

Engineers Without Borders: Tufts University Chapter

El Salvador Water Project
Arada Vieja Implementation
Porvenir Assessment
Las Dispensas School Assessment
January 3-January 14, 2009

Table of Contents

i. Arada Vieja

1. Review of Community Interactions
2. Health Assessment
 - 2.1 Overview of the Community
 - 2.2. Introduction
 - 2.3 Methods
 - 2.4 General Observations
 - 2.5 Results
 - 2.6 Analysis
 - 2.7 Conclusion
3. Engineering Designs Considered
4. Technical Description of Project
 - 4.1 Component Description
5. Materials and Logistics
 - 5.1 Materials
 - 5.2 Logistics
6. Water Quality Analysis of Arada Vieja
 - 6.1 Overview of water testing locations
 - 6.2 Methodology for water collection and analysis
 - 6.3 water quality results
 - 6.4 Discussion of results
 - 6.5 future efforts
7. Plan for Village Participation and Sustainability
8. Summary of Project Implementation
 - 8.1 Summary of Component Implementation
 - 8.2 Lessons learned, future evaluations, and the next phase of the project

ii. Porvenir

1. Community Attributes
 - 1.1 Relationship of Porvenir with NGOs, Government Entities, and Land Owners
 - 1.2 community Involvement in the Project
 - 1.3 Community Decision-making in the Project
 - 1.4 Community Skills/Assets
 - 1.5 Community Organizational Capacity
 - 1.6 Community Financial Capacity
 - 1.7 Community Interest and Commitment to the Project
2. Health Assessment
 - 2.1 Introduction
 - 2.2 Methods
 - 2.3 General Observations
 - 2.4 Results
 - 2.5 Analysis
 - 2.6 Conclusion
3. Basis of Design Discussion
 - 3.1 Water Demand Flow Rates
 - 3.2 Water Supply Flow Rates
 - 3.3 Description of Existing Water Supply and Water Usage

4. Water Quality

4.1 Introduction

4.2 Methodology for Water Collection and Analysis

4.3 Water Quality Results

4.4 Water Quality Discussion

5. Availability of Local Materials

6. Property Ownership and Water Rights

7. Alternative Designs Considered

iii. Las Dispensas

i. Arada Vieja

The purpose of this trip was to (1) assist in the repair of piping between the spring box and the intermediate tank, (2) to perform water quality testing and evaluate the performance of the filters, (3) to continue relationship with the community and receive updates about system maintenance, (4) to perform health surveys.

1. Review of Community Interactions

We had two community meetings with Arada Vieja. The first, which was well-attended by the community, was to find out about the condition of the water system and suggest the creation of a maintenance fund for any repairs the community may need to make of the system in the future. We expressed our desire for the community to lead repairs of the piping while we were there, and told them that we planned on doing health surveys, construction, and water-quality testing during our time there. In the second community meeting, the Water Board and Tufts EWB met to discuss the future of the water system. We made it clear that our involvement with Arada Vieja is coming to a close. For this reason the Water Board must be confident about maintaining the system and should continue to use the maintenance fund they have established to repair the system if necessary.

The community led the repairs of the system while we were there. They provided labor for the construction. The Water Board was very helpful in gathering the community for meetings and construction. All of the community members were friendly towards us and very hospitable; we stayed with two families who housed and fed us. We have established a strong relationship with the community and the interactions between Arada Vieja and Tufts EWB were sincere and valuable.

2. Health Assessment

2.1 Overview of Community

There are about 120 community members in Arada Vieja. The community is centered around a main area that includes a school, a soccer field, a corn-grinding machine, the spiggots where the community obtains water, and a restaurant run by the community. There are about sixteen houses in the community, although a couple of them are currently unoccupied. There is a Water Board in the community that is made up of four well-respected men from Arada Vieja. The community seems well organized and their cooperative efforts can be seen through projects such as the water system we have built with the community and the restaurant.

2.2 Introduction

Health surveys were modified and pre-approved by the IRB before the January 2009 trip. The main purpose of the study was to collect information regarding the health status of the residents of Arada Vieja. The information from this trip can be compared with previous trips. Unfortunately, the water system had not been running consistently for a significant amount of time before we arrived, so this data serves more as base data that we can use for comparison on our next trip. Information gathered from these health surveys includes that of demographics, sicknesses experienced, information about daily life, economic situations, education, methods of transportation and communication in and out of the community. We will use this information in the future to assess the health impacts of the system once it is functioning as intended.

2.3 Methods

Two IRB-certified students from Engineers without Borders conducted each health survey. Students entered the properties of the citizens of Porvenir and asked if one of the heads of households was available to take a health survey. After explaining the purpose of the study and receiving consent from the participants, one student asked the questions and recorded answers while the other took notes and witnessed the interviews. In various households, pictures were taken of the study participant and their houses.

2.4 General Observations

The survey participants were welcoming and willing to participate.

2.5 Results

We surveyed thirteen households in the community. The average number of years participants reported living in Arada Vieja was 15.8 years, and ranged from three to thirty years. Most of the residents reported moving to Arada Vieja from other cities and towns in El Salvador including Zaragoza, Tacuba, and Porta La Libertad. Participants moved to Arada Vieja because of the war, in order to find work, to be able to cultivate their own corn and other foods, and because of family members already living in Arada Vieja or nearby.

The number of residents per household varied from three to nine people. Of those, two to five of the residents were adults, and there were one to seven children per household.

Illnesses reported:

Illness	Number of participants (or participant's family members) who experienced illness	Reported Causes of illness
Stomach pains/aches	3	Changes in weather
Head pains/aches	2	Intense heat in the summer
High blood pressure	2	Due to the war
Diarrhea	3	Kids put dirt in their mouths
Flu	9	Changes in weather, wind and dust

Fever	8	Changes in weather
None	1	

The survey data shows that the people of Arada Vieja suffer most frequently from the flu and fevers. Stomach pains and diarrhea are the next most-frequently suffered illnesses.

The next section asked participants if AIDS, Tuberculosis, and malnutrition are problems in the community. The results are as follows:

Problem	Number that responded 'yes' when asked if the illness was a problem in the community	Number that responded 'no' when asked if the illness was a problem in the community	Number that responded 'sometimes' when asked if the illness was a problem in the community
AIDS	4	9	0
Tuberculosis	2	8	3
Malnutrition	8 (mostly in children)	0	5

There were mixed responses for these three questions. Some people said that these illnesses are a problem because if someone in the community were to get AIDS or TB, than that would be a serious issue in the community. Others interpreted the question as whether or not there were these problems in the community. It seems the wording on this question was not clear enough.

All respondents said that the nearest health facility is the day clinic in San Jose Villanueva. People reported walking, going by car, or a combination of walking and driving to get from Arada Vieja to San Jose Villanueva. Participants had mixed answers to the question, "Does the facility send medical personnel to the community?"; some answered yes, some said no, and some said sometimes. Given the mixed responses, it is hard to make a clear conclusion based on this question. Twelve out of thirteen interviewees said that transportation is an obstacle to receiving health care. About half of participants said that money can be a problem in receiving health care.

When asked if the participant's children had received immunizations, 1/3 of the interviewees with children responded no, and 2/3 said yes (and that the children had gotten immunizations at the clinic).

