LA FORTUNA:
JANUARY 2006 TRIP ASSESSMENT

Prepared by:
Arno Alarcón
Ben Flath
Margaret García
Will Hockett
Briana Niblick
Debra Perrone

Prepared February 9, 2006
# TABLE OF CONTENTS

1.0 INTRODUCTION
   1.1 Project Background  4
   1.2 Water Access  4
   1.3 Trip Participants  4
   1.4 Trip Overview and Goals  5

2.0 SITE DESCRIPTION AND LOGISTICS  5
   2.1 Location and People  5
      2.1.1 Transportation  6
   2.2 Climate  7
   2.3 Physical Characteristics  7
   2.4 Water Supply  7
   2.5 Sanitary Facilities  8
   2.6 Local Materials and Equipment  8
   2.7 Trip Logistics  9
   2.8 Security  10
   2.9 Partnerships  10

3.0 COMMUNITY ASSESSMENT  10
   3.1 Community Survey  10
   3.2 Health Survey  11
   3.3 Hygiene  12
      3.3.1 Water  13
   3.4 Education  13
   3.5 La Fortuna and Tule  13
   3.6 Homes  14
   3.7 Health Clinic  15

4.0 WATER QUALITY  16
   4.1 Watershed Description  16
   4.2 Testing and Data Collection  16
   4.3 Watershed Protection  17

5.0 COMMUNITY INVOLVEMENT  18
   5.1 Importance of Community Involvement  18
   5.2 Community Meetings  18
   5.3 Community Progression  19

6.0 TRIP ACCOMPLISHMENTS  19
   6.1 Site Map  19
   6.2 GPS Points  20
   6.3 Survey Points  20
   6.4 Soil Types and Terrain  21

7.0 CONCLUSIONS  22
List of Tables

Table 1.3.1 La Fortuna trip participants
Table 1.3.2 Lagunitas trip participants
Table 2.6.1 Unit Costs for Materials Collected in January 2005
Table 4.2.1 Summary of water quality data

List of Figures

Figure 1.1.1 Sitemap of La Fortuna
Figure 2.1.1 Map of Honduras, showing the location of San Pedro Sula and Yoro
Figure 2.1.1.1 Pushing through the muddy roads
Figure 2.3.1 Steep slopes of La Fortuna
Figure 2.3.1. Steep slopes of La Fortuna
Figure 2.4.1 Source in La Fortuna
Figure 2.4.2 Source in Tule
Figure 2.5.1 La Fortuna latrine
Figure 2.7.1 Local resident who cooked the group’s meals
Figure 3.2.1 Child Vaccination Records
Figure 3.6.1 Thatched Roof House
Figure 3.6.2 Kiln
Figure 3.6.3 Greywater Discharge
Figure 4.1.1 Macroinvertebrate testing along the stream
Figure 5.2.2 Last Community Meeting
Figure 5.2.1 First Community Meeting
Figure 6.3.1 Holding the rod in the stream
Figure 6.3.2 Surveying in a corn field
Figure 6.4.1 Path through Banana Trees
Figure 6.4.2 Steep slopes of La Fortuna

List of Appendices

Appendix A Site maps of La Fortuna
Appendix B Contacts in Honduras
Appendix C Raw water quality data
Appendix D Minutes from the second community meeting
Appendix E Sketched map of La Fortuna and Tule
Appendix F Raw GPS data
1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

After successfully completing a potable water system in the village of Lagunitas, Honduras, we planned a visit to the neighboring village of La Fortuna (Figure 1.1.1) to begin a similar project. However, after arriving it became apparent that La Fortuna is much worse off than Lagunitas. Their problems extend far beyond a lack of potable water. We hope to address as many of their needs as possible, but our main focus is still on providing clean water.

1.2 WATER ACCESS

The La Fortuna Water Project in Yoro, Honduras will provide a sustainable potable water system for the benefit of over one hundred people. La Fortuna has no water system; water is currently obtained from a stream. Typically, women and children are responsible for hauling water, which takes up a lot of time, as much as an hour a day in some cases. The water obtained from the stream is contaminated, yet only a few people boil their water to treat it. Poor water quality is thought to be responsible for many of the medical problems afflicting La Fortuna. This sort of problem is endemic in the developing world, and is a serious obstacle to any sort of development.

Installing a potable water system would reduce the incidence of water-borne illnesses and save time, which in turn would improve the quality of living and increase economic prosperity. Members of the community have requested government assistance, but have not received the support they need. As a second effort they sought foreign aid and applied for help from Engineers without Borders – USA.

1.3 TRIP PARTICIPANTS

Eight students and one alumnus from various disciplines participated. The group included three native speakers of Spanish, with most of the other participants able to speak some Spanish.

