Oregon State University
Engineers Without Borders
presents

Post-Implementation Trip Report: A Rainwater Catchment and Storage System for Cerro Caballo

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Las Mercedes/El Naranjito, El Salvador
December 2008

ii. Abstract

In December of 2008, the Oregon State University student chapter of Engineers Without Borders sent seven team members to El Salvador to implement a rainwater catchment and storage project in the sub-community of Cerro Caballo. The December 2008 implementation trip was part of a multiphase water project in the communities of El Naranjito/Las Mercedes, and was the seventh trip that EWB-OSU has made to the project region. This report details the trip and includes an overview of the trip goals, a description of the project's technical design, a summary of health promotion activities, and logistical information such as the trip budget and lodging. The appendices include additional resources including design drawings, an inventory of leftover materials and tools, an itemized budget, and pictures. This report is meant to serve as not only a post-trip report for EWB-USA, but also as a resource for the project team in the future.

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1. Project Background

The ridgetop community of Cerro Caballo consists of three families and 16 people. Prior to the project, family members, usually women and children, had to traverse steep, switchbacking trails to collect water from nearby ravines multiple times per day. Families often spent over two hours a day collecting water, detracting from time that could have been spent on other activities such as earning an income or an education. Issues with sanitation were problematic because of the lack of readily available clean water, possibly leading to associated health problems such as diarrheal diseases.

During a previous assessment trip, a team investigated the possibility of using rainwater catchment technology in Cerro Caballo, as all three houses were above the elevation of any possible spring. Notes were taken about house locations, roof sizes, and family members, which provided the basic data necessary to design the system for this implementation.

Six OSU students and a professional mentor traveled:

Scott Crook, undergraduate student in Civil Engineering
Nick Moses, undergraduate student in Mechanical Engineering
Michelle Adlong, undergraduate student in Environmental Engineering
Kaileen Amish, undergraduate student in Environmental Science
Brad Eagleson, undergraduate student in Chemical Engineering
Julia Young-Lorion, graduate student in Public Health
Jaynie Schonbrod, Mechanical Engineer, Professional Mentor.

Responsibilities for trip planning and design were spread out amongst the group as well as some project team members who did not travel. The travel team would like to thank Kelly Kibler, the El Salvador Project Coordinator, and Carl Moen, a student on the project team for their invaluable contributions. Although they did not travel to El Salvador, they both contributed greatly to the project design and trip coordination. The local Peace Corps volunteer, Aaron Oppelt, was also instrumental in this project. He not only served as a translator and a diplomat between families, but also helped the team purchase materials before they were in the country, arranged for transportation, and helped organize meals and lodging.

2. Project Goals

This trip had several goals. In Cerro Caballo, the goals were to construct rainwater catchment systems and laundry washing stations. For the broader community of El Naranjito and Las Mercedes, the goals were to disseminate public health information and survey results, to distribute Potters for Peace water filters and demonstrate their maintenance, and to gather survey data and other information required for possible future projects.

3. System Design

3.1. Design Overview

Consisting of four main components, the Cerro Caballo project was a complex solution to a unique problem. Three of the components—the gutters, tanks, and rain barrels—were designed to provide clean, accessible drinking water, while the fourth, the laundry stations, was designed to improve local water quality by removing chemical pollution from streams.

Gutter systems were attached to existing roofs on the beneficiaries' houses to capture and divert rain runoff to a storage system. Two sets of gutters were attached to each house. One of the sets ran to the water tank while the other ran to the rain barrels.

The tanks themselves were constructed as a long term storage unit for rainwater. With a capacity of 10,000 L each, these tanks will gradually fill up during the wet season from May through October, reach capacity prior to the beginning of the dry season. The stored water will then sustain the beneficiaries for approximately three months of the dry season.

The rain barrels were installed as a supplement to the tank system. While the tank is filling with water during the wet season, beneficiaries will draw water from two 55-gallon water barrels that are connected to the gutter season. The frequency of rainstorms in the area during the wet season should ensure that the barrels have water for almost any given day in the wet season.

Apart from the water catchment and storage system are the laundry stations, which help to improve local water quality. Constructed at each beneficiary's house, these stations offer a convenient alternative to the traditional method of washing laundry in streams. By letting contaminated water slowly filter through the ground, the laundry stations remove pollutants like bleach and detergents from local streams that are used as water sources by people downstream.

3.2. Gutters

To capture the rainwater, the team installed gutters on the roofs of each beneficiary's house. Five-inch plastic gutters were preordered in Tacuba. Once in the community, the team determined the best roof locations for the gutters, taking into account roof material, unevenness of the roof, and proximity to the tank and barrel locations.

Most houses' roofs were made of wooden beams covered by corrugated metal lamina, making it difficult to attach the gutters directly to the edges of the lamina. Therefore, pieces of 3/8" rebar were bent into a squared "S" shape, hooked over the wooden beams under the roof, and attached with screws and metal pipe brackets. U-shaped portions of the bent rebar extended out from under the roofs and held the gutters in place, and additional pipe brackets were used to prevent the gutters from sliding back and forth. The gutters were positioned so the roof extended about halfway over the gutters.

The downspout entrances were covered with wire mesh to prevent large debris, such as leaves, from clogging the system. After each downspout, a "first flush" system was installed to divert

water from the first rains, which contains contaminants from the roof. This system consisted of two vertical three foot long sections of 3" PVC. Only after filling the first flush pipes does water continue on to the tanks or barrels. The ends of the first flush pipes were made of 90° elbows and removable end caps. Small holes poked in the end caps to allow water to slowly drain out of the first flush system.

Two sets of gutters were installed on each house, typically on two opposite sides of the roof. Each gutter fed to either the cinder block storage tank or the barrel system. Therefore, the tanks and barrels for each house had completely separate gutters and first flush systems.

3.3. Tanks

The tanks themselves took up a large portion of the working hours spent on the project. Each holding approximately ten thousand liters, the tanks were very large and required a lot of materials, effort, and attention.

Foundations
To support such large tanks and the water inside them, the project team first built the foundation pads for each tank. Supported underneath by 6" of crushed angular ½" rock, the foundations were an additional 6" thick. Located 3" underneath the surface of the foundation was a grid of 3/8" rebar spaced 8" apart; see figure 1. The grid was situated to place a piece of rebar directly under the wall to allow for vertical rebar to tie into.

To ensure that the large foundations were properly poured in a timely manner, the team rented a gasoline-powered, portable cement mixer from the hardware store in Ahuachapan. The cement mixer was extremely helpful; with its help, the team was able to pour all three tank foundations in one day (see Figure 3.1).

Figure 3.1: *Pouring the foundation of Don Hugo's tank with the cement mixer. The rebar grid can also be seen.*

Walls

Once the foundations were poured and allowed to set, work began on the walls of the tanks. The walls were constructed out of 6”x20”x8” concrete cinder blocks. These blocks were mortared together in an interlocking pattern and fitted to vertical rebar. The vertical rebar was 3/8” and it was tied into the foundation using a 6” “L hook”. One piece of vertical rebar was placed in each block with four additional pieces at the corners of the tank. The vertical pieces of rebar formed vertical columns of stiffness to strengthen the wall from an overturn moment.

