador reinforced these realizations as the project moved forward. EWB-CSU's original assessment focused primarily on the factors outside of the community, the physical aspects of the site, the technical and financial aspects of construction, and the willingness of organizations outside of the community to commit support. And while all of these elements were important during the construction phase of the project, less attention was given to assessing the capacity of the communities' water board to manage improved infrastructure or the communities' willingness or ability to pay the increased costs associated with an improved system.

For NGO's and other organizations to effectively assist communities with improving their water supplies it is necessary that those organizations gather the right information. Much time and effort can be wasted if there isn't a clear focus on what information needs to be collected and how it will be collected. The WPF contributes toward designing better assessment procedures by focusing on the four general factors that contribute to the success of a water project over the long-term. This is important because, NGO's must be able to focus efforts initially on those water supply projects that have a good chance for success, or be able to quickly identify what aspects are going to be the primary obstacle for projects success. For example, in the El Salvador example precipitation is plentiful, community structure is well developed, and there are many international agencies are working in the area – which begs the question; why there is a lack of water? For La Laguneta, the main reasons are due to the economic condition of the community and the difficult of obtaining land needed for wells, tanks or pipelines projects.

The final conclusions of this thesis are that the problem of developing effective and sustainable rural water systems will not be solved by one decision, one technique, or one technology. Rather, it requires instituting better and longer-term support structures for local governance organizations, a wider application of context specific and appropriate technologies, and increased emphasis placed on understanding the complex and nuanced demand for water that people in rural areas express.

Appendix A

Community Assessment Survey

Health Survey Responses La Laguneta, El Salvador

Respondents: Marisol: committee member, community member
Molly: Peace Corp volunteer
Ernesto: Health Promoter, committee member
Filamina Raes: elderly midwife.

Questioners: Jeff Burnham, Molly Sugrue, and Elaina Holburn

1. Population

1. Number of families in the community: 141 (Molly), 137 (Ernesto), 135 (Marisol), 300 (midwife)

2. Number of men older than 12: 210 (Molly), 160 (Marisol)

3. Number of women older than 12: 247 (Molly), 200 (Marisol)

4. Number of children less than 1: 6 (Ernesto), 20 (Marisol)

5. Number of children 2-5: 60 (Marisol)

6. Number of children 5-15: 45 (Marisol)

Ernesto, who keeps records, counts:

- 6 <1 y
- 17 <2 y
- 51 1-4y
- 107 6-9y
- 171 10-19y
- 271 20-59y
- 58 >60y

Molly, based on her surveys, counts

- 94 males <12 y

- 108 girls <12 y

It is reasonable to assume Ernesto and Molly are in agreement.

2. Illness

1. The 5 most important diseases in the community:

- Ernesto: Pneumonia, diarrhea, flu, hepatitis A, arthritis (in the elderly).
- Molly: Diarrhea, flu, fevers, aches and pains, arthritis (in the elderly).
- Marisol: Flu, diarrhea, infections (throat or stomach), bronchitis (in children), vomiting.

2.-7. Information on each disease:

Pneumonia / Bronchitis:
- Affects 20-30 under the age of 12 annually. (all, according to Marisol)
- Affects 2-7 between the ages of 12 and 20 annually.
- Affects 0-10 adults annually (according to Ernesto, Marisol)
- Is believed to be caused by the climate and the change of seasons specifically.
- Treated with home remedies, at the clinic in Guadalupe for non-serious cases, at the hospital in San Vicente in serious cases, with some type of assisted respiration three times per day, and as many as five patients in line at the same time. The respiration is not always effective.

Diarrhea:
- Affects 10-20 under the age of 12 annually (Ernesto says 10, Marisol says 20).
- Affects 5-10 between 12 and 20 annually (Ernesto says 5-8, Marisol says 10).
- Affects 7-20 adults annually (Ernesto says 20, Marisol says 7).
- Believed to be caused by the water (all respondents) and by hygiene practices (Molly).
- Treated with salts rehydration salts and education, serious cases go to the clinic or hospital.

Flu:
- Affects 40 under the age of 12 annually, according to Ernesto; Marisol claims all children are affected by the flu annually.
- Affects 30 between 12 and 20 according to Ernesto, Marisol claims 160 annually.
- Affects 40 or 138 adults, according to Ernesto and Marisol, respectively.
- Believed to be caused by lack of water leading to lack of cleanliness (Marisol), the local northern wind and it's concurrent dust load (Ernesto), and bad air from cooking smoke and burning garbage (Molly).
- Treated locally by the health promoter with acetaminophen and antihistamines, and at the clinic in Guadalupe if there is no medicine available locally.

