# Document 525B
# PRE-IMPLEMENTATION REPORT SHORT FORM

CHAPTER: Worcester Polytechnic Institute
COUNTRY: Guatemala
COMMUNITY: Guachthu'uq
PROJECT: Rainwater Harvesting
ORIGINAL TAC APPROVAL: November 12th, 2012
TRAVEL DATES: May 8th, -May 25th, 2014


Prepared By
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ENGINEERS WITHOUT BORDERS-USA
www.ewb-usa.org

## Pre-Implementation Short Form Part 1 – Administrative Information

### 1.0 Contact Information

| Project Title | Name | Email | Phone | Chapter Name or Organization Name |
|---|---|---|---|---|
| **Project Leads** | Thomas Moutinho | tjmoutinho@wpi.edu | 207.831.7011 | EWB-USA WPI |
| **President** | Michele Mensing | mlmensing@wpi.edu | 732.977.3875 | EWB-USA WPI |
| **Responsible Engineer in Charge** | Michael Reiter | Michael.reiter@wpi.edu | 860.748.3445 | EWB-USA HPC |
| **Traveling Mentor** | Laureen Elgert | lelgert@wpi.edu | 508.450.3313 | EWB-USA WPI |
| **Additional Mentor** | Patricia Austin | Pat.austin@state.ma.us | 508.792.7423 x204 | EWB-USA WPI |
| **Faculty Advisor (if applicable)** | Creighton Peet | cpeet@wpi.edu | | EWB-USA WPI |
| **Health and Safety Officer** | Jessie Ciulla | jmciulla@wpi.edu | 781.987.4139 | EWB-USA WPI |
| **Assistant Health and Safety Officer** | Aaron Pepin | ajpepin@wpi.edu | 603.689.3869 | EWB-USA WPI |
| **Education Lead** | Rita Newman | rpnewman@wpi.edu | 203.962.1357 | EWB-USA WPI |
| **Planning, Monitoring, Evaluation and Learning (PMEL) Lead** | Katie Picchione | krpicchione@wpi.edu | 518.727.8024 | EWB-USA WPI |
| **NGO/Community Contact** | Sucely Ical Lem | CeCep@intelnet.gyt | 502.7950.4039 | CeCep |

 

## 2.0 Travel Team

| # | Name | E-mail | Phone | Chapter | Student or Professional |
|---|---|---|---|---|---|
| 1 | Michael Reiter | Michael.reiter@wpi.edu | 860.748.3445 | EWB-USA HPC | Professional |
| 2 | Laureen Elgert | lelgert@wpi.edu | 508.450.3313 | EWB-USA WPI | Professional |
| 3 | Thomas Moutinho | tjmoutinho@wpi.edu | 207.831.7011 | EWB-USA WPI | Student |
| 4 | Jessie Ciulla | jmciulla@wpi.edu | 781.987.4139 | EWB-USA WPI | Student |
| 5 | Camden Knoff | cmknoff@wpi.edu | 651.269.7023 | EWB-USA WPI | Student |
| 6 | Rita Newman | rpnewman@wpi.edu | 203.962.1357 | EWB-USA WPI | Student |
| 7 | Aaron Pepin | ajpepin@wpi.edu | 603.689.3869 | EWB-USA WPI | Student |
| 8 | Katie Picchione | krpicchione@wpi.edu | 518.727.8024 | EWB-USA WPI | Student |

## 3.0 Health and Safety

The EWB-USA WPI travel team will follow the site-specific Health and Safety Plan that has been prepared for this trip. The Health and Safety Plan is submitted as a separate document.

## 4.0 Planning, Monitoring, Evaluation and Learning

The travel team has reviewed the 901B – Program Impact Monitoring Report template and has assigned travel team members to complete this report during the upcoming trip. We acknowledge that the completed 901B is required with the eventual submittal of the 526 – Post-Implementation Trip Report. **Yes**

# 5.0 Budget

## 5.1 Project Budget

**Project ID**: **006871**
**Type of Trip: Implementation**
**Trip type: A**= Assessment; **I**= Implementation; **M**= Monitoring & Evaluatior

| **Trip Expense Category** | **Estimated Expenses** |
|---|---|
| ***Direct Costs*** | |
| **Travel** | |
| Airfare | 5200 |
| Gas | 0 |
| Rental Vehicle | 0 |
| Taxis/Drivers | 1350 |
| Misc. (Flight Insurance) | 320 |
| ***Travel Sub-Total*** | $6550 |
| **Travel Logistics** | |
| Exit Fees/ Visas | 0 |
| Inoculations | 0 |
| Insurance | 320 |
| Licenses & Fees | 220 |
| Medical Exams | 0 |
| Passport Issuance | 0 |
| Misc. | 400 |
| ***Travel Logistics Sub-Total*** | $940 |
| **Food & Lodging** | |
| Lodging | 1890 |
| Food & Beverage (Non-alcoholic) | 0 |
| Misc. | 350 |
| ***Food & Lodging Sub-Total*** | $2240 |
| **Labor** | |
| In-Country logistical support | 0 |
| Local Skilled labor | 1000 |
| Misc. | 0 |
| ***Labor Sub-Total*** | $1000 |
| **EWB-USA** | |
| Program QA/QC **(1)** See below | $3700 |
| ***EWB-USA Sub-Total*** | $3700 |

| | |
|---|---|
| **Project Materials & Equipment (Major Category Summary) add rows if needed** | |
| See section 2.1 Technical Implementation: Complete List of Materials | 9500 |
| Water Quality Tests | 325 |
| Monitoring | 2000 |
| ***Project Materials & Equipment Sub-Total*** | $9825 |
| **Misc.** ***(Major Category Summary)*** | |
| Report Preparation | 0 |
| Advertising & Marketing | 0 |
| Postage & Delivery | 0 |
| Misc. Other | 0 |
| ***Misc. Sub-Total*** | $0 |
| **TOTAL** | $24255 |

Program QA/QC (EWB-USA Headquarters Project Managers and Chapter Relations Managers)
Assessment = $1,500
Implementation = $3,700
Monitoring = $1,150

**EWB-USA Headquarters use:**

| | |
|---|---|
| ***Indirect Costs*** | |
| **EWB-USA** | |
| Program Infrastructure **(2)** See Below | $1200 |
| ***Sub-Total*** | $1200 |
| ***TRIP GRAND TOTAL (Does not include Non-Budget Items)*** | $25455 |

Program Infrastructure (EWB-USA Headquarters accounting, administration

and fundraising)
Assessment = $500
Implementation = $1,200
Monitoring = $350

**Non-Budget Items:**

| ***Additional Contributions to Project Costs*** | |
|---|---|
| **Community** | |
| Labor | 600 |
| Materials | 0 |
| Logistics | 500 |
| Cash | 475 |
| Other | 0 |
| ***Community Sub-Total*** | $1575 |
| **EWB-USA Professional Service In-Kind** | |
| Professional Service Hours | 224 |
| Hours converted to $ *(1 hour = $100)* | $22400 |
| ***Professional Service In-Kind Sub-Total*** | $22400 |
| ***TRIP GRAND TOTAL (Includes Non-Budget Items)*** | $0 |

**Chapter Revenue**

| ***Funds Raised for Project by Source*** | **Actual Raised to Date** |
|---|---|
| **Source and Amount *(Expand as Needed)*** | |
| Engineering Societies | |
| Corporations | |
| University | |
| Rotary | |
| Grants - Government | |
| Grants - Foundation/Trusts | 3100 |
| Grants - EWB-USA program | 8000 |
| Other Nonprofits | |
| Individuals | 2000 |

| | |
|---|---|
| Special Events | 5000 |
| Misc. | 1200 |
| EWB-USA Program QA/QC Subsidy **(3)** See below | 3800 |
| ***Total*** | $23100 |

| | |
|---|---|
| **Remaining Funds Needed** | **$2355** |

Program QA/QC & Infrastructure Subsidy:
Assessment = $1450
Implementation = $3,800
Monitoring = $950

**6.0 Project Disciplines**

**Water Supply**
____ Source Development
__x_ Water Storage
__x_ Water Distribution
__x_ Water Treatment
____ Water Pump

**Sanitation**
____ Latrine
____ Gray Water System
____ Black Water System

**Structures**
____ Bridge
____ Building

**Civil Works**
____ Roads
____ Drainage
____ Dams

**Energy**
____ Fuel
____ Electricity

**Agriculture**
____ Irrigation Pump
____ Irrigation Line
____ Water Storage
____ Soil Improvement
____ Fish Farm
____ Crop Processing Equipment

**Information Systems**
____ Computer Service

## 7.0 Professional Mentor Resumes

Although the professional mentor has fourteen years of experience in industry, his industry is jet engines and is technical experience is not relatable to this project. However his years of home repair work is directly relevant to this implementation project, which is focused on building rainwater harvesting system on individual houses. Although there will be some water testing done, this implementation trip is about building that is why even though Mike doesn't have experience in the water industry we feel he is best suited to be Technical Mentor. In the next few paragraphs we will discuss how his home repair experience relate to the technical nature of the project and his 14 years in industry speak of his ability to work with students.

There are a few different building techniques planned for this project so we will take them one at a time. A good rainwater harvesting system starts with the gutters, because with more gutters one can collect more water. Mike has had to re-install gutters on his home a few times, as has a tendency to happen in older homes. Through these projects he has become proficient in ensuring the correct gutter angle so water flows towards the downspout and not to some other low point in the system. He is also very comfortable attaching gutters to his house, although as the reviewer will see in the design section we are using a different bracket for holding up the gutters than is used here in the States. However, Mike's experience has taught him that the number of brackets required to hold the water weight can be less important than having brackets spaced close enough together to avoid gutter bowing in between the brackets.

In our system design water flows from the gutters into PVC, which is another building material Mike has worked with. Mike helped his uncle run the PVC plumbing in their vacation home a few years ago which gave him familiarity with how the product works. Plumbing a bathroom is a different set of requirements than plumbing a rainwater system, but the approach to using PVC is the same. You still need to lay the whole system out in advance to make sure pipe fits where you want it to go, fittings exist for where you want to turn, pick the right diameter for the flow, and other considerations. Plus, he's glued enough PVC together that hasn't leaked to know he have a good understanding of that process. So even though Mike hasn't run PVC from a gutter to a rainwater tank, he spent a decent amount of time working with the particular building material.

From the gutter, the water runs through the PVC and into the rainwater tank. Mike never got the opportunity he hoped for to actually install a rainwater collection tank at a community garden here in the States, in preparation for the project he did a significant amount of research and is very comfortable with how the systems install. In Guatemala, tanks like we will be installing are common for people in the city of San Cristobal where we stay and we have also confirmed if we need an extra consult that a registered tank installer is available to visit the community with us.

The last piece of the system is the concrete base and Mike has also put down concrete pads before. One of his friends was putting in a patio and Mike worked with him to create the forms, mix the concrete, fill the form and smooth the concrete.

Mike's work at Pratt & Whitney makes him well suited to be a mentor in a technical environment. Through his career he has held roles of increasing responsibility and currently is in a leadership role where he spends most of his time mentoring younger engineers. This has made him great to work with as our mentor, because he doesn't try to do any of the work for us. Instead he tries to help guide us to the right answer without just telling us what to do. It has made this a great experience for us because we feel like we've learned a lot in the process instead of being dictated to.

We hope this helps explain why Mike is a good technical mentor for our implementation trip to Guachthu'uq. Because this trip is mostly about building, even a general contractor would be a good technical mentor for what we are going to do. Mike might not be a contractor, but he has a lot of experience doing contractor-type work around his house and has learned skills specifically valuable to our implementation trip.

Michael Reiter
264 Mile Creek Rd, Old Lyme, CT 06371
Reiter2207@Gmail.com (860) 748-3445

**Education**
Carnegie Mellon University – Tepper School of Business
Master of Business Administration, December 2004
Worcester Polytechnic Institute
Bachelor of Science in Mechanical Engineering, Focus in Aerospace, May 2000

**Professional Experience**
*Currently maintain a Secret Clearance with JSF Program Access*
*Progressing towards Six Sigma Black Belt Certification*
Pratt and Whitney, United Technologies Corporation East Hartford, CT

## October 2008-Present, Additive Manufacturing Technology Program Deputy

- Expert at Pratt & Whitney for additive manufacturing with an emphasis on powder bed technologies from Arcam (Electron Beam Melting) and EOS (Direct Metal Laser Sintering). Leading Pratt & Whitney through the process of advancing all additive manufacturing technologies from concept, advancement through Technology Readiness Level activities and into production. Responsible for development, documentation and training of Project Engineering discipline on using new technologies which are not fully characterized in rigs and development engines.

## November 2007-November 2010, Ceramic Matrix Composite (CMC) Technology Manager

- Led multi-disciplinary team of engineers to advance the manufacturing process for CMC hardware. Responsibilities included management level reporting, creating technology development strategies, coordinating between Pratt & Whitney and vendor for development planning, delivering hardware and monitoring at engine test.

## August 2005 – November 2007, Integrated Product Team (IPT) Leader

- Organized and led a group of designers, manufacturers, drafters and structural and aero/thermal analysts through the design, analysis, manufacturing and delivery activities of F135 hardware. Provided problem solving and technical support during engine testing, implementing fixes and providing short-term mitigation solutions. Led team through multiple issues at engine test, requiring fixes to be implemented in as short term as week, Applying lessons learned into a leading a more robust redesign effort.

## June 2003 – August 2005, Senior Structural Engineer

- Created structural analysis techniques for composite design and analysis and acoustic analysis. Techniques were incorporated in to Pratt and Whitney standard work for all engineers to use.
- Managed outsourcing for design and analysis of the JSF airframe nozzle seals and external flaps for both the Conventional Takeoff and Landing (CTOL) and Short Takeoff and Vertical Landing (STOVL) variants.
- Developed and executed subelement and full part test plans required to validate Ceramic Matrix and Polymer Composite components for flight, with plans being incorporated in to Pratt and Whitney standard work for all engineers.

**June 2000 – June 2003, Structural Engineer**

- Assisted multiple Integrated Product Teams, performed structural analysis using ANSYS, organized subelement and full part testing and consulted on material characterization efforts for various components of the JSF nozzle. Parts were manufactured from various metals, Ceramic Matrix and Polymer Composites.
- Member of Pratt and Whitney integration team, helping the Lockheed Martin Corporation design aircraft parts that interact with engine components and find solutions acceptable for both companies.

**Extra Curricular**

Engineers Without Borders (EWB) – WPI Chapter, Professional Mentor

Catalysts Powering Educational Performance (CPEP) – Board of Directors, Treasurer

# Pre-Implementation Report Short Form Part 2 – Technical Information

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# 1.0 Description of What Has Been Implemented

This section will outline what has been accomplished on previous trips.

## 1.1 Past Technical Implementations

***Roberto Cojocs House (#26)***
In January of 2013 EWB-USA WPI implemented one 2500 [L] tank, a concrete base and gutters. The following trip in May of 2013 the team implemented an improved overflow system to his tank. In the following trip in January 2014 the team implemented a first flush at both is EWB tank and governmental tank. From this implementation we learned that the concrete base made of entirely concrete is not feasible for the team in a large implementation due to the amount of man-hours it takes to mix and lay the concrete.

***Cristobal Laj Chojoc's House (#8)***
In January of 2013 EWB-USA WPI implemented a 2500 [L] Rotoplas tank and gutters. In May of 2013 the team learned that one of his existing tanks, previously thought to be his, was actually owned by a nearby family and had been moved to that house. In January of 2014 the team implemented a filter on his governmental tanks and helped to improve the condition of his governmental tanks.

***Cristobal Coy Max's House (#27)***
In May of 2014 the team implemented two 2500 [L] Rotoplas tanks, gutters, additional roofing, a first flush, an overflow, a filter, and a two tank concrete base. The concrete base implemented is the design in Figure 7. This implementation went smoothly and showed that the chapter is ready to implement on a large scale.

***Oscar Laj Lem's House (#1)***
Oscar had planned to change the location of his house before May 2015, when we originally told him we would be implementing. Therefore, the team implemented a temporary system that will be made permanent when he has finished moving his home. This system consists of two 2500 [L] tanks, two first flush's, an overflow, and a filter. There was an existing concrete base that the team, with the help of Oscar, repaired and will use for the permanent system.

## 1.2 Past Monitoring

***CECEP and Alvaro***

EWB-USA WPI has been working with El Centro Comunitario Educativo Pokomchi (CeCEP) since 2012. CeCEP is an indigenous, non-governmental, non-political, non-profit, social service and education organization that develops projects focused on conserving and revitalizing the Pokomchi culture (description taken from the CeCEP website). The team's main contact at CeCEP is Sucely Ical Lem. She goes by Sucy and has been an invaluable contact. CeCEP is located in the city of San Cristobal, about a forty minute walk from Guachthu'uq. People from Guachthu'uq frequently visit CeCEP. Sucy maintains orderly communication between community members of Guachthu'uq, the Water Committee, and EWB-USA WPI. She also coordinates translators, homestays, and transportation from Guatemala City to San Cristobal for

 

WPI travelers. Most recently, Sucy has connected the EWB-USA WPI team with the Municipality of San Cristobal, who is willing to provide transportation of construction materials from San Cristobal to Guachthu'uq to aid our project.

In January 2013, Alvaro Caal Lopez, a university student in Guatemala, began assisting EWB-USA WPI. Alvaro works at CeCEP and originally was a translator for the travel team when they began working Guachthu'uq. Since then, Alvaro has become an essential contact and team member. Alvaro's role in the project includes the upkeep of the EWB-USA WPI monitoring system, collection of rain gauge data, and serves as a liaison between Guachthu'uq, CeCep, and EWB-USA WPI. Alvaro's strong presence in this project ensures its success.

Twice a month, Alvaro travels to Guachthu'uq on behalf of EWB-USA WPI. While there, he completes a set of monitoring forms for the homes that were implemented on in January 2013 and January 2014, and those that will be implemented on in May 2014. Additionally, he photo-documents any damage to the EWB-USA WPI rainwater harvesting systems since his last trip to the community. Once he collects this data, Alvaro downloads rain gauge data from the rain gauge set up by EWB-USA WPI in CeCep.

Over the past year and a half, Alvaro has become a means of communication between Guachthu'uq and EWB-USA WPI. Alvaro reports all sentiments from Guachthu'uq regarding the project to EWB-USA WPI and keeps Guachthu'uq updated about the travelers' plans. This sort of news transfer includes updates about the Finca (the community water source), families moving in and out of the community, goals to be met before the next implementation, and any concerns raised by either party. Alvaro delivers data and updates to EWB-USA WPI through one of the past travelers via Skype or email on a bi-monthly basis.

### *Analysis of Consumption Rates*

Based on data collected from the May 2013 census (described below), the average community member consumes a total of 36.96 L each day. Families were asked to approximate how much water they use daily for drinking, cooking, bathing, and washing clothes. On average, each person consumes 3.2 L/day drinking, 3.1 L/day cooking, 11.3 L/day bathing, and 25.24 L/day washing.

It is significant to note that community members use, on average, only 6.81 L/day for drinking and cooking, the tasks that require potable water. The remaining 36.96 L/day do not require water of as high a quality. These are the two consumption rates that can be used to calculate the amount of water a rainwater harvesting system should provide. It is most urgent for rainwater harvesting systems to provide 3.23 L/person/day for drinking. Ideally, systems should provide 6.81 L/person/day to meet both drinking and cooking needs. The remaining water needed for washing and bathing can, if necessary, be obtained from the finca. Many community members already bring clothes to the finca instead of bringing finca water back to their home, since it is much easier to transport clothes than water. However, if rainwater harvesting systems can provide enough water to offset all water needs, systems will save the average family over 1000 hours each year (analysis of this statistic is further explained in section 4.4 Project Impact)

 

The data in the table below lists important statistics in tinajas, the local standard container used for carrying water, in addition to liters. One tinaja is equal to 2.5 gallons. The conversion factor used is 9.5 L/tinaja.

**Table 1: Community Consumption**

| Activity | Tinajas/family/day | Liters/family/day | Tinajas/person/day | Liters/person/day |
|---|---|---|---|---|
| Drinking | 2.06 | 19.61 | 0.34 | 3.23 |
| Cooking | 1.97 | 18.69 | 0.32 | 3.08 |
| Average total (D/C only) | 4.03 | 38.31 | 0.72 | **6.81** |
| Bathing | 7.23 | 68.65 | 1.19 | 11.32 |
| Washing | 18.60 | 176.67 | 2.66 | 25.24 |
| Average (B/W only) | 21.67 | 205.8917051 | 3.89 | **36.96** |
| Average Total (DCBW) | 25.71 | 244.20 | 4.61 | **43.77** |

Currently, the community as a whole uses an average of 1187.5 L/day for drinking and cooking alone and 7570.14 L/day for all water-related tasks.

### *Water Quality as of January 2014*

In addition to increasing the water quantity available to community members, the quality of water available is also a major objective of the project. Since rainwater harvesting is not subject to many pollutants, as are common in groundwater, there are only a few specific contaminants needed to be tested for in the storage tanks. The World Health Organization (WHO) identified common contaminants found in water, and what the acceptable levels are for drinking water, as shown below in Table 2.

**Table 2: Drinking Water Standards as described by WHO**

| Contaminant | Guideline |
|---|---|
| Arsenic | < 0.01 mg/L |
| Fluoride | < 1.5 mg/L |
| Nitrate | < 50 mg/L |
| E. coli | 0 |
| Thermotolerant coliforms | 0 |
| Turbidity | 0.1 NTU |

According to the American Society of Civil Engineers, arsenic is only usually found in groundwater, and it has never been reported in groundwater in Guatemala, so it was eliminated as a possible contaminant. With the WHO standards as a basis for investigation, the team identified hard metals, turbidity, and nitrates as the focus for water quality studies during the first Assessment trip in 2010. Bacteria were not tested for at this time. The Finca and an existing rainwater harvesting tank in the community were tested and compared; summarized results can be found in Table 12 in Appendix C. While the Finca water consistently had higher levels of all contaminants than the rainwater in the storage tank, all levels recorded fell within acceptable drinking water standards.

After implementation of EWB-USA WPI rainwater harvesting systems in January 2013, the team wanted to do more comparative water quality tests (between EWB-USA WPI tanks and existing tanks) with larger sample sizes than were previously tested. During the Assessment trip in May 2013, the team tested water from the Finca and the two tanks at House 26, Roberto's House (one government tank, and one implemented by EWB-USA WPI in January, 3013). Five types of tests were conducted: nitrate, nitrite, ammonia, iron, and bacteria. Even though nitrates were shown to be of acceptable levels during the 2010 water quality tests, nitrate, nitrite, and ammonia are all abundantly used in fertilizers. Since the source of the Finca is located on the edge of a farm, these tests needed to be conducted. Iron was identified as a contaminant to test again because the rainwater harvesting systems collect water off of deteriorating corrugated iron roofs in the community. Bacteria tests had not been conducted previously, so bacteria were also identified as a possible contaminant to investigate. A summary of these test results can be found in Table 13 and Table 14 in Appendix C. Consistent with the results from the 2010 water quality tests, all chemical levels in the tanks and Finca were determined to be of acceptable drinking water standards and no further testing is needed. However, bacteria was found to be a major source of contamination in both the tanks and the Finca. The tests used for bacteria were difficult to read, so further tests needed to be conducted.

During the Implementation trip in January 2014, specialized bacteria tests were conducted to continue the water quality research from May 2013. These tests were Colilert and Petrifilm tests, which identified the presence and quantity of various coliforms, specifically E. coli, and could be body incubated within 24 hours. Once again, tests results were compared from various sources: the Finca, House 26 EWB-USA WPI tank, and House 26 government tank. Additionally, samples of water boiled by the community were compared to samples of un-boiled water to measure the effectiveness of boiling to eliminate bacterial contaminants. Together, the Colilert and Petrifilm tests identify the level of risk of each source. Risk levels are determined by the criteria listed below in Table 3.

**Table 3: Description of criteria for each risk level.**

| **Risk Level** | ***E. coli* in sample** | **Colilert MUG+** | **# *E. coli* Colonies on Petrifilm** |
|---|---|---|---|
| Conformity with drinking water standard | 0 | - | 0 |
| Low | <1/10 ml | - | 0 |
| Moderate | 1 -10/10 ml | + | 0 |
| High | 1 – 10/10 ml | + | 1-10 |
| Very High | >10/10 ml | + | >10 |

Bacteria were not present in any of the boiled samples from any source. This indicated that the community's method of boiling effectively eliminates potentially harmful bacteria. All un-boiled samples had traces of bacteria, with the Finca samples typically posing a higher risk than those of the EWB-USA WPI tank or government tank. A summary of the results in terms of risk level can be found in Figure 1 below.