To give lateral support, ¼” rebar was placed in between each layer of blocks. The ribbing forms additional strength across shear planes and resists the walls from splaying out in the middle under heavy loads. Where one piece of horizontal rebar ended, it was looped around a piece of vertical rebar and doubled back on itself for 8”. The next piece of rebar in the horizontal ribbing would then be added in a similar fashion. This horizontal rebar was doubled back upon itself around a piece of vertical rebar when a new strand was needed to complete the horizontal loop. Combined, the vertical and horizontal rebar formed a grid that will support the wall from buckling due to sloshing water during an earthquake.

The insides of the tank walls were plastered with a special plaster mix that was provided by the mason. It included hydrated lime, concrete, and fine sand. The plaster, applied in three 1/8”-1/4” layers, will keep the water from seeping through the blocks. The floor of the tank was painted with a special water proof paint specially designed for water tanks that are used for drinking water. The paint was acquired in Ahuachapán while the EWB team was in route to the project site.

Inlets/Outlets and Drainage

Openings were placed in the tanks for water to enter and exit. An example of the tank inlet can be seen in Figure 3.2. The lowest opening was located about 3” from the base of the wall and the protruding pipe served as an attachment for a spigot. One other opening was placed in the top row of blocks to allow for an overflow pipe. This 2” diameter pipe will divert excess water into a drainage field when the tank is full. The drainage field for each tank consisted of buried PVC pipes with holes or slits cut into the side to allow the water to gradually diffuse over a large area.

Figure 3.2: *Gutters, first flush, and inlet to tank at Don Jesus’s house, prior to the tank roof being completed.*

Skilled Labor
To construct the tanks, local masons were hired for their skilled labor and practical expertise. Working alongside the masons, the team ensured that the tank was built as designed while the masons ensured that it was built using proper techniques. Without their help, the trip would have needed to be scheduled for a much longer duration. The tank design also hinged upon the masons in that cinder blocks and concrete were chosen for building materials because it was a type of building material that local professionals were familiar with.

Tank Covers
The tank roofs were constructed with a simple joist design, like a floor or ceiling, elevated at one end. It was framed to sit on top of the tank flush with the outside edges. Flat 1”x lumber was laid across the top to support the overlapping 3’x9’ galvanized steel sheets used as roofing. These sheets overhung the edges of the roof by 1-2”, where they were bent over and nailed to prevent water from getting underneath. More 1”x lumber was placed around the edges to fit over the tank walls and prevent the lid from moving. All significant gaps and the seams between each piece of galvanized steel were sealed with silicone caulk.

Wherever possible, 16 penny nails were used in construction of the frame (3 to the end of each joist and 2 where every flat 1x ran across a joist). Two inch sheet metal nails with a washer at the head were used to attach the galvanized steel, as well as where 16 penny nails would have protruded through to the inside of the tank. The steel roofing was nailed approximately every 4” along the edges and 8” along each 1x support beneath.

The lumber was not exactly what was expected—it was all actual dimension. For example, the 2”x4” boards ordered were actually 2”x4” instead of 1.5”x3.5," as would be expected in the U.S. It also varied in length from piece to piece. All the wood was also extremely hard and seemed exceptionally strong. As a result, there were practically no bad boards, so excess wood purchased as a buffer for some expected bad lumber was incorporated into the design instead. Six rows of 1”x12” were used along the top instead of 5 of 1”x8”, due to the quantity of extra 1x12 and high flexibility of the galvanized steel sheets. Also, due to the shallow roof angle and limitations of the battery powered saw, the top end of each joist was not cut flush to the vertical board next to it. This left an insignificant gap of approximately ¼” at the top.

The roof construction can be seen in Figure 3.3. Community members were left with a gallon of waterproof, non-toxic, acrylic paint to cover the exposed wood around the edges of the tank to prevent splitting due to exposure to the weather.

Figure 3.3: *Don Hugo's tank and partially completed roof. Gutters and first flush also shown.*

Changes to design plans
The location of the project had far-reaching effects throughout the design and implementation of the project. Specifically, the project's location on a narrow ridgeline and isolation from larger towns were important factors in the project. Space constraints of the ridgeline itself influenced the design to change during the pre-trip planning stage from one large community system to three individual systems. Additionally, the exposure to forceful, persistent winds on the ridgeline steered the design away from constructing new roofs for rainwater capture to installing gutters on the existing roofs. Finally, the team decided to make the tank at Don Manuel's house shorter and taller due to concerns about its location near a cliffside.

3.4. Rain Barrels

Capacity
While the tanks provide a large storage capacity for long-term use, rain barrels provide each household with temporary storage for summertime use. Each house received two 55-gallon plastic rain barrels for a total storage capacity of 110 gal (416 L). During the rainy months of approximately May through October, these barrels should supply each family their total daily water.

Setup
The barrels were constructed in a cascaded design such that the overflow from the first barrel filled the second barrel. The first barrel sat atop two layers of cinder blocks, while the second barrel sat beside it atop one layer of cinder blocks. The height difference allowed for the overflow pipe at the top of the outer face of the first barrel to feed directly into the top face of the second barrel, which also was open to the atmosphere. This setup can be seen in Figure 3.4.

Figure 3.4: Setup of rain barrels at Don Jesus's house.

Inlets
After passing through the first flush system, as explained in Section 3.2, the water runs through a 3"x2"reducer and then enters the first barrel via a hole in the lid. The barrels purchased were new, and their lids had two capped and threaded bung holes, one of which was widened to create the inlet. The inlets were covered with fine wire mesh that prevents additional debris and insects from entering the barrels. The pipe and the lid were not mechanically attached in case the barrels someday need to be moved.

Overflow
A 2" PVC overflow pipe was installed in each barrel. The overflow hole was drilled with a 2 1/8" hole saw bit and filed to allow the 2" pipe to fit. Originally, the plan was to install 2" bulkhead fittings to seal the overflow and tap fittings. However, the bulkhead fittings pre-ordered in Ahuachapán were not the parts expected, so changes to the design were made and alternate parts were purchased. A female fitting was inserted through the hole from the inside of the barrel to the outside. A 2" rubber o-ring was placed over the fitting, and then the male unthreaded-to-threaded fitting was screwed on. Finally, the fitting was sealed with caulk. These details are shown in Figure B.3 in Appendix B.

The second barrel had an overflow similar to the first, which fed directly to a 2" PVC pipe that was buried under the ground. This pipe, varying in length depending on constraints of space, led to a drainage gallery made up of a grid of 1" and 2" pipe that had holes and/or slats cut to allow water passage. The perforated pipe was buried in a trench filled with gravel and covered with soil.

Spigots
Galvanized ¾" spigots were installed at the bottom of each plastic barrel. Except for the smaller-sized hole and hardware, the spigot attachment was nearly identical to the overflow attachment.

3.5. Wash Stations

After the June 2008 trip, wash station materials were left at Don Pascual's home in Las Mercedes, with plans to build the wash station during the December 2008 trip. Upon arrival, the travelers found that Don Pascual had already built a very nice wash station with the provided materials, as can be seen in Figure 3.5.

Figure 3.5: *Wash station built by Don Pascual after the March 2008 trip*

In Cerro Caballo, two wash stations were completed during this trip, one for the Don Jesus household and one for the Don Manuel household. The wash stations were constructed with cinder blocks and concrete, and two slightly different designs were implemented, and are pictured in Figure 3.6. At Don Jesus's house, proper drainage was best achieved using gravel under and surrounding the base of the wash station. At Don Manuel's house, the wash station was placed near the barrel system, allowing a PVC pipe from the wash station to tie into the barrel overflow drainage. The wash station was built on a concrete foundation. Both wash stations were topped with a concrete slab with ¼" rebar. Don Hugo, a skilled mason, preferred to receive the materials to build his own wash station rather than having the project team construct it for him.