Fevers:

- Believed by Molly to be caused by poor treatment of other illnesses, leading to escalation of symptoms.
- Treated at the clinic in Guadalupe.
- Vomiting:
- Marisol reports that 20 under the age of 12, 6 between 12 and 20, and 10 over the age of 20 (with the elderly more represented) are affected by vomiting annually.
- She believes that vomiting is caused by undercooked food, and by lack of food and water.
- Ernesto (the Health Promoter) treats the illness with amoxicillin, when it is available.

Arthritis:

- 30 adults are diagnosed with arthritis by Ernesto yearly.
- The cause is believed to be old age.
- Treatment focuses on education about caring for elders, and ibuprofen is applied for the pain. Ernesto dispenses up to five tablets when the patient is diagnosed, and from then on they must purchase the pain relievers themselves at the clinic in Guadalupe.

Aches and Pains:

- Molly reports that these pains affect women much more than men
- She believes that the illness is psychosomatic, and is related to the oppressive influence of poverty: continual work, no respite, and worry about children or younger siblings.
- Pain relievers are sometimes prescribed, but there is no psychological treatment available in the village.

Hepatitis A:

- 3-4 children under the age of 12 are diagnosed with hepatitis A each year.
- There are no new cases diagnosed in those over the age of 12.
- Ernesto considers the disease a symptom of bad hygiene.
- Treatment consists of ingesting large amounts of honey, and sometimes treatment by a doctor.
- Prevention education focuses of latrine use and care, chlorinating water (with PuriAgua), hand washing, covering plates, and proper disposal of paper in latrines.
- When a case is diagnosed, education focuses of "vigilance" (prevention of spreading) and includes a house visit by Ernesto to check whether the prevention steps listed above are being followed.

8. Gender differences: There are very few differences between health of men and women, with the exception of non-specific "aches and pains" which affect women more frequently. Molly also notes that women seem to suffer more than men from depression.

9. Malaria: Malaria is universally not considered a problem in La Laguneta, although there are about 3 cases of Dengue per year (according to Marisol).

10a. HIV/AIDS: While El Salvador reportedly has the second highest incidence of HIV infection in Central America (according to Molly), there are no known cases in La Laguneta. The clinic in Guadalupe offers blood tests, but a patient must ask for it personally and directly. People don't check for it (Marisol).

10b. Cancer: Marisol reports that cervical and prostate cancers are the most common known cancers in La Laguneta, although people do not check for them. Cervical cancers are most often diagnosed incidentally during exams for vaginal infections, which are considered common.

11. Tuberculosis: Tuberculosis is not considered a problem in La Laguneta.

3. Birth, Death, and Seasonal Illness

1. Lifespan by gender:
   - Expected lifespan of women: 60 years
   - Expected lifespan of men: 50 years (Marisol) to 80 years (Ernesto)

2. Children:
   - Birth rate: 25/y (Ernesto), 6.5/y (Marisol), 3/y (Midwife)
   - Childhood mortality: 1/y (Ernesto), 4/y (Marisol), 3/y (Midwife: two infant, one 11 year old this year)

3. Infant mortality (less than 1 year old): 2/y (Marisol and Midwife), less than 1/y (Ernesto)

4. The 5 most common causes of death in the community:
   - Infectious diseases
   - Pneumonia
   - Diarrhea
   - Age
   - Accidents

5. Seasonal illnesses:
   - "Mal de Mayo": flu, diarrhea, "fevers" in May – June (beginning of rainy season).
   - Pneumonia in February and March (dry season)
   - Flu in October and December (dry season)

6. Childhood mortality (ages 1-5): 2/y (Marisol), none in the last 10 years (Ernesto)

4. Daily Living

1. Sources of water for various needs:
   - Water for drinking, cooking, bathing, and hand washing is collected at pumps during the dry season. During the rainy season, only water for human consumption is collected at the pumps.
   - Livestock are given water from the wells only when necessary.
   - Irrigation is strictly rainwater.

2. Distance to domestic water: The distance to collect water depends on where one lives. An average distance would be about 100 m, although some residents must walk considerably farther.