Table 1.3.1. La Fortuna trip participants

<table>
<thead>
<tr>
<th>Participant</th>
<th>Responsibility</th>
<th>Major</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arno Alarcón</td>
<td>Health Survey</td>
<td>Mechanical Engineering</td>
<td>2006</td>
</tr>
<tr>
<td>Ben Flath</td>
<td>Water Quality</td>
<td>Civil Engineering</td>
<td>2007</td>
</tr>
<tr>
<td>Margaret Garcia</td>
<td>Surveying</td>
<td>Civil Engineering</td>
<td>2007</td>
</tr>
<tr>
<td>Lori Gonzalez</td>
<td>Health Survey</td>
<td>Electrical &amp; Computer Engineering</td>
<td>2009</td>
</tr>
<tr>
<td>Will Hockett</td>
<td>GPS</td>
<td>General Engineering</td>
<td>2006</td>
</tr>
<tr>
<td>Fidel Maltez</td>
<td>Professional Advisor</td>
<td>Civil Engineering</td>
<td>2005</td>
</tr>
<tr>
<td>Briana Niblick</td>
<td>Water Quality</td>
<td>Civil Engineering</td>
<td>2007</td>
</tr>
</tbody>
</table>
Lagunitas is the site of our older project, which is now complete. This was our fourth visit to Lagunitas; we returned to examine the construction work and to continue our educational program there related to watershed protection and system maintenance.

1.4 TRIP OVERVIEW AND GOALS

The EPA P3 Phase I grant funded a site visit to La Fortuna which took place from January 8-18, 2006. Major trip objectives included:

- A survey of the terrain including probable water distribution pipeline routes, supplemented by GPS data
- The acquisition of water quality data
- The gathering of relevant demographic information, especially related to health, economy, and education
- The establishment of a strong relationship with the community. This was critical to ensure their trust, and to promote enthusiasm and cooperation within the community.

Our main objective in the project is to work with the community on the design and implementation of the water system, and to ensure that it will be sustainable. Therefore, the project will not end after the system is built; the most important aspect will be the education of the community in the operation, management and maintenance of the systems. With cooperation from NY Help and FUCOHSO, latrines will also be provided to the village (See Appendix B). The residents of La Fortuna communicated other needs to us, such as better wastewater disposal, sanitation, and housing. We hope to address as many of these needs as possible. We will ensure that our design meets the requests and needs of the community. The intercultural dialogue between our team and the community members is perhaps the most important aspect of the project.

2.0 SITE DESCRIPTION AND LOGISTICS

2.1 LOCATION AND PEOPLE

La Fortuna is located in the Yoro district of north central Honduras. The closest airport is San
Pedro Sula, about 100 miles from the city of Yoro, the capital of the Yoro district (Figure 2.1.1). The area is rural and rugged, and agriculture is the primary occupation for community members. The village is surrounded by other similar villages. The population of La Fortuna is comprised of approximately 24 families with a total population of 104 people. The village has welcomed EWB-USA and has been incredibly hospitable. Next to La Fortuna is another village called Tule. There are only 7 houses in Tule its 33 citizens are welcomed in the La Fortuna community because the two villages are so close together.

Figure 2.1.1. Map of Honduras, showing the location of San Pedro Sula and Yoro

2.1.1 TRANSPORTATION

One of the main issues during the trip to La Fortuna was transportation. Even while driving on the main paved road from the airport to the beginning of the dirt road to La Fortuna was difficult. Throughout the drive, the roads were steep and winding. There

Figure 2.1.1.1. Pushing through the muddy roads
were occasions when part of the road was missing or covered with rubble and large boulders. However, the conditions on the dirt road to the village were much worse. It was not paved and even more steep and winding than the main road. There were multiple instances when the trucks seemed to be at or over the edge of the cliffs. Rather than being outlined with large trees or a safety barrier, the cliffs were outlined by thin trees and weeds or in many instances, nothing at all. Furthermore, whenever it rains, even in small amounts, the dirt roads turn in thick, quaggy mud. This presented problems when leaving the village. Many people were needed to push the trucks almost halfway to the paved road, a distance of about 5 kilometers (see Figure 2.1.1.1).

These issues are important to the implementation of any major construction projects which may occur in La Fortuna. Not only will it be difficult to transport the material to the village, but because travel within the village consists only of small footpaths, all supplies must be carried on foot. The paths are narrow, steep and difficult to travel even without being weighed down by 6-meter segments of PVC pipe. The paths also cross streams multiple times.

2.2 CLIMATE

Honduras is hot and humid almost year-round. Temperatures vary by altitude rather than season. The average high temperature nationwide is 32°C (90°F) and the average low is 20°C (68°F). Temperatures are coolest in mountain areas where the Yoro district is located. The yearly average temperature in Yoro is 80°F. The dry season is from December to May and the hurricane season is usually from August to November.

2.3 PHYSICAL CHARACTERISTICS

La Fortuna sits in a valley with diverse areas of vegetation. Some areas are made up of dense forest with thick underbrush, while other areas are temperate forests with little or no groundcover. Topographically, the village is located on steep slopes and hills (Figure 2.3.1). La Fortuna residents have cleared the sides or tops of many hills to plant crops, usually beans and rice. Most houses are situated reasonably close to a stream that runs down the center of the valley. The stream varied between six and ten feet across. The soil throughout the valley tends to be a moist sandy clay.