Figure 3.6: *Wash stations at Don Jesus's house (left) and Don Manuel's house (right).*

4. Health Promotion

4.1. Goals

There were four major goals set for the December 2008 trip to El Salvador and included: the dissemination of health assessment results from the December 2007 trip, the distribution of Potters for Peace water filters, to meet with the local health educator, and to provide educational tools that encourage hand washing practices within Cerro Caballo.

4.2. Community Meetings

A community meeting was held on December 21, 2008 on a piece of newly purchased land in the outskirts of Las Mercedes. This land was purchased by the community and is intended for the development of a health and community center that will be available to all community members in the area. More than 30 individuals arrived to this meeting that was led by members of the water board along with other community leaders.

Health Assessment Presentation
After the major business was covered by the community leaders, a poster presentation was given to the group by Julia that highlighted important findings from the health assessment that was performed in December 2007. Community members were very responsive and interactive with the information that was given, especially the women.

Potters for Peace Filter Demonstration and Distribution
Many of people present traveled by foot from around the region to purchase Potters for Peace water filters and to learn how to use and maintain them. An explanation and demonstration was given to the group by Julia and Kaileen, followed by filter distribution. Emphasis on the replacement of filters every two years was given to those who received new filters. The distribution of filters occurred after the meeting was finished, as people had to walk back to Las Mercedes to the house of Don Maximino and Doña Emiliana, where the filters were stored. Figure 4.1 shows some of the community members who were present.

Figure 4.1: *Community Meeting in Las Mercedes.*

Community Health Educator
After filter distributions were completed, a meeting was held with the community health educator to talk about the perceived health needs that were present in the local communities, especially those that were relevant to the EWB project. The health educator identified many health problems, a few which were directly related to the access of clean water. These included, but are not limited to, diarrhea, intestinal parasites, and malnutrition in children under five years of age, in addition to the absence of strong hand washing practices in people of all ages. Many of the problems identified by the health educator are exacerbated by misinformation within the community, a result of older and uninformed belief systems. The health educators that work in these communities are trying to educate people by holding health fairs and going door to door, in addition to providing them with information on where they can access health resources. This reemphasizes the importance that EWB has in these communities by providing access to clean and safe water to those in need.

4.3. Tippy Taps

In an attempt to encourage hand washing practices in the community, "tippy taps" were constructed for households in Cerro Caballo. The tippy taps were made from old, plastic containers that had been previously used to hold water and were set up as hand washing stations. These educational tools were easy to construct, used only a small amount of water to implement, and were fun for the children in the community, as can be seen in Figure 4.2. Small soap containers were also attached to the structure to encourage effective hand washing practices. Tippy taps were hung outside the door of dwellings for easy access.

Figure 4.2: *Tippy Tap use by children in Cerro Caballo.*

5. Site Assessments

Several areas have been considered for future site implementations based upon information from the local Peace Corp volunteer, surveying data, and roof sizing. This information has led us to consider two possible sites for future implementations, with the possibility of a third site in El Naranjito if community members show more interest in participation. The first of these is a gravity fed system in Lower Las Mercedes. The second involves upgrading an existing gravity fed system in Cerro Segovia by replacing the polyducto piping with buried PVC pipe and storage tanks. The last project expected to be considered is in El Naranjito, involving a gravity fed system from a currently unknown source.

To complete the surveying, a Criterion laser range finder with a prism filter was borrowed from Jim Kiser of the OSU Department of Forestry. The filter ensured that the laser only sighted on the prism array preventing inaccuracies associated with sighting leaves and branches in surrounding areas.

Due to the recent work by the NGO FONAES, many of the locations that have been considered in the past no longer need a water project. The FONAES rainwater catchment systems provide water to many people above the water table in the communities of El Naranjito and Las Mercedes.

5.1 Lower Las Mercedes

Overview
This area is also known as La Cumbre. The spring and a potential tank site were also looked at during the summer 2008 trip. Of the three potential sites, this area seems to be the most in need of a water project. Seven families have expressed interest in the project, for a total of 38 potential beneficiaries.

Community Support
While in Lower Las Mercedes, Brad Eagleson, Michelle Adlong, Kaileen Amish, and Scott Crook met with seven heads of households to discuss the possibility of a project in the future. There was a high level of interest, likely due to Lower Las Mercedes' need of water. Of the communities surveyed they are the most in need of a water project. Community members were willing to provide the manual labor needed to construct the project. About half of the households voiced specifically that if a rainwater catchment system was implemented instead of a gravity system, they would not be interested in participating.

The community has already obtained rights to use the spring being considered, as long as the water is only drawn during the night. This poses an interesting engineering problem that likely ends in a shut off valve placed both at the spring head and at the tank basin so that water can be turned off and on in the mornings and evenings. Flow measurements were taken at the spring and were estimated to be 0.2 L/s during the dry season.

This community did not believe that vandalism would be an issue for two reasons. First, the line would pass through an area with little or no foot traffic. Second, they claimed that there would be no jealousy in the community because everybody would presumably be included in the project.

Terrain

The terrain in this area was the harshest of the three sites surveyed, and would involve laying pipe from below Don Maximino's house in La Cumbre down to the community of Lower Las Mercedes. The path starts at the spring on a level ground before quickly dropping down about 15 meters. The route would then follow the contours of the ridge until reaching Lower Las Mercedes. For approximately the first 100 meters, the slope of the ridge is very steep and full of boulders, both of which cause concerns about difficulties laying the pipeline. The terrain can be seen in Figure 5.1.

Figure 5.1: The steep hillside near the spring for Lower Las Mercedes is a physical challenge to any potential pipeline.

The proposed pipeline would pass through Don Eucelio Lopez's land. While in the community a dialogue was started about allowing EWB-OSU to run a pipe line through his land. At the time he was agreeable to the idea, but an official or unofficial contract should be signed before the project commences.

A 22 meter drop can be seen over the entire length of the 500 meter projected pipeline path, from the spring to Don Sebastien's house. At this point, the route splits to three potential tank locations, as can be seen in Figure 5.2. Site III is directly up the hillside, with an elevation gain of about 6.1 meters. Site II is farther downhill with an elevation loss of 36.8 meters; this location appears to be the best location due to its elevation and a favorable landowner. Site I is just down the road from Site II, with a total elevation loss of 33.4 meters. It should be noted that if the tank is located in either of the two lower locations, Don Maximino would most likely opt out of the project, as his house would be farther away than he desires. This is something important to

consider, since he would be the best contact in the La Cumbre area after Aaron Oppelt has left the community.

Accuracy

Due to limited experience with the Criterion, and difficulty working on the terrain, and only a single trusted survey of this hillside, it is difficult to assess the accuracy of this data. When used carefully, the Criterion is accurate to within 6". Azimuth data is presented in Figure 5.3, but was only measured sporadically due to technical difficulties with the Criterion.