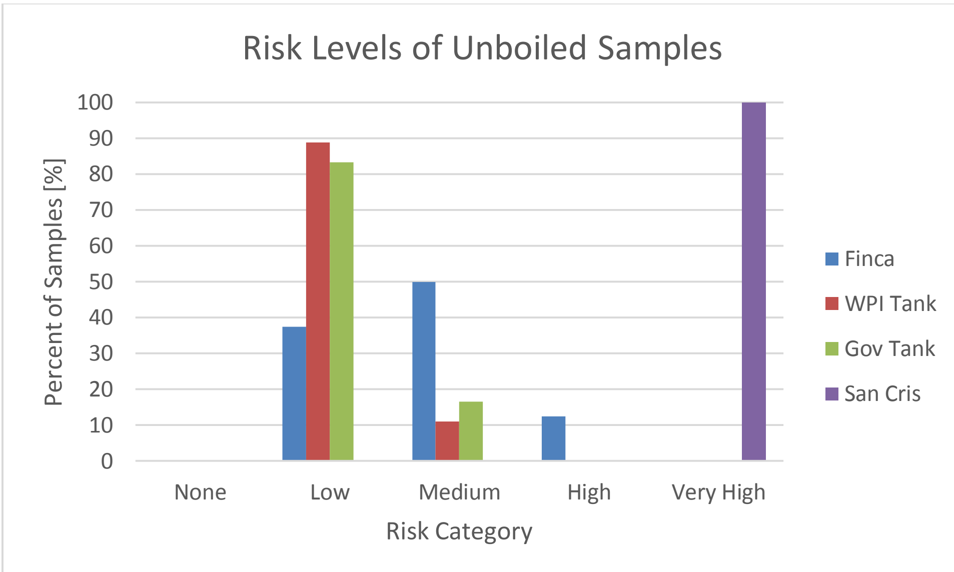


**Figure 1: Summary of bacteria test results from January 2014.**

Samples were collected from tap water in San Cristobal at the request of our partners at CeCEP. In addition, since the since the community samples did not produce any E. Coli colonies on the Petri film tests, our advisor suggested we sample a stream in San Cristobal to see if it would show E. coli colonies. The stream did produce many E. coli colonies, and confirmed that the Petri film media was able to show positive E. coli colonies.

As the EWB-USA WPI rainwater harvesting project continues to expand within Guachthu'uq, more bacteria tests need to be employed to gauge the quality of water across the community. Since the bacteria tests were conducted in January of 2014, improvements to the design of the EWB-USA WPI rainwater harvesting system have been made which focus specifically on reducing the amount of contaminants entering the tanks. Further tests will show the effectiveness of these design improvements in minimizing the presence of bacteria.

***Census***

In order to better gauge the socio-economic status, health, water usage, and age distribution of the people in Guachthu'uq, EWB-USA WPI completed a census of each home in May 2013. The team compiled the census with the help of CeCep, and worked with Alvaro and other translators provided by CeCep to survey the community. The results of this census help EWB-USA WPI to make better approximations of water consumption and to more accurately rank the beneficiary list according to the water needs and family structure of each home.

***Interviews***

To complement the census data, EWB-WPI conducted semi-structured interviews in January, 2014 to better understand families' specific water-related circumstances. Twelve families were interviewed: Houses 8 and 26, which received systems in January 2013; Houses 1 and 27, which were implemented on during or right before the interviews in January 2014; and Houses 5, 9, 16, 18, 21, 28, 29, and 31, which will receive systems in May 2014. Questions prompted discussion about:

Families' current water use habits
How they track water use on monitoring sheets
How frequently they travel to the finca and how long it takes
Other tank programs in which they participated (if applicable)
How they clean tanks and/or filters (if applicable)
Their perception of inequality to water access throughout the community
The status of the finca
How EWB systems will change their current water situation

An impromptu meeting with the manager of the Finca also took place and was recorded as an interview. These interviews helped strengthen relationships between EWB-WPI and community members. They also shed light on complex community dynamics. Interview summaries were added to our profiles of each family and will be used for evaluating and monitoring purposes as time goes on. Data will also be used to quantify how EWB-WPI systems improve the lives of the community members.

## 1.3 Community Contracts (MOUs)

EWB-USA WPI has established three legal documents that define the roles of the stakeholders in this project.

### *Statement of Expectations*

In order to ensure that the beneficiaries and EWB-USA WPI have a mutual understanding of the project process and the expectations set by each party, an agreement contract was formed in May 2013. This contract outlines the scope of the project for EWB-USA WPI, CeCep's involvement in the project, and each beneficiary's duty before and after they receive a rainwater harvesting system. The contract is signed by the Water Committee President, the Beneficiary, and Sucy. The full contract can be found in Appendix E.

### *Beneficiary Payment Agreement*

Once each home receives a rainwater harvesting system, it is expected that they contribute five percent of the total costs of the system. This money is payable to CeCep and can be paid in installments. The agreement lists the total cost of the system and breaks down what each component costs. Families sign that they will pay the expected five percent, will assist in the construction of future implementations, and will not sell their tank without first purchasing it from CeCEP. The contract is signed by the Water Committee President, the Beneficiary, and Sucy. The full contract can be found in Appendix E.

### *Future Implementation Expectations*

Each home is fully assessed by EWB-USA WPI on the trip prior to its system implementation. After this assessment, the team sets a few obtainable objectives that the family must meet in order to be implemented on during the subsequent trip. An example of an objective is preparing the site for pouring of a concrete base. This contract lists the scope of the project for EWB-USA WPI and lists the tasks that must be completed by the beneficiary family. It is signed by the Water Committee President, the Beneficiary, and Sucy. The full contract can be found in Appendix E.

***Families who have signed these contracts***

January, 2013

House 8 Cristobal Laj Cojoc (Water Committee President)
House 26 Robert Chojoc (Water Committee VP)

January 2014

House 1 Oscar Laj Lem
House 27 Cristobal Coy Max

January 2014 (Implementation planned for May, 2014)

House 5 Filomena Gualim Caal
House 9 Cristobal Lem Suram
House 16 Elvira Cal Chun
House 18 Domingo Caj Pop
House 21Miguel Caj Pop
House 28 Alfonso Xona Jul
House 29 Ricardo Gualim
House 31 Juan Cac Pop

## 2.0 Description of What Needs To Be Implemented

This section outlines the technical implementation plan, monitoring plan, education plans, community contract (MOUs), and the trip itinerary.

## 2.1 Technical Implementation

This section outlines the technical design of the EWB-USA WPI rainwater harvesting system, the planned implementation, and the list of necessary construction materials.

***Description of Technical Design***

This section will discuss the current design of the EWB-USA WPI rainwater harvesting system.

### System Overview

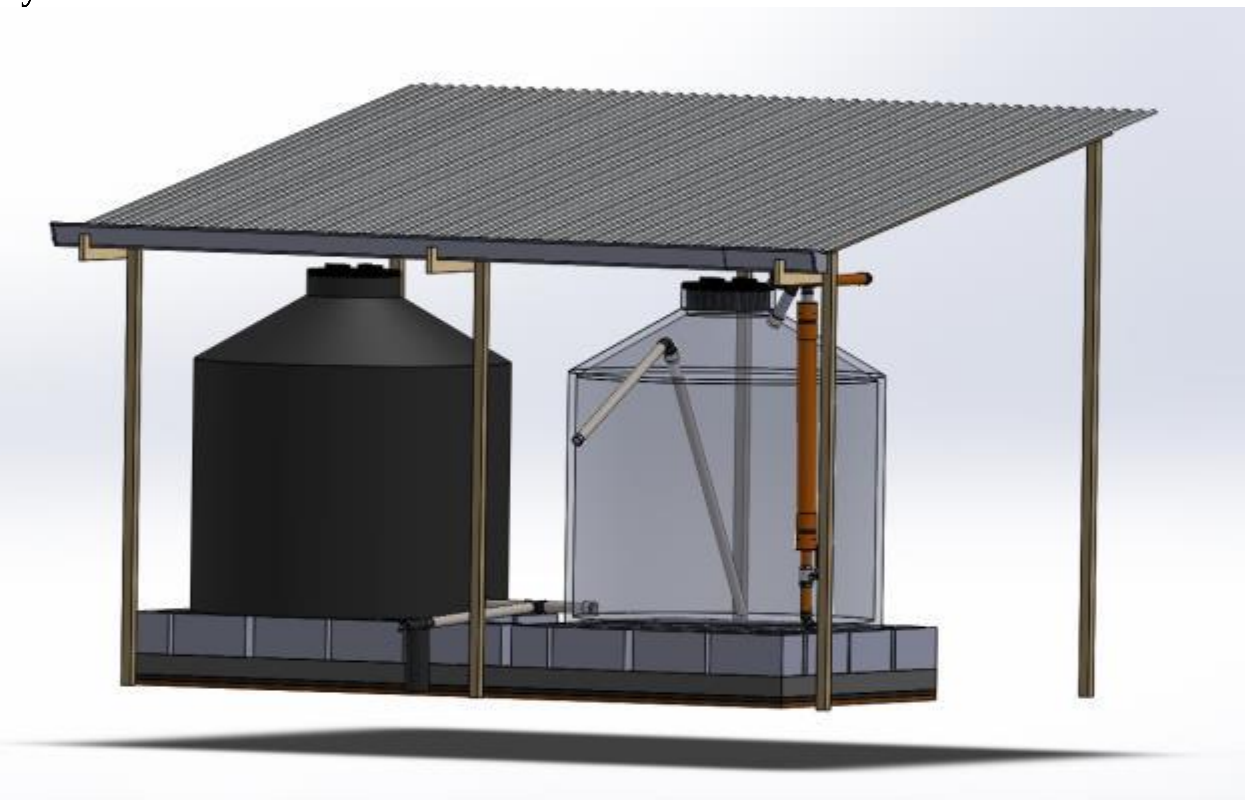

**Figure 2: Complete Rainwater Harvesting System**

The complete EWB-USA WPI system is composes of a gutter system, first flush, one or two Rotoplas tanks, an overflow that feeds from the bottom, a particulate filter, and a concrete base.

### Overflow

To create an adequate overflow system, the amount of water exiting the tank through the overflow pipe must equal the amount of water entering the tank from the gutters/downspout. To achieve this balance, the overflow pipe must be positioned a certain distance below the maximum water level in the tank. This height of overflow, shown below in Figure 3, is determined through a series of calculations, explained below.

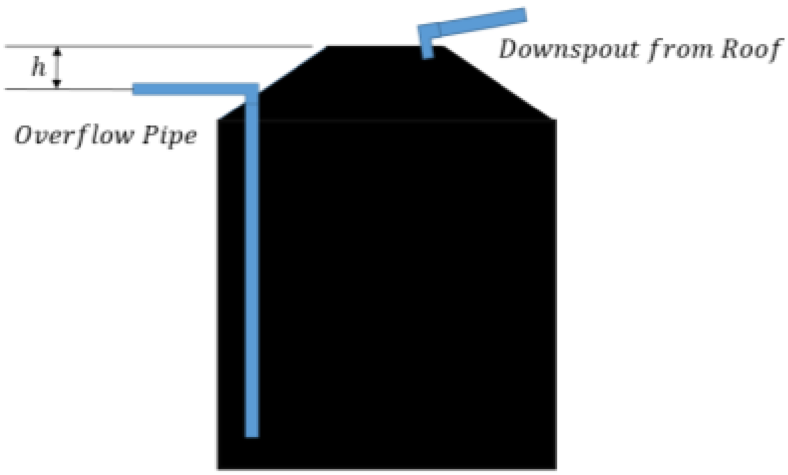


**Figure 3: Typical tank with overflow pipe pulling water from the bottom of the tank.**

### Step One: Inputs

Roof area
Maximum Average Rainfall
Desired overflow pipe diameter
Length of overflow pipe (inside tank)

While the roof area will be different for all homes, the other three inputs are the constant for the calculations. Maximum average rainfall was determined to be 0.072 cm/minute from 5 months of data the EWB-USA WPI rain gauge stationed in San Cristobal. The desired overflow pipe diameter and length are 1.5 inches and 2 meters, respectively. From these inputs the flow rate necessary can be computed with the relationship below.

$$Q_{in} = Roof\ Area * Rainfall$$
$$Q_{in} = Q_{out}$$

### Step Two: Bernoulli's Equation

To determine the necessary space (h) between the very top of the tank and the overflow pipe, Bernoulli's equation was used. The left side of the equation is taken inside the tank as the water level is rising, and the right side of the equation is taken at the end of the overflow pipe.

$$\frac{P_1}{\rho} + \frac{{V_1}^2}{2} + gz_1 = \frac{P_2}{\rho} + \frac{{V_2}^2}{2} + gz_2 + H_{losses}$$
$$P_{1,2} = Pressure\ (Pascals)$$

 

$$\rho = Density\ (998 \frac{kg}{m^3})$$
$$V_{1,2} = Velocity\ (\frac{m}{s})$$
$$g = gravity\ (9.81 \frac{m}{s^2})$$
$$z_{1,2} = Height\ (meters)$$
$$H_{losses} = frictional\ losses\ (meters)$$

The losses in the overflow pipe were removed from this set of calculations and computed separately. The pressures at both points of interest is atmospheric; the inside of the tank will not become pressurized (see Equation 0). The heights difference can be replaced by the variable h (see Equation 0). The velocity of the water level inside the tank can be set to zero because during an overflow situation, the water level should not be rising or falling.

$$P_1 = P_2 = P_{atm}$$
$$z_1 - z_2 = h$$
$$V_1 = 0$$

With those assumptions and changes in variables, the following relationship between height of overflow and velocity of overflow water can be determined (see Equation 0 below).

$$V_2 = \sqrt{2gh}$$
$$Q_{out} = A_{pipe} * V_2$$
$$V_2 = \frac{Q_{out}}{A_{pipe}}$$
$$h = \frac{{V_2}^2}{2g}$$

**Step Three: Frictional Losses**

Once the baseline overflow height is determined through Bernoulli's equation, the pressure (and effectively height) lost by friction in the pipe and fittings is calculated. Before losses can be calculated, the Reynolds number of the water in the overflow pipe is found.

$$Re = \frac{4 * Q}{\pi * D * \nu}$$
$$Q = flow\ rate\ \left(\frac{m^3}{s}\right)$$
$$D = pipe\ diameter\ (m)$$
$$\nu = viscosity\ \left(10^{-6} \frac{m^2}{s}\right)$$

 

Unless the roof area is less than 10 square meters, the flow of water through the overflow pipe will be turbulent (laminar losses are typically much less than turbulent). The turbulent losses are computed through the following equations.

**Major Losses**

$$Straight\ pipe\ losses = f * \frac{L}{D} * \frac{V^2}{2 * g}$$
$$f = 0.316 * Re^{\frac{1}{4}}$$
$$L = pipe\ length$$
$$D = pipe\ diameter$$
$$V = velocity\ of\ water$$
$$g = gravity\ \left(9.81\ \frac{m}{s^2}\right)$$

**Minor Losses**

Minor losses due to entrance effects at the bottom of the overflow pipe and the 45 degree elbow in the overflow.

$$Minor\ losses = k * \frac{V^2}{2 * g}$$
$$k = 0.4\ for\ water\ on\ PVC$$
$$V = velocity\ of\ water$$
$$g = grvity\ (9.81 \frac{m}{s^2})$$

**Final Result**

$$h = Bernoulli\ height + straight\ pipe\ losses + minor\ losses\ (entrance\ and\ elbow)$$
$$h = \frac{V^2}{2g} + f * \frac{L}{D} * \frac{V^2}{2 * g} + 2 * \ k * \frac{V^2}{2 * g}$$

The relationship between roof area and overflow height is shown below in Figure 4. The blue line is the direct results, and the orange and gray lines are the heights with a safety factor of 1.5 and 2, respectively.

 

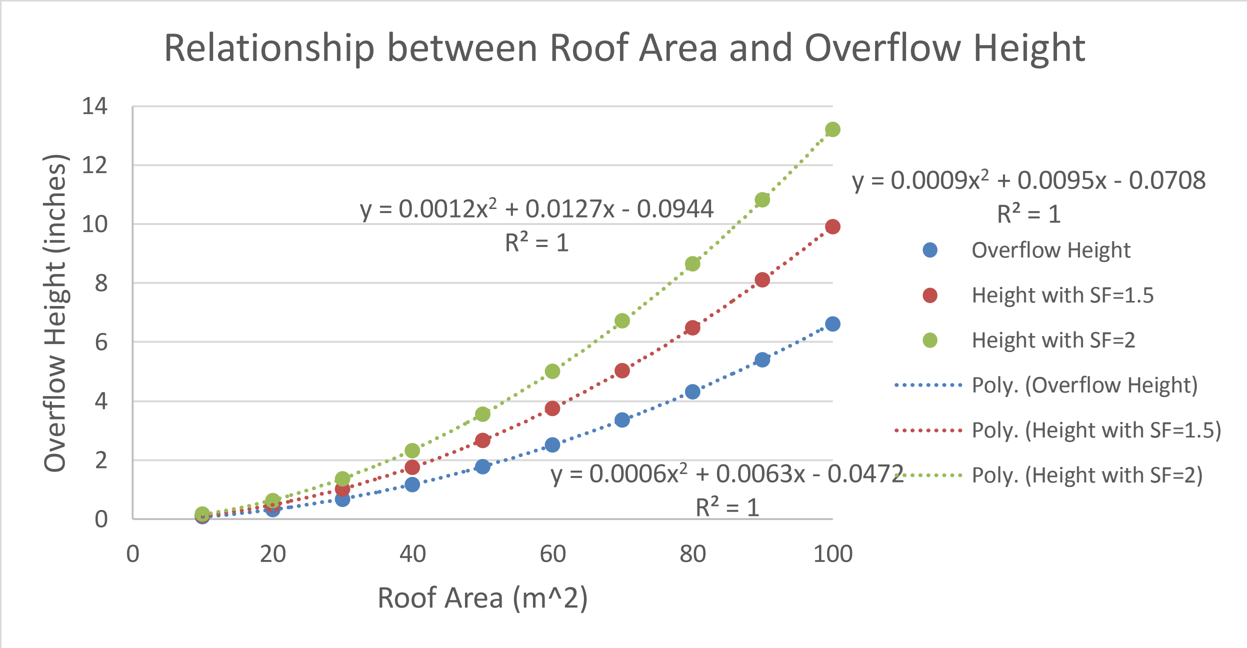


**Figure 4: Graph of roof area and overflow height.**

# First Flush

The EWB-USA WPI first flush consists of a 4 inch diameter PVC pipe that has a liter plastic water bottle inside to block mixing when the first flush is full (shown on the right in Figure 5. There is a valve at the end of the 4 inch pipe that allows community members to empty the system after each rainfall. The system is supported from the bottom by a stick to all families to collect the water that is removed from the first flush after each rainfall. This water can be used for cleaning but not drinking. The system removes 0.2 [L] of water per 1 [$m^2$].

The relationship between roof area and length needed for first flush is shown below in Figure 6. Depending on the amount of vertical space, the graph shows options for a 3" diameter or 4" diameter first flush.

**Figure 5: EWB-USA WPI First Flush**

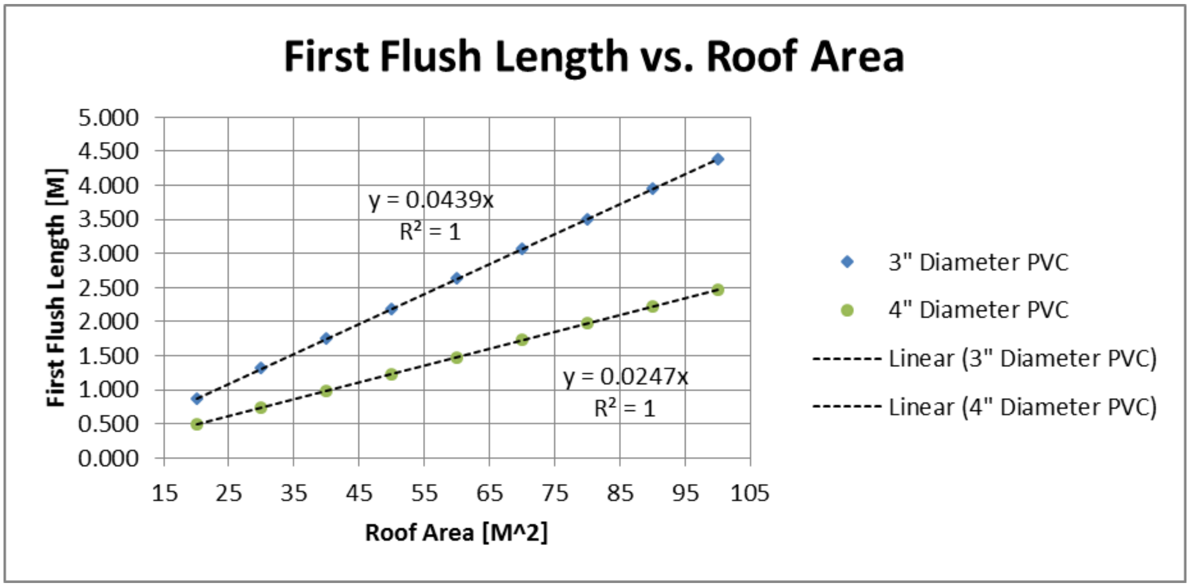


**Figure 6: Graph of relationship between length of first flush and roof area.**

 

## Concrete Base

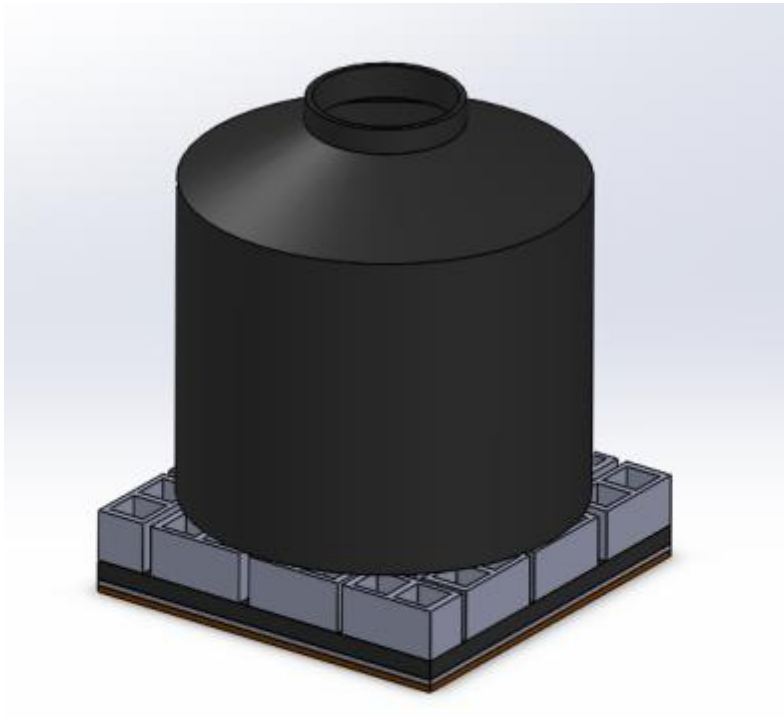

**Figure 7: EWB-USA Concrete Base**

The concrete base is comprised of a 4 inch, steel reinforced, concrete pad with a 24 cinderblock array on top. The cinderblock act to raise the tank 8 additional inches off the ground in order to allow families to access water at the spigot located at the base of the tank.

## Gutters

The EWB-USA WPI rainwater harvesting system uses wood gutter clips, designed by Cristobal Laj Cojoc (WQ President). These gutter clips have been working for over a year at his house. However, we have done a static analysis of the system in order to verify the system.