2.4 WATER SUPPLY

The main source of water for La Fortuna is the stream that flows through the valley. Its origin is a spring at the mouth of the valley with a flow rate over 70 gallons per minute (Figure 2.4.1). Because the village is so spread out, the spring is as far as 3 km from some houses. There is an existing spring box at the source, which provides untreated water to the four closest houses. In Tule, one house is supplied by a small stream via a PVC pipe about 1 km long. This source does

Figure 2.3.1. Steep slopes of La Fortuna
not come from a spring, but rather the pipe is set in a small pool about 10 feet by 10 feet (Figure 2.4.2). This water is also untreated before consumption.

2.5 SANITARY FACILITIES

In La Fortuna there are only three existing latrines (Figure 2.5.1), all of which are in the vicinity of the school building and are seldom used by community members. However, plans are in place for a group called New York Help to build six latrines for the community beginning in February 2006. There is no central community landfill for disposal of hazardous or infectious wastes and most waste is discarded on the ground throughout the community.

2.6 LOCAL MATERIALS AND EQUIPMENT

Information on costs of supplies for a water system was collected in January 2005 in a store in Yoro, Honduras. Costs of PVC pipe were collected in January from Durman Esquivel, another store in Yoro Honduras. These unit costs (shown in Table 2.6.1) were collected in Lempiras and converted to US dollars. The largest costs are for Portland cement and PVC pipes. These are two of the most important materials in building a water system. These costs were found during the construction of a water system in the nearby village of Lagunitas and only reflect that project and its objectives. It has not yet been determined how we can best help the La Fortuna community.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Unit</th>
<th>Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC pipe (2-inch diam.)</td>
<td>6 meter segments</td>
<td>6.23</td>
</tr>
<tr>
<td>cement</td>
<td>27 kg bag</td>
<td>15.00</td>
</tr>
<tr>
<td>PVC accessories and PVC paste</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>barbed wire</td>
<td>400 yards</td>
<td>20.97</td>
</tr>
<tr>
<td>nails</td>
<td>boxes 2.5-3in</td>
<td>0.53</td>
</tr>
<tr>
<td>nails per pound</td>
<td>3 in</td>
<td>21.91</td>
</tr>
<tr>
<td>chicken wire mesh</td>
<td>rolls 72&quot;</td>
<td>33.67</td>
</tr>
</tbody>
</table>
dimensional lumber
gravel, rock
accessories (water faucets)
shrubbery
wire fencing

board meter
M
Each
Units
200 meter roll

2.40
40.00
1.50
58.00
22.00

Information on 1-inch and ½-inch pipe was also collected, if any parts of the system use different sized piping. Unit costs are as follows:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-inch pipe</td>
<td>6 meter segments</td>
</tr>
<tr>
<td>1-inch pipe</td>
<td>6 meter segments</td>
</tr>
<tr>
<td>½-inch pipe</td>
<td>6 meter segments</td>
</tr>
</tbody>
</table>

2.7 LOGISTICS

As mentioned in the transportation section, travel throughout Honduras is difficult and time consuming. The bus ride from the airport in San Pedro Sula to the city of Yoro went through steep slopes, winding roads and land slides. Some stretches of the road were partially blocked by loose rock. In some cases, the road surface had crumbled due to heavy flooding. Although the bus could pass through unhindered, if conditions had been only a little worse, the roads might have been impassable.

The town of La Habana is located approximately 30 minutes by bus from the city of Yoro. In La Habana the group transferred from the bus to a pick-up truck provided by FUCOHSO. Approximately half a mile from La Habana, the dirt road to La Fortuna begins. The road is about 6 miles long and takes 4.5 hours to travel by foot or 2.5 by truck. About 2 miles from La Fortuna, there is a small stream crossing, where the bridge is often washed out. The group needed to stop and build a small bridge before continuing past this point.

Since traveling to and from the village was very difficult, the amount of supplies the group could bring was limited. This restricted what food, water and first aid the group could bring. Once the group arrived in La Fortuna, they stayed in the newly built, one room schoolhouse. This was possible only because school was not in session.

All meals were usually eaten outside the schoolhouse. Local resident women prepared two meals a day, usually consisting of rice and beans, both of which were grown in the village. On rare occasions, there would be flour tortillas or chicken; however, this required extra funds. Also, purified drinking water in 5 gallon bottles were transported from La Habana to La Fortuna every 4 days.

Although first aid was not a large issue on the trip, there were some instances when health was a concern. After the second day, six of the ten group members became sick; for two days...
they vomited and had diarrhea. It is important to note that the people who took the Cipro, or antibacterial medication, recovered faster than the others who waited for a couple days. Many of the community members believed that getting sick was linked to bathing in the nearby waterfall or from that night’s dinner. However, the half the group that bathed did not get sick and some of the people who eat the dinner did not get sick. Therefore, there is no concrete evidence on how the team members became ill.