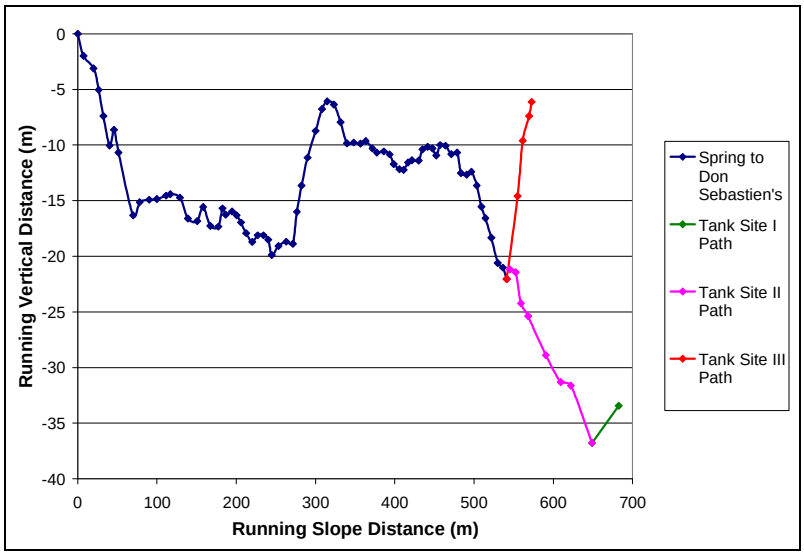

***Figure 5.2**: Slope Distance vs. Elevation Change. Each potential tank location is shown. The large elevation increase at 300 m could be avoided by crossing through Don Eucelio Lopez's land.*

***Figure 5.3:** A representation of the contours of the expected path along the hillside based upon the compass bearing at each point. This is intended to give the viewer an estimate of how the ridges connect. This data is not a contour diagram of the hillside.*

5.2 Cerro Segovia

Overview
The community of Cerro Segovia is located to the northwest of Las Mercedes/El Naranjito, and is on the outer edge of the water board district. Residents retrieve their water from a stream that runs through the community at a lower elevation than most houses. The community currently has a makeshift polyducto tube, much like a garden hose, that is gravity-fed and delivers water from the stream to many of the houses. Houses also seem to be well cared for, indicating the community is not as needy as some of the others encountered. However, community members have expressed strong support of a permanent gravity-fed system with storage tanks. The potential system would provide water to seven houses, five families, and 18 people. Provision of water to the seventh house was the landowner's prerequisite for use of the stream, according to Cerro Segovia community members.

Another potential project is rainwater catchment for three houses, which consist of three families and 22 people in Cerro Segovia that are located far above the elevation of the stream. These people seem to be in greater need of a project than the rest of the community.

Community Support
The community was generally enthusiastic about the potential for the project, as expressed during a community meeting before the site assessment. They said that they are willing to work together and with EWB for the project. Strong support by the three potential rainwater families was hard to judge; when the houses surveyed, only one of the families was home.

Supplies
The key issues with the terrain in this area would be getting supplies to build the projects. Although the community of Cerro Segovia is at least an hour's hike away from the rest of the community EWB is working in, there is a well-kept gravel road leading to Cerro Segovia, indicating that transporting construction materials by truck would be feasible. However, the transportation cost may be greater due to the greater distance from Tacuba.

5.3 El Naranjito

The community of El Naranjito is perhaps the most densely populated area within the communities and sub-communities of El Naranjito and Las Mercedes. In the past, projects have been considered in the area, but none has ever been implemented. During the December 2008 trip the travelers intended to survey the area for potential gravity or rainwater systems. However, a survey of the area was not completed due to lack of support from the community.

From conversations with the PCV Aaron Oppelt, it appeared that there was mixed support of the project in the community. Some community members were interested in participating in an EWB project, but others wanted to find a solution on their own. Due to the lack of interest, the travel team did not survey the area and made it clear to the community that their project would be set aside for the time being.

6. Trip Logistics

Arrival
The first group of two travelers, which left five days earlier then the others, flew into Comalapa International Airport in San Salvador. They met up with Aaron Oppelt, the Peace Corps volunteer, and stayed one night at his apartment in San Salvador. The next day they traveled to Ahuachapán by bus and then to Tacuba, where they spent two nights at Mama y Papas, while gathering food and materials. They purchased groceries from Super Selectos in Ahuachapán and fruits and vegetables from the street markets in Ahuachapán. Although most of the bulk construction materials had been ordered prior to the trip from Daysi's store in Tacuba, the first group ordered the remainder of the materials needed from Daysi's and a hardware store in Ahuachapán. On the fourth day in El Salvador, the first group hired a truck to drive them up to the community of El Naranjito.

The next day, the second group of five travelers flew into San Salvador. They took a taxi directly from the airport to Ahuachapan, where they stopped at the hardware store to get additional supplies, then continued on to Tacuba and picked up the rest of the supplies at Daysi's. They then rode to the community in the back of a truck driven by Don César.

In the Community
The entire group stayed in El Naranjito for 11 days while completing the project. They slept in a three-room concrete building with tiled floors and a metal roof that was owned by Don Fermin. Each morning at sunrise and every evening after sunset, they hiked 30-45 minutes to and from the project site in Cerro Caballo. Three meals per day were served by one of the beneficiary families at the project site. Travelers bathed in a stream pool that was also used by the locals to bathe and do laundry.

Departure
Before leaving the community, a truck was hired to move leftover materials to Don Maximino's house for safe storage. The first departing group of four then rode in the truck to Tacuba and took a taxi to San Salvador. They stayed one night in San Salvador at the hostel La Estancia prior to departing from Comalapa International Airport.

The second departing group remained in the community for three additional days in order to complete additional site assessments. They stayed at the Peace Corps volunteer's local house, hosted by Don Maximino. On Christmas Day, they hired a truck to drive them back down to Tacuba, where they then took a taxi to San Salvador. They also spent one night in La Estancia and flew out from the airport the next day.

7. Budget

Budget Overages
The budget for this trip was $12,100. More specifically, $5,000 was allotted for airfare and travel insurance and $7,000 was planned for materials, including all in-country expenses. This trip went over budget by $3,938, for a total trip cost of $16,038. The main area of discrepancy was materials, which went over by $3182. See Appendix C for detailed budget and expense information. Overall, transportation costs were greater than originally budgeted for, mainly due to increases in fuel costs. This also caused part of the materials overage, because transporting the materials to the community is included in the cost of the materials. There were two other main reasons for the extra materials cost; material costs were higher than expected, particularly for lumber and cement, and the quantities of sand and gravel needed were higher than originally estimated.

Unused Materials
Upon completion of the project, some of the left over materials were sold back to community members. Items such as cement and lumber will go bad if not used and moving them to storage would incur additional transportation cost, so selling them to the community was a win-win situation. In total, this saved over $300.

New Travel Funding Policy
In the future, travel teams must adhere to the new EWB-OSU Travel Funding Policy, which was created in response to the budget overages of the December 2008 trip. Future budget estimates will need to be more detailed and available to the entire travel team prior to the expenditure of any money. A dedicated travel accountant will track all related expenses that occur before and during the trip. Should the project go over budget while teams are in the country, the travel policy has specific procedures for requesting additional funding from the EWB board members.