Figure 8: Gutter Clip

## Static Analysis

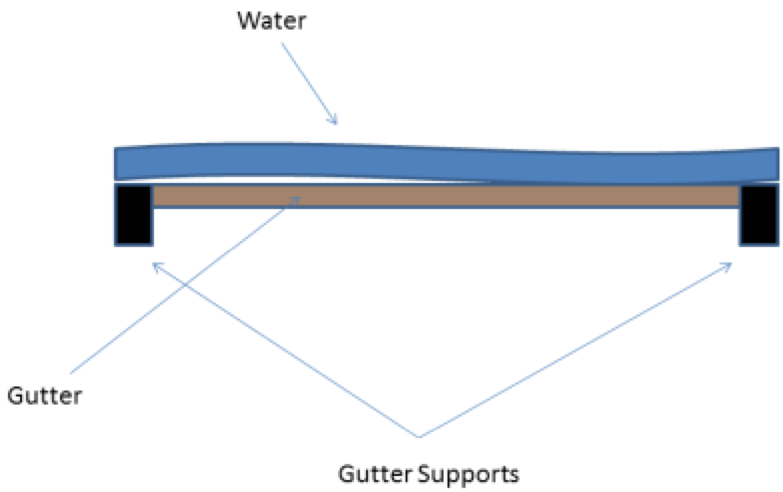


Figure 9: Schematic of Gutter

 

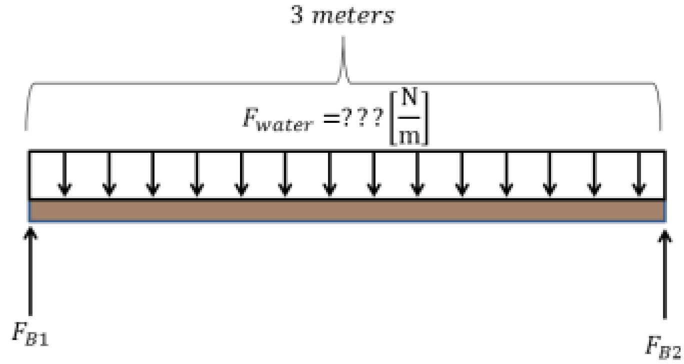


**Figure 10: Free Body Diagram of Gutter**

**To Solve for F$_{water}$:**

$$Mass = Volume * Density$$
$$Where: Volume = (3\ m) * (.089\ m) * (.0254\ m) = \mathbf{.00678\ m3}$$
$$Density = \mathbf{997\ kg/m3}\ at\ 25°\ C$$

**Therefore:**

$$Mass = (.00678\ m3) * (997\ kg/m3) = \mathbf{6.76\ kg}$$

**Now F$_{water}$ can be solved:**

$$Fwater = (6.76\ [kg]) * \left(9.81 \left[\frac{m}{s_2}\right]\right) = \mathbf{66.3}\ [\boldsymbol{N}];\ where\ gravity = 9.81 \left[\frac{m}{s_2}\right]$$

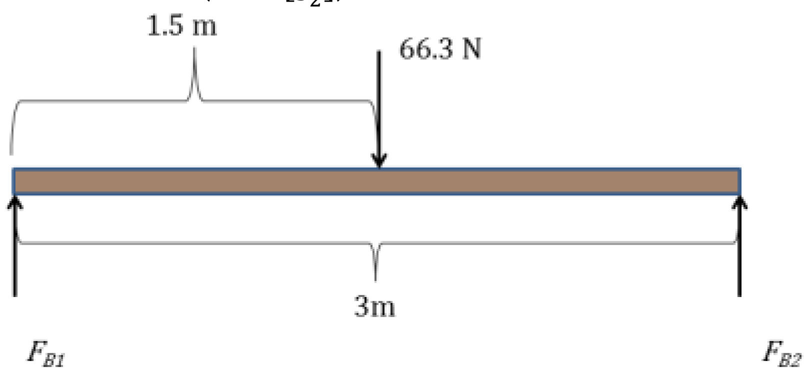


**Figure 11: Static Analysis**

$$\sum MF_{B1}:\ -(1.5\ m) * (66.3\ N) + (3\ m) * (F_{B2}) = 0;\ \ F_{B2} = 33.15\ N$$
$$\sum Fy:\ \ FB1 - (66.3\ N) + (33.15\ N) = 0;\ F_{B1} = F_{B2} = 33.15\ N$$

It is vital to measure the static forces acting upon the gutter supports to ensure they do not fail due to the weight of the water. This analysis was conducted schematically using a 3 meter long section of gutter with supports on either end. The dimensions of water running through it are approximately 3m x .089m x .0254m. As determined mathematically, the forces acting upon each gutter support are approximately 33.15 N (7.45 lbf). It has been determined that the supports are plenty strong enough to hold this weight.

 

***Individual Implementation Plans per Home***

In this section, each house has 3 pages. The first page is a basic profile for the home, listing various pieces of information important to the implementation on that home. On the second page, there are drawings of all of the houses that the team plans on implementing at. There are two drawings per house, the one on the top emphasizing specifically the roof area that will be used to collect water, the piping, and the tanks. The second drawing focuses exclusively on the dimensions of the existing house and roof area. In the top drawings, roof area that will be used for rainwater collection are highlighted in pen and arrows were drawn to indicate the direction of water flow into the gutters. Gutters are then represented by shaded regions at the edges of the highlighted roof area. Circles, most often at one end of these gutters mark where first flushes will be implemented at each home. Parallel lines drawn from these indicate the piping that will need to be put in place to feed the tanks, which are drawn as large circles on a rectangular concrete base. Each tank is then numbered and referenced on the left side of the drawing to indicate whether the tank was implemented by EWB-USA WPI or was implemented previously by the government. After the drawings on the third page is a graph of the expected level of water in their tanks over the course of a year. The captions at the bottom of these graphs detail how many people it's serving, how many tanks the house has access to, and the roof area that those tank(s) are drawing from. A materials list containing all of the materials needed in this implementation is located at the end of this section in Table 11.

 

## Oscar Vicente Laj (House 1)

7 people live in the house

Figure 12: Side view of Oscar's house.

**Existing Tanks**

| | |
|---|---|
| Government: | 0 |
| Embassy: | 0 |
| Other: EWB | 2 – 2500L |

**Existing Roof Area**

14.58 $m^2$ for house roof area 1

14.58 $m^2$ for house roof area 2

**Plan for Implementation**

How many tanks: n/a

Cement base: n/a

2 First flush units are necessary in this implementation. The options are:

- For the house roof 1:
  - (4" diameter PVC)-36 cm long
  - (3" diameter PVC)-64 cm long
- For the house roof 2:
  - (4" diameter PVC)-36 cm long
  - (3" diameter PVC)-64 cm long

Gutter Length: Two lengths of 5.4 m each

The two tanks will be connected together with a pipe at the bottom. Then, they will be moved to the concrete base.

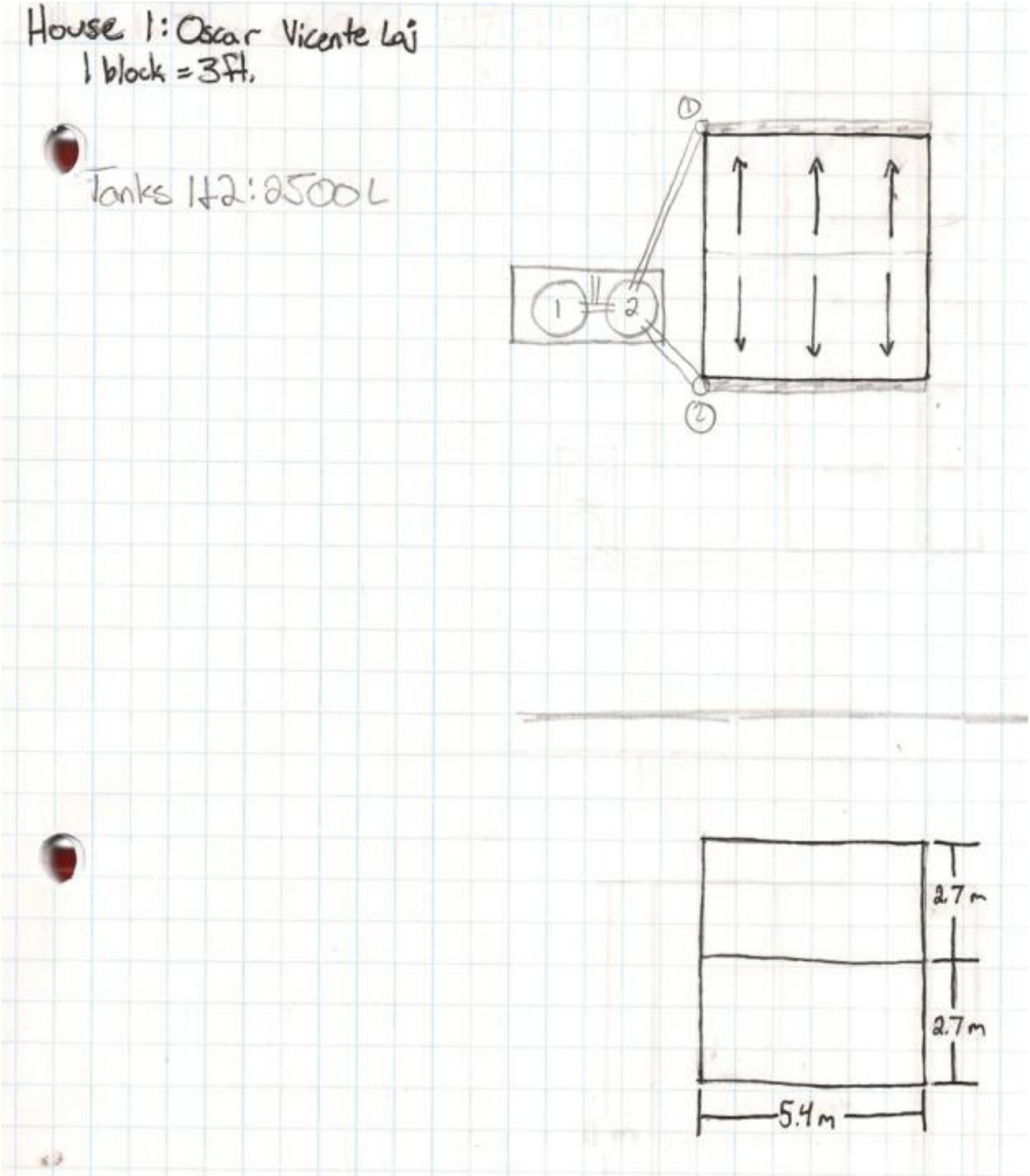


**Figure 13: House 1 Sketch**

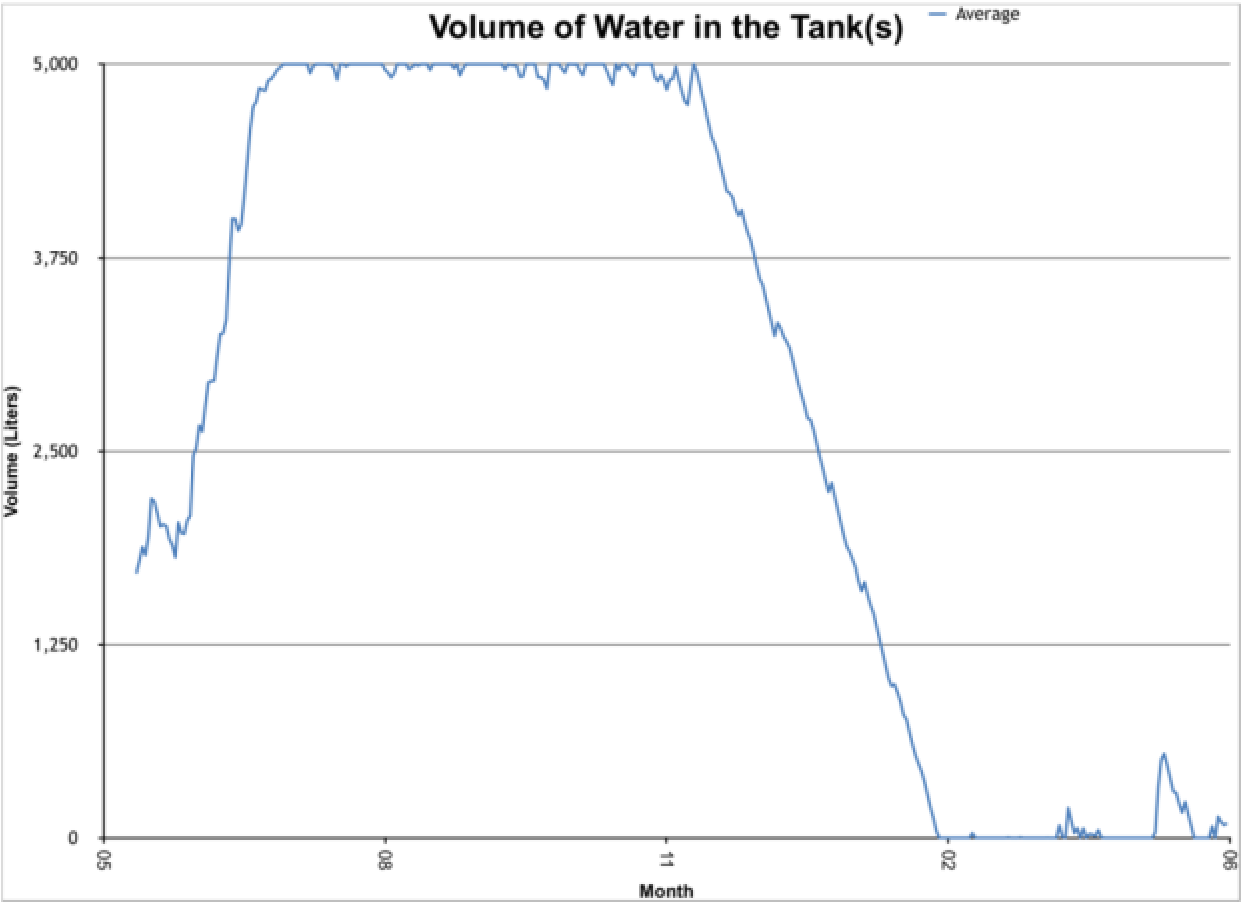


**Figure 14: Graph for 7 people sharing 5000 L from 29 m2 of roof**

## Filomena Gualim Yuja (House 5)

**Figure 15: Photo of the front of Filomena's house.**

7 people in the house

**Existing Tanks**

| | |
|---|---|
| Government: | 1-2500L (owned by her brother) |
| Embassy: | 0 |
| Other: | 0 |

**Existing Roof Area**

57.24 $m^2$

**Plan for Implementation**

How many tanks: 2 – 2500L

One 2 Tank Base: 1.52m x 3.66m

1 First flush unit is necessary in this implementation. The options are:

- For the House roof 1:
  - (4" diameter PVC)-80.8 cm long
  - (3" Diameter PVC)-143.7 cm long

Gutter Length: 10.8 m

**Agreed Work to be done Before May**

List of items to be done by the family before May (clear land, raise roof, etc.)

- Prepare the area for the base.
- Collect small to medium stones.

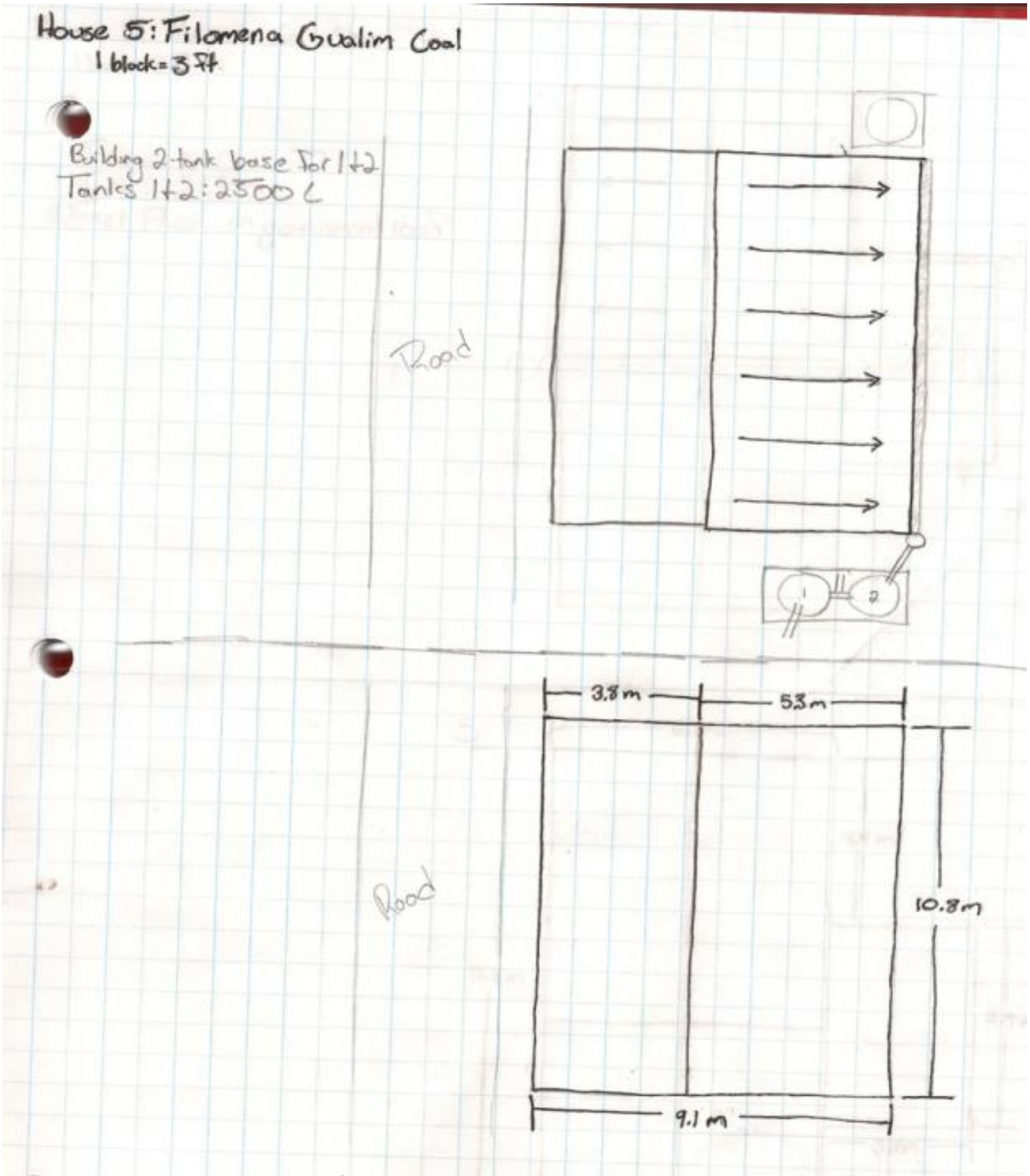


**Figure 16: House 5 Sketch**

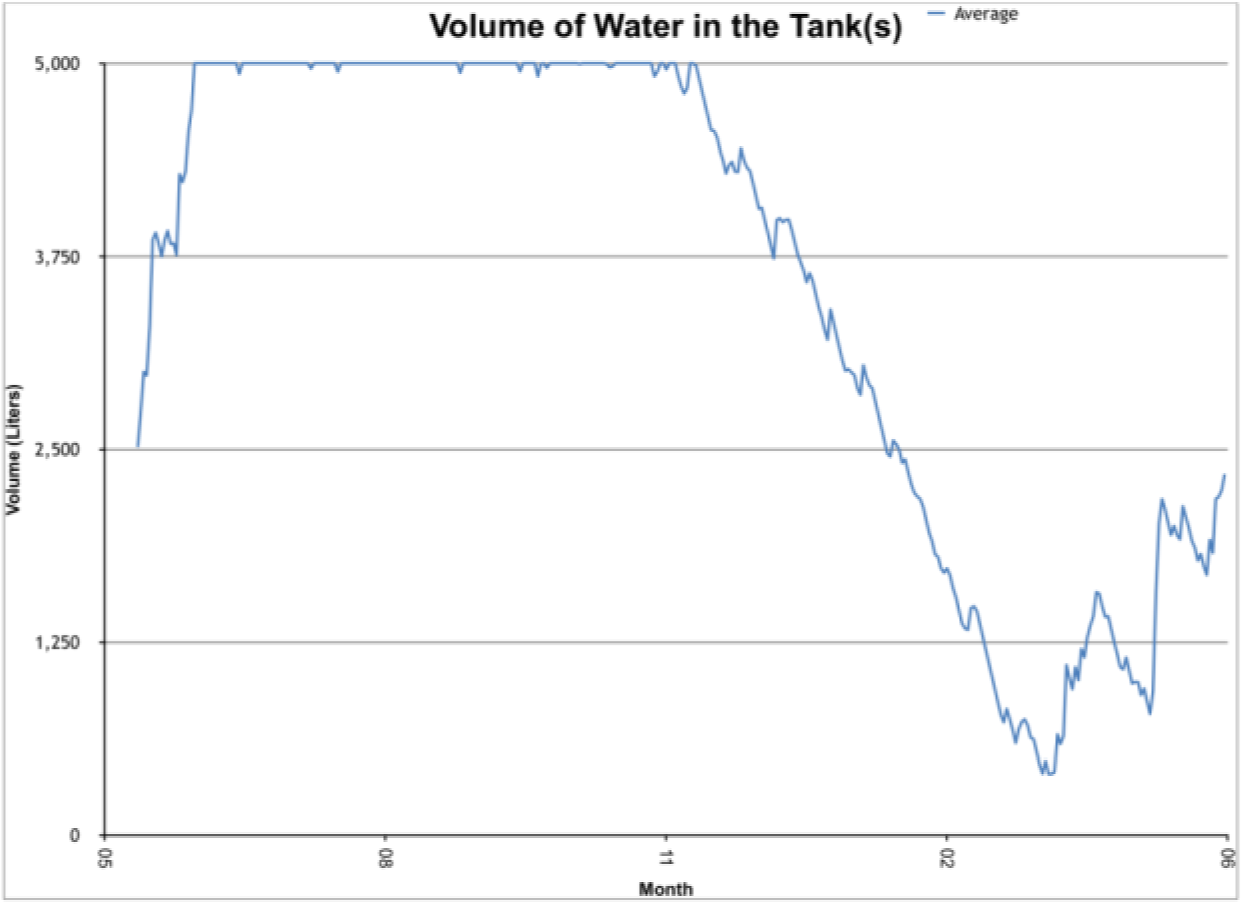


**Figure 17: Graph for 7 people sharing 5000 L from 57 $m^2$ roof**

## Cristobal Lem Suram (House 9)—The Midwife

10 people living in the house

**Existing Tanks**

| | |
|---|---|
| Government: | 2-1700L |
| Embassy: | 0 |
| Other: | 0 |

**Existing Roof Area**

13.5 $m^2$ house roof 1

65.2 $m^2$ house roof 2

**Plan for Implementation**

How many tanks: 2 – 2500L from WPI

These two new tanks will be placed on the existing base and a new two tank base will be created to hold the 2 old 1700 L tanks. New Base: 1.52m x 3.66m

**Figure 18: Photo of the roof of Cristobal's house.**

2 First flush units are necessary in this implementation. The options are:

- For the house roof 1:
  - (4" Diameter PVC)-33 cm long
  - (3" Diameter PVC)-60 cm long
- For the house roof 2:
  - (4" Diameter PVC)-104.8 cm long
  - (3" Diameter PVC)-186.4 cm long

Gutter Length: Two lengths of 9.4 m and 6 m

Updates to government tanks:

- The EWB-USA WPI tanks will overflow into the existing government tanks.
- A new overflow will be built for the existing government tanks.

**Agreed Work to be done Before May**

List of items to be done by the family before May (clear land, raise roof, etc)

- Prepare the spot for the tank.
- Collect small and medium stones.