The next question asked where participants receive health information. Most people said their health information comes from the health clinic. Others said from classes at the school, from family, and two people said they do not receive information regarding health.

All except one participant said they get their water for drinking and cooking from the filters. The one interviewee who reported getting water from elsewhere said it was because her household was not always able to pay the \$2/month fee for water, so they get water from a well near their house. Some participants reported using water from the filters for all other water uses (such as cleaning, bathing, irrigation, etc.), while others reported using river water. The interviewees also reported washing their clothing in the river. In the majority of households, the woman head of household was the one going to get the water. Some participants also said that their children or everybody in the family helps with water collection. Water was collected by all 13 households during the hours of 6:00-8:00 a.m.

The next question asked if the color, odor, or taste of the water had ever changed. All thirteen people responded 'no'.

When asked if there was enough water during all times of the year, only three participants responded 'yes'. Others said 'sometimes' or 'no'. Some interviewees said that there had not been enough water because the pipes going to the filters had broken. Those that said they experience water shortages during some times of the year said that there is enough water in the summer, but that they experience water shortages in the winter. March and April were cited as the most difficult months.

When asked if interviewees use any methods to purify their water in their homes, one said they use bleach, three said they use in-home filters, and the rest said that they do not use any in-house purification methods. All thirteen interviewees said that they store water in their house in 5-gallon plastic jugs called 'cántaros' in Spanish. All those interviewed said they clean the plastic jugs either with soap or bleach (the majority use soap).

All participants said that a typical meal is rice and beans. All household heads reported always having enough food to feed the entire family, although some people said they have to buy food sometimes (when they run out of food they have grown themselves). 5 participants said that they grow all their own food. The remaining interviewees said they use a combination of growing their own food and buying food from markets. Eleven participants said their families eat 3 times a day, one said their family eats 2-3 times a day, and one person said their family eats 3-4 meals per day. All except one person reported that the woman and man of the household eat the same food.

The next question asked if women breast-feed their babies. All respondents said yes.

In response to the question, "When and how frequently do you drink water?", most said when they were thirsty or needed to drink. One person said they drink every ten minutes, and one person said they drink three liters per day. In addition to water, community members reported drinking coffee, milk, juice, and soda.

All but two houses use latrines to go to the bathroom. One house had two latrines, while two houses had zero. Kids also use the latrines in all of the families that reported owning a latrine. Six of thirteen people surveyed said they do not go to the bathroom anywhere

but their latrines, four people said they use bathrooms other places when they leave the community, one person said they sometimes go to the bathroom at the river, one person said they sometimes go further away from the house, and one person said her family goes anywhere they can.

All participants said that they burn their trash.

Four households have at least one adult working. One family also earns some money from selling crops, although income generated per month varies. One household also said that one of the adults works sometimes. The rest of the households do not earn money. Of those that worked, income earned per month varied from \$30-\$200. That money is mostly spent on food and other necessities. None of the families pay taxes.

The highest level of education achieved by a participant was through 6th grade. One person had completed 5th grade, one had completed 3rd grade, three had completed 2nd grade, and the rest had not received any education. Three participants said they can read and write, five said they could read or write somewhat, and five people said they could not read or write. However, all participants said that their children go to school. Most kids went/go to school in Arada Vieja, one goes to school in San Jose Villanueva, and one kid goes to school in Zaragoza. The school year is from January to November, and children attend school five days a week.

All participants said that they leave the community sometimes. Reasons for leaving included to buy things, to go to the clinic when sick, to work, and to visit family. Most people leave from the community by foot. Some pay to get driven by a car, a pick-up, or a bus sometimes. Some people said they walk part of the way to San Jose Villanueva and then drive the rest of the way (get driven the rest of the way). Sometimes cars come to Arada Vieja and offer to bring people to San Jose Villanueva for different amounts of money. Besides this, there is no public transportation.

Eight people reported having regular access to radio while five said they did not. Nine people said they have regular access to a television while four said they did not. All participants said they have regular access to a cell phone. Only one household reported sometimes having access to newspapers. None of the families have regular access to a car.

The following is a list of problems identified by the community: some people said there were no problems. Others said that there is a lack of transportation, there are problems with the quality of the school, there is a large distance between Arada Vieja and San Jose Villanueva which means there is not easy access to clinics and schools, there are still water problems, that the roads need to be improved, and that they need electricity.

Types of projects people said would help deal with these problems would be the creation of a public transportation system, the creation of a better school, improvements to the roads, and a project to bring electricity to the community.

2.6 Analysis

Results show that the flu and fevers are the most commonly experienced illnesses in the village. Most attributed these illnesses to changes in the weather and other environmental factors such as dust and wind. To treat these and other illnesses, many people said they bought medicine/pills in San Jose Villanueva and visited the clinic there. Some people also use home remedies such as making teas with leaves from plants in the village. While it is good that they have access to the clinic in San Jose Villanueva, the clinic is only open during the day and is a long walk away. Thus, more serious health problems would be difficult to address immediately given the distance between Arada Vieja and other towns, the poor roads going to the village, and the lack of public transportation.

There are low levels of education among the adults in Arada Vieja, but it is encouraging to see that almost all of the children are attending school. As some adults had received no education, this means that the next generation will be significantly more educated as a group.

All but two families reported using latrines to go to the bathroom. This is important because latrines create a clear separation between the house and kitchen areas and the place to go to the bathroom. All respondents also recognized the importance of washing hands, especially following going to the bathroom.

The one problem that persists that of water. It is encouraging that almost everybody gets water for drinking and cooking from the filters. We found on the trip that there may be misunderstanding about using the spigot with filtered water for drinking and cooking and using the spigot with unfiltered water for other purposes. Unfortunately, Arada Vieja has not had a steady flow of filtered water due to breaks in the piping system. However, we are confident that people will use the filtered water when the system is functioning properly.

The problems mentioned most frequently in the community surrounded issues of transportation (the lack of public transportation and bad roads leading to the community) and the lack of electricity.

2.7 Conclusion

It is clear that flu and fevers are common problems in the community. People in Arada Vieja experience these illnesses when seasons change. Since the water system has not been up and running smoothly for a significant period of time, people have been drinking unfiltered water. We also found that even when the filters are running, people may be getting unfiltered water for cooking and drinking. When we asked why people were not drinking from the spigot providing filtered water, the majority of people were aware of the difference between spigots. We think that habit (the spigot that has been used by the village for a longer time is unfiltered) is keeping people from using filtered water for consumption. We hope to change these habits by doing community education on the next trip to make sure the community understands the importance of drinking filtered water.

We talked to the Water Board about this issue in our community meeting at the end of the trip, and we hope that they have encouraged people to drink out of the filtered spiggot. On the next trip, we hope people have been drinking the filtered water so that we can compare rates of flu, fever, and other illnesses and hopefully see an improvement in health outcomes. Thus, we are still trying to record the impact of our project on the community's health. We hope that our most recent repairs to the system will get the system running successfully and will improve the health of the community.