3. Temporal lack of water: There is not sufficient water during the dry season, which lasts from December to April.

4. Temporal presence of water: During the rainy season there is sufficient water due to barrel collection.

5. Number of wells in the community: 8: five public and three private (Ernesto). Molly and Marisol set the number at 7, with only two private.

6. Water purification: Puriagua is used to purify water for drinking and cooking: it is applied by the capful to water collection vessels before the water is stored in a barrel. Puriagua is dilute sodium hypochlorite.

7. A normal meal:
   - Beans, cream (from a tube), plantains, tortillas. (Ernesto)
   - Beans, rice, plantains, tortillas. (Molly)
   - Rice and beans. (Marisol)

8. Temporal lack of food: During the winter there is not always enough food. This is believed due to the lack of work, and particularly affects single care-giver families.

9. Malnutrition: There are problems with growth and development in children, as well as numerous other problems due to malnutrition. AIN (a local health organization, of which Marisol is a member) recommends preparing soup from locally available fruits and greens as a way of dealing with malnutrition.

10. Food acquisition:
   - San Vicente during the coffee season (paid for with finca wages), and during periods of no work with wages from selling leaves and firewood (Marisol).

- Stores (Ernesto).
- Stores in La Laguneta. Some families have small plots for corn, tomatoes, and carrots (Molly).

11. Number of meals per day: 3, usually, sometimes 2.

12. Dietary differences between men and women, children and adults: none (although men are expected to eat more).

13. Dietary changes during pregnancy: women eat more when they are pregnant, have cravings, and are encouraged to eat fruit between meals. Molly suggests that pregnant women try to obtain iron supplements from the clinic in Guadalupe or from the health promoter.

14. Taboo foods: None, although many refuse to eat frogs.
15. Percentage of women who breastfeed:
    - 50 % (Ernesto).
    - 100% (Marisol).
    - 100% (Midwife): at least until the child is one year old, some feed until the child is 3.

16. Existing sanitary facilities:
    - fosa secas y arboreras (latrines)
    - No sinks or faucets exist: water is drawn from storage with bowls, or by scooping with hands.

17. Percentage of families using latrines: Nearly 100%. Two families lack latrines and use the fields instead.

18. Communal bathrooms: 3 latrines for males, 3 for females, located at the school: use is restricted to students.

19. Communal bathing facilities: none.

20. Communal washing facilities: a bus ride ($2) will take people to a river, where they wash clothes sometimes in the dry season. The river is very dirty, and at least on one occasion gave an instant rash to a boy playing in it.

21. Use of fields for defecation/urination: children often do not use latrines. Two families lack latrines and use the fields.

22. Trash disposal: No communal garbage cans. Trash is thrown into coffee groves, woods, and often burned. There is land several meters from La Laguneta that has been given permission to be used as a dump. Actual use of this facility seems sporadic at best. Trash is visible outdoors everywhere that is public.

5. Community Health Resources

1. Nearest Clinic: Located in Guadalupe. There are 2 doctors, 3 nurses, almost constant electricity. Villagers from La Laguneta take a bus to the clinic.

2. Community services: The Casa de Salud in La Laguneta is the main source of healthcare in the community. It is primarily a dispensary.

3. Caring for the sick: The sick are cared for by their families. Members of the Health Committee visit the sick according to sector of the village, according to Marisol.

4. Curing the sick: The health promoter (Ernesto) cures those ill enough to see him. There are also two midwives in La Laguneta: Filamina Raes and Nina Salvador Raes. Those too ill for the health promoter are sent to the clinic in Guadalupe or the hospital in San Vicente.

5. The health promoter receives training from the government which does not cover all illnesses. Marisol reports that Ernesto has 11-12 years of experience as a health promoter.

6.-13. Vaccines:

- Everyone uses vaccines, except those who are allergic. Molly reports rumors of hepatitis vaccine shortages.
- Vaccines are given through the Casa de Salud. Only Ernesto and Marisol (who worked for three years with ProFamilia) give shots.
- Supply can affect vaccination programs, also members of the community must make the effort to go the Casa de Salud, and not all do, according to Molly. To combat this, the health promoter goes house to house and makes presentations in the church on Sunday mornings to encourage vaccinations.
- Available vaccines: polio, hepatitis, DPT, DT, TT, pentavalente, BCG, influenza.
- Parents do not pay for their children's vaccines.
- Vaccines are provided via the clinic in Guadalupe by the ministry of health.