 

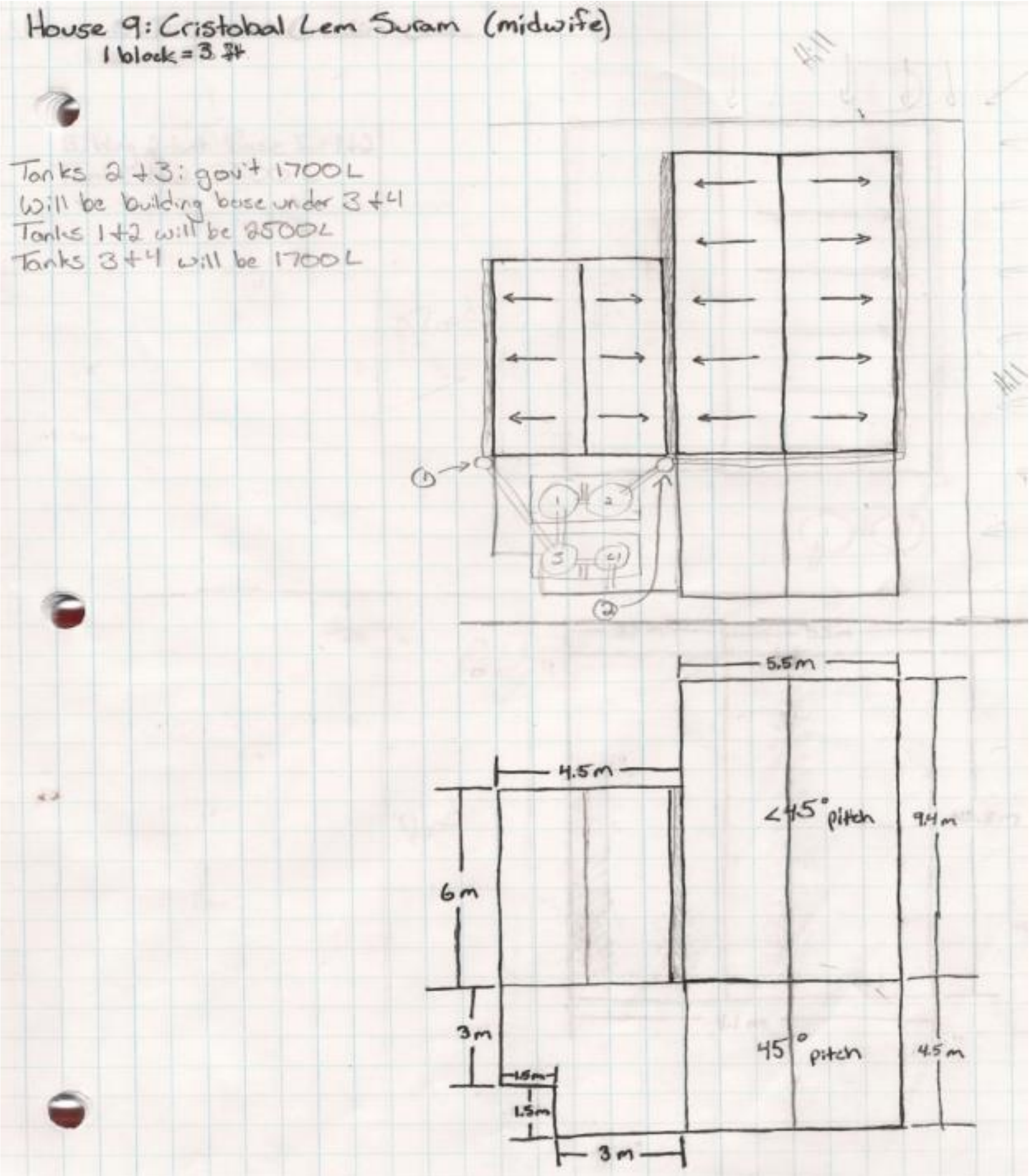


**Figure 19: House 5 Sketch**

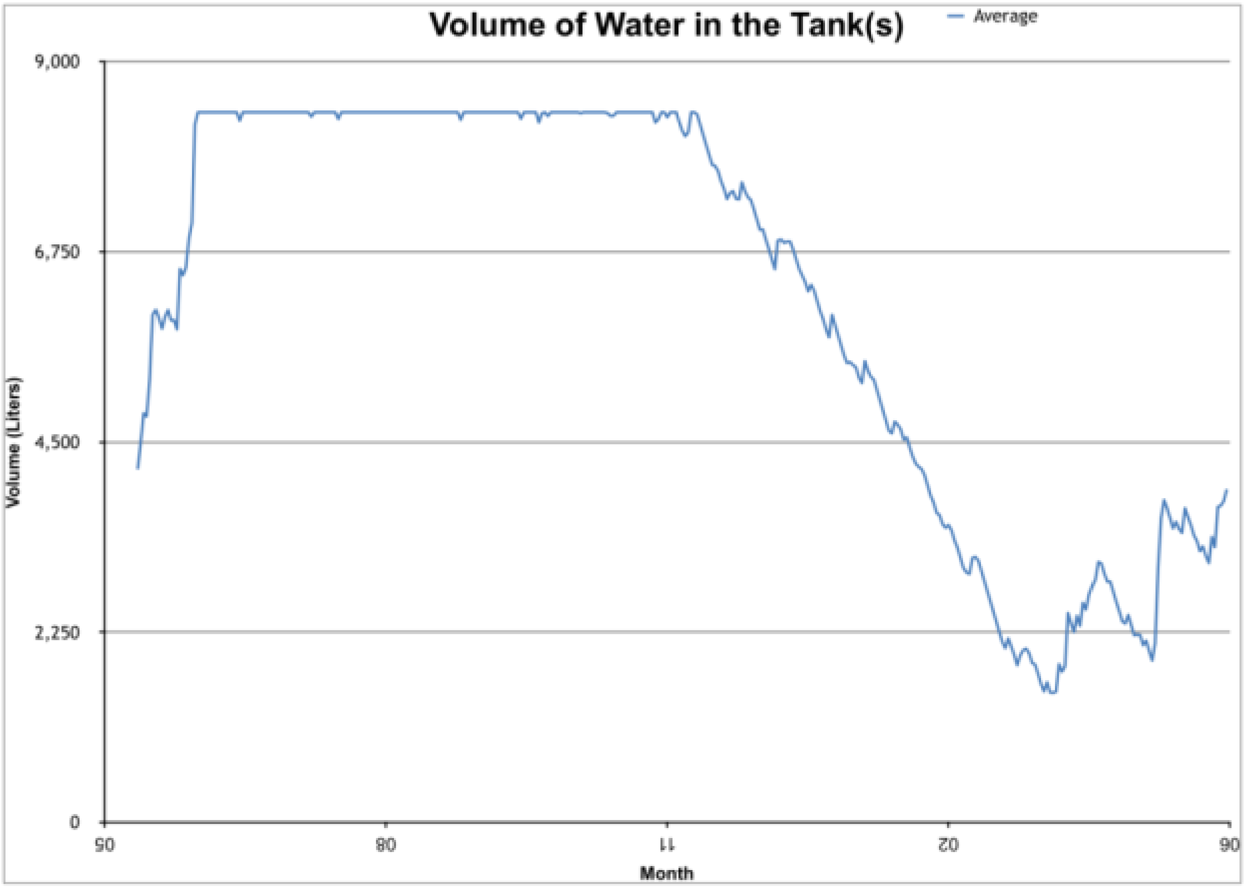


**Figure 20: Graph for 10 people sharing 8400 L from 79 m2 roof**

## Elvira Cal Chun (House 16)

7 people live in the house

Figure 21: Front of Elvira's house.

**Existing Tanks**

| | |
|---|---|
| Government: | 1-2500L |
| Embassy: | 0 |
| Other: | 0 |

**Existing Roof Area**

55.87 $m^2$

**Plan for Implementation**

How many tanks: 1 – 2500L

Two-Tank Base: 1.52m x 3.66m

1 First flush unit is necessary in this implementation. The options are:

- For the House roof1:
    - (4" Diameter PVC)-79.8 cm long
    - (3" Diameter PVC)-141.8 cm long

Gutter Length: 11 m

**Agreed Work to be done Before May**

List of items to be done by the family before May (clear land, raise roof, etc.)

- Prepare the site for the tank
- Collect small and medium stones

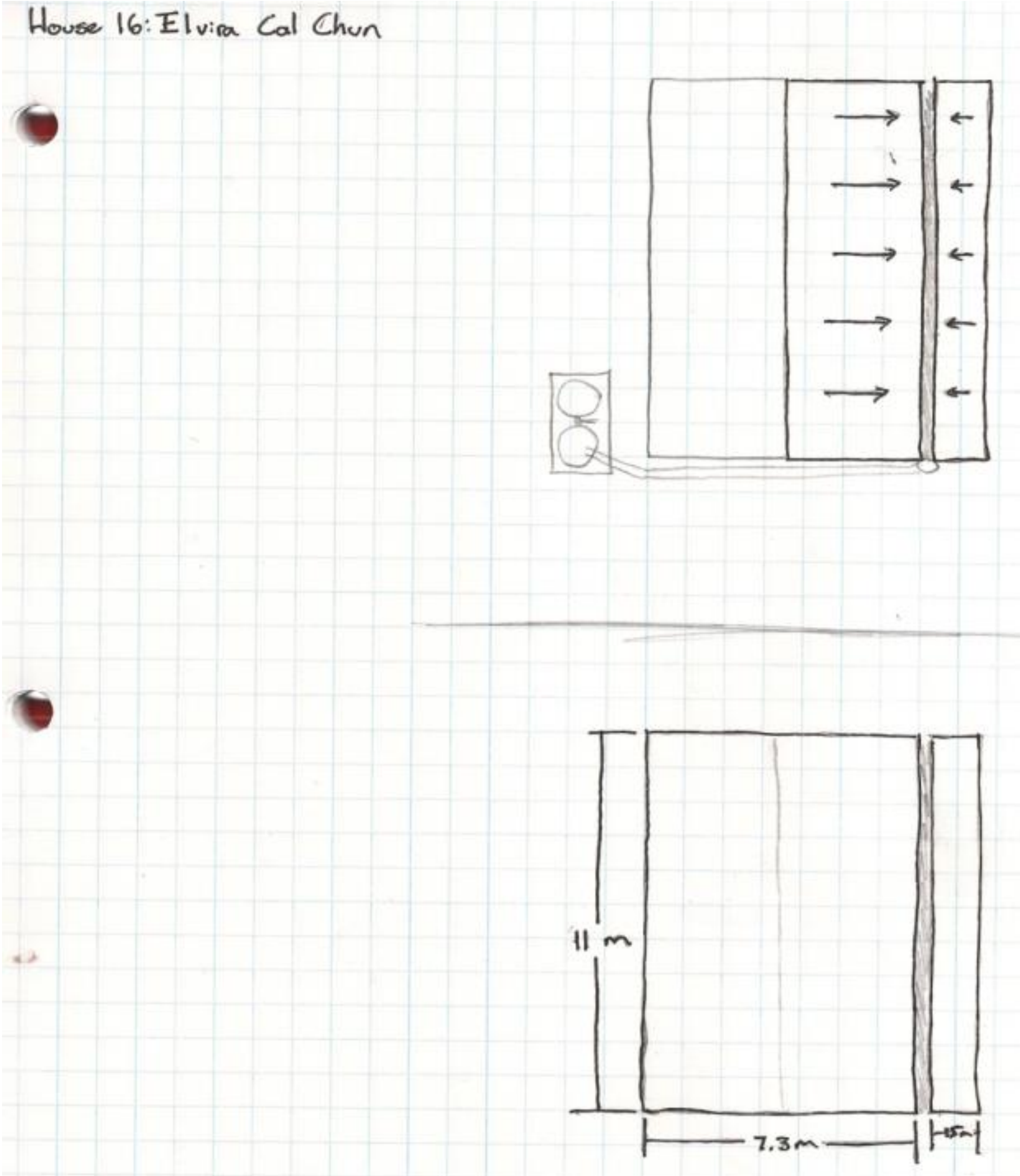


**Figure 22: House 16 Sketch**

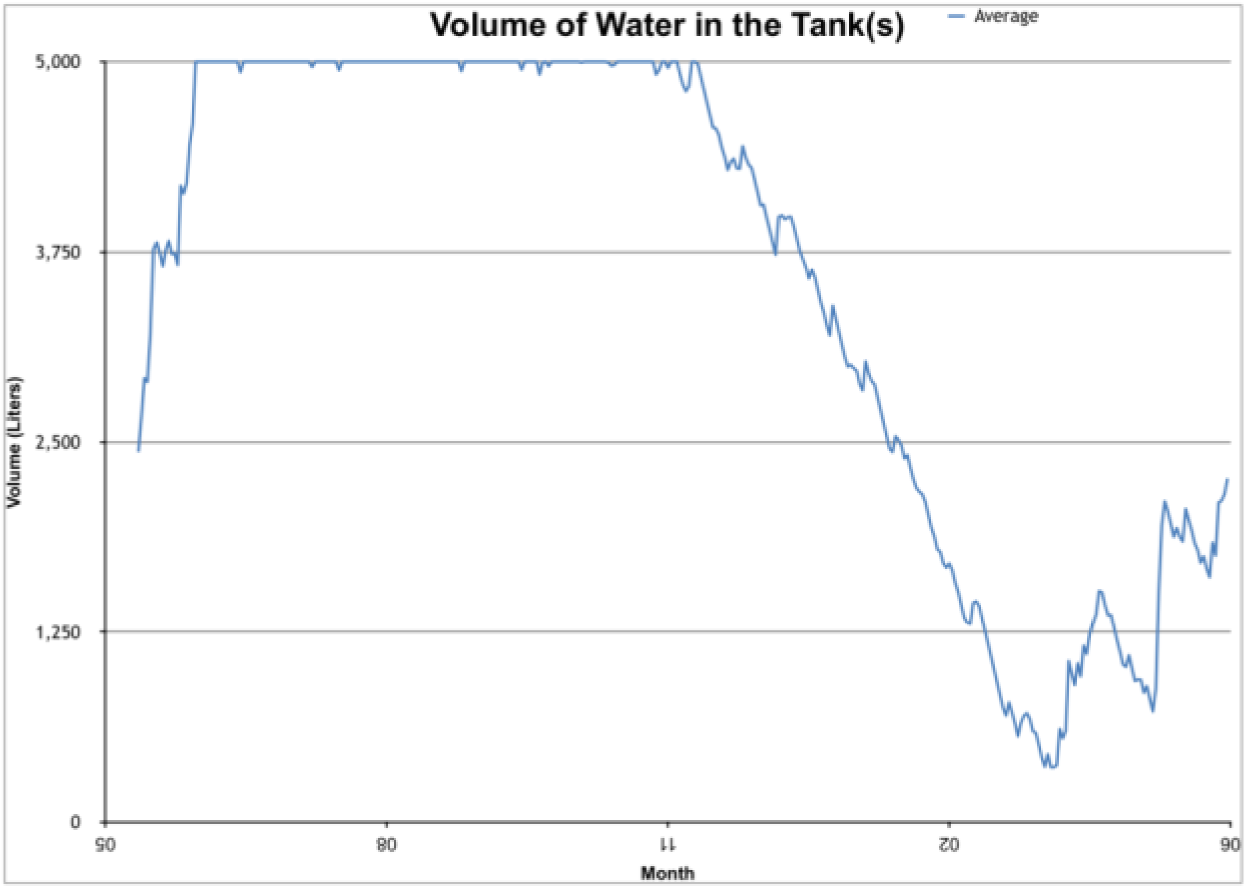


**Figure 23: Graph for 7 people sharing 5000 L from 56 m2 roof**

 

## Domingo (House 18)

10 people in the house

**Existing Tanks**

| | |
|---|---|
| Government: | 0 |
| Embassy: | 0 |
| Other: | 0 |

**Existing Roof Area**

100.1 $m^2$

**Plan for Implementation**

How many tanks: 2 – 2500L

Two-Tank Base: 1.52m x 3.66m

**Figure 24: View of Domingo's house from the road.**

1 First flush unit is necessary in this implementation. The options are:

- For the House roof 1:
  - (4" Diameter PVC)-247.2 cm long
  - (3" Diameter PVC)-439.4 cm long

Gutter Length: 14.3 m

**Agreed Work to be done Before May**

List of items to be done by the family before May (clear land, raise roof, etc.)

- Raise patio roof 15cm
- Cut off the roofing that is being use as the gutter

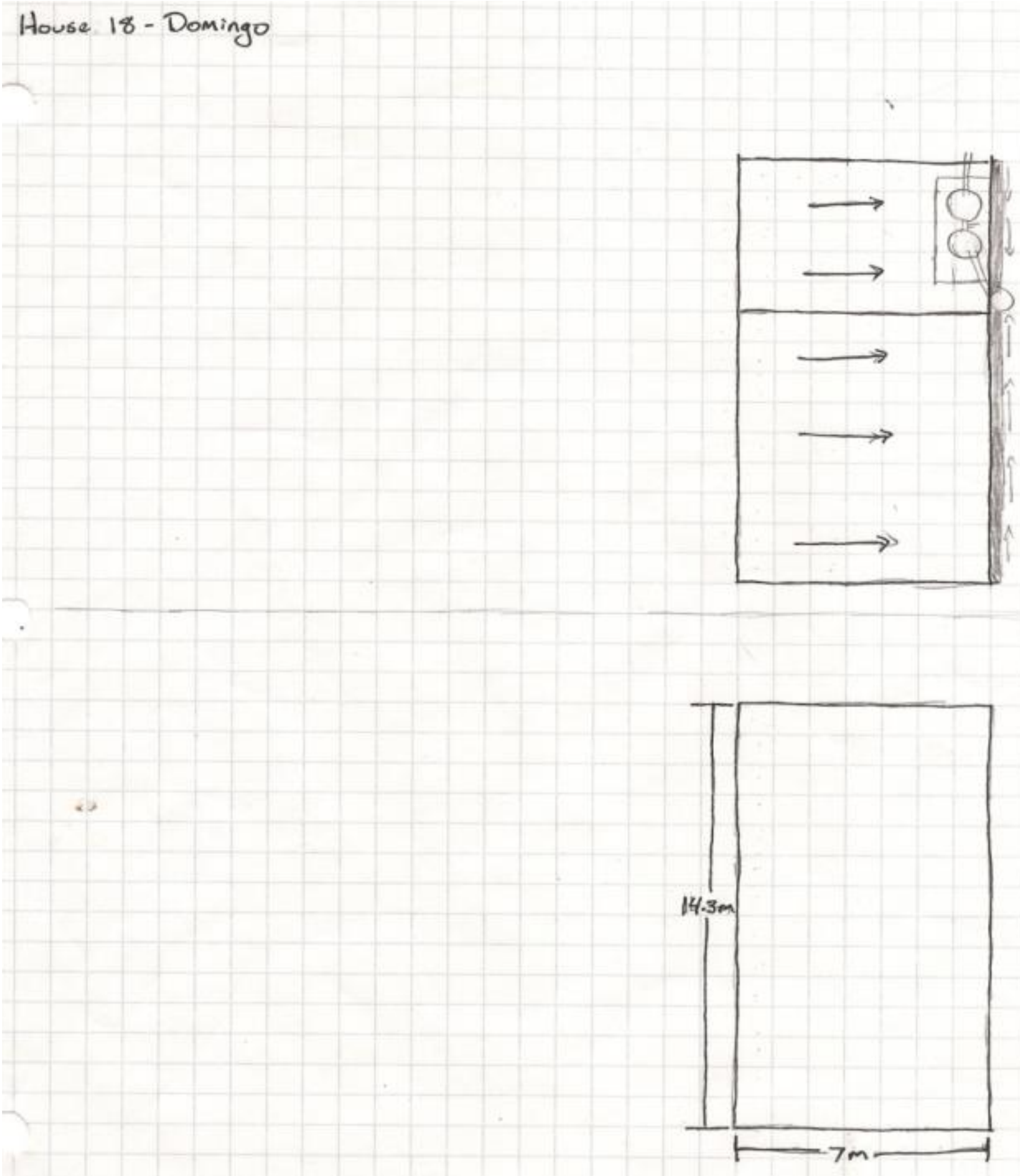


**Figure 25: House 18 Sketch**

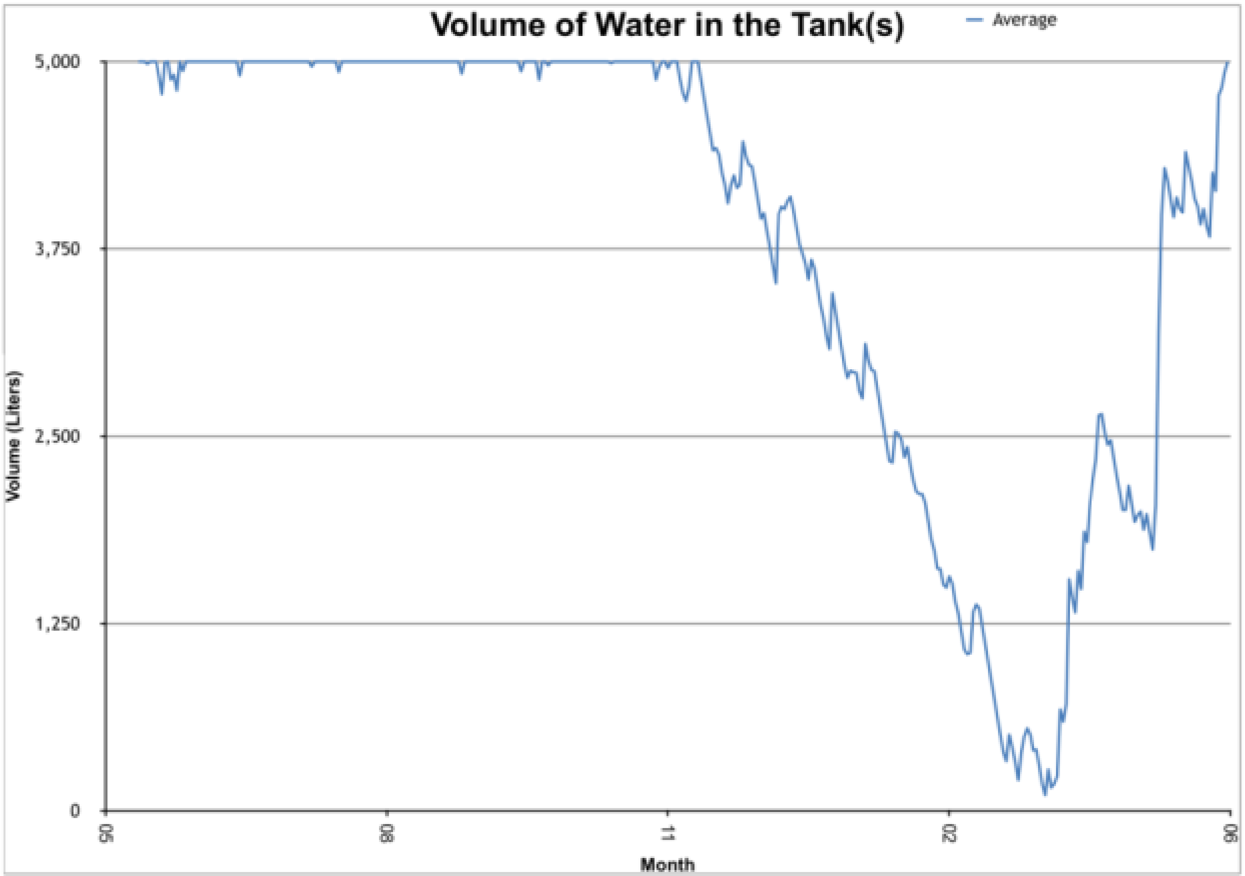


**Figure 26: Graph for 10 people sharing 5000 L from 100 m2 roof**

## Miguel Caj Pop (House 21)

**Figure 27: Photo of government tank at Miguel's house.**

7 people in the house

**Existing Tanks**

| | |
|---|---|
| Government: | 1-2500L |
| Embassy: | 0 |
| Other: | 0 |

**Existing Roof Area**

22.5 $m^2$ for the house roof

17.86 $m^2$ for the government roof

**Plan for Implementation**

How many tanks: 1 – 2500L

Use existing cement base

2 First flush unit is necessary in this implementation. The options are:

- For the House roof:
  - (4" Diameter PVC)-60 cm long
  - (3" Diameter PVC)-71 cm long
- For the Government roof:
  - (4" Diameter PVC)- 48 cm long
  - (3" Diameter PVC)-78 cm long

Gutter Length: Two lengths of 5 m each

Updates to government tank:

- First Flush on the government system will need the proper adaptors/bulkheads
- Proper overflow will be installed on the government tank.

**Agreed Work to be done Before May**

List of items to be done by the family before May (clear land, raise roof, etc.)

- Modify the direction of the roof (for the water to flow in the same direction)
- Install lid on the government tank