8. Appendices

Appendix 8.A. Map of project location

Appendix 8.B. Design Drawings

Appendix 8.C. Itemized Budget

Appendix 8.D. Inventory of Materials/Tools

Appendix 8.E. Community Member Contact Information

Appendix 8.A: Location Maps

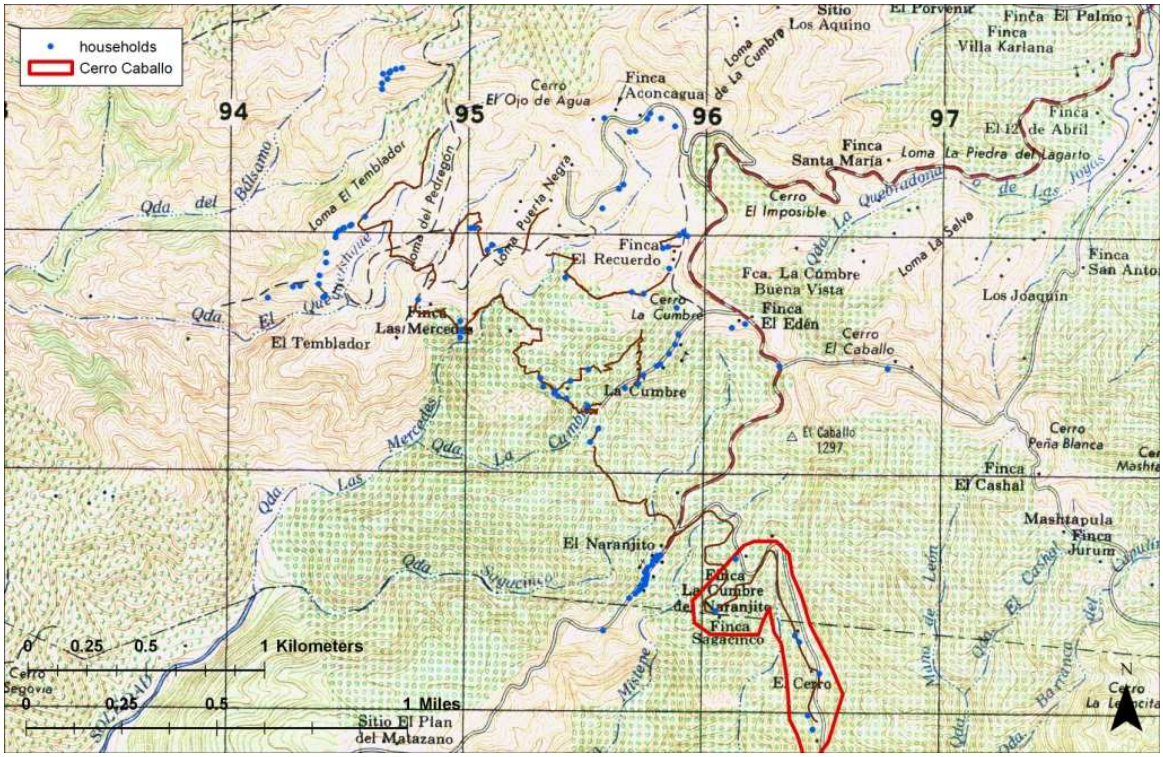

Figure 8.A.1: *Las Mercedes/El Naranjito vicinity map*

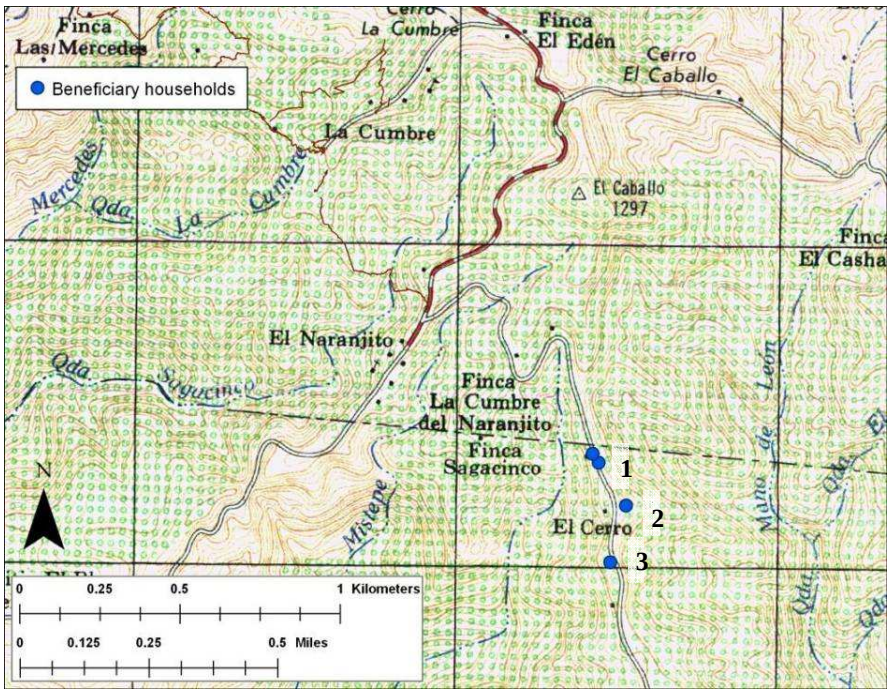

Figure 8.A.2: *Cerro Caballo household locations. (1) Don Manuel household; (2) Don Jesus household; (3) Don Hugo household.*