3. Engineering Designs Considered

When we got to Arada Vieja, the community members showed us the PVC piping suspended about six feet above the river. There was a metal cable strung from two trees across the river, from which was hanging the 2" piping. The community members told us a tree had fallen across the river, and had broken the original pipe. Before the tree had fallen, there was a galvanized steel pipe suspended by the same cable with a make-shift tree branch supporting it. The branch was not cemented to the ground or to the pipe. They had temporarily replaced the steel pipes with PVC, and they were afraid it might happen again. They wanted to put in more galvanized steel piping and support it with columns instead as well as the cable. This way, it would still be above the river height during the wet season.

They hoped we would be able to supply them with the new galvanized steel pipes, and cement, and then they would use the old, broken steel piping as columns. However, we thought this would not actually eliminate the possibility of falling trees breaking the piping, so we suggested putting the galvanized steel on the riverbed and cementing it to the rocks. Although this did mean that the piping would be covered with water during the wet season, we thought it was important for it to be out of reach of falling trees. We thought that if the pipes were as close as possible to the riverbed, and were strongly cemented down, it would not matter that they will be submerged during the wet season.

We supplied the community with the galvanized steel piping and cement, and helped them to cement the galvanized steel piping down on the riverbed.

4. Technical Description of Project

4.1 Component Description

The technical implementation of this trip was limited in scope, but necessary in maintaining the system in place. The system currently pipes water from two spring sources to an intermediate storage tank about two kilometers downhill. Here, it builds up the pressure necessary to power the RAM pump which pumps the water from below the intermediate tank to the community tank and filters.

The implementation portion of this trip was to install piping from the spring sources across a riverbed. The original pipes were made of PVC and elevated above the river line, but were damaged beyond repair during the wet season when the river flooded. To avoid this from happening in the future, we designed a new piping structure to be cemented to the bedrock of the river, to prevent the river from doing any damage during future wet seasons. A profile of the piping system designed can be seen in **Figure 4.1-1**.

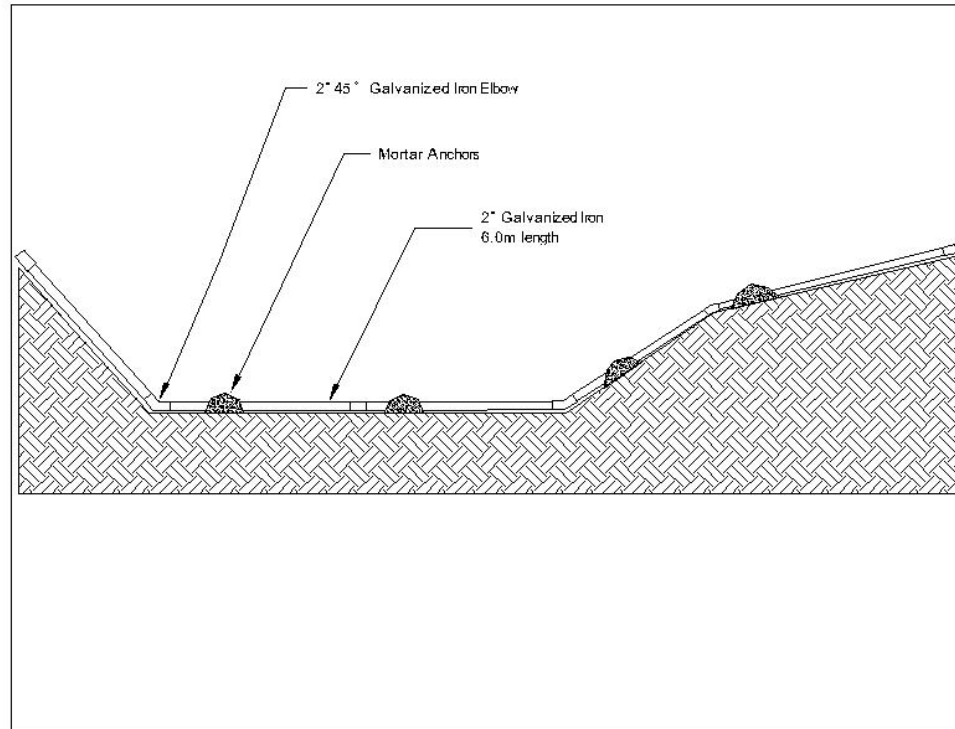


Figure 4.1-1 Profile View of Piping Design Across River
(Not to Scale)

This part of the piping was designed so that two 6 meter galvanized iron pipes would lay on the river bed, with 45° elbows connecting to more galvanized iron pipes on either side. This design avoids any PVC from being below the water line, even during the wet season. Since the pipe lays perpendicular to the flow, galvanized iron would not break similar to how the PVC did already.

In addition, a mortar mix was prepared to anchor the galvanized iron at 3-4 foot intervals depending on the profile of the river. This would help ensure that the pipe did not bend due to the force of the river. The mix was made with two parts sand, one part cement, and .75 parts water. To help strengthen the anchors, rocks and boulders surrounded the pipe and were mortared into place.

The second part of this piping implementation was to strengthen the piping from the second spring source that ran parallel to the flow of the river. The system in place was

polyethylene flexible tubing, which had broken in multiple places due to river flow and trees and branches. Galvanized iron was used to replace these as well, but because of less flow, ½” galvanized pipes were used. Ten six-meter galvanized pipes were used in total, spanning from the second spring source to downriver at a point above the water line, where it was hooked back up to the polyethylene tubing. Similarly, this was also mortared at many locations to prevent movement and strengthen the line.

5. Materials and Logistics

5.1 Materials

The materials used to construct the system described above are listed here:

- 8 bags Portland Cement
- 80 gallons sand
- 10 x 6-meter ½” galvanized iron pipes
- 4 x 6-meter 2” galvanized iron pipes
- Necessary pipe fittings, joints, and elbows

All the materials were bought locally in order to facilitate sustainability of the system. The community has access and the resources to purchase replacement parts if necessary in the future.

5.2 Logistics

Implementation of these components was designed in order to be constructed only with manual labor. Transportation of materials to the site was done on foot with help from community members. Construction of the system was also performed with help from the community members, with an overall supervision from EWB-Tufts.

6. Water Quality Analysis of Arada Vieja

6.1 Overview of Water Testing Locations

In Arada Vieja, the majority of the community used to get their daily drinking water from a spigot, referred to in this document as the “*old chorro*”, the water from this location comes from the *large storage tank*. However, a new spigot was installed in the spring, referred to in this document as the “*new chorro*”, whose water comes from the clean water storage tank after running through the *filters* instead of the large storage tank. Water is pumped up to both the large tank and the filters in the same piping via a *hydraulic ram pump* which sits 100 feet down a large hill. The water from this pump comes from an intermediate holding tank that is located approximately 25 feet uphill. This tank’s water is gravity fed from a community spring box and a spring box owned by David, who agreed to share his water with the community. The *springs* are located about

a quarter-mile up stream and across a river. This river runs close to the ram pump and is where the majority of the community bathes and washes their clothes, the children also play in this water frequently. During the rainy season, the community also collects water in rainwater collection barrels for everyday use. It is estimated that each family in the community uses about 80L of water per day (Tufts EWB Health Survey Results, 2006).