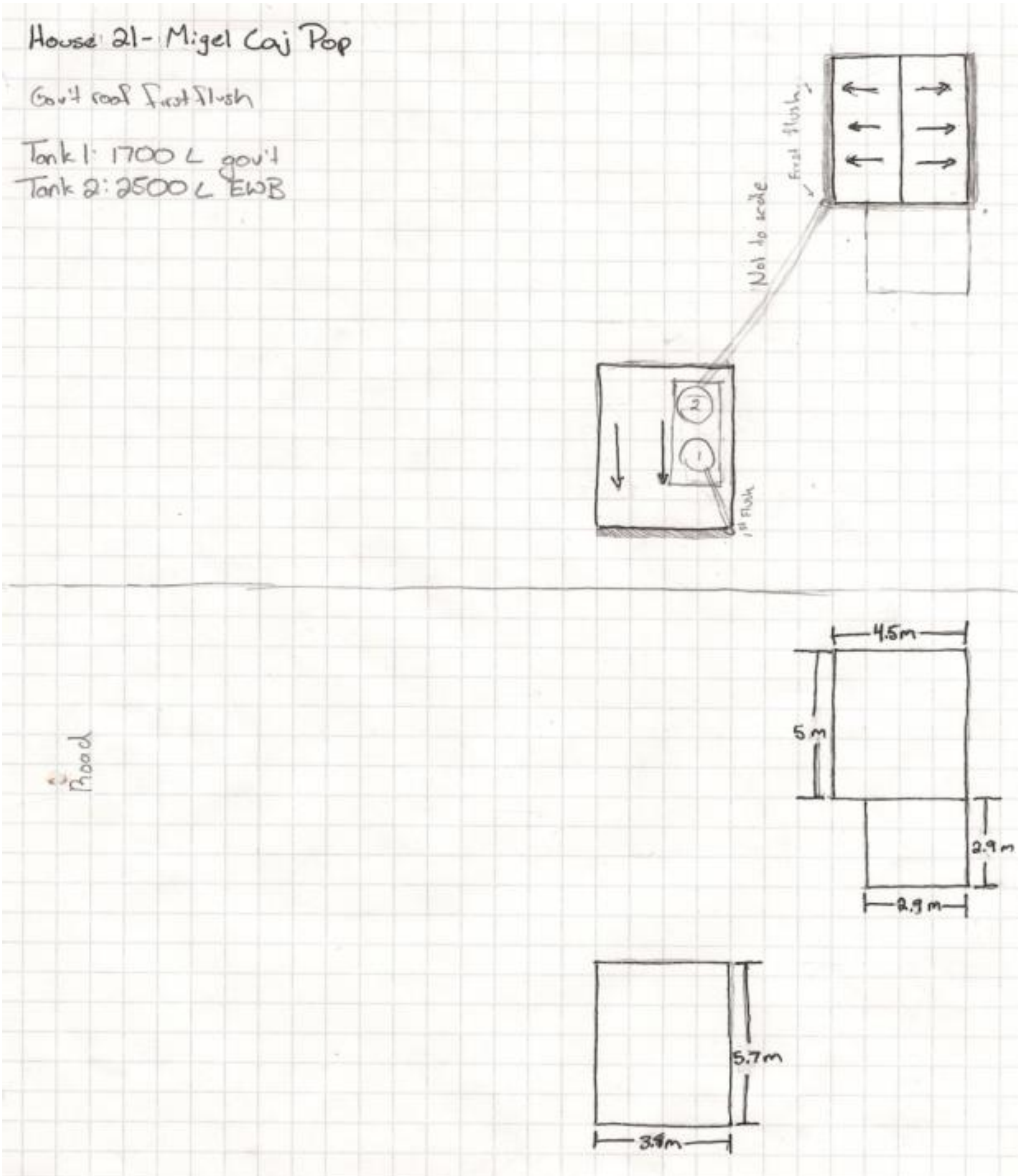


Figure 28: House 21 Sketch

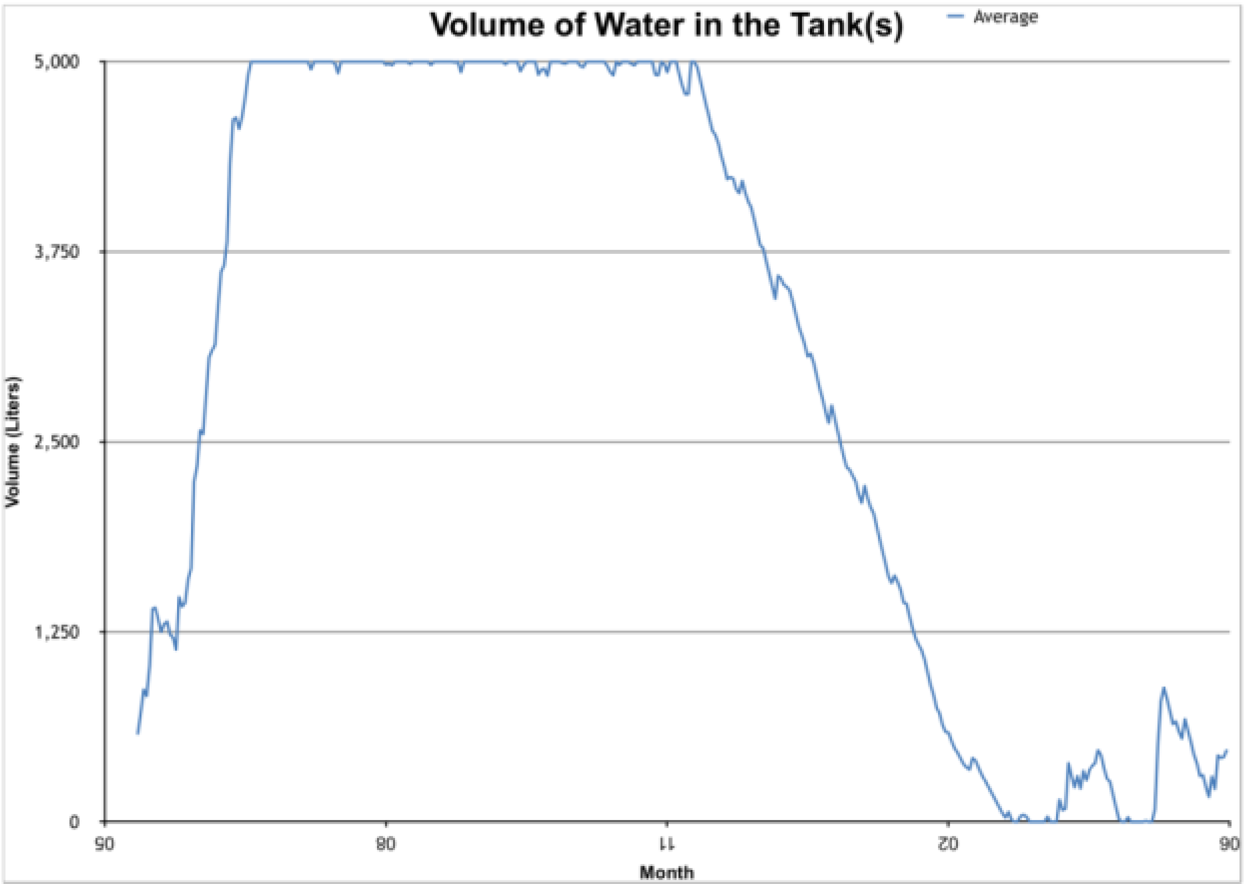


**Figure 29: Graph for 7 people sharing 5000 L from 40 m$^2$ roof**

## Alfonzo Xona (House 28)

5 people in the house

**Existing Tanks**

Government: 0
Embassy: 1-5000L concrete tank
Other: 0

**Existing Roof Area**

57.04 $m^2$

**Plan for Implementation**

**Figure 30: View of the front of Alfonso's house.**

How many tanks: 1 – 2500L

One 1 Tank Base: 1.52m x 1.52m

- Next to the lower unused roof

1 First flush unit is necessary in this implementation. The options are:

- For the House roof:
  - (4" Diameter PVC)-92.9 cm long
  - (3" Diameter PVC)-165.2 cm long

Gutter Length: 9.9 m

The roof area and first flush length may depend on the actual size of the roof after it is reconstructed.

**Agreed Work to be done Before May**

List of items to be done by the family before May (clear land, raise roof, etc.)

- Construct the roof for the tank
- Prepare the area for the base
- Collect small or medium stone

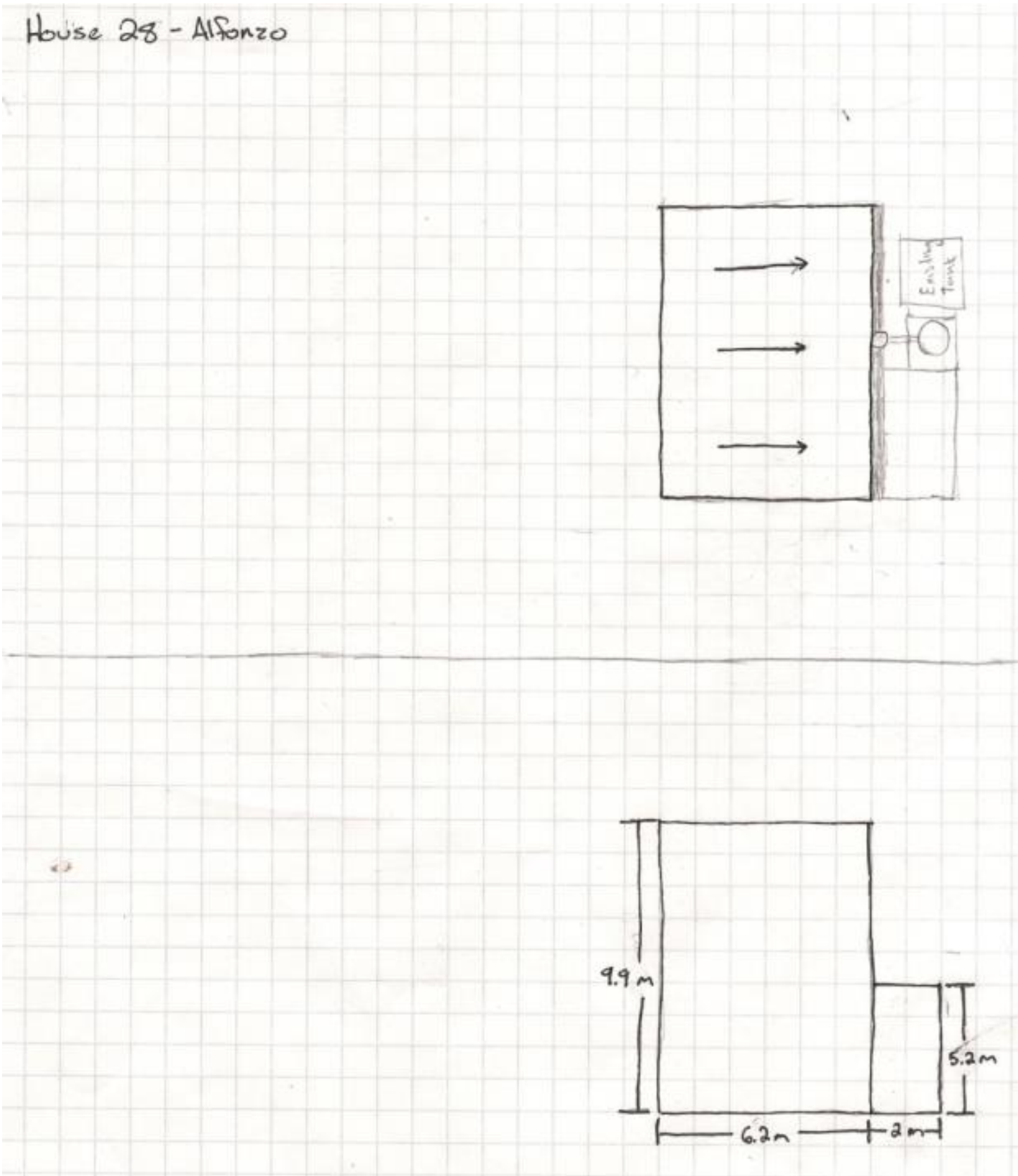


**Figure 31: House 28 Sketch**

 

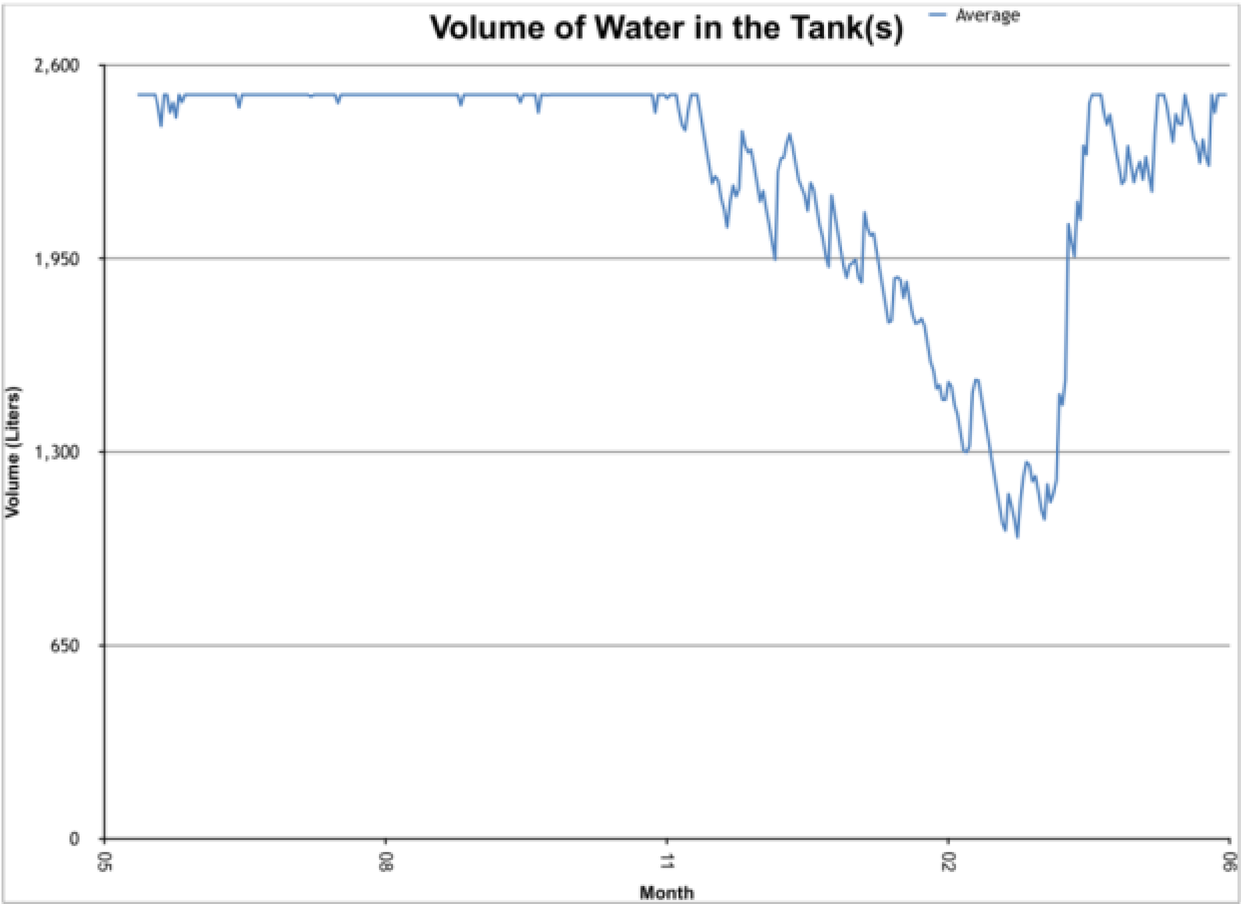


**Figure 32: Graph for 5 people sharing 2500 L from 61 m$^2$ roof**

 

## Ricardo Gualim (House 29)


**Figure 33: View of Ricardo's house from the road.**

6 people live in the house

**Existing Tanks**

| | |
|---|---|
| Government: | 1 – 2500L |
| Embassy: | 0 |
| Other: | 0 |

**Existing Roof Area**

77.97 $m^2$

**Plan for Implementation**

How many tanks: 1 – 2500L

One 1 Tank Base: 1.52m x 1.52m

1 First flush unit is necessary in this implementation. The options are:

- For the House roof:
    - (4" Diameter PVC)-300 cm long
    - (3" Diameter PVC)-533.2 cm long

Gutter Length: 8m

Updates to the government tank:

- 1 first flush with 3" male connecter.
- Need patches for broken hole on the tank.

**Agreed Work to be done Before May**

List of items to be done by the family before May (clear land, raise roof, etc.):

- He has to prepare the spot to put the base.
- Cut off the roof that is going in the wrong direction that is currently used as his gutter.

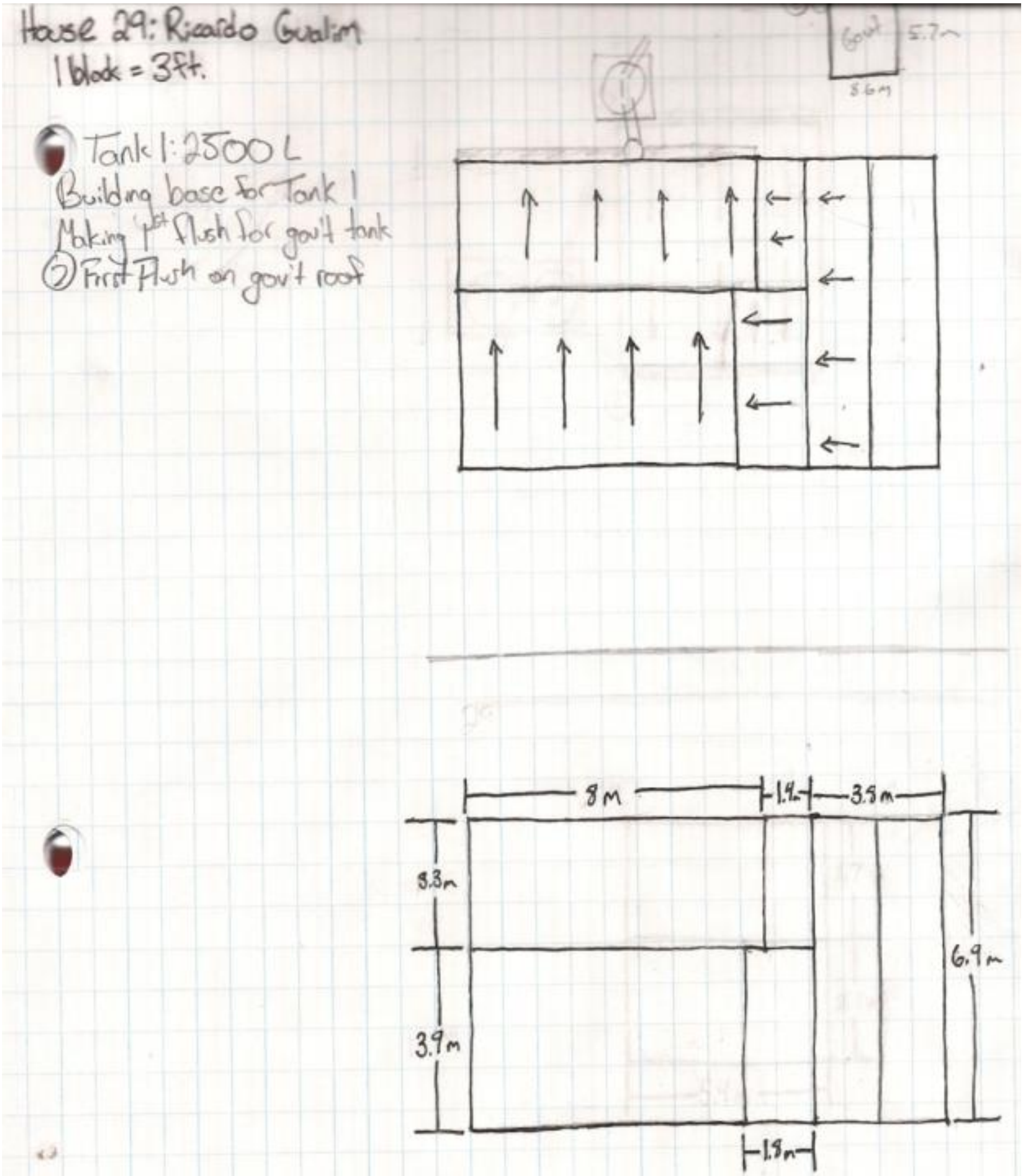


**Figure 34: House 29 Sketch**

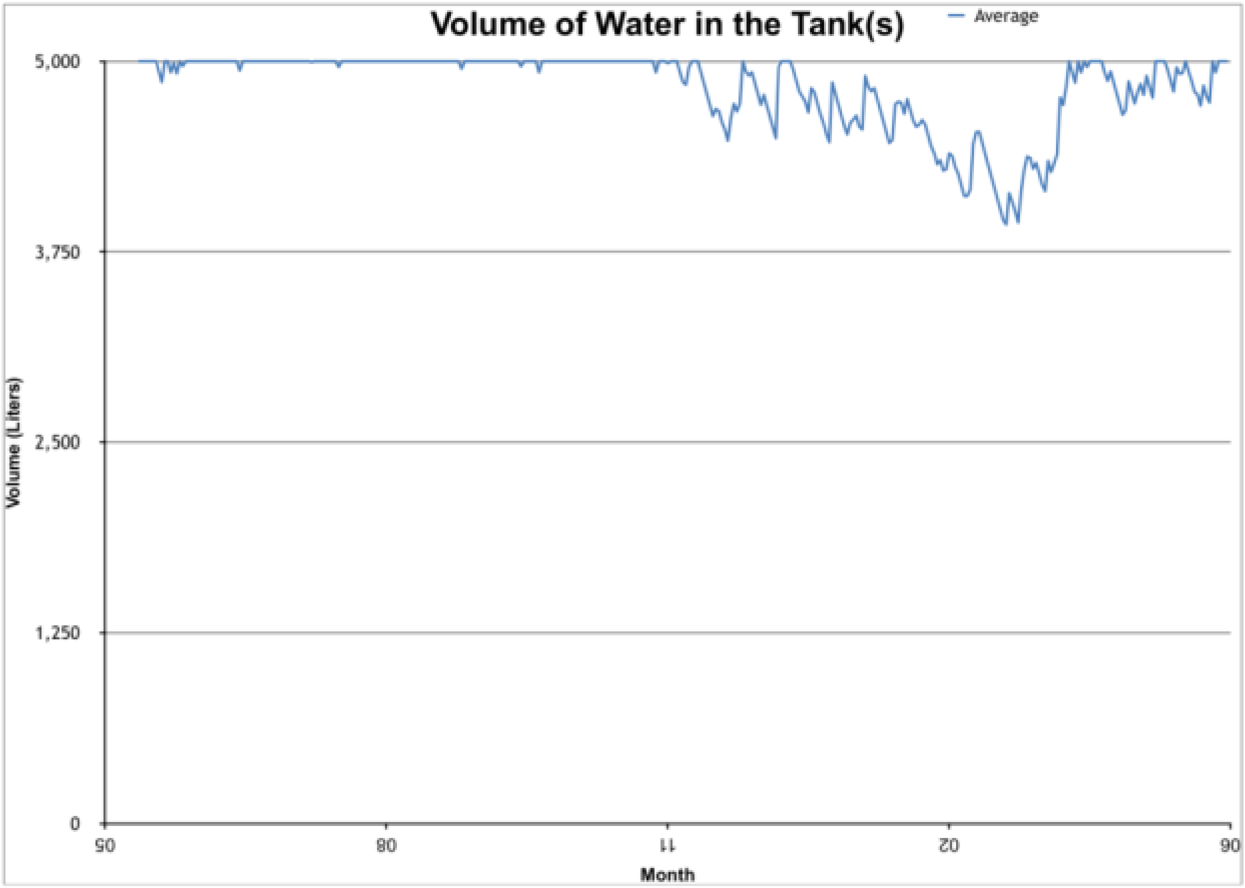


**Figure 35: Graph for 7 people sharing 5000 L from 98 $m^2$ roof**

## Marcela Cal Chun (House 31)

7 people living in the house

**Existing Tanks**

| | |
|---|---|
| Government: | 1-2500L |
| Embassy: | 0 |
| Other: | 0 |

**Existing Roof Area**

26.5 $m^2$ house roof 1

48.9 $m^2$ house roof 2

**Figure 36: Government tank at Marcela's house.**

**Plan for Implementation**

How many tanks: 1 – 2500L

Use existing cement base.

2 First flush unit is necessary in this implementation. The options are:

- For the house roof 1:
    - (4" Diameter PVC)-17.3 cm long
    - (3" Diameter PVC)-30.7 cm long
- For the house roof 2:
    - (4" Diameter PVC)-59 cm long
    - (3" Diameter PVC)-104.9 cm long

Gutter Length: 7.9 m, 4.9 m, 3.8 m

Updates to the government tank:

- The new EWB-USA WPI implemented tank will overflow into the existing government tank.
- A new overflow will be installed on the existing government tank.

**Agreed Work to be done Before May**

List of items to be done by the family before May (clear land, raise roof, etc.)

- Prepare the spot where the pipe runs through the house (the kitchen area)
- Clear off the existing tank base to make room for the new tank.

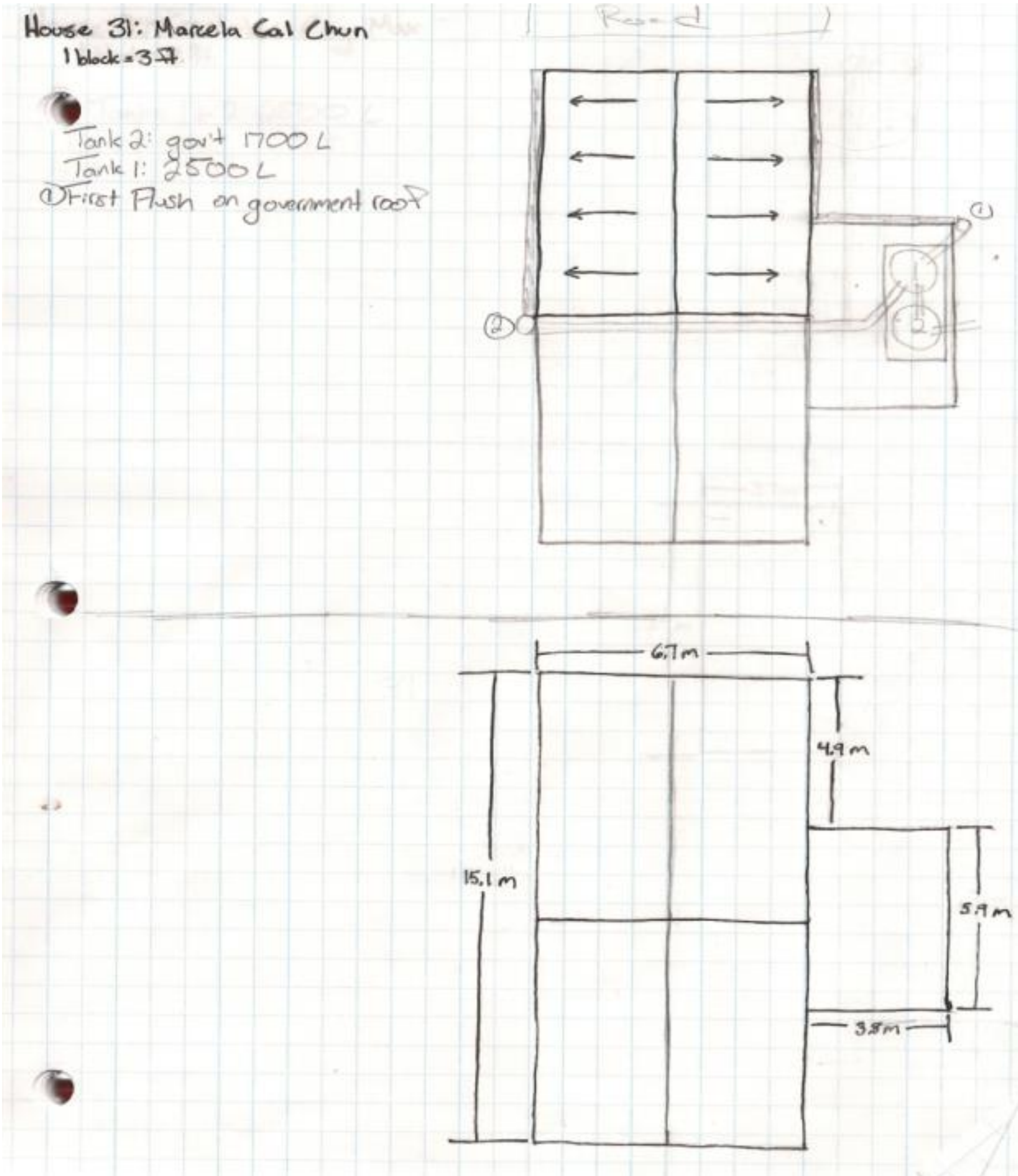


**Figure 37: House 31 Sketch**

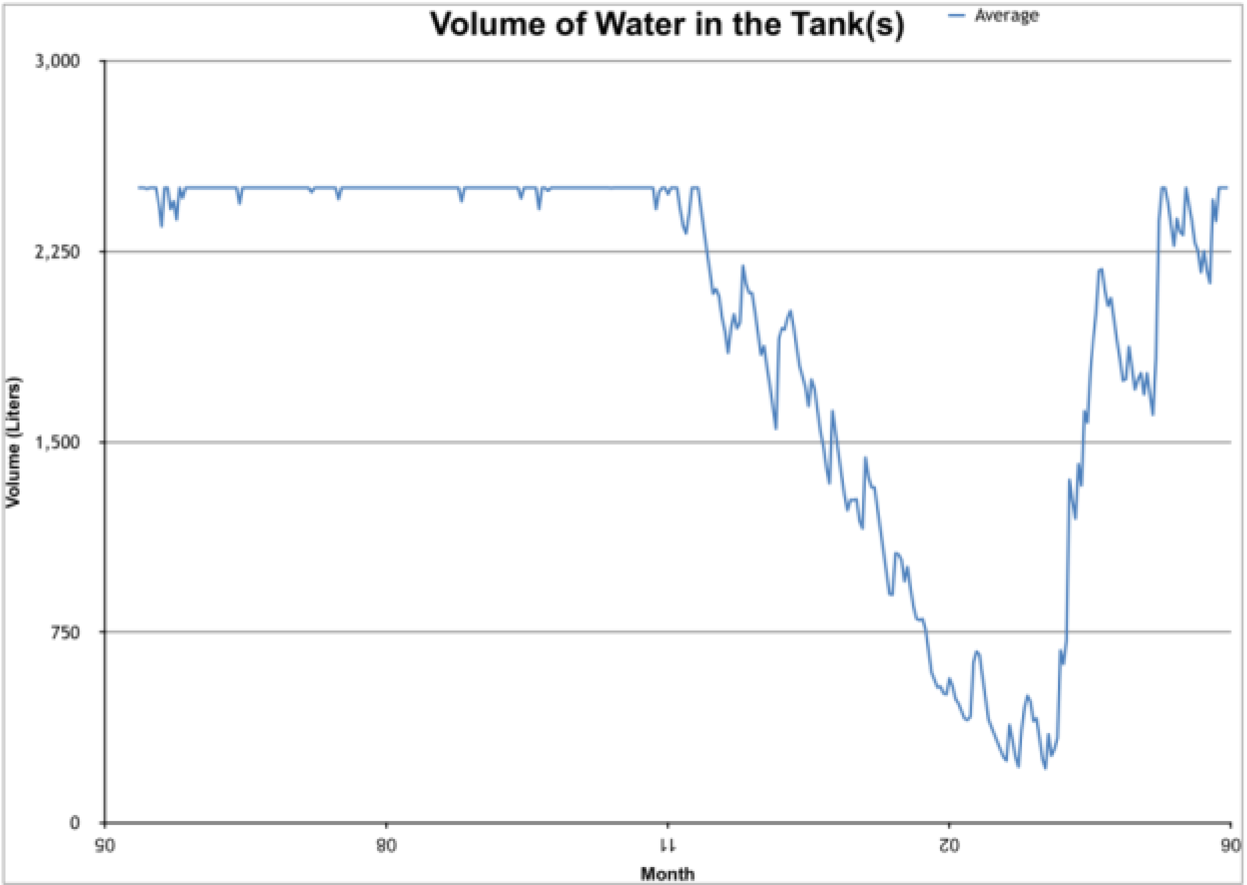


**Figure 38: Graph for 7 people sharing 5000 L from 75 $m^2$ roof (additional gov't 2500 L tank)**

 