Appendix 8.B: Design Drawings

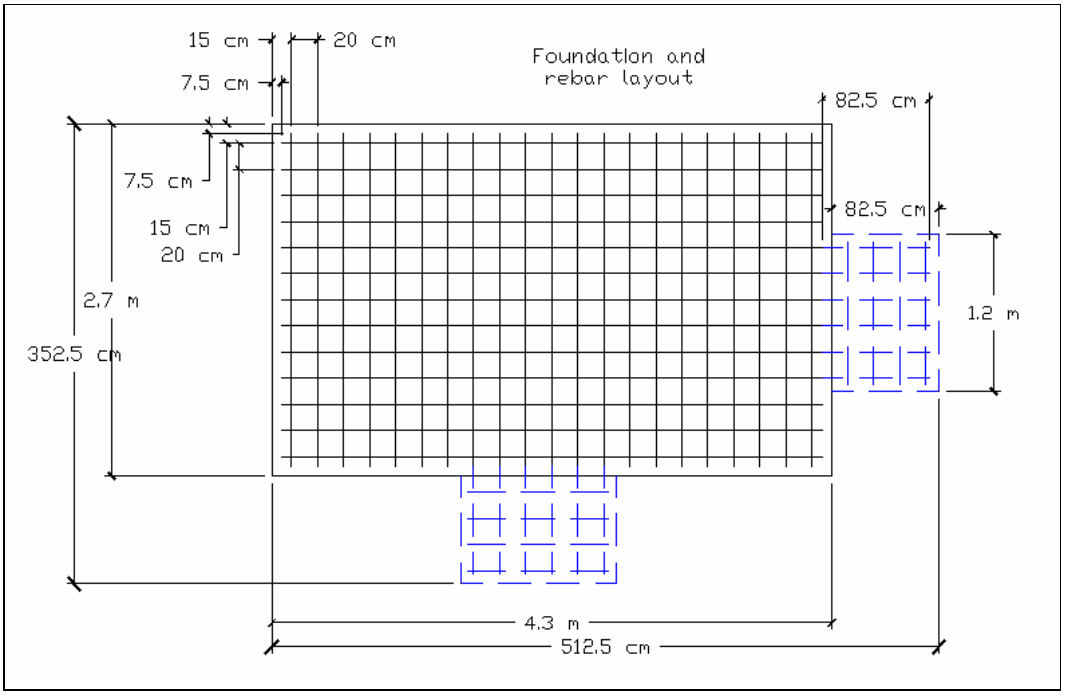

Figure 8.B.1: *Tank foundation rebar layout- plan view*

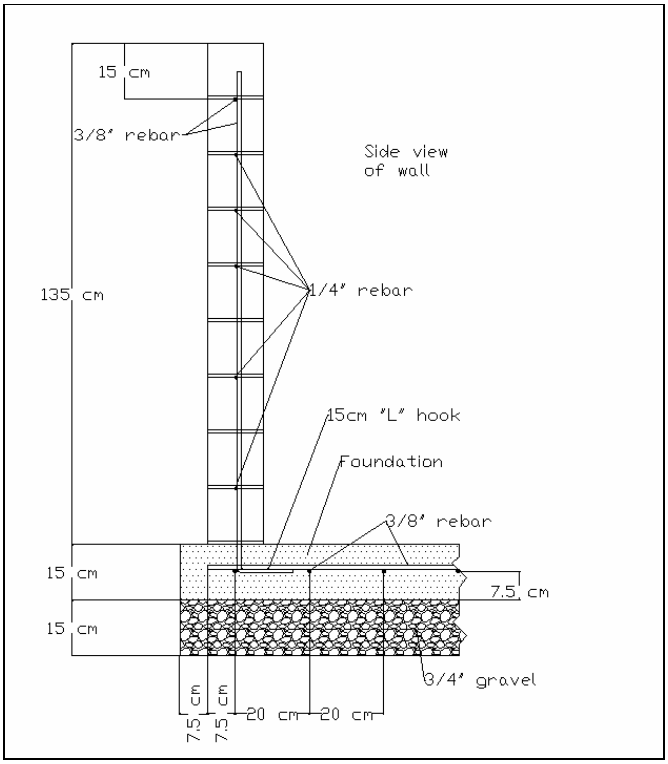

Figure 8.B.2: *Tank foundation and side wall – profile view*

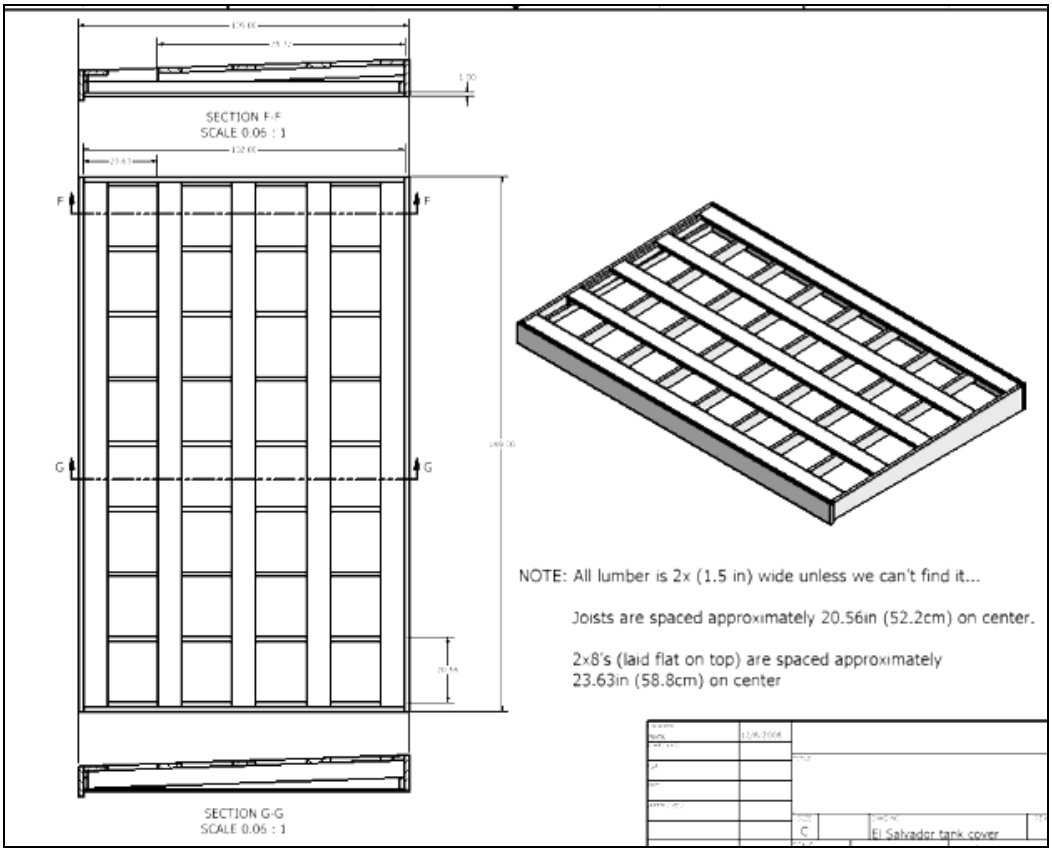

Figure 8.B.3: *Tank roof design*

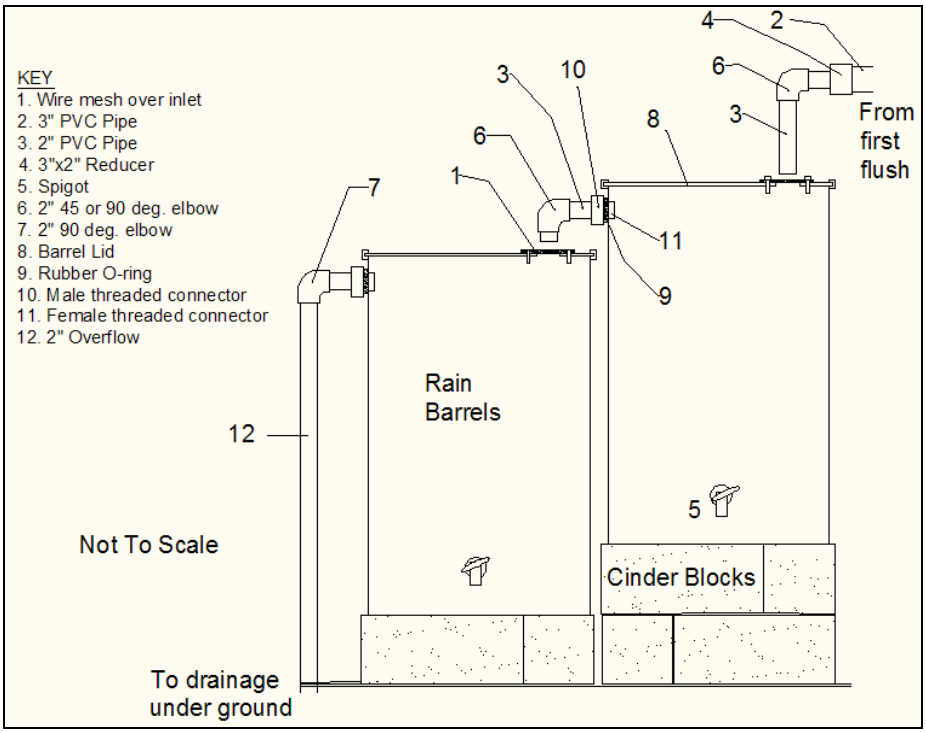

Figure 8.B.4: *Rain barrel assembly.*

Appendix 8.C: Itemized Budget

Materials Subtotal	***($8,682.30)***	
Daysi's Factura 2687	($1,825.60)	block, gravel, sand
Daysi's Factura 2688	($1,949.50)	cement
Daysi's Factura 2690	($834.42)	gutters, PVC connectors, materials for Zone 6
Daysi's Factura 2691	($1,360.25)	lumber, additional sand
Daysi's Factura 2692	($1,295.66)	rebar, lamina, nails, screws, PVC connectors, lime, trowels, hacksaw blades
Daysi's Factura 2693	($815.85)	Barrels, wire, 1" PVC, PVC & galvanized connectors, spigots
Daysi's Factura 2694	($501.02)	3" PVC, PVC connectors, spigots
Hardware store in Ahuachapan	($180.00)	concretorio rental, drill bits, fasteners, paint
Purchases made in Corvallis	($120.00)	Tape, mason line, speed square, chisel set, extension cord & plug adapters, hole saw, saw blade
Cement sold	$200.00	
Transportation Subtotal	***($652.50)***	
K&J arrival, Airport to San Salvador	($35.00)	
K&J arrival, San Salvador to Tacuba	($5.00)	
K&J arrival, Tacuba to Cerro Caballo and moving materials from Don Pascual's	($70.00)	
2nd Group arrival, Airport to Tacuba	($95.00)	
2nd Group arrival, Tacuba to El Naranjito	($35.00)	
Concretorio	($70.00)	
Trip to get gas for the concretorio	($35.00)	
1st Group departure, El Naranjito to Tacuba & moving materials to Don Maxamino's	($70.00)	
1st Group departure, Tacuba to San Salvador	($70.00)	
Jaynie departure, San Salvador to Airport	($12.50)	split with a PCV, would have been $25
J&N departure, San Salvador to Airport	($25.00)	
2nd Group departure, Las Mercedes to Tacuba	($35.00)	
2nd Group departure, Tacuba to San Salvador	($70.00)	