14. Public health programs:

- Atencion Integral de Nutricion (AIN) treats children up to two years old by measuring their weight, visually inspecting them for nutritional deficiency. AIN is comprised of 5 women and the health promoter (Marisol is one of the women).
- The village government includes a Health Committee, which gives orientations on garbage and sanitation.
- Both Marisol and the midwife report that there is significant birth control use in the village. Some of it is given via shot, sometimes via pill. In the past it was hard for many women to get their husbands permission to use birth control.

15. Transportation is a problem in that the bus to Guadalupe does not run at night.

16. The cost of treatment is a problem, and can lead to untreated illnesses developing into serious or chronic problems. Sometimes the health committee raises funds for health services by hosting activities, according to Marisol.

6. Education

1.-4. Schools:

- There is one primary school in the community.
- There are no other schools in La Laguneta.
- After completing primary school, students can take the bus to Guadalupe to continue through the 8th grade. After that, 9th through 12th costs money, and few from La Laguneta send their children.

5.-7. Literacy:

- Percent able to read: about 80%
- Percent able to write: likely guesses range from 60% to 90%
- Percent able to write their name: 95% at most: the older generation is less literate, according to Molly.

8. Educators of the community about health issues: the Health Promoter, AIN, the Peace Corp volunteer, and the Health Committee.

9. Relationship between health teachers and health providers: In the case of Ernesto, who represents the most 'official' health position in the community, they are the same. Ernesto seems to be involved in almost all health efforts in the village, and Molly states that he is an unusually active and effective organizer for health issues, compared to health promoters in surrounding villages.

7. Transportation and Communication

Number of houses having access to:
1. A telephone: 20 (cell and landline)
2. A radio: 100%
3. A television: 80%-90%
4. A newspaper: none, although Marisol points out that because many work outside of La Laguneta, as many as 50% of households could access a newspaper if they so desired.
5. A vehicle: There is 1 truck in the village according to Molly and Ernesto. We noticed 2, and that number was confirmed by Marisol.

8. Goals of EWB Project

Q: How do you think this project will benefit the community?

A: "It will hopefully improve the quantity and quality of water and reduce the work necessary to bring water. Health will improve due to better water and better treatment,

and more water will allow people to bathe, wash hands, and practice better hygiene habits." - Molly

"Water helps the community in every way: through better health and community development." - Ernesto

"It (water) is the most important. Everyone dreams about having water. Perhaps those who own wells can profit. Water will help in every way." - Marisol

"This water project would help a lot. We have 8 cantarro s, then we have 6, then 4, then 2, then no water in March and April and we have to pay for a truck to go to Vera Paz, 2$ per person to wash and bathe, and the river water is only for washing." - Midwife

Spanish Translation of Standard EWB Survey

1.

Cuantas familias existen en su comunidad?

Cuantos hombres adultos (16 años o más) existen en la comunidad?

Cuantas mujeres adultas (16 años o más) existen en la comunidad?

Cuantos niños menores de 1 año existen en la comunidad?

Cuantos niños de 2 a 5 años existen en la comunidad?

Cuantos niños de 5 a 15 años existen en la comunidad?

2.

Cuales son las 5 enfermedades o lesiones más importantes que afectan a la comunidad?

(para cada uno de las 5)
De esta enfermedad, cuantos niños tienen este problema cada año?

Cuantos adultos jóvenes?

Cuantos adultos mayores?

Esta enfermedad afecta más seguido a las mujeres, a los hombres, o afecta igual a los hombres y las mujeres?

Que cree que sea la causa de esta enfermedad en la comunidad?

Quien da tratamiento a esta enfermedad? Donde se da el tratamiento? Cual es el tratamiento que se da?

Existe una diferencia de salud en general entre los hombres y las mujeres? Cuales son las diferencias?

El paludismo (malaria) es un problema aquí? Cual es el tratamiento? Que métodos de prevención se toman?

La SIDA es un problema en la comunidad? Existe manera de identificarla? Donde?

La tuberculosis es un problema en la comunidad? Donde va la mayoría de la gente a conseguir tratamiento?

3.

Cual es el promedio de años de vida de las mujeres? De los hombres?

Cuantos niños nacen cada año? Cuantos mueren?

Cuantos niños menores de 1 año mueren cada año?

Cuales son las cinco causas mas comunes de muerte en la comunidad?

Existen enfermedades que llegan siempre en la misma temporada del año?

Cuantos niños entre 1 y 5 mueren cada año?

4.

Donde se consigue agua para cocinar?