6.2 Methodology for Water Collection and Analysis

6.2.1 Water Collection

Water samples were collected from the old and new churro, the clean water storage tank, and the inlets and outlets of all three filters. On January 8, 2009 samples were taken from the new and old churro, filter 1 outlet, filter 2 outlet, and filter 3 outlet. The pump had been off during collection of these samples. More samples from filter 1 outlet, filter 2 outlet, and filter 1 inlet and outlet were taken on January 11, 2009 with the pump on. On January 13, 2009 samples from the clean tank, the new churro, and outlets of filter 1, 2, and 3 were taken in the morning with the pump on. For each sample collected, three 50mL samples of water were collected in order to have enough water to perform one 100mL test with some water leftover in case of a spill. The 50mL collection bottles were triple rinsed before each 50mL collection. The samples were labelled with the date and time of collection along with the collection site. The samples were placed in a cooler for transport until the tests could be administered which occurred approximately 30 minutes after the water samples were collected each time. Water quality tests were performed in the volunteer house of Epilogos Charities.

6.2.2 Water Analysis

Bacteria counts were determined by first obtaining a water sample from the location to be tested in three 50mL sampling bottles as explained in 3.21. 100mL of each sample were used for the 100mL bacteria test using a Coliscan MF Plus Membrane Filter Apparatus. Time between sampling and plating was kept to a minimum. Disposable pipettes, hand sanitizer, isopropyl alcohol, and sterile latex gloves were used to promote accuracy and limit introduction of bacteria during administration of the test. After filtration, the filter papers were placed in individual Petri dishes with pads treated with Coliscan MF solution, the dishes were placed in a portable incubator (Hach Product #2569900) for 24 hours at 35 °C. After 24 hours, the total coliform and E. Coli counts were determined and recorded for later analysis.

6.3 Water Quality Results

Sample Source	Date and time sample collected	Status of pump	Total coliform	E. coli
Old churro	1/8/2009 16:00	off	6	0
new churro	1/8/2009 16:00	off	9	5

filter 1 outlet	1/8/2009 16:00	off	125	6
filter 2 outlet	1/8/2009 16:00	off	11	0
filter 3 outlet	1/8/2009 16:00	off	21	2
control	1/11/2009 16:00		4	0
filter 2 outlet	1/11/2009 16:00	on		4
filter 3 inlet	1/11/2009 16:00	on		20
filter 3 outlet	1/11/2009 16:00	on		0
Old churro	1/11/2009 16:00	on		0
new churro	1/11/2009 16:00	on		17
control	1/13/2009 10:00		7	0
clean tank	1/13/2009 10:00	on		18
new churro	1/13/2009 10:00	on	10	4
filter 1 outlet	1/13/2009 10:00	on	28	0
filter 2 outlet	1/13/2009 10:00	on	4	0
filter 3 outlet	1/13/2009 10:00	on	7	0

Notes: All values are in counts/100mL
 US EPA standard is 0 counts/100mL for E. coli
 Data from 1/8/2009 had no control
 Controls were bottled water

6.4 Discussion of Results

The data suggests that the new churro, which should be clean, is actually supplying the community with water that is more contaminated or at least just as contaminated as the untreated water coming from the old churro. The first set of data collected on 1/8/2009 must be thrown out as there was no control set up. Sources of error in these results include any contamination of the samples from sample collection to use of bacteria test apparatus. Gloves were not worn by sample collectors and nor was any antibacterial hand sanitizer used before collection. From the data that we can gain insight on, it appears that filter 2 is not completely removing E. coli as can be seen from the sample from the filter 2 outlet on 1/11/2009. However, it is possible that the test was contaminated at some point after collection since the filter 2 outlet showed no E. coli from the results from the 1/13/2009 samples. The filters do appear to be significantly removing E. coli from the 1/13/2009 results. The results from 1/13/2009 also show that the new churro is contaminated with E. coli and the results from 1/11/2009 suggest that the new churro is even more contaminated than the old churro. This is unacceptable in reference to the goal of the system to remove all E. coli from the water supply. Since the sample taken on 1/13/2009 from the clean tank show a significant amount of E. coli contamination, it is plausible that after the water is treated by the filters, surviving E. coli bacterium are reproducing in the clean water tank. The high residence time in the clean water storage tank and the capability of bacteria to grow at a geometric rate may explain the high E. coli count from the new churro if there is detritus in the clean water storage tank. The community informed us that they had cleaned the tanks recently. Perhaps their cleaning methods introduced bacterium into the clean water storage tank and was not efficient in removing any food source for the bacteria to multiply. The clean water

storage tank absorbs a great deal of heat and the resulting high temperature of the tank may enhance bacterial reproduction even more so. Measures must be taken to prevent bacterial growth in the clean water storage tank in future trips to Arada Vieja.

Another cause for concern is the apparent lack of bio-film growth on the filters. Filter 3 appeared to have some algae growth which may aid in E. coli removal. However, filter 1 and filter 2 had no bio-film at all. This may effect the efficiency of the filters and as stated before, any surviving E. coli that passes through the filters has the potential to multiply in the clean water storage tank as the filters do not have any residual disinfectant effect.

6.5 Future Efforts

The water quality testing procedure must be improved for future trips. Multiple samples should be tested at multiple times of day during multiple days to obtain a larger, more trustworthy data set. Samples should be collected using sterile gloves or at least after using anti-bacterial hand sanitizer.

In order to prevent bacterial growth in the clean water storage tank, a few measure should be taken. First, cleaning of the tank should be observed by the next travel team to make sure that they do the cleaning sterilely. Chlorine may possibly be used in the clean water storage tank in order to ensure no bacterial growth in the tanks. However, there are many issues that come along with the use of chlorine and its use may not be worth the negative effects. The clean water storage tank should be painted a light color to reflect heat or some sort of cooling/heat reflection system should be implemented to lower the temperature inside the clean water storage tank to slow down bacterial growth.

7. Plan for Village Participation and Sustainability

Before implementing this part of the system, a community meeting was held with the Water Board and any other members who wanted to join. The team discussed our goals for the trip, and asked if the community agreed with them or had other ideas. This resulted in a mutual decision to proceed with construction of this system, and the community agreed to recruit help in the absence of Tufts EWB while they purchased materials.

When designing the system and purchasing materials, sustainability was consistently considered. All components were bought locally to assist future repairs that the community might need to make. During one of the community meetings, a maintenance fund was discussed, and the community expressed that there is currently one in place in order to collect money needed to upkeep the system. So logistically, the community can repair anything that needs it.

During construction, it was understood that both Tufts EWB and community members would be participating in the manual labor. Members of the community were at the site during all construction phases, both to ensure knowledge of the system was current and accurate, and to assist in the physical labor.