2nd Group departure, San Salvador to Airport	($25.00)	
Lodging Subtotal	***($236.00)***	
Mama y Papa's	($32.00)	2 people for 2 nights @ $8 per night per person
El Naranjito	($162.00)	2 people for 2 nights, then 7 people for 11 @ $2 per night per person
Las Mercedes	$0.00	3 people for 1 night, then 4 people for 2 nights @ $2/person/night ($22 - lumber)
La Estancia	($42.00)	6 people for 1 night @ $7 per night per person
Food Subtotal	***($411.00)***	
Groceries	($150.00)	Super Selectos & Ahuachapan markets
Don Hugo's family	($233.00)	$1 per person per meal
Don Jesus's family	($28.00)	$1 per person per meal
Masons Subtotal	***($566.00)***	
Don Roberto	($225.00)	
Don Hugo	($225.00)	
Don Roberto's son	($48.00)	$12 per day, 4 days
Other mason (name?)	($68.00)	$17 per day, 4 days
Flights & Insurance Subtotal	***($5,490.80)***	
Flights	($5,246.80)	
Insurance	($244.00)	
Grand Total (estimated)	**($16,038.60)**	

Figure 8.C.1: *Detailed Expense Summary*

Item	Budget
Galvanized Piping (Zone 6)	$100.00
Flights & Insurance	$5,000.00
Materials	$7,000.00
Materials Training	$100.00
Legal Fees for Cerro Segovia	$200.00
Total	**$12,400.00**

Figure 8.C.2: *High-Level Budget approved by the Board*

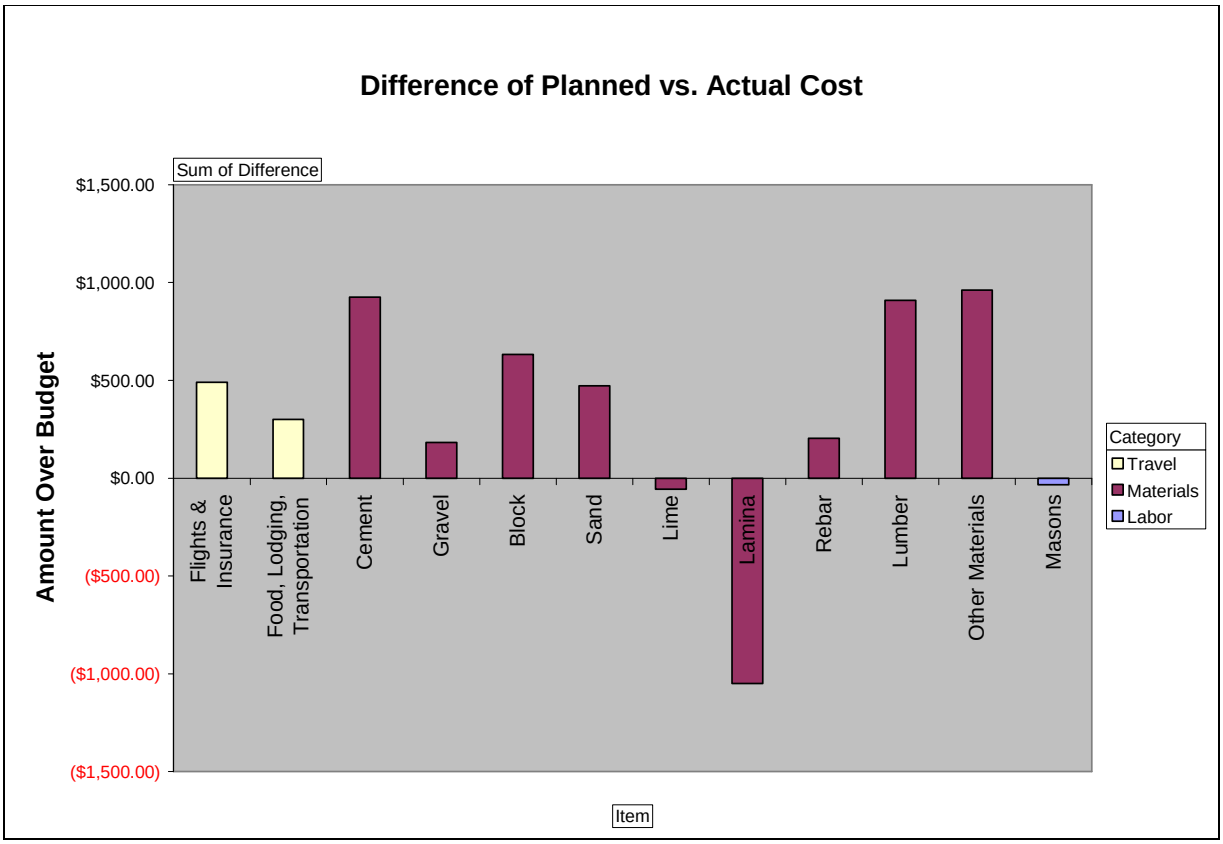

Figure 8.C.3: *Planned versus actual cost, itemized as much as possible*

Category	Item	Planned	Actual	Difference
Travel	Flights & Insurance	$5,000.00	$5,490.80	$490.80
Travel	Food, Lodging, Transportation	$1,000.00	$1,299.50	$299.50
Labor	Masons	$600.00	$566.00	($34.00)
Materials	Cement	$1,024.00	$1,949.50	$925.50
Materials	Gravel	$260.00	$442.50	$182.50
Materials	Block	$234.00	$865.60	$631.60
Materials	Sand	$270.00	$742.50	$472.50
Materials	Lime	$150.00	$94.50	($55.50)
Materials	Lamina	$1,350.00	$300.00	($1,050.00)
Materials	Rebar	$354.00	$558.00	$204.00
Materials	Lumber	$204.00	$1,113.75	$909.75
Materials	Other Materials	$1,654.00	$2,615.95	$961.95
Total		**$12,100.00**	**$16,038.60**	**$3,938.60**