**List of Totals Being Implemented**
12 Total First Flushes
13 Overflows
4 bases (2 tank)
2 bases (1 tank)
11 Rotoplas tanks

**Table 4: Elements of Rainwater Harvesting System Planned per Household**

| Home | 1st Flush | Overflow | Tank | Base (2 tank) | Base (1 tank) |
|---|---|---|---|---|---|
| 5 | 1 | 1 | 2 | 1 | 0 |
| 9 | 2 | 2 | 2 | 1 | 0 |
| 16 | 1 | 2 | 1 | 1 | 0 |
| 18 | 1 | 1 | 2 | 1 | 0 |
| 21 | 2 | 2 | 1 | 0 | 0 |
| 28 | 1 | 1 | 1 | 0 | 1 |
| 29 | 2 | 2 | 1 | 0 | 1 |
| 31 | 2 | 2 | 1 | 0 | 0 |

 

### *Material Allocation per House by System Component*

**Table 5: Materials to build each concrete base.**

| Base Quantities | House 5 (2) | House 9 (2) | House 16 (2) | House 18 (2) | House 21 | House 28 (1) | House 29 (1) | House 31 | Totals |
|---|---|---|---|---|---|---|---|---|---|
| Plastic Covering for Concrete (72") [yd] | 5 | 5 | 5 | 5 | 0 | 5 | 5 | 0 | 30 |
| Tie Wire [ft] | 3 | 3 | 3 | 3 | 0 | 3 | 3 | 0 | 18 |
| Cinder Blocks | 50 | 50 | 50 | 50 | 0 | 25 | 25 | 0 | 250 |
| Ready Mix Concrete 50kg | 28 | 28 | 28 | 28 | 0 | 14 | 14 | 0 | 140 |
| 2"x4"x12' wood | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 8 |
| 2"x4"x5' wood | 2 | 2 | 2 | 2 | 0 | 4 | 4 | 0 | 16 |
| Rocks [m3] | 0.50 | 0.50 | 0.50 | 0.50 | 0.00 | 0.25 | 0.25 | 0.00 | 2.50 |
| 2 L Bottles | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 12 |
| 1/4" Rebar | 15 | 15 | 15 | 15 | 0 | 15 | 15 | 0 | 90 |
| 3/4" Crushed Stone | 0.50 | 0.50 | 0.50 | 0.50 | 0.00 | 0.50 | 0.50 | 0.00 | 3.00 |
| Water [L] | 154 | 154 | 154 | 154 | 0 | 78 | 78 | 0 | 772 |

**Table 6: Materials to build gutter connections at each home.**

| Gutters | House 5 | House 9 | House 16 | House 18 | House 21 | House 28 | House 29 | House 31 |
|---|---|---|---|---|---|---|---|---|
| 3" Downspout | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 2" Downspout | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 |
| Gutter Caps | 2 | 6 | 2 | 2 | 4 | 2 | 2 | 4 |
| Gutter Unions | 1 | 2 | 1 | 1 | 0 | 1 | 0 | 1 |
| Gutters (6m) | 2 | 5 | 2 | 3 | 2 | 2 | 2 | 4 |

**Table 7: Materials needed to construct the first flushes at each home.**

| First Flush | House 5 | House 9 | House 16 | House 18 | House 21 | House 28 | House 29 | House 31 |
|---|---|---|---|---|---|---|---|---|
| 2" PVC Tube (6m) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1.5" PVC Tube (6m) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 4" x 2" Reducer | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 |
| 4" x 1.5" Reducer | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 |
| 4" PVC Tube (6m) | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| 1.5 Male Adaptor | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 4 |
| 1.5" Italy Valve (metal) | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 |
| 1.5" x 45 deg elbow | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 |
| 4" union | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 4 |
| Water Bottle | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 |

**Table 8: Materials need to build overflows at each home.**

| Overflow Quantities | House 5 | House 9 | House 16 | House 18 | House 21 | House 28 | House 29 | House 31 |
|---|---|---|---|---|---|---|---|---|
| Rotoplas Tank Inlet | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 |
| 1.5" PVC Tube (6m) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 1.5 Male Adaptor | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 |
| 1.5" PVC Elbow | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 |
| 1.25" PVC Tube (6m) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Mosquito Netting | As needed | As needed | As needed | As needed | As needed | As needed | As needed | As needed |

 

**Table 9: Materials needed to make the connections between the gutter downspout and the tank inlet.**

| To Tank | House 5 | House 9 | House 16 | House 18 | House 21 | House 28 | House 29 | House 31 |
|---|---|---|---|---|---|---|---|---|
| 2" PVC Elbow | 4 | 8 | 4 | 4 | 4 | 4 | 4 | 8 |
| 2" PVC Tee | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 |
| 2" PVC Tube (6m) | 1 | 2 | 2 | 1 | 3 | 1 | 1 | 2 |
| 2" x 1.5" Reducer | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 |
| 1.5" PVC Tube (6m) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Rotoplas Tank Inlet | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 |
| 1.5 Male Adaptor | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 |
| Mosquito Netting [yd] | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

**Table 10: Materials needed to create tank connections, if necessary.**

| Tank Connections | House 5 | House 9 | House 16 | House 18 | House 21 | House 28 | House 29 | House 31 |
|---|---|---|---|---|---|---|---|---|
| 1.5" Male connector | 2 | 4 | 2 | 2 | 0 | 0 | 0 | 0 |
| 1.5" Female Connector | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1.5" PVC Tube (6m) | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1.5" PVC Tee | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| .5" Faucet | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |

## *Complete List of Materials*

**Table 11: Materials List for Implementation**

| Overall Materials | House 5 | House 9 | House 16 | House 18 | House 21 | House 28 | House 29 | House 31 | Summation | Price per Part | Total Price [Q] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2" PVC Tube (6m) | 2 | 3 | 3 | 2 | 4 | 2 | 2 | 3 | 21 | 95.8 | 2011.8 |
| 1.5" PVC Tube (6m) | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 28 | 68 | 1904 |
| 1.25" PVC Tube (6m) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 48 | 384 |
| 4" PVC Tube (6m) | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 4 | 198 | 792 |
| 4" x 2" Reducer | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 11 | 12 | 132 |
| 4" x 1.5" Reducer | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 11 | 25 | 275 |
| 2" x 1.5" Reducer | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 10 | 10 | 100 |
| 1.5" PVC Elbow | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 13 | 9 | 117 |
| 2" PVC Elbow | 4 | 8 | 4 | 4 | 4 | 4 | 4 | 8 | 40 | 9.4 | 376 |
| 1.5" PVC Tee | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 5 | 9.75 | 48.75 |
| 2" PVC Tee | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | 0 | 15.8 | 0 |
| 1.5" x 45 deg elbow | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 11 | 12 | 132 |
| 1.5 Male Adaptor | 6 | 10 | 9 | 6 | 5 | 6 | 5 | 8 | 55 | 5.6 | 308 |
| 1.5" Italy Valve (metal) | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 11 | 90 | 990 |
| 4" union | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 4 | 22 | 25.5 | 561 |
| Water Bottle | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 11 | 0 | 0 |
| Rotoplas Tank Inlet | 2 | 4 | 3 | 2 | 3 | 2 | 3 | 4 | 23 | 20 | 460 |
| Mosquito Netting (1 yd) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 8 | 24 | 192 |
| Plastic Covering for Concrete (72") | 5 | 5 | 5 | 5 | 0 | 5 | 5 | 0 | 30 | 14 | 420 |
| Tie Wire | 3 | 3 | 3 | 3 | 0 | 3 | 3 | 0 | 18 | 7 | 126 |
| Cinder Blocks | 50 | 50 | 50 | 50 | 0 | 25 | 25 | 0 | 250 | 3.2 | 800 |
| Ready Mix Concrete 50kg | 28 | 28 | 28 | 28 | 0 | 14 | 14 | 0 | 140 | 42.75 | 5985 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2"x4"x12' wood | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 8 | 40 | 320 |
| 2"x4"x5' wood | 2 | 2 | 2 | 2 | 0 | 4 | 4 | 0 | 16 | 20 | 320 |
| Rocks | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0.25 | 0.25 | 0 | 2.5 | 0 | 0 |
| 2 L Bottles | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 12 | 25 | 300 |
| 1/4" Rebar | 15 | 15 | 15 | 15 | 0 | 15 | 15 | 0 | 90 | 11 | 990 |
| 3/4" Crushed Stone | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 0 | 3 | 235 | 705 |
| Water [L] | 154 | 154 | 154 | 154 | 0 | 78 | 78 | 0 | 772 | 0 | 0 |
| .5" Faucet | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 5 | 17 | 85 |
| 1.5" Female Connector | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 5 | 10 | 50 |
| Rotoplas Tanks | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 11 | 2306 | 25366 |
| 3" Downspout | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 36 | 36 |
| 2" Downspout | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 11 | 36 | 396 |
| Gutter Caps | 2 | 6 | 2 | 2 | 4 | 2 | 2 | 4 | 24 | 16 | 384 |
| Gutter Unions | 1 | 2 | 1 | 1 | 0 | 1 | 0 | 1 | 7 | 15.9 | 111.3 |
| Gutters (6m) | 2 | 5 | 2 | 3 | 2 | 2 | 2 | 4 | 22 | 259 | 5698 |
| Totals (Queztal) | | | | | | | | | | | **45377.05** |

The above materials list is a complete list of the materials that will me ordered before travelling to Guatemala. This is due to that fact that even though all of these materials are available locally, they are not available in such large quantities. All PVC pieces, gutter materials, valves, and tools will be ordered from Millennium, a hardware store in San Cristobal. The crushed stone, rebar, ready mix concrete, and cinder blocks will be purchased from Macsam's (ContruRED), another hardware store in San Cristobal. All wood is purchased from a small, family owned store that is located en-route to Guachthu'uq. The Rotoplas 2500L tanks will be ordered directly from Rotoplas and delivered to San Cristobal.

### *Material Storage and Transport Logistics*

Due to the scale of this implementation, much care and planning has gone into organizing appropriate transportation and storage of construction materials. The municipality of San Cristobal has assisted with transport of materials during the previous implementation, and has agreed to assist on future implementations. The municipality will provide, free of charge, storage for materials and transport of those materials to Guachthu'uq. The materials ordered prior to the implementation date will either be stored at the store of purchase or stored on municipality grounds. The transport of materials will be coordinated with the municipality prior to the team's arrival in San Cristobal, and will occur in the morning during a working day.

 

The organization of transport of materials will occur in two stages. This is highlighted in the trip itinerary. The storage and drop off of materials will be overseen by two members of the EWB-USA WPI team, who have the designated responsibility to keep track of materials. They will each accompany one truck to Guachthu'uq during transport, and will make sure the necessary materials are unloaded at the correct homes. They will continue this responsibility throughout the trip, keeping records of materials used at each home, locations of materials, and any extra purchases made. Designation of these roles will help the implementation run smoothly, and lower the chances of set-backs during construction due to misplaced materials.

On the first Saturday of the trip, May 10th, a few members of the team will go to Macsams to pick up all pre-purchased materials and order more if necessary. Macsams has their own delivery truck, and its service is free with purchase of construction material. The crushed stone, rebar, cinder blocks, and tie wire will be transported from Macsams to Guachthu'uq during the morning of the 10th. Macsams has agreed to make a quick stop at the wood store on the way up to Guachthu'uq, where other members of the team will have made the necessary wood purchases for the frames for the concrete bases that morning. With wheelbarrows already stored with the Water Committee in Guachthu'uq, this marks all of the necessary material to start laying the stone and wooden frames for the concrete bases.

On the following Monday, May 12th, two trucks from the San Cristobal municipality will transport all the remaining materials (PVC, gutters, tanks, ready mix concrete) to Guachthu'uq. The loading and un-loading of materials will be quick and efficient since there are four to five municipality employees per truck, and each of the eight families that are being implemented on will assist. Pending availability of water at the Finca during this time for preparation of concrete bases, the municipality may also provide a water truck which will fill four tinajas (50 gallon drums) with water to be used for mixing of concrete. Occasionally the Finca runs low during this time of year, so it would be irresponsible to take water that is used by surrounding communities for drinking and cooking to lay concrete bases.

If any other materials are needed during the remainder of the trip, they will either be carried up by members of the EWB-USA WPI team or transported with the van that runs from the center of San Cristobal to the base of Guachthu'uq.

 

## 2.2 Monitoring

The project in Guachthu'uq is monitored in three ways: first, Alvaro surveys the community bi-weekly; second, the team conducts water quality tests; and third, the team conducts interviews during each trip.

### *Monitoring Forms*

In the time leading up to the May 2014 implementation trip, Alvaro will be utilizing new monitoring forms created by the EWB-USA WPI travel team (Appendix B). The first form is for houses that will be implemented on during the May 2014 trip. The families will be asked where they get their water from, how long they spend collecting water, and which member collects the water. If the family already has a tank that was not installed by EWB, they are asked how they maintain it.

The second form is for the four houses that have already been implemented on during previous EWB-USA WPI trips. The first questions are identical to those from the first form. It then asks if the system is functioning properly, how the family is maintaining the system, and if they are content with the system in general. The goal of this is to gauge how effective the rainwater harvesting systems are and to ensure the families are maintaining their systems as they have been instructed. The form reminds Alvaro to check each system to make sure the first flush has no water in it, the gutters are clean, and the mosquito netting in the gutters is clear of debris.

The final form is a checklist for Alvaro to fill out as he interviews each family. He is instructed to write notes on updates of the community and general attitudes from the families towards the systems. This form also serves as a guide for Alvaro to monitor each house's preparedness for implementation. All eight homes that will be receiving EWB systems on the May 2014 trip have been given a specific set of requirements that they must complete by the time the travel team arrives. Examples of these requirements range from clearing space for the tanks to raising or expanding the roof to make it feasible for the gutter system. This form will allow Alvaro to make sure each house has complied with the instructions set by EWB-USA WPI and is prepared prior to the arrival of the travel team.

### *Water Quality*

Continuous monitoring of water quality is essential to gauging the potability of water from the various sources accessible to the community and improving system design as necessary. Based on previous water quality tests conducted on EWB-USA WPI trips, bacteria presence is of primary concern. During this implementation trip, the team will continue using the Colilert Protocol tube tests and Petrifilm Protocol tests as used in January 2014. The Colilert test will indicate the presence of bacteria based on color change and presence of E. coli based on fluorescence under a black light. The Petrifilm test will indicate presence of bacteria colonies (red) and the presence of E. coli (blue). Each sample source will be subjected to three trial tests of each type and results will be documented on the "Water Quality Data Sheet" forms in Appendix B.

 

**Colilert**

To conduct the Colilert test, the following procedure will be used:
Collect water samples in special plastic bags, "Whirl-paks"
Mark the test tube cap and body with location, sample number, date, and initials
Invert the "Whirl-paks" to homogenize the sample
Insert a new plastic dropper into the "Whirl-pak" water sample, so liquid will be collected in the dropper (do not touch the dropper tip)
Each tube will be filled to ~10mL
Tightly recap and invert until chemicals dissolve

**Figure 39: Body Incubation**

Incubate for 21-22 hours at body temperature (tests can be placed close to the body as seen in Figure 39)
Check test color (yellow means coliform bacteria is present)
Shine a black light on the tubes in the dark (fluorescing means E. coli is present)
Take pictures of test results

**Petrifilm Protocol**

To conduct the Petrifilm test, the following procedure will be used with the same "Whirl-pak" samples taken for the Colilert tests:
Remove test from bag (do not touch the layer between film)
Mark the test on the white layer with location, sample number, date, and initials
Insert a new plastic dropper into the "Whirl-pak" water sample, so liquid will be collected in the dropper (do not touch the dropper tip)
Lift the top white flap of the Petrifilm to expose the red circular region
Dispense 1mL of liquid onto the center of the red region
Manually remove any bubbles that may have formed using the dropper
Set the white flap back down (sample will start to spread and fill the red region; additionally use the spreader if necessary)
Allow the Petrifilm to sit for 1 minute so the sample solidifies into a gel
Place the Petrifilm between two pieces of cardboard (never touch the inside layer of the Petrifilm) and tape the four ends of the cardboard together temporarily
Incubate for 21-22 hours at body temperature. The test method used (developed by Prof. Robert Metcalf) can be incubated in a pouch using a person's body heat, as seen in Figure 39. This eliminates the need for procuring an incubator.

 

Remove Petrifilm from cardboard

Count colony formation (blue colonies with gas bubbles are E. coli and red colonies are bacteria)

Record results in spreadsheet and take pictures

**Methodology**

To begin to looking at seasonal variations in water quality, some locations will be re-tested on this trip. For instance, tests will be repeated at the Finca tap and basin to see if the chance in water flow during the dry season makes water quality any different than it is in January when water is plentiful. Other water sources will be tested to evaluate the effectiveness of system design elements meant to improve water quality (such as the first flush and tank filters). Additional tests will take place at homes where implementation will occur within the next year and at other places of interest.

The table below details definite test sources, the purpose for testing, and the number of trial tests (1 Colilert + 1 Petrifilm = 1 trial) to be conducted.

| Water Source | Purpose | # of Trials |
|---|---|---|
| Finca Tap | Change in quality during the dry season | 3 |
| Finca Basin | Change in quality during the dry season | 3 |
| House #26: Roberto's Government Tank | Effect of netting and first flush | 3 |
| House #26: Roberto's EWB Tank | Effect of netting and first flush | 3 |
| House #27: Cristobal's EWB Tank | New system from January 2014 | 3 |
| House #29: Ricardo Government Tank | Testing prior to making changes May 2014 | 3 |

The table below details potential test sources, the purpose for testing, and the number of trial tests (1 Colilert + 1 Petrifilm = 1 trial) to be conducted. The summation of these sets of 3 trials at each water source (both definite and selected potential sources) encompass one "experiment" to be conducted simultaneously. During the course of the trip, two experiments will be conducted on separate days to ensure consistency of data collection.

| Water Source | Purpose | # of Trials |
|---|---|---|
| House #31: Marcela's Government Tank | Testing prior to making changes May 2014 | 3 |
| House #26: Roberto's EWB Filter | Effectiveness of tank filter | 3 |
| House #27: Cristobal's EWB Filter | Effectiveness of tank filter | 3 |
| House #21: Miguel's Government Tank | Testing prior to making changes May 2014 | 3 |
| House #28: Concrete Tank | Water quality for less expensive tank option | 3 |

 

**Test Result Analysis**
All of the test results will be compiled to categorize the level of safety observed in each trial. This way, it will be clear how many trials were collected before indicating varying levels of safety at each source. The table below details the way the Colilert and Petrifilm test results should be interpreted to lead to this compilation.

| Risk Level | E. Coli/sample | Colilert Fluourescence | Petrifilm # Blue&gas |
|---|---|---|---|
| Low | <1/10 ml | - | 0 |
| Moderate | 1-10/10 ml | + | 0 |
| High | 1-10/ml | + | 1-10 |
| Very High | >10/ml | + | >10 |

***Interviews***
In our effort to better understand the dynamic cultural context of our project and the community, we will again conduct between 12 and 20 semi-structured interviews with community members throughout the implementation trip. There are three distinct groups of people who should be interviewed: one, the four families who received systems from us on implementation trips since January 2013; two, the eight families who will receive systems on the May 2014 trip; and three, the eight to ten families who will receive systems on the next implementation trip in May 2015. The questions for each interview will aim to prompt conversation about the following topics:

Water

Water use and sources (how much, where from, for what tasks)

How long does it take to go to the finca and how many people go?

How many trips per day?

How systems change the quantity, quality, and access to water

What factors contribute to water inequality among community members

Rainwater Harvesting Systems

Cleaning systems

Maintaining systems

Improvements made

Lifestyle changes

Community

The socio-political situation at the Finca

School and education

Role of Women

Other past tank programs

Perception of the COCODE, Water Committee, and Committee of Women

Personal

Review census data (age, number of family members)

Financial situation/work status

General information about living expenses, taxes, and other daily concerns

 

What is a tank worth? What is a system worth?

Over time, information gathered in the interviews will be used to evaluate the success of implementation. EWB-USA WPI will look for changes in water use and where water comes from, changes in the quantity, quality, and access to water, and evidence of community development as a result of knowledge gained through this project.

## 2.3 Education

To educate the community, the team has decided to use posters that the families in the community can use as reminders of ways to maintain the cleanliness of their water.

The team will work closely with three members of the community to facilitate the spread of knowledge throughout Guachthu'uq: The president of the Water Committee, Cristobal, the vice president of the Water Committee, Roberto Chojoc, and the midwife, Maria MoCristobal and Roberto are authority figures in the community. Maria already has a deep understanding of water quality and has experience spreading knowledge of water conservation, boiling/chlorinating water, and general health throughout the community. The team believes she will have the necessary skills and knowledge to pass on further concepts from EWB-USA WPI to other members of the community.

On the previous implementation trip the team discussed education strategies with our NGO, Sucy. She emphasized that this education material should be used as a reminder of good habits because many of the community members already know the proper ways to maintain their rainwater harvesting systems. The team also discussed that it is appropriate to use a red and green color scheme to represent bad and good practices in the pictorial education posters.

**Entire Community**
The following poster will presented to all of the families in the community.


**Figure 40: Boiling Water Education Poster**

The team encourages community members to boil their water for 10 minutes prior to use (Figure 40).

 

**Families with EWB System**


**Figure 41: Roof Maintenance**

Maintaining a clean system without roof and gutter debris is important to maintain a properly functioning first flush system and potable water (Figure 41).


**Figure 42: Cross-contamination Prevention and Water Use**

Separation of containers will help prevent cross-contamination of water from the Finca and tank water. This poster also illustrates the proper use of water from each respective source (tank water for drinking and cooking, Finca water for cleaning, washing and bathing) (Figure 42).