Donde se consigue agua para tomar o beber?

Donde se consigue agua para bañarse?

Donde se consigue agua para lavarse las manos?

Donde se consigue agua para los animales?

Donde se consigue agua para irrigar las cosechas?

Que tan lejos hay que ir para conseguir agua para beber?

Hay suficiente agua en todas las temporadas del año?

En que temporadas del año hay suficiente agua? Porque hay agua en esta temporada?

Cuantos pozos existen en la comunidad?

De donde viene el agua en la comunidad?

Como se purifica el agua para beber?

Describa una comida normal.

Hay suficiente comida para todos en todas las temporadas del año?

La desnutrición es un problema? Cuales son los problemas con la desnutrición?

Donde y como se consiguen alimentos?

Cuantas comidas diarias se acostumbra comer?

Como es diferente la dieta de los niños a la de los adultos?

Como es diferente la dieta de la mujer a la del hombre?

Como cambia la dieta de la mujer cuando está en cinta?

Hay algunos alimentos que no se permiten?

Cuantas mujeres (que porcentaje) le dan pecho a sus hijos?

Que facilidades sanitarias existen?

Cuantos usan baños rústicos?

Cuantos usan escusados?

Cuantos usan los campos para sus necesidades?

Como se dispone de la basura?

Que porcentaje de casas tienen baños?
Existen facilidades o baños comunes? Cuantos hay y en donde?

Hay basureros comunales? Donde están?

5.

Cual es la clínica mas cercana? Quien trabaja ahí? Tienen electricidad? Que tan seguido tiene electricidad? Como llega la gente a esta clínica?

Que tipo de servidores médicos existen en la comunidad? Cuantos hay?

Quien cuida a los enfermos?

Quienes curan a los enfermos?

Que entrenamiento reciben los que curan?

Cuantos (%) en la comunidad reciben vacunas?

Que interfiere con que reciban vacunas?

Donde obtienen vacunas los niños?

Que vacunas existen para los niños?

Los padres pagan para las vacunas?

Quien pone las vacunas?

Donde se consiguen las medicinas?

Como se pagan las medicinas?

Que programas se salud publica existen en la comunidad?

El transporte es un problema para obtener tratamiento?

El costo es un problema?

6.

Hay una escuela en la comunidad?

Cuantas escuelas primarias hay en la comunidad?

Cuantas escuelas secundarias?

Cuantas escuelas religiosas?

Cuantos (%) pueden leer en la comunidad?

Cuantos (%) pueden escribir?

Cuantos (%) pueden solamente firmar su nombre en la comunidad?

Quien enseña a la comunidad de asuntos de la salud?

Como son las relaciones entre el maestro de salud y el proveedor de salud?

7.

Cuantas casas tienen siempre un acceso a teléfono?

Cuantas casas tienen siempre acceso a un radio?

Cuantas casas tienen siempre acceso a televisión?

Cuantas casas tienen siempre acceso a un periódico?

Cuantas casas tienen siempre acceso a un vehiculo?

8.

De que manera piensa usted que este proyecto pueda beneficiar a la comunidad?

Appendix B

Project Application Form

EWB-USA Project Application Form

This form must be submitted by the community requesting EWB-USA's assistance.
The NGO may assist the community in completing this form.

Note: Please provide as much information as possible pertaining to the items described below. Thorough information will facilitate the review process and allow EWB-USA to evaluate the viability of your project in a timely manner. Attach additional pages as needed. Applications received by the 15th of each month will receive notification by the end of the first full week of the following month.

Preferred method of submission is to email completed form to: projects@ewb-usa.org to:

Manager
EWB-USA
1880 Industrial
Circle, Suite B-3
Longmont, CO,
80501 USA

PART 1: GENERAL INFORMATION

I. Project Information

a. Project Title:
Potable, Running Water in Rural El Salvador
b. Project Location:
La Laguneta, La Paz, El Salvador
c. Current Status:
Concept Level
d. Project Summary (provide a 2-3 line summary of the proposed project and the need it addresses):

The proposed project is a water system in a rural community in El Salvador where there currently are five public wells that only provide one cantarro (about 25 liters) of water per family per day for six months of the year. The community is looking for a way to increase water availability and access by pumping water up from another source. Problems include a low water table where the community is located (have a 103m well that did not hit water) and the community is located on the side of a mountain with the closest well 4km away.

e. Check the specific services or needs addressed in this application. Check all that apply.