8. Summary of Project Implementation

8.1 Summary of Component Implementation

The community had two priorities for piping repair:

- In addition to the spring box that we had worked on previously, there is a second spring box along the river that is used to augment water supply during the dry season. The spring had been connected to the intermediate tank using polyethylene piping that ran along the river bed. The piping was not sturdy enough to withstand the flows during the wet season, and so replacement of the piping was the community's top priority. We bought materials and assisted the community replacing the polyethylene pipe with 1/2" galvanized iron pipe. This pipe was reinforced along the river bed using rocks and mortar.
- Prior to our January trip we had learned that the 2" pipe from the main spring box had been broken. Prior to Tufts EWB's involvement with the project, the galvanized pipe over the river was supported about 2 meters above the stream bed by wooden posts set on concrete footings. This autumn a tree fell on the galvanized pipe, bending it and breaking it off from the PVC pipe. The pipe had been temporarily repaired by replacing the galvanized pipe with PVC pipe suspended with a wire cable wrapped around the pipe and tied to trees on either side of the river. This solution was fine for the dry season, but the pipe is only 1 meter off the stream bed and will be broken when the high flows return. We buy materials and assist the community replacing the PVC pipe with galvanized iron laid along the stream bed.

8.2 Lessons Learned, Future Evaluations, and the Next Phase of the Project

We are still having difficulty getting the community to use the clean spigot as opposed to the old, unfiltered dirty spigot. This is perhaps because the community is used to using the dirty spigot. We have attempted to educate the community on the benefits of using the new spigot, but our attempts have clearly fallen short. Regardless, the water quality tests show that the clean spigot is, in fact, not actually significantly cleaner than the water from the dirty spigot. However, in the future we hope to solve this problem. With the water from the clean spigot clean, getting the community to use this clean water is imperative for the project to be viewed as a success.

In the future we hope to finalize this project with a post-implementation trip. In this trip we would like to resolve the water quality issues in the clean water storage tank, successfully convince the community to use this clean water for drinking, cooking, and cleaning, and ensure the maintenance of the system after we close the project. This will require further education of the water board on maintenance of the system.

ii. Porvenir

Tufts Engineers Without Borders sent six students and a Faculty Advisor, Professor Durant, to El Salvador to assess the community of Porvenir for a water project. The team traveled from January 3rd to January 14th, but not all of this time was dedicated to Porvenir alone. Three full days were spent assessing the community, as well as additional conversations and visits.

The team went into the assessment with knowledge from the local NGO, Epilogos Charities, that the community of Porvenir was interested in receiving help with a water project. It was not known previous whether they were interested in a water accessibility and delivery project, or a water quality project.

The Tufts EWB travel team met with the community as a whole to discuss the goals of Tufts EWB, why Tufts EWB was in the community currently, what the team would like help with, and had a discussion on the overall concerns that community members had. The travel team also visited each of the houses in Porvenir to conduct IRB-certified community health surveys in order to gather information on the overall health issues associated with Porvenir.

In order to assess a water project, both information on water accessibility and supply was gathered as well as information on water quality. Measurements, flow rates, and detailed descriptions of the water sources were gathered from tests the Tufts EWB team performed in addition to information received from questioning community members.

Land surveying equipment was used to map Porvenir, focusing on elevation differences which would be necessary for a water distribution project. House locations and water source locations were also mapped to assist Tufts EWB in the assessment discussions between the travel team and the rest of the project group.

The information gathered will be used by Tufts EWB members to determine the feasibility and effectiveness of a project that could be implemented by Tufts Engineers Without Borders in the future.

1. Community Attributes

1.1 Relationship of Porvenir with NGOs, Government Entities, and Land Owners

The residents of Porvenir have a relationship with the owners of the land that they live on. The land owners, who live in cities and other parts of El Salvador, allow the people of Porvenir to live on their land free of charge. It is unclear how stable this situation is, although the people of Porvenir have been living there for about 45 years. Porvenir also has a relationship with the NGO based in San Jose Villanueva called Epilogos. Epilogos and Porvenir have met to discuss community needs, and Epilogos has been involved in

setting up families in need of housing with Habitat for Humanity and Rotary groups to build houses. Epilogos is located near the village, and the community can easily contact Epilogos for help if necessary. The people of Porvenir have access to a medical clinic located nearby, although the condition of the roads makes it difficult for much transportation to or from the community. Finally, some of the elder members in the town have taken interest in the recent mayoral election, feeling hopeful about the possibility of an elected official who will actually create meaningful change, listen to the community, and respond to it's needs.

1.2 Community Involvement in the Project

We would like the community to be as involved as possible in the project in order to ensure the project's sustainability. The community has already been involved in determining what our project should be focused on. They told us that their biggest concern is having enough water during all times of the year, and they would like to have a water distribution system installed to reduce the distance community members have to walk to obtain water. Throughout the project, we would like to include the community in construction, and ultimately provide the education and support necessary to allow the community to be in charge of running and maintaining the system. We want the community to be actively engaged in the project since it will benefit Porvenir. We are planning on create a Water Board in Porvenir that will represent community interests and communicate with us about their water situation. The Water Board will also be responsible for maintaining the system after our departure from the community. We have identified a few possible candidates, who stick out as town leaders of water delivery based on their home's location.

1.3 Community Decision making in the project

We have already had a group meeting with Porvenir. We will continue to have group meetings throughout the project in order to discuss project plans with the community. These discussions will also help us make sure that we are meeting the needs identified by the community instead of imposing our ideas on them. The community will be involved in deciding what system design would best fit their water consumption demands. We found that the community wanted to be involved and we're happy to see fresh younger faces. Some of the older members in the community lack a little motivation. We believe this is because in the past many people and groups have come to the town and not followed up with a project. One man expressed bitterness that he assumed we would never return or follow up with the ideas we had all discussed.

1.4 Community Skills/Assets

The community members have helped us thus far by escorting us through the village and introducing us to the families of Porvenir. It seems like they are willing to help us as much as possible because they understand that the project will improve their water

situation. The younger members of the community definitely show a lot of potential based on their abilities to communicate with us (regardless of our Spanish speaking abilities) and some of the older members were very friendly and open when we went door to door. Not all households greeted us with such a friendly attitude. There are at least 10 kids in the community who will begin English classes in the near future as well. We were able to catch a glimpse of the labor skills of some in the community. In an extremely short amount of time, various family members came together and were able to clear a plot of land that is set aside for a Habitat house. This showed us how the families are hard working especially when they know the task is important. We have not yet learned what kind of skills the community has to offer and have not asked about the possibility of staying in their homes during future trips.

1.5 Community organizational capacity

There is a community president and vice-president that are respected members of the community that will help us get the community involved. We will create a water board that will hopefully include these two community members to help with the organization of this project. We hope that the Water Board and other members of the community will provide labor for constructing the system, and that the Water Board will be in charge of the maintenance of the system.

1.6 Community financial capacity

Due to the fact that many citizens of Porvenir earn little or no money, we cannot expect large financial contributions to the project. However, to ensure the sustainability of the system after our departure, we will encourage the Water Board to create a maintenance fund. Each family will contribute to this fund by paying a couple of dollars per month. Thus, if a part of the system needs repair, the community will have money to buy materials to repair the problem itself. The community expressed understanding for the need for clean water and thus will understand the importance of even just a small financial contribution.

1.7 Community interest and commitment to the project

Epilogos brought this community and problem to our attention. We are responding to a need identified by the community. We held a community meeting to get a better sense of the interest in and commitment to the project. An estimated 15 people came to the meeting. We were encouraged to see that many people at a meeting to talk about the preliminary stages of a possible water project. It seems like the community is seriously interested in a water distribution system and will be involved in seeing the project through its completion. Specific cases of people who have lost friends or family to preventable disease made a few people more motivated to continue to investigate the project possibilities.