2.8 SECURITY

While in La Fortuna, the group encountered a few security issues. Security guards from the village to watched over the school, where we slept and stored our supplies. Each night, one to three men slept inside the school or sat outside the door. Furthermore, during the daytime when the teams were out collecting data, the schoolhouse door was locked, as well as guarded. This was alarming at first, especially since these issues never seemed to be a problem in the previous village, Lagunitas.

Through community surveys, the group learned about robberies and murders in the town. However, there was no concrete information on the events because many residents denied the claims and hinted that they were rumors.

Also, during a house survey, a widow explained that she could never leave her house because last time she did, it was robbed. This startled the group because an essential component of this project is community unity. If a resident is afraid that a neighbor will rob her, then this suggests that the security level must be improved.

2.9 PARTNERSHIPS

It would not be possible to work in La Fortuna without the help of several key partners. The most critical partner to the project’s success is the Fundación de Cosecha Sostenible (FUCOHSO), the Honduran branch of Sustainable Harvest International. In fact, without FUCOHSO, this project wouldn’t exist- It was FUCOHSO which helped Lagunitas and La Fortuna apply to EWB-USA for assistance. Yovany, the national director of FUCOHSO, served as the email contact and relayed messages to our other partners. FUCOHSO has provided transportation and lodging in their La Habana office. Students from Universidad Nacional de Ingeniería (UNI- National Engineering University of Nicaragua), participated in the site assessment, helping the survey group. They will continue to assist in the La Fortuna project in the coming months. For a full list of partners see Appendix B.

3.0 COMMUNITY ASSESSMENT

3.1 COMMUNITY SURVEY

In January 2006 a community health survey was conducted in La Fortuna. The objective of this health survey was to get an understanding of the health and lifestyle of the villagers. Included in the survey were questions detailing, the age, health, food, and habits of the residents. It was carried out by two female native Spanish speakers and over the course of two weeks conducted a
semi-structured interview at each house in the area. The group also included a non-Spanish speaker whose role was pretty much useless. Having the two women interviewers helped create a good atmosphere because most often we interviewed the mother of each household. The mother is usually responsible for transporting water, and tending the sick. As head of the household we feel she was the most able to answer our questions.

The information we gained from the interviews is valuable because we now understand the needs of the community. It also allows us to use this information to establish a baseline for the health of the community. Once the project is completed, another round of interviews will be conducted. The results from the two will be compared so that we can quantify the benefits of our project.

The interviews also gave the community a chance to have their questions answered about our project. During the first visits to some of the homes not all villagers were aware of our project. Many villagers were skeptical that we would actually return and build a water system. This skepticism is understandable because many organizations have come to La Fortuna promising various things but never returned. As the week progressed the skepticism turned into hopefulness and curiosity. Villagers had been going to meetings and were now more informed about what our project would entail.

3.2 HEALTH SURVEY

The goal of the health survey was to quantify the number of days villagers were sick. This would then be followed with a second survey after project completion to document the improvement. Unfortunately the information we got from residents is more generalized. Most residents reported being sick extremely often, but were not always being able to quantify that in terms of per month or per year. Most villagers suffer from repeated bouts with Dengue fever, stomach illnesses, Chagas disease, and colds. A handful of women of all ages complained of chronic colds and flus. When asked about what causes these sicknesses, the villagers blame the lack of hygiene and the water they drink.

Purely from a visual analysis the people of La Fortuna look shorter and skinnier than other Hondurans, or even other rural Hondurans. Without any medical experts on the trip this is purely a subjective analysis. The difference in appearance is noticeable to the untrained eye. This could be caused by a combination of genetic and health factors, but it is possible that malnutrition is largely responsible. Many teenagers appear shorter, skinnier, and less developed than their peers would be elsewhere in the country. Their diets are comprised of two meals of rice, beans, and corn tortillas. Some families add a meal of meat, usually chicken, once every two to three weeks. Yucca and fruit are eaten to fortify the diet, but with no regularity. Many homes reported that there wasn’t always enough food for the family.

On the positive side, most children had received full vaccinations (Figure 3.2.1). These are received for free from nearby clinics, or from visits from health professionals. Honduras has the highest percentage of AIDS infections in Central America, but nobody reported it as a problem in La Fortuna. Only two interviewed women out of thirty homes reported having miscarriages.
Through interviews, we found that Chagas disease is one of the most significant non-water borne diseases. Chagas is a protozoan parasite transmitted to humans by small insects. When bitten the host passes the disease to the person. Chagas occurs in two stages. While most people show no symptoms during the first stage, some suffer flu-like symptoms, including fever or swollen glands. This stage can be lethal for infants. The disease then lies dormant for decades, slowly causing severe heart, intestine, and kidney problems.\footnote{Boston College Chagas Disease Facts http://www.bc.edu/schools/cas/biology/research/insect/chagas/}

The teacher informed us that a Honduran organization had come to fumigate houses. She did not know how effective they were in destroying or limiting Chagas. She did not know when the organization had visited La Fortuna. Because of the location and living conditions in La Fortuna, Chagas is likely to be a disease many villagers have without knowing they have it. Chagas should also be a health consideration for future Lafayette College EWB trips. Because of where we stayed, the frequent visits to the homes, and the numerous bug bites Chagas should be tested for after returning to the United States.