_X__ Water Supply (WS)
_X__ Water Treat. & Purification (WTP)

f. What is the cause and history of the problem and what efforts have been made to address this need or problem in the past? If any efforts were made, please describe the outcome.

There was an attempt to drill a deeper well in the community about two years ago but once they reached 103m without reaching water, the mayor decided to stop drilling. The five public wells that the community is using are between 15 to 20m deep and have very limited amounts of water. We are currently requesting permission from another (closer) municipality for use of one of their wells and then we plan to solicit funding for pumps and tubes to bring water to the community.

g. Do you have a specific solution strategy you would wish EWB-USA to help implement in your location (Circle):

YES We are going to try to find an already drilled well even if it is farther away because we've been told drilling for a deeper well would be much more expensive. However, we are open to ideas and suggestions. So far no engineers have come to assess the site or project.

II. Requesting Organization, Contact Information & Mission

Name of the Individual requesting EWB-USA's Assistance: Molly Sugrue, Peace Corps Volunteer

Contact Phone: 011-503-892-3256
Contact Email: mollysugrue@hotmail.com
Contact Address:

_____

If the individual(s) represent an organization, provide the name of the organization:
Name of Requesting Organization:

_____
Mission or Goal of the Requesting Organization:

_____
_____
_____
Website of Organization (If applicable):

_____
Name of individual who will be the on-site primary project facilitator (if different from the requesting individual):

_____
E-mail or Address:

_____
Has a chapter of EWB-USA already been contacted to work on this project? Yes
If Yes, name of Chapter & Contact person: EWB-CSU, Jonathan Cullor
E-mail or Address: cullor@msn.com

III. Beneficiary Group(s) Information

1) Name the Group(s) who will benefit from the project. Indicate how many people will be impacted and over what geographic area: (e.g. 500 people in 2 communities approx. 5 km apart)

There are 1073 rural El Salvadorans (250 families) in two communities approximately 1 km apart who will benefit from this project. The communities are located on the side of Volcan Chinchontepeque in the hilly northern region of La Paz.

2) Describe the beneficiary group(s) in terms of ethnicity, tribal and religious affiliations, spatial organization, primary occupations and current income of all the sub-groups (if more than one). Are social relationships harmonious in the area where the beneficiary groups reside?

Social relationships among the beneficiary groups are harmonious. They are fairly homogenous: ethnically El Salvadorian, Catholic. Many are related and all have worked together on community projects in the past. Main source of income for both communities is farming and working in the coffee fincas that the area is known for.

3) Describe the general area surrounding where the beneficiary group(s) reside in terms of ethnicity, religious affiliations, spatial organization, primary occupations and current income in the surrounding areas. Are social relationships harmonious between the beneficiary groups and the surrounding groups?

Both communities are part of the municipality San Juan Nonualco in the department of La Paz. However, they are closer and have bus access to Guadalupe (pueblo in the department of San Vicente). As a result we work closer with the mayor from Guadalupe. The surrounding area is also made up of ethnic El Salvadorans with the majority being Catholic. However, El Salvadorans living in the pueblo tend to be wealthier with more access to earning through trade and have a well established water system. Good relationships exist between both communities, the pueblo and the mayor.

4) How are decisions made within the beneficiary group(s) – i.e., village elders, tribal councils, democratically-elected village representatives, etc? How do women participate in decision-making?

Both communities included in this project (La Laguneta and Chile) have democratically-elected village representatives called ADESCOs. There are 11 members including a President, VP, secretary, etc. However, the community is responsible for making decisions for the community and the ADESCO is responsible for organizing and planning. There are two women currently serving on the ADESCO in La Laguneta and they are expected to participate equally with the men (attending meetings, raising money, etc.).

5) Describe the relationship between the local project facilitator/Non-Governmental Organization (NGO) and the beneficiary group(s). How are decisions made between these two entities? What is the communication mechanism between these two entities? In what way do they communicate?

So far we have no NGO committed to the project since we are waiting for permission to use one of Guadalupe's wells. We will be looking for assistance from PCI (Plan Concern International) and/or Cruz Roja Salvadoreña.

6) Describe some of the skills, traditions and resources the community is well known for?

La Laguneta has collaborated successfully with several NGOs in the past and has provided manual labor in building the local health clinic, as well as the community meeting house. They are hard workers and all projects they have taken on were completed on time.

7) Provide a description of some of the challenges faced by the intended beneficiary group(s). Please describe how these were identified?