2. Health Assessment

2.1 Introduction

Health surveys were modified and pre-approved by the IRB before the January 2009 trip. The main purpose of the study was to collect preliminary health information from the residents of Porvenir. Information gathered from these health surveys includes that of demographics, sicknesses experienced, information about daily life, economic situations, education, methods of transportation and communication in and out of the community. All of this information will be used to identify community health problems, and assess if there is a way in which we can assist. We will use this information in the future to focus community health efforts.

2.2 Methods

Two IRB-certified students from Engineers without Borders conducted each health survey. Students entered the properties of the citizens of Porvenir and asked if one of the heads of households was available to take a health survey. After explaining the purpose of the study and receiving consent from the participants, one student asked the questions and recorded answers while the other took notes and witnessed the interviews. In various households, pictures were taken as well.

2.3 General Observations

Most of the community members approached were welcoming and willing to take time out of their lives to answer the health survey questions. The wording on a couple questions seemed to confuse participants so we re-phrased them as necessary. Many of the households had chickens, puppies, or other animals running around, including through the kitchen and eating areas. Most houses also had at least some trash littering the ground, while their method of trash disposal was burning. Usually the heads of household surveyed were women. The majority of the houses in Porvenir had latrines, but not all, including some of the larger families. There was a notable lack of education for most of the adults.

2.4 Results

We surveyed eleven households in the community. The average number of years participants reported living in Porvenir was 13.8 years, and ranged from three to twenty-four years. Most of the residents reported moving to Porvenir from other cities and towns in El Salvador including Santa Tecla, Comasagua, Corinto and various other locations. Participants moved to Porvenir mainly to be closer to their families, and because their current home did not have enough room for the grow size of the family.

The number of residents per household varied from one to thirteen people. Of those, a range of one to seven of the residents were adults, and there were zero to six children per household.

Illnesses Reported:

Illness	Number of participants (or participant's family members) who experienced illness	Reported Causes of illness
Flu	5	Changes in weather and climate
Headaches	2	Intense heat in summer and dehydration
Low Blood Sugar/ Diabetes	1	Unsure
Bronchitis	2	Dirty air, change in weather
Muscle or Joint pains	3	Labor, weather changes
Fever	4	Changes in weather and climate

○ The survey data shows that the people of Porvenir suffer most frequently from the flu and fevers. Muscle pains and regular headaches are the next most-frequently suffered illnesses.

○ The next section asked participants if AIDS, Tuberculosis, and malnutrition are problems in the community. The results are as follows:

Problem	Number that responded 'yes' when asked if the illness was a problem in the community	Number that responded 'no' when asked if the illness was a problem in the community	Number that responded 'sometimes' when asked if the illness was a problem in the community
AIDS	5	2	2
Tuberculosis	8	1	0
Malnutrition	7	2	0

○

For the question on AIDS, many people reacted as though they knew it was a problem, but then explained that it was because "certain individuals made poor choices". They understand that if one member of the community contracts the disease AIDS or TB, it is likely to spread quickly. One family had lost two friends to the epidemic in the last three years. Others were unsure of what the disease was. With TB, unlike in Arada Vieja, the community almost unanimously felt that the disease was a health concern. It seems to be a more prominent threat, and better understood by all across the education spectrum. It seems the wording on this question was not clear enough, and perhaps should have been more community specific.

Respondents said that the nearest health facility was either the day clinic in San Jose Villanueva, or a clinic in the nearby town of Zaragoza. One family reported going to Santa Tecla for their medical consultations, perhaps because they still have family in that area. Almost half the people reported walking to the clinic, and the other half explained that a bus was available if you could walk to where it would pick you up. The bus seems to cost less than a dollar. Participants had mixed answers to the question, "Does the facility send medical personnel to the community?"; few answered simply "yes", some said "no", and most said sometimes, or if an individual is particularly ill. Given the mixed responses, it is hard to make a clear conclusion based on this question, but those who reported "sometimes" said that this meant two or three times per year. The community of Porvenir seems to be receiving medical information from a variety of sources including a health promoter, the Red Cross, the clinics, family members, or some do not receive care at all. Five out of nine who answered the question said that transportation is an obstacle to receiving health care, while the others say the buses are sufficient, and one reported never even visiting. A few participants said that money can be a problem in receiving health care, but most agreed that it was not the consultation that was expensive, but rather the medicines prescribed that were impossible to afford.

When asked if the participant's children had received immunizations, all of the interviewees with children responded yes, and 1/3 said no, because they do not have children.

Seven of eleven participants reported getting their water for drinking from the pila by the river, at the base of one man's property. The water needed for washing and other non-drinking uses was generally gathered from the river. Four other people reported different systems of water collection. One, who found the river to be too far for their age reported using an area near her home. One reported only using the river water. One family uses a well, that is hand-made about a kilometer away from the main center of town. One family has a water system on their roof, with filters at the bottom of the pipes, so they rely mainly on rain water, but admit to not using much. Most people seem to use the river water and the pila, but the river water at times flow high enough and contaminates the pila water. Because of this, the water will change color when they are in the rainy season. In the summer, some report that the water is too hot to drink. Four of nine respondents reported no change in the water taste color or odor. In the majority of households, the men are those who are going to get the water, because it is often a longer walk uphill. Other families said that they all go together, and one family says that just the kids go to retrieve the water. Water was generally collected in the morning, because it is cooler, and before the working hours. For families who are not at work, they collect water any time of day.

When asked if there was enough water during all times of the year, only three participants responded 'yes'. Others said 'sometimes' or 'no', reporting that in the summer months there is much less water than in the winter. March and April were cited as the most difficult months.

When asked if interviewees use any methods to purify their water in their homes, one

said they use a chlorine chemical to purify it, and another has a filter attached to his rain pipes. The rest, the majority of the families in the town, use no method of water purification. Most interviewees said that they store water in their house in 5-gallon plastic jugs called 'cántaros' in Spanish, others use barrels or drums. All those interviewed said they clean the plastic jugs either with soap or bleach (the majority use soap).

All participants said that a typical meal is rice and beans. Some added that tomatoes, onions, tortillas, and even cheese are added when there is enough money to purchase or make these items. All but one household reported having enough food to feed the entire family, and the one said barely, noting that they live for each harvest; "we work to eat". Although some people said they have to buy food sometimes, all of the families grow some part of whatever it is that they consume. Seven participants said their families eat 3 times a day, one person said their family eats at least 4 meals per day, or, whenever they are hungry, and one family reported to eating only one or two times, if they were tight on money, or simply forgot to eat a meal. All except one person reported that the woman and man of the household eat the same food.

The next question asked if women breast-feed their babies. All respondents with children said yes.

In response to the question, "When and how frequently do you drink water?", most said when they were thirsty or needed to drink. One man even said "water equals life". One family reported drinking around a liter a day, while another drink four or five liters a day. This is dependent on family size. One person reported drinking as much as they could, even if it was not enough. In addition to water, some community members reported drinking juice, coffee, and soda very infrequently, when their budgets allowed for it. One man reported to drinking almost solely coconut juice.