3.3 HYGIENE
We found that hygiene standards vary widely between homes in La Fortuna. Only seven homes were able to afford pit latrines. This includes one latrine in Tule. There are an additional three latrines around the school, but these were padlocked when we arrived. Only during the school year are they used by students. Human waste for the rest of the community goes in the river, or in buckets in or around the home. This is troubling because of the connection between human sickness and proximity to waste.

Only one home and the school have pilas. The pila at the school was filled for us to use while we were there but we didn’t determine if it was used by residents when we weren’t there. Without running water it would be at least a 20 minute hike to bring water to the pila. Providing simple structures like these could increase the health and well being of the community substantially. In interviews the teacher told us that she tries to get across the importance of good hygiene but realizes that few students have the resources to practice them. Bathing and human waste in the
river degrade the health of the environment and the community. Bathing damages the environment by not letting the ground filter the soap. Human waste causes a decrease in water quality for users downstream.

3.3.1 WATER
There are 23 occupied homes in La Fortuna. Of these 5 homes have a water source that is piped to their home. For the other 18 homes water is carried from the stream to their homes. The average time spent on this is chore is 20 minutes round trip. This job is often carried out multiple times per day by the women and children. Eliminating this chore by providing a water system would increase the time residents could spend on other activities like farming or education. Of the 7 occupied homes in Tule, 4 of them have a water system. The rest average 15 minutes round trip to get water.

For both villages the current water systems that are in place are temperamental. All residents reported that during the dry season the water is reduced or not available. Residents also report problems with the system braking for no apparent reason. None of these systems have any form of chlorination or filtering in place. While we might not have the resources to rebuild the entire system, the reality dictates that we may need

3.4 EDUCATION
La Fortuna has one school which provides free education from 1st through 6th grades. Unfortunately, many residents do not take advantage of this. Of the 32 students that are enrolled, on average only 26 attend school each day. Education is widely respected in the community with the town leadership being the most educated community members. The reason for lack of attendance is then not cultural disregard. The teacher told us the reasons the students are absent include sickness, needing to work at home, or a lack of clean clothes. The teacher believes the health risks in La Fortuna are Chagas and stomach problems related to water quality. This was substantiated by interview data from residents who believe that water-borne illnesses are how they get sick most of the time.

Some of the demographic information that we collected in La Fortuna points to a generation gap in education. Most children below the age of 18 have a higher level of education than their parents do. This is a positive sign for the future of La Fortuna. La Fortuna children are able to go to school, and are going to school longer than their parents did. Many parents said they only attended through 1st or 2nd grade. Like in most countries, education is tied to well being. Villagers that have graduated 6th grade generally have larger and better constructed homes.

3.5 LA FORTUNA AND TULE
La Fortuna is a decentralized village connected only by footpaths. Spread over nearly two square miles it consists of 24 occupied houses, and 104 residents. Tule is a small nearby village consisting of 6 houses and 29 people. Tule is close enough to be included in our project. The residents of Tule are much better off economically; the houses reveal a higher standard of living compared with the residents of La Fortuna. All are built using adobe walls, all but one have a
corrugated roof. The exception is a home over 300 square feet that is the largest in either village, it has a roof made of ceramic shingles.

Almost all residents of both villages are subsistence farmers. They supplement their income by selling small amounts of coffee beans to middle men who visit after the harvest.

3.6 HOMES

La Fortuna homes use basic construction techniques commonly found in rural Honduras. Homes are often constructed from wooden beams with adobe walls. Of the 24 occupied homes in La Fortuna three impoverished homes that lack walls, or have insulation made from palm fronds. These materials inadequately protect or insulate the homes. These three also have thatched roofs (Figure 3.6.1). One of resident blamed the thatch as where the Chagas carrying bugs live.

All homes are dirt floors, but this is common to rural areas everywhere and not as serious of a concern. The size and construction of the homes in La Fortuna varied widely. They went from a 12’ by 16’ dwelling that housed 7 people to a 60’ by 50’ home for 4 people. Most homes are roughly 20’ by 20’ and constructed from mud layered upon wood frames. They sometimes have the kitchen separated from the living quarters, or away from the home under a roof. During our visit we started to notice that many homes are not equipped with exhausts for the ovens. Even some that do seem to be badly designed and smoke filters out mainly through the roof. This was not something we had considered in pre-trip planning and we failed to take quantifiable data of which homes have smoke problems. Smoke filters through the roof and blackens everything with ash. This creates breathing difficulty and many residents reported problems with asthma. Providing even simple metal exhausts could improve the air quality dramatically inside the homes.

One home in La Fortuna, and two in Tule are equipped with kilns (Figure 3.6.2). These are large clay structures that are used for making bread and dinners. One owner mentioned that she often sells bread made using her kiln.
The homes vary most by what utilities they have. Greywater discharge (Figure 3.6.3) from bathing and dishes is rarely taken care of. A small number of homes have a simple box built outside a window that is used for dishwashing. A Tule home modified this design to include a hose that carried the water slightly further from the home. Exact numbers of these were not recorded. This stagnant water results in more mosquitoes, flies and bees being around the home. Only one home has a pila.