We have not had as much support from our mayor (from San Juan Nonualco) as we might have hoped. In a meeting attended by representatives from both communities, the mayor said he would permit an NGO to work on the project but that that would be the extent of his assistance.

III. Project Impacts

1) Could any segment of society be marginalized, excluded or lose their current societal function because of this project? In what way?

I believe this project will have the opposite effect. Currently the chore of getting water is time consuming and very demanding, and mostly is left for women to do. If the current water situation could be improved, it could only lead to greater participation of women in the community and more time to be involved in decision-making. Women receive no status for collecting water; it is merely a difficult job that, if anything, serves to marginalize them by eating up so much of their time.

2) What potential impacts, both negative and positive, are anticipated or could possibly occur as a consequence of this project? Please consider health, economic, environmental, social, cultural, and ecosystem impacts. For any possible negative aspects that you foresee, how can these negative impacts be diminished? As we identify specific solution strategies and proceed with design, we will discuss potential impacts again.

POSITIVE: As I mentioned above, I believe this project will free up time for women to become more involved in the community and to participate more in decision making. Especially during the dry season, much time is committed to getting enough water for one's family.

Even more important are the impacts on health the current water shortages have on these communities. During the dry season they have approximately 25 liters for an entire family (average 4 to 6 people) to drink, bathe with, wash clothes, do dishes, maintain proper hygiene (brushing teeth, washing hands, etc.). As a result, important health practices are not followed in many families since there simply is not enough water available. With more water available, hygiene will be improved and, almost certainly, overall health.

NEGATIVE: The project is very large and will require a lot of work and financial support to be successful.

3) Who is expected to own the project proposed in this application for which EWB-USA is being requested to provide assistance?

The ADESCO (elected body of community leaders) and the community will own the completed system of water.

4) How do you anticipate the project will be managed?

Most likely the NGO funding the project will manage and make decisions with the support of the ADESCO and the labor of the communities.

5) Who will educate the beneficiaries on how to use, manage and maintain this project? How do you foresee this happening?

As far as proper health and hygiene is concerned, both communities have their own health promoter and functioning health committees. La Laguneta also has a Peace Corps Volunteer who is working in rural health and sanitation. As far as managing the pump and water system, both communities also have water committees who are responsible for collecting fees, paying bills, and maintaining the system. Additionally, in other similar

projects a member of the community was trained by an NGO and hired by the community to maintain the system making this person responsible for the upkeep of the system.

6) Will the proposed project be freely accessible to all persons in the local area, or will it be restricted for use by certain groups? Describe.

It will be accessible to all persons in the local area. There will be costs of maintaining and running the system and all those interested will have to contribute (financially and through labor) as they can, but as long as persons are willing to work/contribute to the project, all will have access to the water.

7) Do you anticipate a fee structure – if so, who will charge and collect the fee?

There most certainly will be a fee structure due to the costs of managing and running a water system. There is currently a water committee in each community that will be responsible for collecting fees and managing well usage. Accounts are kept by the committee and submitted to the ADESCO for review.

IV. Roles of Partners in the Project

1) EWB-USA primarily provides technical assistance for the design and development of projects. In some cases, it can provide only very limited financial assistance for project construction. It what ways do you envision EWB's involvement in this project? What specific skills can EWB-USA offer that are not available locally?

We are looking to get this project off the ground. Since the drilled 103m well did not hit the water table, we are looking for alternative means of bringing water to these communities. However, due to the distance from the communities to the wells, and the lack of technical know-how, we are looking for assistance in creating an appropriate and economical plan for a water system. We hope that an NGO will be more likely and willing to help with this project if we already have a feasible plan laid out. Additionally, we are looking for any financial support toward the water system.

2) What support both financial and/or non-monetary will be offered by the local community?

In the past the community has provided manual labor to all of its development projects and are ready to provide whatever support they can to see this project completed.

3) What support and funding will be offered by other local agencies and organizations, including governmental organizations and the non-governmental organization (NGO) (if any) facilitating the project? What have these groups committed to provide?

We are currently preparing a solicitude to PCI (Plan Concern International) and Cruz Roja Salvadoreña. We are, however, waiting for permission from the Mayor of Guadalupe to use a local well. PCI specifically helps with pump costs and tubing, so their assistance would be ideal.

4) What other agencies and organizations may be solicited or are likely to provide assistance?