Five of the houses had latrines, three of them were close to the house, while one was about the house and another was below it. Three families reported going wherever possible, including holes in the ground, or near the river, because they have no latrine. Two other families reported have a latrine that did not work, and have another system that required water which he did not have enough of to use on the restrooms. Most kids would not use the latrines if their parents did not, or if they did not have one. Some were only allowed to use it if there was parental supervision, so while the parents were at work, they would use other locations. Five of nine people surveyed said they go to the bathroom in other locations, especially when working, or not near the home. All families reported that both they and their children wash their hands post bathroom use, and most often with soap if they can afford it.

All of the households burn their trash.

In six households there is at least one member of the family who is working. One family also earns some money from selling crops. The rest of the households do not earn money. Of those that worked, income earned per month varied from \$40-\$220 per

month. That money is mostly spent on food, medicine, and other necessities. None of the families pay taxes except for one, who reports having to give 10 percent of his earnings to the "empresa" in exchange for living on the land, cell phone use, and other perks. Others report that they would pay if it included certain benefits as well.

The highest level of education achieved by a participant was through 6th grade (one person). One person had completed 3rd grade, one had completed 2nd grade, and the rest had not received any education. Three participants said they can read and write, two said that they could read a little, often limited to just their name. Four participants said they could not read or write. Three participants said that their children go to school. Three families did not have kids, and for three families with kids, they were either unable to attend because they needed to work, or were not old enough to attend yet. Those who go to school go to Zaragosa, or a Centro Escolar in Guadalupe. The school year is from January to November, and children attend school five days a week.

All but two participants said that they leave the community sometimes. Reasons for leaving included to buy food, clothing, or medicine, to go to the clinic when sick, to work, to go to church, and to visit family. Most people leave from the community by foot. Some pay \$0.40-\$0.60 for a bus to San Jose Villanueva. Many report that this bus does not come all the way down to the town, so they must walk to meet it in Zaragosa. Besides this bus, there is no official form of public transportation.

<u>Regular Access To:</u>	Yes	No
Radio	6	5
TV	3	8
Phone	9	1
Newspaper	4	5
Car	0	11

The following is a list of problems identified by the community: Education, water, better roads and access to the community, electricity and better light, a functioning town center to unite the community.

Types of projects people said would help deal with these problems would be a better way to save water when the river is so high, creating a way to bring water closer to the home, obtaining water AND light, and finally, it is important to many to form a better relationship with the new mayor than the one that they had with the past mayor.

2.5 Analysis

Results show that the flu and fevers are the most commonly experienced illnesses in the

village. Most contributed these illnesses to changes in the weather. To treat these and other illnesses, many people used the clinics in San Jose Villanueva and Zaragosa. Some people also use home remedies to assist with various ailments, many which were passed down through generation. While it is good to have access to the clinics, the one in San Jose Villanueva is decent walk away. The roads in Porvenir are also a large area of concern for many in the town, that is, if there were to be a serious medical emergency, it is difficult to get medical assistance to the area.

In Porvenir, there is very low average education, with most adults receiving basically none. Along with this, only a small portion of the children go to school, but those who do said that they enjoy it and look forward to the classes. This bodes well for the future of the town with the next generation being significantly more educated.

More families in Porvenir than in Arada Vieja were NOT using the latrines. Although the health in the community does not seem to be worse, we feel that restroom sanitation is an important part of the general health of the community -- if a few members are using the river and not a latrine, then the entire community is in jeopardy. However, all respondents, regardless of latrine use, recognized the importance of washing hands following going to the bathroom.

The water problems in Porvenir seem to be more ones of quantity and accessibility, rather than quality. Most of the families recognize the importance of water in their day to day lives, especially considering their lack of money for other drinks or forms of hydration. At this point, the community is concerned with finding a different way to distribute the current water that they have.

The problems mentioned most frequently in the community surrounded issues of water, access to other communities, better roads, education for more members, and a lack of electricity

2.6 Conclusion

The flu and fevers are the most common illnesses in the community. People in Porvenir, and other areas in the country, experience these illnesses when seasons change. Currently the main sources of drinking water are either the well near one man's house, or the spring at the base of another home. Both experience mild contamination from rain water and river water. Most in the town use one of two rivers for the majority of their other water needs (cleaning clothing, showers, etc.). While the town does not have totally clear leaders, we were able to meet the President and Vice President of the community, who seem to be well educated on the problems, and willing to work hard to help themselves and their neighbors. We hope to have the opportunity to help out this community with distribution of their water. Our next trip will hopefully be a continued assessment of the situation to take official measurements and see what options are plausible in the area so that it is sustainable. Easier access to water will undoubtedly improve the general health of the community.

3. Basis of Design Discussion

3.1 Water Demand Flow Rates

During community interviews and informal discussions, families said that they used about one five-gallon bucket per person per day, or 19 Liters. Assuming this is the average demand per person, the following can be calculated.

Two sources of water can be found in Porvenir. One source, a well behind a community member's house, Tomás, supplies 2-3 families with water depending on the season. The number of individuals in these families is estimated to be a total of 15-20, but no more accurate information on this could be gathered from anyone. Assuming 20 people used this well, at least 280 L per day was estimated as the need from this source.

The second source was described as the only other source that the rest of the community needed. This source is located near Domingo's house next to the river. The total number of community members in the community is estimated to be 120 people. Based on this, it can be assumed that the water demand from this house is at least 2280 L per day.

3.2 Water Supply Flow Rates

Only one of the sources could be tested for flow rates, which is the source behind Tomás house. The overflow of this system is piped into a large pool, and it was this overflow that was measured for flow rates. If leaks or pipe breaks exist between the well and this outflow, it will only decrease the supply, so measurements from this pipe were assumed to the worst case scenario of flow rate from the well. This well averaged 3.75 L/min, which meets more than the demand of this source of 280 Liters per day.

It was unable to otherwise measure the recharge time of this well, or measure the recharge time of the spring source near the river. In future trips, more accurate methods will need to be employed to measure the water supply rates for this community.

3.3 Description of Existing Water Supply and Water Usage

Porvenir currently has two water sources. One water source is a well behind a community members house, Tomás. This source is estimated to be used by 20 community members. It is a large well, and was initially dug to seven meters in depth. Recently, an earthquake caused damage to the well, and it has not been outputting as much water as it had in the past by a significant factor. This well used to be able to fill up two 20m x 15m x 2m deep pools, but currently cannot begin to fill them up.

The well is downhill from a cornfield, which implies that fertilizers are entering the water supply. Some members of the community expressed knowledge that fertilizers may be entering the water, and were confident that it makes them sick. Water quality tests for nitrates/nitrites and phosphates will need to be performed on future trips. The well is also open to the environment, meaning insects, runoff, and tree-fall are entering the well, and can visibly be seen.

The second water source is a spring box on the side of a hill next to the river behind Domingo's house. Most of the rest of the community uses this as their primary water source. This spring box is about 2 ft deep by 2 ft wide and 2 ft long. It is filled from an aquifer in the side of the hill that it abuts. A perforated pipe extends into the hillside to collect water from the aquifer.