During the health survey information was collected on the dimensions and material of the roofs. 23 homes have a corrugated iron roofs, however 7 of those don’t have full corrugated iron and are supplemented with other materials. The condition of the iron also varies from those with large rust holes to brand new. Other roof materials, in order of preference included ceramic shingles, wood shingles, and lastly thatched. Three homes in La Fortuna had thatched roofs and these were the more impoverished households. One mother said the chinch bugs (T. cruzi) in the thatched roofs were the main cause for her children’s illness. Refer to the Health section of this report for further information.

3.7 HEALTH CLINIC

The closest clinic is located in the village of La Laguna, approximately 1 hour from La Fortuna by foot. Common vaccines include those for tuberculosis, polio, penta valente, and typhoid-diphtheria (for women ages 12 to 49). Common illnesses for which people from La Fortuna visit the clinic include skin rashes, severe diarrhea and vomiting, anemia, asthma, dengue, and DPC. Common medications prescribed include aspirin, ibuprofen, penicillin, acetaminophen, and antihistamines. When women are pregnant, they typically visit the clinic four times in nine
months and take vitamins regularly. No other precautions are taken for pregnant women. The clinic offers no dental services, so people take medicine for any pain.

4.0 WATER QUALITY

4.1 WATERSHED DESCRIPTION

The watershed includes both villages, La Fortuna and Tule. There are however, two sources, one in each village. Tule is located upstream of the source in La Fortuna. The source in La Fortuna is referred to as the “main source”; the source in Toule is referred to as the “second source.” This distinction is based on the flowrate of each source. The main source flows at a rate of 70 gallons per minute, while the second source flows at a rate of approximately 12 gallons per minute. Downstream from the main source is the village of La Fortuna, which includes predominantly crop fields for corn, beans, rice, and coffee. Upstream from the main source are the village of Tule, crop fields for corn, beans, rice, and coffee, fields for grazing, and a small logging operation, which cuts approximately 60 trees per day. Officials from the logging operation have marked trees with white paint along the ridgeline to delineate the watershed. In an effort to protect the watershed, the logging company has agreed with La Fortuna to only cut trees outside of the watershed.

4.2 TESTING AND DATA COLLECTION

Water quality was tested in six locations: at the main source, at a second source in the neighboring village of Tule, at two houses close to each source (House 1 and House 2), and at various points along the stream that flows through La Fortuna. Refer to the site map for the locations of the main source and the two houses. GPS points were not collected for the other sampling locations. The water quality data collected pertains to water temperature, pH, alkalinity, conductivity, nitrate levels, and the presence of fecal coliform. Flow measurements and macroinvertebrate studies were also conducted. Refer to Table 4.2.1 for a summary of the water quality data collected in La Fortuna and Tule.

<table>
<thead>
<tr>
<th>Site Location</th>
<th>Main source: 3 locations (approx. 10’ span)</th>
<th>Above behind House 1</th>
<th>Water fall bathing area</th>
<th>Fish pond</th>
<th>Source above fish pond (second source)</th>
<th>House 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Day Weather</td>
<td>Sunny No rain</td>
<td>Sunny</td>
<td>Sunny</td>
<td>Sunny</td>
<td>Sunny</td>
<td>Sunny</td>
</tr>
<tr>
<td>Previous Day Weather</td>
<td>No rain</td>
<td>Partly sunny</td>
<td>Partly sunny</td>
<td>Partly sunny</td>
<td>5-min. downpour</td>
<td>5-min. downpour</td>
</tr>
<tr>
<td>Estimated flow (gpm)</td>
<td>5 11 70</td>
<td>3</td>
<td>not conducted</td>
<td>8</td>
<td>12</td>
<td>not conducted</td>
</tr>
<tr>
<td>River readings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water temp (deg C)</td>
<td>20.2 21.6 20.4</td>
<td>21.5</td>
<td>20</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>8.0 8.0-8.1 8.8</td>
<td>8.5</td>
<td>8.7</td>
<td>8.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conductivity (ppm)</td>
<td>171 168 157</td>
<td>176</td>
<td>168</td>
<td>340</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hach Test Results</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkalinity (mg/l)</td>
<td>190-200 230-240</td>
<td>220</td>
<td>190-200 220</td>
<td>220</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Coliform (pos/neg)</td>
<td>positive</td>
<td>20 negative</td>
<td>220 positive not detected</td>
<td>220 negative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrate (mg/l)</td>
<td></td>
<td>not detected</td>
<td>not detected</td>
<td></td>
<td>not detected</td>
<td></td>
</tr>
<tr>
<td>Macrinvertebrates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitive species (y/n)</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
<td>not conducted</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Dominant group/taxa</td>
<td>snails</td>
<td>aquatic worms</td>
<td>caddisflies</td>
<td>not conducted</td>
<td>tadpoles</td>
<td>not conducted</td>
</tr>
</tbody>
</table>