 

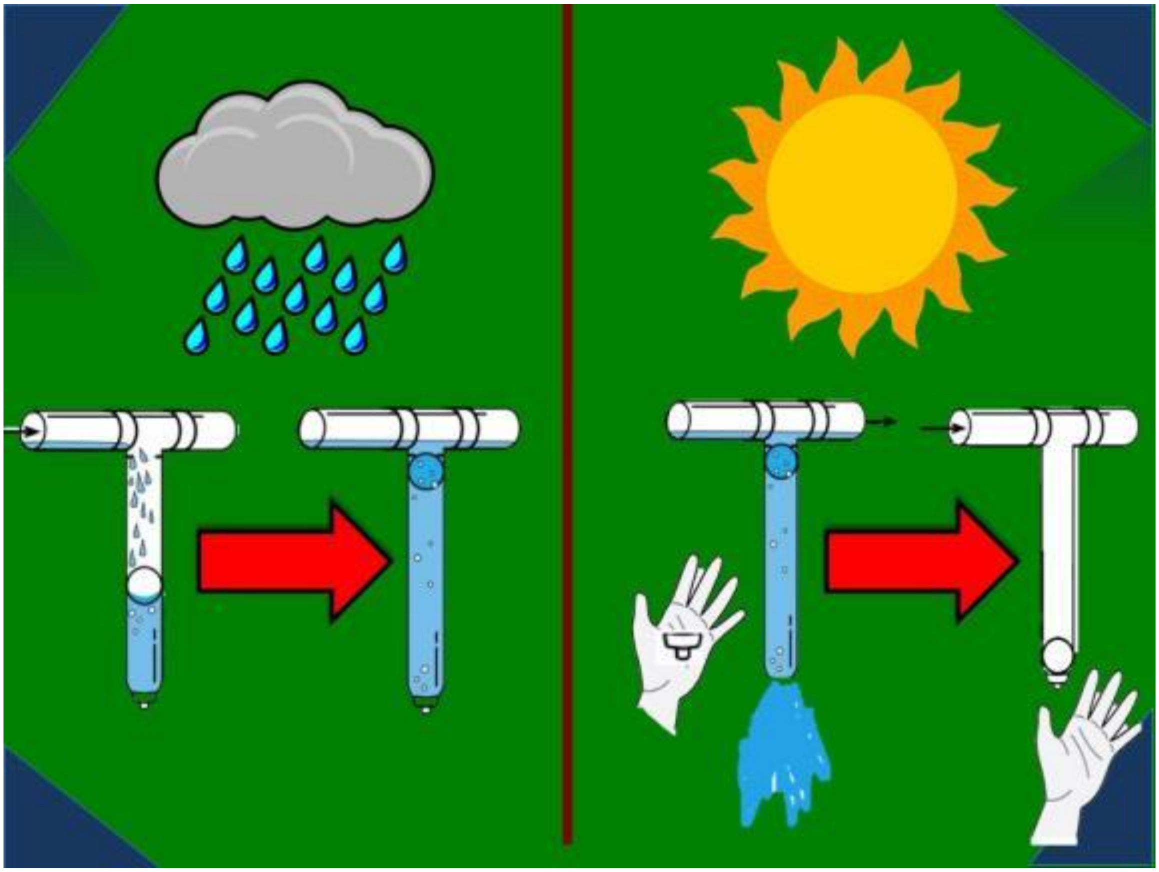

**Figure 43: First Flush Maintenance**

This poster illustrates proper maintenance and operation of the first flush system. When it starts to rain, the first flush will collect the initial rainfall and roof debris before allowing rainfall to collect in the tank. Once the rain stops, families must empty out the water collected in the first flush to prepare for the next rainfall and first flush catchment (Figure 43).

## 2.4 Contracts

The contracts discussed in section 1.3 Community Contracts (MOUs) will be used on this May 2014 implementation trip.

### *Picking the next set of homes*

The next set of homes to be implemented on in May 2015 will be chosen via need based assessment by the Water Committee with guidance from EWB-USA WPI.

### *Assessing the chosen set of homes*

After the Water Committee chooses the next homes from the census and EWB-USA WPI checks the list to be impartial and limit any favoritism, the team will assess the chosen homes. This process will consist of the following:
Pre assess the home for any existing system
Ask homeowner for his or her opinion on the system
Verify family information

 

Draw the site
Image the site
Make tentative plans for implementation
Analyze system after assessment
Make more concrete plans
Write out tasks for the family to prepare before next trip
Bring contracts to families for signatures

## 2.5 Itinerary

Day 1—Thursday, May 8th

1. Flight Boston → Guatemala City (arrive 2 or 3PM)
2. Van ride Guatemala City → San Cristobal (arrive 7 or 8PM)

Day 2—Friday, May 9th

1. 8AM: Team meeting at CeCEP
    a. Discuss trip plans with NGO and translators—Sucy and Alvaro
    b. Review materials that were pre-purchased
    c. Make list of materials that need to be purchased
2. 1PM: Separate into two groups
    a. Both groups visit Guachthu'uq to inspect the eight homes for implementation, check that they have prepared their land properly, and take note of changes made
3. 5PM: Water Committee Meeting
    a. Go through plans for trip, community meeting agenda, location to store construction materials/tools during implementation
    b. Choose next ten homes for implementation—planned for May 2015
4. 8:30PM: Finalize materials list for purchasing and coordinate agenda for next day

Day 3—Saturday, May 10th

1. 8AM: Team meeting at CeCEP with translators to go through itinerary
2. 9AM: Separate into three groups
    a. Group 1: Purchase necessary materials from Millenium (PVC fittings)
    b. Group 2: Purchase concrete base materials from Macsams (crushed stone, rebar, tie wire). Comes with free transport. Purchase wood for base frames on the way to Guachthu'uq.
    c. Group 3: Final preparations for education materials for community meeting (printing)
3. 11AM: Separate into two groups in Guachthu'uq.
    a. Begin set up for concrete bases (6 homes): spread stone, lay frames, set rebar.
    b. Begin assessments for future implementation homes.
4. 3PM: Community Meeting in afternoon
5. 5:30PM: Reconvene at CeCEP to debrief and go over next day itinerary

Day 4—Sunday, May 11th

 

1. 9:30AM: Team meeting at CeCEP to discuss logistics for Monday mass-material transport
2. 12:30PM: Separate into three groups
    a. Group 1: Finish implementation on House 1 and continue assessments for future homes (time pending)
    b. Group 2: First set of water quality tests
    c. Group 3: Two family interviews
3. 5PM: Reconvene at CeCEP to debrief and go over next day itinerary

Day 5—Monday, May 12th
1. 9AM: Material transport by municipality trucks to Guachthu'uq. Two team members will oversee delivery of all materials to proper locations.
    a. During this time the water quality test team members will have to go back to CeCEP to evaluate test results.
2. 12PM: Split up into two groups to do two concrete bases at two-four homes near each other. EWB team is split between those two groups to see and help with concrete bases (the two materials people are split between those two groups).
3. 5PM: Reconvene at CeCEP to debrief and go over next day itinerary.

Day 6—Tuesday, May 13th
1. 8AM: Team meeting at CeCEP to discuss plans for the day.
2. 9AM: Travel to Guachthu'uq and separate into three groups to finish the four-six bases.
3. 12PM: Reconvene for lunch.
4. 1PM: Separate into three groups.
    a. Group 1 and 2: Finish concrete bases.
    b. Group 3: Water quality tests or family interviews.
5. 5PM: Reconvene at CeCEP to debrief and go over next day itinerary.

Day 7—Wednesday, May 14th
1. 8:30AM: Team meeting at CeCEP to discuss plans for the day.
2. 9:30AM: Travel to Guachthu'uq and separate into two groups to begin hanging gutters and building first flushes. If extra time or people, a third group might form to conduct interviews.
3. 12PM: Two-three team members go to CeCEP to evaluate water quality results.
4. 5PM: Reconvene at CeCEP to debrief and go over next day itinerary.

Day 8—Thursday, May 15th
1. 8:30AM: Team meeting at CeCEP to discuss plans for the day.
2. 9:30AM: Travel to Guachthu'uq to separate into two groups.
    a. Group 1: Finish gutters.
    b. Group 2: Begin laying cinder blocks on the bases that were laid on Monday.
3. 5PM: Reconvene at CeCEP to debrief and go over next day itinerary.

Day 9—Friday, May 16th
1. 8:30AM: Team meeting at CeCEP to discuss plans for the day.

 

2. 10AM: Possible meeting with San Cristobal Mayor to thank for donation of trucks and continue relationship.
3. 12PM: Travel to Guachthu'uq and separate into three groups.
    a. Groups 1 and 2: Lay cinder blocks on bases that were finished on Tuesday, set up tanks, and build first flushes.
    b. Group 3: Conduct interviews or water quality tests.
4. 5PM: Reconvene at CeCEP to debrief and go over next day itinerary.

Day 10—Saturday, May 17th
1. 9AM: Team meeting at CeCEP to discuss plans for the day.
2. 10AM: Travel to Guachthu'uq and separate into three groups.
    a. Group 1: Finish tank connections, first flushes, and overflows.
    b. Group 2: Assess homes for next implementation.
    c. Group 3: Conduct family interviews.
3. 3PM: Community meeting.
4. 5:30PM: Reconvene at CeCEP to debrief and go over next day itinerary.

Day 11—Sunday, May 18th
1. 9AM: Team meeting at CeCEP to discuss plans for the day.
2. 10AM: Travel to Guachthu'uq and separate into three groups.
    a. Group 1: Finish tank connections, first flushes, and overflows.
    b. Group 2: Assess homes for next implementation.
    c. Group 3: Make changes to previously implemented systems if necessary (Houses 1, 8, 26, and 27)
3. 5PM: Reconvene at CeCEP to debrief and go over next day itinerary.

Day 12—Monday, May 19th
1. 8AM: Team meeting at CeCEP to discuss plans for the day.
2. 9AM: Travel to Guachthu'uq and separate into two groups.
    a. Group 1: Finish implementations.
    b. Group 2: Conduct interviews/water quality tests/assessments as needed.
3. 2PM: Reconvene in Guachthu'uq to organize un-used materials and say good-byes.
4. 5PM: Meet at CeCEP to debrief and clean up.

Day 13—Tuesday, May 20th
1. 6AM: Van ride from San Cristobal to Antigua.

Day 14—Wednesday, May 21st
1. 8AM: Flight from Guatemala City→Boston.

 

## 3.0 Was This Return Implementation Trip Planned as Part of a Phased Construction?

**Yes**

## 4.0 Site Assessment

In this section we will discuss what past teams have learned about the community.

## 4.1 Stakeholders

***CeCEP***

The Centro Comunitario Educativo Pokomchi, or CeCEP, is one of the greatest assets to EWB-USA WPI. A cultural museum focused on spreading education and awareness about the indigenous communities in the Alta Verapaz area, CeCEP offers a unique insight on Guachthu'uq and the rainwater harvesting project. They provide social and educational services to the local Pokomchi communities. Once establishing itself as the team's NGO, CeCEP has provided EWB-USA WPI with invaluable resources and guidance. Namely, Sucely Ical Lem and Alvaro Caal Lopez have been turning points in the project.

Sucely is the director of CeCEP and has generously allowed the travel teams to use a work space in the museum to plan and meet during their trips. Additionally, she understands the scope of the project and provides insight about how to work with the sociocultural interactions in Guachthu'uq and answers questions that travelers have about all aspects of the project. She communicates with EWB-USA WPI via email, and ensures that the team has updates about Guachthu'uq as needed. Sucy also coordinates homestays, transportation to and from Guatemala City, and translators for WPI travelers. She plans to continue to provide assistance throughout the duration of the project.

The residents of Guacthu'uq speak Pokomchi, the local mayan dialect. CeCEP ensures that the travel teams are equipped with translators on each trip. Often, these translators are the same from trip to trip. This allows translators to have a heightened understanding of the project and allows for a more productive dynamic in the community. CeCEP also ensure that all travelers have a proper debriefing of the community before their first in country visit.

As mentioned in previous sections, Alvaro is a university student who works closely with EWB-USA WPI. His contributions to the project, including distributing and collecting in country monitoring, tracking system functionality, and communication with EWB-USA WPI via email, give the team a year round presence in the community

In January, 2014, Sucy helped connct EWB-USA WPI with members of the Municipalidad de San Cristobal, the local government of the city. The Municipality agreed to transport construction materials from San Cristobal and the neighboring city, Coban, to Guachthu'uq during the January, 2014, implementation and will continue to support this project on future implementation trips. Building a relationship with the local government is essential to the long-term success of this project.

***Water Committee***

The Water Committee formed between the January 2013 Implementation trip and the May 2013 Monitoring trip. Its purpose is to act as a liaison between the beneficiary families and EWB-USA

WPI. Members of the Water Committee are past and future beneficiaries, and their role has become more defined over the past two trips. One of the major goals of the Water Committee is to help families prepare their homes to be functioning sites for rainwater harvesting systems. For this upcoming trip, the committee agreed to oversee families clearing the area for their concrete bases, gathering stones for bases, and altering their roof lines for the implementation of gutters. It was also established that the committee will not be paid for their services and will serve terms such that there is not a complete change of officers from year to year.

### *Women's Committee*

La Comite de Mujeres is a group of politically active women in the community. Interviews conducted in January 2014, divulged the existence of the Women's Committee as an established and esteemed activist group focused on cultural and social concerns in the community. During one interview, the manager of the Finca exclaimed that he prefers working with the Women's Committee since, in his opinion, they are a more reasonable, focused group than the CoCoDe. Interviews on the May 2014 trip, interviews will seek more information on how the Women's Committee operates and its specific areas of influence. It is possible the Women's Committee could be a vehicle through which knowledge, expertise, and entrepreneurial spirit may spread.

### *CoCode*

In the past the EWB-USA WPI chapter has tried to use the current community government as a mode of communication. The Community Development Council (CoCode) is a small group of community members who are elected every two years by the community to politically represent Guachthu'uq in the Municipal government of San Cristobal. The CoCode members do not receive any form of monetary compensation for their positions. This stratified government program is meant to allow communities to more effectively communicate their needs to higher government officials. Guachthu'uq recognizes that their limited access to water is a major problem within the community. Thus, members of the CoCode reported this problem to the municipality government. After several years of work, these efforts developed into the government tank program. However, this problem is not isolated to Guachthu'uq; it affects all citizens living in and around San Cristobal.

Within the community, there is concern over the role of the CoCode. Some members of the community wish to remain removed from politics. Some raise concerns over the CoCode's ability to charge fees for community meetings, absence from activities like cleaning the finca, and maintaining the road. During interviews in January, 2014, many community members reported that the CoCode charged extra fees to keep one's name on the list for the government tank program. These accounts varied widely, which may indicate political corruption within the CoCode.

Our team has found that working with the CoCode as the major line of year round communication is largely ineffective since members of the CoCode have limited access to technology and lack means of intra-community information distribution. CeCep has moved into this role as our major line of communication with the community. Students at CeCep are in contact with members of the Guachthu'uq Water Committee and the committee reports to the community members. This mode of communication is a relatively new addition to our project and we are looking forward to the benefits that it will offer to the future of the project.

***Families***

Families are one of the main stakeholders in this project. Families who receive rainwater-harvesting systems that provide water security will spend significantly less time collecting water from the finca. Water may also be higher quality, potentially reducing the need to spend money on firewood and chlorine to clean water. Families will be able to spend more time on education, entrepreneurial endeavors, family time, and recreation when they no longer need to go to the finca as often.

Rainwater harvesting systems will also mitigate problems that arise around the finca. If women and children no longer need to go to the finca in the early hours of the morning (2:00-5:00 am), there will be fewer conflicts with waiting on line, fewer occurances of water running out, less controversy over water rights, less worry about dirty water from needing to drink what other people use to wash their clothes. There will be improved access to water all around.

 

## 4.2 Community Map

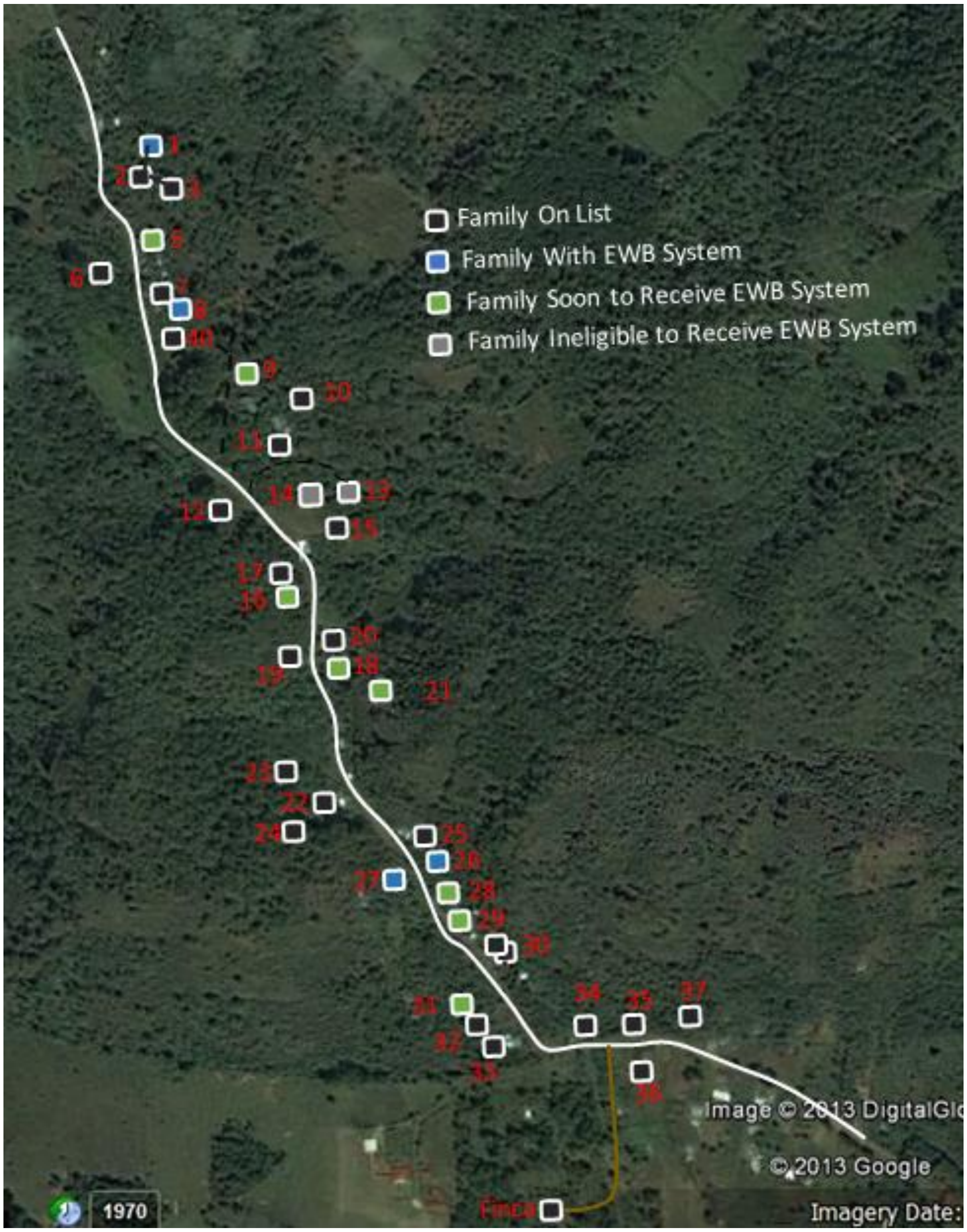


**Figure 44: Community Map**

## 4.3 Community Booklet

The EWB-USA WPI chapter has been creating a booklet to document the families of the Guachthu'uq community. This booklet contains information on every house in the community including family members' ages, interview information, census data, and general history for each family. This booklet will serve as a resource for the EWB students at WPI. Team members can reference this booklet when needed for information regarding the families in community. The booklet is not displayed in this report because it is exceedingly long.

 

Similarly, EWB-USA WPI has created a census of Guachthu'uq at the request of the president of the Water Committee. The census contains information on the names, ages, and relationships of every member of every household as well as the number of tanks each household has and total volume capacity of water able to be stored in those tanks. The president of the Water Committee now has knowledge of exactly how many people live in Guachthu'uq and the number of tanks every household has. This data will be referenced when the committee needs to determine the next families to receive rainwater harvesting systems. Please refer to Appendix D to see the census of Guachthu'uq.

## 4.4 Project Impact

***Storage Capacity***
In January, 2014, EWB-WPI assessed all the existing tanks in the community. This data will be used to help select the next families to receive systems. It is also useful for evaluating the storage capacity of the entire community. On average, each family has 3909.1 L (411 tinajas) of water storage capacity. Seven families have no tanks, while three families have over 8400 L of storage. Cumulatively, the community has 129,000 L (13,578 tinajas) of tank storage capacity.

Based on the consumption rate calculated from the May 2013 census, if all the tanks are full, the water needs of the community could be supported for almost four days.

***Time Spent Accessing Water***
The only data we currently have on time spent collecting water from the finca is from the twelve interviews conducted in January, 2014. Community members use water in four main ways: drinking, cooking, bathing, and washing clothes. Of those interviewed, the average time required to make one trip to the finca is about 45 minutes (0.75 hours). Basing calculations on the assumptions that **all water is collected from the finca** (that is, ignoring the factor that some families already have tanks) and that **each tinaja requires one trip** to the finca, the time an average family might spend traveling to and from the finca is approximately **18 man-hours each day, about 6600 man-hours per year,** to collect water to meet all water needs. 18 man-hours a day might mean that a woman and her five children make three trips to the finca every day. This is not unheard of in Guachthu'uq.

More commonly, many women bring their laundry to the finca itself to minimize the amount of water they must carry. With this in mind, the number of hours spent carrying water is greatly reduced. On average, a family with no tanks spends **3 man-hours** a day collecting water for drinking and cooking. A woman and her children may make one or two trips to the finca to collect enough water to drink and eat.

If the drinking and cooking water can be offset by rainwater harvesting systems—which provide better quality water more appropriate for drinking and cooking—then the amount of time spent collecting water is greatly reduced. If every family in the community has adequate tank storage capacity to meet their drinking and cooking needs year-round, each family will save over **1000 hours each year**. The community as a whole will save **88 hours each day**, over **32,100 hours**

 

**each year**. Adequate rainwater harvesting systems will free up a significant amount of time for families and inevitably give them the ability to change their lives.

## 5.0 Professional Mentor Assessment

### 5.1 Professional Mentor Name and Role

Michael Reiter, he is the Responsible Engineer in Charge and will be travelling for this implementation trip.

### 5.2 Professional Mentor Assessment

The students have done a tremendous job getting ready for this implementation trip. Each home implementation was thought out in detail to the point where we are comfortable ordering building materials before we go so they are waiting for us when we get on location. This trip is the culmination of every assessment and implementation trip that came before it. The reason we did previous implementations on a smaller scale was to work out all the bugs in our construction approach and process. With this trip we are now confident we can quickly and efficiently install all of the systems you read about in this report.

All of the students contributed equally to the writing and assembly of this report. Over the past few years I have seen this chapter grow into an extremely efficient group for managing all the technical aspects of this project, as well as understanding the importance of risk assessment and finding the right experts to work with. They have leveraged professionals in the community and professors at WPI to put together a true team of mentors to review the technical aspects of this report, every technical aspect has been vetted by at least one professional besides myself.

I look forward to the next few months of working with these students to continue practicing how to work with the building materials, water test procedures and logistics of this implementation trip.

### 5.3 Professional Mentor Affirmation

I was a part of this design effort and take responsibility for the course this project takes.

By signing this form your chapter is stating that your design has not changed and that you are going back to the community to finish implementation of your original design.

_Thomas J Moutinho Jr.____________________ ____3.16.14___________________
Project Lead Signature Date

_ Thomas J Moutinho Jr.___________________
Print Name

 

# Appendices

## Appendix A

***Form 1***

**To be Implemented on May 2014**

**House #**

**Preparations**

What is the progress on the listed preparations for implementation?

**General Water Usage Questions**

Name all the sources you get water from on a regular basis.

How many hours do you spend travelling to and from those sources per day?

How many hours do you spend at those sources?

Who in your family collects water from these sources?

Depending on the source, do you have a specific use for that water? (example: only do laundry at the Finca, or only drink from tank)

**System Questions**

If the family has some sort of water storage system (government tank, cement tank, etc.)
What do you do to maintain your system?

 

*Form 2*

## Previously Implemented Homes

**House #**

**General Water Usage Questions**

Does this EWB implemented system provide sufficient drinking water for your family?

Do you collect water from another source (not the EWB implemented tank)? If yes, where?

How many hours do you spend travelling to and from those sources per day?

How many hours do you spend at those sources per day?

Who in your family collects water from these sources?

What do you use the tank water for?

What do you use the water from the other sources for?

**System Questions**

Have you made changes to your EWB implemented system? Why and what were they?

Are there any problems with the system?

Have you been cleaning the filter? How? How often?

Have you been clearing debris off the malla? How often?

How are you using your first flush? (Do you allow it to fill up during each rainstorm and empty it afterwards?)

Do you collect and use the water from your First Flush?

What do you use that water for?

Are you content with the system?

What do you do to maintain the system?