This spring box is also open to the environment, prone to the same problems as the well. It is also downhill from a massive cornfield, and cows also graze on the hill, meaning runoff of fecal matter is likely to enter the spring box. To add to the issues of this spring box, it can only be accessed 6-9 months of the year because of its height and proximity to the river. During the wet season, the river flow completely encompasses the spring box, rendering it inaccessible and contaminated.

Both the well and spring box are at locations that are not central relative to the community. Community members expressed frustration at the distance necessary to retrieve water every day, with some community members needing to walk two kilometers or more to collect water. To add to this, they need to carry the weight of five-gallon buckets this distance.

4. Water Quality

4.1 Introduction

Water for drinking and cooking in Porvenir is primarily from two sources: a shallow groundwater-fed well nearby Tomas's house and a springbox located along the river downhill from Domingo's house. Most of the community retrieves their water from the springbox near Domingo's house during the dry season. During the rainy season, the river covers this springbox and the community retrieves water from Tomas's well as well as from rainwater. Preliminary water quality tests were taken of water from the well and springbox. Tests of the rainwater were unable to be collected as it was the dry season. In a community meeting, the community expressed little desire for cleaner water and instead, their wants were more geared towards easier accessibility of the water they had and concerns with the quantity of water they are currently able to extract from the community's two sources.

4.2 Methodology for Water Collection and Analysis

4.2.1 Water Collection

Water samples were collected from both the well near Tomas's house and the springbox near Domingo's house. Three 50mL samples of water were collected from each site in order to have enough water to perform one 100mL test with some water leftover in case of a spill. The 50mL collection bottles were triple rinsed before each 50mL collection. The samples were labelled with the date and time of collection along with the collection site. The samples were placed in a cooler for transport until the tests could be administered which occurred approximately 30 minutes after the water samples were collected. These preliminary samples were collected at approximately 4:00 p.m. El Salvadorian time.

4.2.2 Water Analysis

Bacteria counts were determined by first obtaining a water sample from the location to be tested in three 50mL sampling bottles as explained in 3.21. 100mL of each sample were used for the 100mL bacteria test using a Coliscan MF Plus Membrane Filter Apparatus. Time between sampling and plating was kept to a minimum. Disposable pipettes, hand sanitizer, isopropyl alcohol, and sterile latex gloves were used to promote accuracy and limit introduction of bacteria during administration of the test. After the filter paper corresponding to Tomas's well and Domingo's springbox were placed in individual Petri dishes with pads treated with Coliscan MF solution, the dishes were placed in a portable incubator (Hach Product #2569900) for 24 hours at 35 °C. After 24 hours, the total coliform and E. Coli counts were determined and recorded for later analysis.

4.3 Water Quality Results

Location tested	Date tested	Total coliform	E. coli
Shallow well near Domingo	1/11/09	86	0
"Springbox" near Tomás	1/11/09	18	0
Control (bottled water)	1/11/09	0	0

Notes: All values are in counts/100mL
US EPA standard is 0 counts/100mL for E. coli

4.4 Water Quality Discussion

The results of the 100mL tests from Porvenir suggest that both sources meet the EPA standard of 0 counts/100mL of E. coli. However, these results may not be accurate as

only one set of tests were administered. In future trips, multiple samples should be tested at multiple times of day during multiple days to obtain a larger, more trustworthy data set. Tests should be taken during the rainy season as differing conditions may effect the water quality results. For instance, the river contaminates the springbox near Domingo during the rainy season and would most likely cause a spike in E. coli levels. Also, contaminants other than E. coli, including nitrites and nitrates, should be tested for in future trips to Porvenir. Both water sources were located downhill from fertilized corn fields. The chemicals from the fertilizer may be leaching into their water supply. It should be noted that the community was not interested in any treatment of their water to improve its quality and did not believe that their water was making them sick.

5. Availability of Local Materials

Materials necessary for simple manual labor and construction are available within four kilometers. Materials such as concrete, sand, aggregate, timber, tubing (PVC and otherwise), reinforcing bar, and masonry are available in the nearby city center of San Jose Villanueva, which Porvenir is officially part of. There are both walking paths and driving paths to this city for transportation of materials.

Other prefabricated materials, such as water tanks, plastic materials, or any large material components may not be retrievable by the community members alone. These are all available within a 10-mile radius in the outskirts of San Jose or nearby shopping centers, but these are not likely to be accessible by the community when none of them have a form of private transportation. Public transportation exists, but would not be ideal to transport materials unless a delivery service was provided.

6. Property Ownership & Water Rights

In Porvenir, the question of property ownership and water rights was a complicated issue. The community of Porvenir is comprised of about 25 families who live on the land for free. Someone (or a few people) owns most of the land but does not live on it. The people who live in Porvenir have some sort of deal with the landowners in which they can live there for free as long as they take care of the land. The rest of the land in Povenir is owned by a local priest.

There are two water sources in Porvenir- two spring boxes. One is located by the river, and the land surrounding it belongs to the people owning most of the land in Porvenir. However, we believe there is a law in El Salvador stating that any land by a river is publicly owned. If so, we would be able to do work on that spring box, or at any other point along the river. If we do make plans to work by that spring box, though, we will need to find out if this law actually exists and how far away the river it extends to.

The other spring box is owned by the priest, however, the community has a good relationship with him and he has told us that he approves of us working on his land to

improve the water situation in Porvenir

7. Alternative Designs Considered

During this semester the El Salvador weekly meetings will focus on formulating designs of a centralized water delivery system in Porvenir that will increase the quantity of water available to the community and improve its accessibility. In order to increase the quantity of water available to the community, another fresh water source must be utilized. Therefore an additional well or springbox may be required. A pump will most likely be needed to transport the water from the water source. The pumps being considered are a gravity fed Ram pump, a hand pump, or a solar powered pump. During this semester, Tufts EWB will devise several different designs and determine which design to implement. Another assessment trip may be required aid in this decision.

iii. Las Dispensas

While we were in San Jose Villanueva, Mike and Susie wanted us to look at a local school that had water quantity and quality problems. They pump water out of a deep well, but there is not as much water as there used to be. This could be caused by a number of things, from a recent earthquake that shifted the groundwater flow, to a decrease in the water table caused by a number of small wells in the surrounding community, or by the large, highly commercialized new housing development down the road. In the dry season the lack of water is worse, but even in the wet season a man must turn off the pump whenever it makes the noise of running dry.

They also have a problem with the quality of their water. They think it is very dirty and is getting them sick, and our quality tests show dangerous levels of e. coli. They have a few over-flowing latrines that they think cannot be good for the quality of the water in the well, but that there are also many other factors in the surrounding neighborhoods that could be contributing to the poor water quality.

We are hoping that by the time we are able to go back to El Salvador (probably in about 5 months) that they will already have some solution to the water quality problem, because school has already begun and there are children drinking the dirty water. However, if not, we hope to help them out, if possible, by providing them with slow sand filters like we have in Arada Vieja. Providing them with new latrines or helping to clean out the old ones is also a possibility, and something we could look in to as well.

Water Quality Results from Centro Escolar: Canton las Dispensas

Sample source	Date sample was collected	Total coliform	E. coli
school pila trial 1	1/9/2009	52	9
school pila trial 2	1/9/2009	42	10

Notes: All data are in counts/100mL