Table 4.2.1. Summary of water quality data
The flow rate at the main source was measured at over 70 gallons per minute. This flow is sufficient to supply all of La Fortuna and Tule with water. Temperature and conductivity were found to be relatively uniform throughout the watershed. Conductivity values were high, approximately 200 ppm, but this is likely due to ionization of the clay soil and sediment as it is washed into the stream. The pH readings are also high, ranging from 8.0 to 8.7, which indicates that something may be contributing to basic soil. Alkalinity, which is related to pH insofar as it demonstrates the buffering capacity of the stream, was found to be approximately 200 ppm. This is a relatively low value for alkalinity, and it is possible the stream has experienced a recent influx of acidic chemicals, but more data is needed. No nitrate was detected in any of the samples. In a healthy stream, nitrate levels are often less than 1.0 mg/L.\(^2\) In addition, the macroinvertebrate studies demonstrated a wide variety of organisms and many of these organisms are sensitive to pollution. Both of these findings agree with low nitrate levels. However, human and animal waste, which tend to increase nitrate levels, are both likely to occur in the stream. Therefore, it is unusual that no nitrate was detected.

Six of eight fecal coliform results were positive. The six positive results came from water samples collected throughout La Fortuna; the two negative results were found in Tule. Both the second source and a private fish pond that receives water from the second source tested negative for coliform. The water from the second source flows through a pipeline that leads directly to the private property where the fish ponds are located.

### 4.3 WATERSHED PROTECTION

Watershed protection is an integral part of the project in La Fortuna. The watershed provides a habitat for animals, mitigates flooding, and prevents erosion. If the watershed is not protected, the proposed water system will merely distribute contaminated water, which would barely improve the current situation.

There has been some recent progress in terms of education about watershed protection. Sigfrido Amaya, President of the Lagunitas Water Board, visited La Fortuna in January to present a workshop on watershed protection. The majority of the community came to hear his presentation. One of La Fortuna’s residents, Chencho, proposed to create a class on watershed protection for a radio station in the nearby city of Yoro. In addition to Sigfrido and Chencho, students from the National Engineering University of Nicaragua (Universidad Nacional de

---

Ingeniería) may help educate the community on agricultural aspects of watershed protection and on improved farming techniques. Several educational sessions took place during January 2006, but in order to achieve sustainability, the education must continue and the community of La Fortuna must continue to apply the skills gained through such workshops to daily life.

5.0 COMMUNITY INVOLVEMENT

5.1 IMPORTANCE OF COMMUNITY INVOLVEMENT

Although often overlooked, organizing the community is critical to the success of the project. One of the main goals of the site assessment trip was to establish a strong relationship with the community. It is critical to gain the community’s trust, inspire enthusiasm and promote community unity. While this may not directly bring water to the people, these elements build the social foundation upon which is needed to implement and maintain a water system. While we are collaborating with La Fortuna to build physical infrastructure, the social infrastructure is a prerequisite.

5.2 COMMUNITY MEETINGS

On the January 2006 site assessment trip we observed a transformation. Initially community was at first disorganized. A full water board was not yet elected and some people reported not knowing anything about the project. By the end of the trip, organization, awareness, participation and enthusiasm increased dramatically.

The first community meeting was held on Monday, January 9th. Approximately fifteen adults, and many children, were in attendance. During this meeting, each of the EWB teams, including topography, community surveying and water quality, explained what they would be doing over the next two weeks and gave a demonstration of their tasks.

On the first day of field work, Tuesday, January 10th, five people from the village helped with field work (including Yovany, Carlos, and Chencho from La Fortuna and Rigoberto from FUCHOSO). After a few hours only Chencho was helping with surveying and Carlos was helping with water quality data.

Sigfrido Amaya Suarez, president of the Lagunitas water Board, came to the second community meeting. He spoke about watershed management and about the importance of organizing as a community (See Meeting Minutes in Appendix D). As the Lagunitas water system was almost complete at this time, Sigfrido was able to communicate his trust in our organization. He explained the progression of the project in Lagunitas and reassured members of the La Fortuna community. At this meeting sixteen adults from La Fortuna were present. Sigfrido stressed that although the whole community needs to be involved, sixteen people is enough to get things started.

At the end of the second community meeting, there was an informal water board meeting. The water board discussed how to encourage more people to attend the meetings. The board
members sketched a map of the village (See Appendix E) and used it to determine which families had shown up to meetings so far.

On Monday, January 16th Fidel Maltez, a Lafayette alumnus, walked through the entire community with Aurelio. They went from house to house talking about the project and getting people excited about the project. In the afternoon, there was a formal water board meeting. At this meeting a water board constitution was written. Tasks were also set for after we leave and dates were set for these tasks. In addition, they divided the community into groups of houses. Each water board member was responsible for one group of homes. Each member would visit their respective families, inform them of all meetings, motivate them to be involved in the project and include them in the work.