USAID (Agency for International Development), through Peace Corps, provides some financial assistance for small projects – there is, however, a $5000 cap and it is competitive process.

5) Part of EWB-USA's mission is to provide, if possible, opportunities for students to interact with local University students. Are any local universities interested in collaborating in this project?

The project is at an early stage of development. No universities have been approached; however, the community would be happy to work with students and would appreciate working and collaborating with them. There are several universities in San Salvador.

V. Travel Logistics

1) When is the best time for a visit to the area, considering weather, transportation access, holidays, as well as availability of the beneficiary group(s) and NGOs facilitating this project?

Roads are manageable all year round and there are daily buses to and from the site. There is a rainy season in El Salvador from April to November (though it is only constant for a couple of weeks of that time) which could interfere with work but did not disrupt work on our community meeting house. National holidays were businesses shut down are the week before Easter, the first week in August, and from the 23rd of December to the 1st of January.

2) What local accommodations are available for the EWB-USA team? What are estimated per day living costs for the visiting team?

Depending on the teams requirements per diems in the community could start at $2.00 a day. Local accommodations would be available though this may require the team to stay with local families. (I also have a house in La Laguneta that could accommodate several people).

3) Is American aid welcome in the proposed project area?

Yes. Definitely.

4) What hazards may exist to persons from EWB-USA traveling to this project location (health issues, transportation difficulties, weather, insects, malaria, etc.)

Dengue does exist in the area but the community has never had a case. During the rainy season there are frequent rain storms but they rarely disrupt transportation. Malaria is a problem in El Salvador but not in this area.

5) Where is the nearest hospital? What kind of health care providers regularly staff this facility? How far from the project site? Provide address and phone number.

The nearest hospital is in San Vicente: Santa Jertruty's (011503-393-0261). The hospital can be reached by public buses in around an hour and a half, and by car or truck in under an hour. It can attend to most medical needs and also can transfer patients to the hospital in San Salvador if necessary.

VI. Other Information

Please add any other information you think is relevant to this project.

Signature | Date

Molly Sugrue | mollysugrue@hotmail.com
Printed Name | E-mail Address

12/29/04

Signature | Date

Jonathan Cullor | cullor@msn.com
Printed Name | E-mail Address

PART 2: DETAILED PROJECT DESCRIPTION

A. Project Concept and Design

1) Describe the project concept in more detail.

Upon obtaining permission from the Mayor in the nearest pueblo (Guadalupe, 3kms), the plan is to solicit a water project from PCI or Red Cross El Salvador. It is expected that this project will be complicated and expensive, due to the distance from the well to the communities and given the fact that most of that distance is up hill. Any technical or monetary assistance would be greatly appreciated and necessary to making this project a success.

2) What alternative designs or solutions have been considered for this project? If other options were considered, let us know why they were rejected?

There was an original plan to drill a deeper well in the community however once 103 meters was reached it was decided it was too costly to continue drilling. Since then (approx. 2 years ago) no other attempts have been made.

3) Provide as much quantitative information as possible in the next set of questions:

If this is a water project, indicate where the water will come from?

We are still awaiting permission from the local mayor to use a well. Distance to wells, though, runs from 4 to 5 km. Permission depends on quantity of water available and if it is enough to supply the communities.

If this is a water purification project, describe the diseases currently prevalent that are associated with water pollution and any quantitative and qualitative health assessment that has been done.

Specifics are unknown, however most water in the area is contaminated with human waste as well as possibly by agricultural run-off. At a minimum, I would assume a chlorine treatment would be required.

B. Project Funding and Management

1) Has a project budget been developed? If so, please provide a detailed breakdown, separating material and labor costs.

NO.

2) What resources are locally available for this project? (Include both physical resources, such as construction materials, land, etc.; as well as human resources, such as local labor, skilled workmen and experts, community groups, school groups, health educators, etc.).

The communities can provide unskilled and skilled workers (masons, construction managers, etc.). They also have health promoters and health committees that can help with health education and proper health practices (an important component to the project).

It is understood that PCI (if it becomes involved with the project) would provide the majority of the construction materials (tubing and pumps) as well as skilled workers and engineers.

There is also a Peace Corps volunteer working in the area that has been working on community leadership, organization and motivation, as well as in health education in schools and in the community.

3) List suppliers for key equipment if such information is available and provide contact information, if available. Will local labor and workmanship be offered free as part of the contribution from the beneficiary group(s) or will there be a fee?

No information is currently available.