Figure 8.C.4: *Planned versus Actual Cost in table form*

Item	Actual
Cement	$1,949.50
Gravel	$442.50
Block	$865.60
Sand	$742.50
Lime	$94.50
Rebar	$558.00
Lumber	$1,113.75
Lamina	$300.00
Piping & Fittings	$890.94
Gutters	$450.00
Fasteners & Glue	$303.16
Tools	$46.50
Other Materials & Tools	$925.35
Total	**$8,682.30**

Figure 8.C.5: *A further breakdown of material costs*

Appendix 8.D: Inventory of Materials/Tools

Table 8.D.1: *The following surplus supplies were left in Don Maximino's shed in lower Las Mercedes. Note that some of these supplies remain from the project trip of June 2008 and were not used specifically for this trip.*

Piping and Connectors					
PVC			Galvanized Steel		
PVC Piping	**Length**	**Quantity**	**Galv. Piping**	**Length**	**Quantity**
1/2"	6 m	42	3/4"	6 m	2
3/4"	7 m	30	1 1/2"	6 m	1
1"	8 m	12			
2"	9 m	2			
4"	3 m	1			
PVC Fittings	**Size**	**Quantity**	**Galv. Fittings**	**Size**	**Quantity**
2"-1" reducer	2"	7	1"-1/2" reducer	1"	2
3"-2" reducer	3"	8	2"-1" reducer	2"	
45° elbow	1/2"	19	3"-2" reducer	3"	
45° elbow	3/4"	9	45° elbow	1/2"	5
45° elbow	1"	2	45° elbow	3/4"	6
45° elbow	2"	11	90° elbow	1/2"	2
90° elbow	3/4"	11	90° elbow	3/4"	5
90° elbow	1"	52	90° elbow	1"	11
90° elbow	2"	7	Connector	3/4"	3
90° elbow	3"	1	Connector	1"	2
Ball valve	1/2"	1	Tee	1"	1
Ball valve	3/4"	1	Spigots	3/4"	5
Ball valve	1"	2	Union joint	3/4"	3
Ball valve	2"	10	Union joint	1"	1
Connector	1/2"	>50			
Connector	3/4"	>54			
Connector	1"	39			
Connector	2"	11			
End cap	3"	9			
End cap	1"	32			
Female adapter	1/2"	1			
Female adapter	3/4"	1			
Female adapter	2"	8			
Male adapter	2"	7			
Tee	1"	13			
Tee	2"	8			
Tee	3"	4			

Lumber				Protective Equipment	
Width	**Length**	**Height**	**Quantity**	**Item**	**Quantity**
1"	10"	8'	4	Ear Plugs	5
2"	4"	7'	3	Ear Protection	2
2"	4"	12'	5	Safety goggle	3
1"	10"	10'	23	Surgeon Mask	1
2"	5"	10'	9	Work Gloves	7
2"	4"	10'	5	Work vest	

Miscellaneous Supplies					
Item	**Size**	**Quantity**	**Misc. Items**	**Size**	**Quantity**
Anchors, plastic	For 3/4" screw	29	Rebar	6m	6
Flat Lamina #26	3' -9'	1	Rebar	4m	3
Float valve		1	Rebar	6m	19
Gutter (5" PVC)	6 m	2	Rebar fasteners		25
Gutter end cap		1	Screws, Phillips	Various	
L brackets	2"	34	Screws, Phillips flat head	1 1/2"	150
Mesh, fine		2	Valve, check		4
Nails	2"	>100	Valve, check covers		3
Polyurethane tubes		2	Wire, bailing	3 lb	1 roll
PVC glue	240 ml	6	Wire, galvanized	30 lb	1 roll
PVC sand paper		2			

Tools					
Item	**Size**	**Quantity**	**Item**	**Size**	**Quantity**
8" Monkey wrench		1	Paint Brush 4"		1
Batteries for drill/saw*		3	Pickax		1
Buckets		3	Pressure gauge		1
Cantaro (3gal)		1	Saw, circular*		1
Caulk	tubes	5	Saw, circular blades	5 1/2 "	2
Caulk gun		1	Saw, Hacksaw		3
Drill*		1	Saw, Hacksaw blades		13
Drill accessory kit*		1	Saw, hole*	2 1/8"	1
Drill bit	1/4"	8	Saw, hole	25 mm	1
Drill bit	3/32"	10	Scissors		1
Drill bit	7/16"	2	Screwdriver, flathead		1
Drill bit set	1/8" - 1/2"	1	Screwdriver, Phillips		1
Drill bits, Phillips		14	Sieve, fine sand		1
Duct Tape	roll	1	Sponge		1
File, flat		1	Square		1
Filter (Potters for Peace)		2	Straight Line		1
Flagging	detail roll	1	Straight Line Chalk		1
Gas Jug (5gal)		1	Tin Snips		1
Level		2	Trowels		4
Measuring tape		3	Wire Cutter		1
*Denotes items that were brought back to Oregon			Wood chisel set	3 pieces	1

Appendix 8.E: Community Member Contact Information

Table 8.E.1: *The following is the contact information for some important individuals in the community and in San Salvador.*

Name	Phone Number	Description
Cesar Chantue	7201.6034	Best Pickup Driver (does special deliveries and brings people up)
Office	2223.1100	Company that runs Tom's Finca
Clandia	7910.1827	Assistant to Lawyer
Daysi Tienda	7545.5819	Hardware and General Store in Tacuba (most basic items (tools, materials) can be paided using direct transfer)
Emiliana Carcia	7932.6702	Aaron's Host Mom and ADESCO President
Estancia	2275.3381	San Salvador Hostel
Felix	7056.0885	Van Driver
Fermin	7201.2827	House in El Naranjito
Falbio	7236.9468	Lower Las Mercedes Contacts
Hobel	7970.3128	Contact in El Naranjito
	7763.8171	
Hugo	7721.7159	Contact in Cerro Caballo (mason)
Halicer	7789.4611	Mason
Mama y Papa's Hostel	2417.4268	Hostel in Tacuba
Marcelo	7737.6295	Taxi in San Salvador and Country Transport (Taxi from airport to Tacuba can also drive a van for larger storage)
Olga	7883.4880	Health Promoter
	7922.9939	
Maximino	7892.3256	Aaron's Host Dad, President of Water Board (possible contact for Lower Las Mercedes and best starting point for contacts in the community)
Miguel Angel	7732.8309	Contact Zone 6
Neto	7875.8389	Pickup Driver
Pablo Piecho	7240.1734	Contact in Cerro Segovia
	7997.0581	
Pascual	2413.7119	Zone 6 contact (also sells coffee)
Rigoberto	7509.1685	Finca Care Taker
	7501.6250	house to stay at
Roberto	7589.4305	Trusted Mason (Proven, trusted and skilled mason)
Roselio	7635.6031	Pickup Tacuba
Tom Hawk	7885.5633	Finca Owner
Vidales	2243.0002	Hardware Store in Ahuachapán (more specialized parts sold here and owner speaks english)
Jose Ernesto Vidale	7871.0856	English speaking owner of Vidales
Victor	7514.0036	Mason