The last community meeting of the trip was held on Tuesday, January 17th. All but one or two of the 55 adults in the community were present. The water board presented their constitution and their plan for the upcoming months. The difference from the first meeting was remarkable in attendance (see Figures 5.2.1 and 5.2.2), organization and enthusiasm.

5.3 COMMUNITY PROGRESSION

Over the course of a week and a half we saw the leadership of La Fortuna gain confidence, the water board become more organized and the community become more involved. This progression is a substantial step in the right direction.

6.0 TRIP ACCOMPLISHMENTS

6.1 SITE MAP

By entering all of the GPS data into a collective database, a site map can be created by using a Geographical Information System (GIS) (See Appendix A). The site map is a critical tool throughout the duration of the project. It is essential to forming a visual picture of how the components of this project come together. The GPS points will be plotted on a topographic map of La Fortuna and Tule. These points include the houses and sources in La Fortuna and Tule, the delineated watershed, and the walking paths. Not only does this aid the design teams, but it also
allows other members of the group who have not traveled to La Fortuna to visualize the town’s structure.

6.2 GPS POINTS

During the site visit in January 2006, points were collected using a hand-held Global Positioning System (GPS) (See Appendix F). The GPS reported the northing and easting of each point and also had the capability to record elevations. The accuracy of the data collected with the GPS is about 15-30 feet, which is acceptable for a site map but not for the design of the water system.

The coordinates corresponding to each house in La Fortuna and in the neighboring town of Tule were entered into the system. The GPS was also used to record the positions and elevations of the water source that feeds into the La Fortuna area, as well as the water source in Tule. Various points along both the walking and proposed pipeline paths were also documented.

6.3 SURVEY POINTS

During the January 2006 site assessment trip, surveying data was also collected (See Appendix G). This data is essential to designing a water system. By surveying both La Fortuna and Tule, two-hundred eleven points were collected. These points not only include the proposed pipeline route, but the houses and water sources.

Currently, there are difficulties with interpreting and plotting the survey data. Due to a misunderstanding while practicing at Lafayette College, the surveying team only took one backsight while in the villages. Since two backsights are needed for horizontal angles, we currently do not have the X,Y coordinates of each point. Although this does not affect the elevations, it does make calculating the X,Y coordinates more difficult.

However, due to detailed field drawings this obstacle should not threaten the overall success of the project. Moreover, to ensure that the elevations and positions of each point are correct, the
GPS points taken along the pipeline will also be used. The pipeline trail will then be refined based on pictures taken by each team. Although the slight error in surveying increase the amount of time and effort needed to process the data, the final information should be sufficient for design.

Future surveying teams should meet with previous team members so they can learn from their mistakes. Although the surveying team calculated the elevations at the end of each day, they did not calculate the X, Y coordinates. Therefore, it is suggested that the group calculates both the horizontal and vertical values of the points at the end of each surveying day. It is also suggested that the group either sets up over a known point, which is ideal, or takes two backsights. By setting up over a known point, surveying will be easier and the data will have elevations and X,Y coordinates.

6.4 SOIL TYPES AND TERRAIN

The pipeline route along the path varies in terrains and therefore has many differing soil types. Much of the land near both sources is forest (Figure 5.4.1). This land has an abundance of banana and plantain trees. Some areas also have thick roots and rocks. The soil is covered with rotting organic matter and, for the most part, seems to be easily removed. The residents of La Fortuna farm for a living, and therefore, most of the land near the houses is for the agriculture industry. This area includes crops such as sugar cane, corn, coffee and beans. The advantage of putting a water pipeline through the region is twofold: first, it allows for water accessibility right to the place of residence and second, it is more cost-effective because the path is more direct. The cons of working in this area are also twofold: the community needs to be willing to cut through crops and they need to be willing to work with hard, dry soil.

The land that is close to the walking path varies between moderate-slopes with various plants and weeds growing and very steep-slopes, which are covered with trees and high brush. In Figure 5.4.2, below, the steep inclines can be seen. For the most part, the land will not cause implementation difficulties because the soil is loose and the residents are very efficient clearing the path. However, the extreme incline of some areas may complicate digging.

Figure 6.4.1. Path through Banana Trees  Figure 6.4.2. Steep slopes of La Fortuna
7.0 CONCLUSIONS

The trip was a success. We met our objectives of collecting demographic and GPS data for each home, surveying a probable water pipeline route, and collecting water quality data. The people of La Fortuna are enthusiastic about the project and most want to help in every way possible. Although they are excited about the prospect of a water distribution system, some have asked for other basic needs, such as new houses and latrines. We are capable of designing and installing a water system, but we also need to consider what would best benefit the community.

EWB Lafayette’s work so far in La Fortuna has been funded by the EPA P3 Phase I grant, which provided $10,000 to buy equipment and perform the site visit. Work in the coming months will be a continuation of Phase I, and will focus on design work and fortifying relationships with the community of La Fortuna and other local contacts. In May, 2006, EWB Lafayette will present to the EPA in Washington, D.C., with the hopes of receiving further funding for work in La Fortuna.