 

***Form 3***

**Master Monitoring Sheet** **Fecha __________**

Through the surveys, try to get a feel on the following three topics.
What's the word on the Finca?
What's the feel on the EWB implemented systems?
Anything new we should know about in the community?

---

**House 8**

Surveyed ☐ Unavailable ☐

**House 26**

Surveyed ☐ Unavailable ☐

**House 27**

Surveyed ☐ Unavailable ☐

**House 1**

Surveyed ☐ Unavailable ☐

Levantar el techo 65 cm.
Instalar los canals de manera que tenga desnivel hacia la base.

**House 5**

Surveyed ☐ Unavailable ☐

Preparar el area de 4m x 2m y bajar la tierra 90 cm.
Recolectar 1.5m de piedras pequenas o medianas para la base.

**House 9**

Surveyed ☐ Unavailable ☐

Preparar el lugar del tanque que esta cerca de la base actual. Quitar la tierra y bajarla a 50 cm y nivelarla.
Recolectar 1.5m de piedras pequenas o medianas para la base.

**House 16**

Surveyed ☐ Unavailable ☐

Nivelar la tierra en donde se colocara la base en la orilla de la calle de 4m x 2m y bajar la tierra 60 cm.

Recolectar 1.5m de piedras pequenas o medianas para la base.

**House 18**

Surveyed ☐ Unavailable ☐

Elevar 15 cm el techo del patio.
Quitar las laminas que actualmente se usan como canales.

**House 21**

Surveyed ☐ Unavailable ☐

Modificar la direccion de las laminas de manera de que el agua corega enfrente y detras de la casa.
Instalar una tapa en el tanque dado por el gobierno. Se entrega a Miguel Q10.00 para la compra del mismo.

**House 28**

Surveyed ☐ Unavailable ☐

Construir el techo para el tanque con la altura necesaria.
Preparar el area de 2m x 2m en donde se coloca ira la base para el tanque.

**House 29**

Surveyed ☐ Unavailable ☐

Preparar el lugar donde se hara la base, 20 cm hacia abajo.
Quitar las laminas que estan demas y cortar las 2 laminas de manera que todos tengan la medida.

**House 31**

Surveyed ☐ Unavailable ☐

Crear el lugar donde la tuberia pasara (la cocina).
Mover o crear sufficiente espacio en la base que ya existe para instalar el nuevo tanque.

**Alvaro Checklist**

Check to see if there is water in the first flush.

Check to see if the water in the gutter is clogged/dirty.

Check to see if there is debris in the gutter/on the roof.

Are there any puddles of water collecting near the system?

Is there anything out of the ordinary with the system?

# Appendix B

## Water Quality Data Sheet

Source: Boiled: Tester:
Date/Time: Incubation Length:

| Colilert (Tube) | YES | NO | Petrifilm |
|---|---|---|---|
| Yellow? (Bacteria present) | ☐ | ☐ | Blue Colonies (*e. coli*): |
| Fluorescent? (*e. coli* present) | ☐ | ☐ | Red Colonies (other): |

| Colilert (Tube) | YES | NO | Petrifilm |
|---|---|---|---|
| Yellow? (Bacteria present) | ☐ | ☐ | Blue Colonies (*e. coli*): |
| Fluorescent? (*e. coli* present) | ☐ | ☐ | Red Colonies (other): |

| Colilert (Tube) | YES | NO | Petrifilm |
|---|---|---|---|
| Yellow? (Bacteria present) | ☐ | ☐ | Blue Colonies (*e. coli*): |
| Fluorescent? (*e. coli* present) | ☐ | ☐ | Red Colonies (other): |

Notes:

---

Source: Boiled: Tester:
Date/Time: Incubation Length:

| Colilert (Tube) | YES | NO | Petrifilm |
|---|---|---|---|
| Yellow? (Bacteria present) | ☐ | ☐ | Blue Colonies (*e. coli*): |
| Fluorescent? (*e. coli* present) | ☐ | ☐ | Red Colonies (other): |

| Colilert (Tube) | YES | NO | Petrifilm |
|---|---|---|---|
| Yellow? (Bacteria present) | ☐ | ☐ | Blue Colonies (*e. coli*): |
| Fluorescent? (*e. coli* present) | ☐ | ☐ | Red Colonies (other): |

| Colilert (Tube) | YES | NO | Petrifilm |
|---|---|---|---|
| Yellow? (Bacteria present) | ☐ | ☐ | Blue Colonies (*e. coli*): |
| Fluorescent? (*e. coli* present) | ☐ | ☐ | Red Colonies (other): |

Notes:

# Appendix C

Water Quality Results:

**Table 12: Summary of water quality test results from the Assessment trip in 2010.**

Engineers Without Borders
Guatemala Survey – 2010
Chemistry Results for Drinking Water Sources

| Parameter | **Acceptable Result** | **Sample 01- Rain Water Tank** | **Sample 02—Wood Finca** | **Sample 03—Finca** |
|---|---|---|---|---|
| **Total Iron (mg/L as Fe)** | 0.3 | < 0.05 | 0.22 | 0.09 |
| **Total Hardness (mg/L as $CaCO_3$)** | < 500 | 1.2 | 230 | 220 |
| **Turbidity (NTU)** | < 1.0 | 0.89 | 4.0 | 4.0 |
| **Total Alkalinity (mg/L as $CaCO_3$)** | < 500 | 4.9 | 230 | 220 |
| **Conductivity (µS/cm @ 25°C)** | 1000 | < 10 | 430 | 420 |
| **Total Suspended Solids (mg/L)** | < 5.0 | < 5.0 | < 5.0 | - |
| **pH (Standard Units)** | 6.0-9.0 | 6.1 | 7.2 | 7.3 |
| **Nitrate (mg/L as N)** | 5.0 | < 0.10 | 0.89 | 0.84 |

 

**Table 13: Summary of Chemical Water Test Data from Assessment May 2013.**

| Water Source | Date | Nitrite (0-0.5 mg/L) | Nitrate (0-30 mg/L) | Ammonia (0-2.5 mg/L) | Iron (0-3 mg/L) |
|---|---|---|---|---|---|
| **House 26 EWB-USA WPI Tank** | 5/6/2013 | 0 | 0 | 0.25 | 0.01-0.05 |
| **House 26 Gov't Tank** | 5/6/2013 | 0 | 0 | 1.0-3.0 | 0 |
| **House 26 EWB-USA WPI Tank** | 5/8/2013 | 0 | 0 | 0.5 | 0.00-0.005 |
| **House 26 Gov't Tank** | 5/8/2013 | 0 | 0 | 1 | 0 |
| **Finca** | 5/8/2013 | 0 | 0 | 0 | 0 |

**Table 14: Summary of bacteria test results during Assessment May 2013. Reported in count per 100 mL.**

| Source | Date | Time of Incubation | "Other Coliforms" | "E. coli" |
|---|---|---|---|---|
| **House 26 EWB-USA WPI Tank** | 5/6/2013 | 48 | 0 | 0 |
| | 5/8/2013 | 48 | 150 | 0 |
| | 5/11/2013 | 48 | 50 | 0 |
| **Finca** | 5/8/2013 | 48 | 200 | 100 |
| **House 26 Gov't Tank** | 5/6/2013 | 48 | 700 | 0 |
| | 5/8/2013 | 48 | 750 | 0 |
| | 5/11/2013 | 48 | 350 | 0 |
| **House 31 Gov't Tank** | 5/11/2013 | 48 | TMTC | 0 |

# Appendix D

## Casa 1

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Oscar Vicente Laj | padre | M | 1981 |
| Mauricia Cal Cal | madre | F | 1986 |
| Alida Laj Cal | hija | F | 2003 |
| Sandra Laj Cal | hija | F | 2005 |
| Oscar Laj Cal | hijo | M | 2008 |
| Shirley Laj Cal | hija | F | 2011 |
| Bebe? Laj Cal | hija/o | M/F | 2013 |
| ______________ | ______ | ____ | _____ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 2 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 5000 [L] |

**Apuntes:**

## Casa 2

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Isabela Caj | madre | F | 1970 |
| Mateo Caal | padre | M | 1960 |
| Marcial Caal Caj | hijo | M | 1997 |
| Flavio Caal Caj | hijo | M | 2000 |
| Lidia Isabel Caal Caj | hija | F | 2003 |
| Luis Everardo Caal Caj | hijo | M | 2006 |
| Anabela Cal Caj | sobrina | F | 2010 |
| Romi Rodolfo Caal Caj | hijo | M | 2010 |
| ____________ | _____ | ___ | ____ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 2 |
| Tanque de Concreto (5000L): | 1 |
| Volumen Total: | 8400 [L] |

**Apuntes:**

## Casa 3

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Julio Jalal Latz | padre | M | 1981 |
| Cristina Cal Caj | madre | F | 1988 |
| Roman Cal Jalal | hijo | M | 2005 |
| Amaly Cal Jalal | hija | F | 2007 |
| Ingrid Cal Jalal | hija | F | 2008 |
| Juan Cal Jalal | hijo | M | 2012 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 2500 [L] |

**Apuntes:**

## Casa 4

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Isabel Xona | madre | F | 1962 |
| Estamslao Caal | padre | M | 1975 |
| Cristina Caal Xona | hija | F | 1997 |
| Vitalina Caal Xona | hija | F | 2001 |
| Alida Consuela Caal Xona | hija | F | 2003 |
| Alvaro Leonardo Caal Xona | hijo | M | 2005 |
| Elvia Evimiria Caal Xona | hija | F | 2007 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 2 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 3400 [L] |

**Apuntes:**

## Casa 5

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Baldeniar Quej Yuja | padre | M | 1977 |
| Filomena Gualim | madre | F | 1983 |
| Fabiola Quej | hija | F | 2001 |
| Fabiana Quej | hija | F | 2005 |
| Gladis Azucena | hija | F | 2007 |
| Gerson Noe | hijo | M | 2010 |
| Yesica Filomena | hija | F | 2012 |
| ________________ | _______ | ____ | ______ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 0 [L] |

**Apuntes:**

 

## Casa 6

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Carlos Jom Yuja | padre | M | 1978 |
| Rosa Gualim | madre | F | 1979 |
| Denis Jom Gualim | hijo | M | 2002 |
| Aislian Jom Gualim | hijo | M | 2004 |
| Yulisa Jom Gualim | hija | F | 2007 |
| Natali Jom Gualim | hija | F | 2009 |
| Selvin Jom Gualim | hijo | M | 2009 |
| Mararia Lem Yuja | abuela | F | 1937 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 2 |
| Tanque de Concreto (5000L): | 1 |
| Volumen Total: | 10900 [L] |

**Apuntes:**

 

## Casa 7

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Jose Sis Yuc | padre | M | 1987 |
| Graciela Cardona V. | madre | F | 1989 |
| Wilfredo Sis Cardona | hijo | M | 2007 |
| Katy Sis Cardona | hija | F | 2009 |
| David Sis Cardona | hijo | M | 2012 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 2500 [L] |

**Apuntes:**

## Casa 8

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Cristobal Laj Cojoc | padre | M | 1968 |
| Letestina Xoc jol | madre | F | 1962 |
| Cesar Laj Xuc | hijo | M | 1992 |
| Alicia Pop Jom | nuera | F | 1994 |
| Maria Laj Xuc | hijo | M | 1994 |
| Romelia Laj Xuc | hija | F | 1998 |
| Bairon Laj Xuc | hijo | M | 2003 |
| Teni Laj Xuc | hija | F | 2012 |
| ______________ | ______ | ____ | _____ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 1 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 2 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 5900 [L] |

**Apuntes:**

## Casa 9

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Cristobal Lem Suram | padre | M | 1931 |
| Maria Mo | madre | F | 1943 |
| Angela Lem Mo | hija | F | 1980 |
| Domingo Lem Xoy | El marido de Angela | M | 1979 |
| Karen Gualim Lem | nieta | F | 2009 |
| Maria Gualim Lem | nieta | F | 2010 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 3 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 5100 [L] |

**Apuntes:**

## Casa 10

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Santiago Lem Mo | padre | M | 1969 |
| Margarita Pop Lam | madre | F | 1973 |
| Maria Lem Pop | hija | F | 1992 |
| Reinaldo Lem Pop | hijo | M | 1994 |
| Claudia Lem Pop | hija | F | 1997 |
| Juan Lem Pop | hijo | M | 1999 |
| Gladis Lem Pop | hija | F | 2001 |
| Mario Lem Pop | hijo | M | 2003 |
| Hector Lem Pop | hijo | M | 2005 |
| Flori Lem Pop | hija | F | 2009 |
| Brandon Lem Pop | hijo | M | 2011 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 2 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 3400 [L] |

**Apuntes:**

## Casa 12

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
| --- | --- | --- | --- |
| Alejandrina Yuja Leu | madre | F | 1996 |
| Edin Raul Coc | padre | M | 1988 |
| Ivan Humberto | hijo | M | 2010 |
| Maria Alejandra | hija | F | 2012 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
| --- | --- |
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 1 |
| Volumen Total: | 5000 [L] |

**Apuntes:**

## Casa 15

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Leandro Yuja Lopez | padre | M | 1960 |
| Josefina Lem Mo | madre | F | 1960 |
| Roberto Cae | yerno | M | 1986 |
| Elsa Yuja | hija | F | 1987 |
| Victor Yuja | hijo | M | 1998 |
| Alida Yuja | hija | F | 2000 |
| Glanda Cac Yuja | nieta | F | 2012 |
| _______________ | _______ | ____ | _____ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 1 |
| Volumen Total: | 7500 [L] |

**Apuntes:**

 

## Casa 16

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Elviva Cal | madre | F | 1963 |
| Elviva Roxana | hija | F | 1992 |
| Paulina Juya | hija | F | 1994 |
| Yesema Carolina | hija | F | 1997 |
| Mano Salvador | hijo | M | 1999 |
| Alexander Michael | hijo | M | 2002 |
| Marcos Enrique | hijo | M | 2004 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 2500 [L] |

**Apuntes:**

## Casa 17

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Edgar Yuja | padre | M | 1990 |
| Catarina Macz | madre | F | 1985 |
| Wilian Macz | hijo | M | 2001 |
| Jorge Macz | hijo | M | 2003 |
| Aracely Macz | hija | F | 2010 |
| Frans Yuja | hijo | M | 2012 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 1 |
| Volumen Total: | 5000 [L] |

**Apuntes:**

 

## Casa 19

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Matilda Jor Yuja | madre | F | 1993 |
| Victor Caj | padre | M | 1986 |
| Berta Dronely | hija | F | 2009 |
| Victor Jose | hijo | M | 2012 |
| ____________ | _____ | ___ | ____ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 0 [L] |

**Apuntes:**

 

## Casa 20

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Mario Enrique Cul Laj | padre | M | 1990 |
| Clara Caj Cul | madre | F | 1990 |
| Alexandra Isabel | hija | F | 2011 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 2500 [L] |

**Apuntes:**

## Casa 21

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Miguel Caj Pop | padre | M | 1968 |
| Rosalia Moran | madre | F | 1973 |
| Feliza Caj Moran | hija | F | 1994 |
| Baldomero Caj Moran | hijo | M | 1995 |
| Aura Caj Moran | hija | F | 1997 |
| Juam Caj Moran | hijo | M | 1999 |
| Florencio Caj Moran | hijo | M | 2001 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 2500 [L] |

**Apuntes:**

## Casa 22

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Terosa Yuja Lopes | madre | F | 1970 |
| Celestino Jor Yuja | hijo | M | 1996 |
| Nicolas Jor Yuja | hijo | M | 2000 |
| Blaxinca Estela | hija | F | 2004 |
| Suri Manela | hija | F | 2005 |
| Carlos Yuja | hijo | M | 2011 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 0 [L] |

**Apuntes:**

 

## Casa 23

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Adelia Chen Toc | hija | F | 1994 |
| Abelino Cal | padre | M | 1946 |
| Marcela Toc | madre | F | 1954 |
| Sonia Maribel | hija | F | 1999 |
| Mario Xim Laj | El marido de Adelia | M | 1991 |
| ______________ | ______ | ____ | _____ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 5 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 11000 [L] |

**Apuntes:**

## Casa 24

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Alicia Chentat | madre | F | 1985 |
| Cerapio Chulo | padre | M | 1983 |
| Ingrid Azucena | hija | F | 2005 |
| Wilson Leonal | hijo | M | 2008 |
| Delma C. C. | hija | F | 2012 |

### Capacidad de Almacenamiento Existente (2013)

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 1 |
| Volumen Total: | 5000 [L] |

**Apuntes:**

## Casa 25

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
| --- | --- | --- | --- |
| Emilio Chen Guidin | padre | M | 1958 |
| Elvira Chen Len | madre | F | 1958 |
| Antonio Chen Choc | hijo | M | 1992 |
| Silvestr Chen Guidin | hijo | M | 1995 |
| Noima Chen Guidin | hija | F | 1997 |
| Gricelda Yuja Quej | nuera | F | 1993 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
| --- | --- |
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 1 |
| Volumen Total: | 7500 [L] |

**Apuntes:**

## Casa 26

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Elidia Esperanza Xona Yuja | madre | F | 1974 |
| Roberto Chojoc | padre | M | 1969 |
| Ricardo Jor Xona | hijo | M | 1992 |
| Elida Candelana | hija | F | 1997 |
| Romelia | hija | F | 1999 |
| Maria Rosario | hija | F | 2006 |
| ______________ | ______ | ____ | _____ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 1 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 5000 [L] |

**Apuntes:**

 

## Casa 27

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Cristobal Coy Max | padre | M | 1969 |
| Herlunda Ixian | madre | F | 1971 |
| Elvia Coy Ixian | hija | F | 1997 |
| Luis Coy Ixian | hijo | M | 2002 |
| Romiro Coy Ixian | hijo | M | 2003 |
| Angelina Coy Ixian | hija | F | 2007 |
| Niño Laj Cal | hijo/a | M/F | 2013 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 2 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 5000 [L] |

**Apuntes:**

## Casa 28

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Alfonso Xona | padre | M | 1978 |
| Carmelina Laj Yuja | madre | F | 1984 |
| Edin Xona Laj | hijo | M | 2002 |
| Josue Xona Laj | hijo | M | 2004 |
| Loida Xona Laj | hija | F | 2005 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 1 |
| Volumen Total: | 5000 [L] |

**Apuntes:**

 

## Casa 29

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Ana Yuja | madre | F | 1948 |
| Ricardo Gualim | padre | M | 1947 |
| Eliceo Gualim | hijo | M | 1992 |
| Carlos Moran | hijo | M | 1988 |
| Maria | nuera | F | 1993 |
| Osraldo Yuja | sobrino | M | 2012 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 2500 [L] |

**Apuntes:**

## Casa 30

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Martolo Jom | padre | M | 1972 |
| Herlinda Velasquez | madre | F | 1964 |
| Javier Jom Velasquez | hijo | M | 1988 |
| Jamrel Jom Velasquez | hijo | M | 1991 |
| Rumalda Jom Vlasquez | hija | F | 1994 |
| Irma Jom Velsquez | hija | F | 1996 |
| Gloria Jom Velasquez | hija | F | 1998 |
| Jose Jom Velasquez | hija | F | 2000 |
| Ana Toc Pop | nuera | F | 1997 |
| ______________ | ______ | ____ | _____ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 2500 [L] |

**Apuntes:**

## Casa 31

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Juan Cac | padre | M | 1960 |
| Marcela Cal | madre | F | 1961 |
| Fernando Quej | hijo | M | 1993 |

### Capacidad de Almacenamiento Existente (2013)

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 1 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 2500 [L] |

**Apuntes:**

## Casa 32

| **Persona en Familia** | **Posición de la familia** | **Género** | **Fecha de Nacimiento** |
|---|---|---|---|
| Emilio Gualim Ical | padre | M | 1984 |
| Ana Maria Quej | madre | F | 1984 |
| Kevin Gualim | hijo | M | 2005 |
| Cristian Gualim | hijo | M | 2008 |
| Janari Gualim | hija | F | 2010 |

**Capacidad de Almacenamiento Existente (2013)**

| **Tipo de Tanque** | **Cantidad** |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 2 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 5000 [L] |

**Apuntes:**

## Casa 33

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Anjelina Quej | madre | F | 1988 |
| Axel Quej | hijo | M | 2005 |
| Angelica Quej | hija | F | 2007 |
| Angela Quej | hija | F | 2011 |
| ______________ | ______ | ____ | _____ |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 0 [L] |

**Apuntes:**

## Casa 34

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Maria Magdelena | madre | F | 1983 |
| Lerando Gualim | padre | M | 1978 |
| Edgar Gualim | hijo | M | 2001 |
| Drasely Mar Lem | hija | F | 2002 |
| Wendy Boxang | hija | F | 2004 |
| Saion Maribel | hija | F | 2005 |
| Edwin Yobany | hijo | M | 2007 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 1 |
| Volumen Total: | 5000 [L] |

**Apuntes:**

## Casa 36

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Zoila Esperanza Ical | madre | F | 1988 |
| Jilberto Cojoc | padre | M | 1986 |
| Fermin Cojoc | hijo | M | 2008 |
| Leydi Carina | hija | F | 2009.5 |
| Yolanda Noami | hija | F | 2012 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 0 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 0 [L] |

**Apuntes:**

## Casa 40

| Persona en Familia | Posición de la familia | Género | Fecha de Nacimiento |
|---|---|---|---|
| Secundino Lem Mo | padre | M | 1960 |
| Lucia Cal Suram | madre | F | 1962 |
| Cesar Damian Lem Cal | | M | 1989 |
| Angela lem Cal | | | 1994 |
| Ignauio Lem Cal | | | 1991 |
| Maria Magdelena Lem Cal | | F | 1998 |
| Ingrid Gabriela Garcia Calmo | Nuera | F | 1998 |
| Viwicio Lem Cal | | | 2000 |
| Elvia Leticia Lem Cal | | | 1998 |
| Naney Fabiola Lem Garcia | Nieta | F | |
| Dani Joel Moran lem | Nieto | M | 2013 |

**Capacidad de Almacenamiento Existente (2013)**

| Tipo de Tanque | Cantidad |
|---|---|
| Tanque de EWB USA WPI (2500L): | 0 |
| Tanque Gubernamental (2500L): | 0 |
| Tanque Gubernamental (1700L): | 2 |
| Tanque de Concreto (5000L): | 0 |
| Volumen Total: | 3400 [L] |

**Apuntes:**

## Appendix E

Official contracts on next page:

 

**Ingenieros Sin Fronteras, USA**
**Worcester Polytechnic Institute**

Implementación en Mayo de 2014

El objetivo de Ingenieros sin Fronteras es implementar sistemas de agua pluvial a cada casa en Guachthu'uq. Estos sistemas serán diseñados de acuerdo a las condiciones de la casa y la cantidad de personas que viven allí para proveer una cantidad suficiente de agua para cocinar y beber. Nuestro objetivo es promover mejor calidad de agua.

Los sistemas de agua pluvial, de Ingenieros sin Fronteras solamente pueden ser totalmente implementados si el dueño de la casa tiene que preparar su tierra antes de la implementación en mayo de 2014.

Después que estas preparaciones sean completadas, Ingenieros sin Fronteras se compromete a implementar un sistema adecuado de colección de agua de lluvia.

El dueño de la casa hará:

____________________ prepararé la tierra para mi sistema y también preparé el resto de las cosas en la lista arriba antes de mayo 2014.

| | | |
|---|---|---|
| Cristobal Laj Cojoc | Beneficiario | Sucely Ical Lem |
| Presidente Comite de Agua | Beneficiario Guachthu'uq, Guatemala | CECEP |

Centro Comunitario Educativo Pokomchi
CECEP
MUSEO KATINAMIT
"Fortaleciendo la Cultura Pokomchi, porque Lo Nuestro Vive"

**Museo Katinamit**
San Cristóbal Verapaz
Tel. (502) 7950-4896
CeCep@intelnet.net.gt

**Engineers Without Borders, USA**
**Worcester Polytechnic Institute**

Implementation, May of 2014

The objective of Engineers Without Borders is to implement a rainwater harvesting system at each home in Guachthu'uq. This system will be designed based on home conditions and number of inhabitants, to supply a sufficient quantity of water for drinking and cooking. Our objective is to promote better quality of water.

In order to allow for complete implementation of an Engineers Without Borders (EWB) rainwater harvesting system, the homeowner is required to prepare his plot of land before implementation.

Upon the completion of these preparations EWB commits to implement adequate rainwater harvesting system.

The home owner will complete the following before May 2014:

I ________________________ will prepare my plot of land with the above items before the arrival of EWB in May of 2014 for implementation of a rainwater harvesting system.

| | | |
|---|---|---|
| Cristobal Laj Cojoc | Oscar Laj Lem | Sucely Ical Lem |
| President of the Water Commitee | Beneficiary | CECEP |

**Museo Katinamit**
San Cristóbal Verapaz
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El grupo de estudiantes 'Ingenieros sin Fronteras' ha trabajado con la comunidad de Guachtuhq desde el 2009. Ellos han ayudado a proporcionar los recursos necesarios y han ayudado a instalar un sistema de agua pluvial para que los beneficiados puedan contar con un recurso de agua confiable. Los estudiantes de 'Ingenieros sin Fronteras' esperan poder llevar a cabo este proyecto a largo plazo con el propósito de beneficiar a la mayoría de las familias de esta comunidad. Este proyecto será ejecutado conjuntamente con el Centro comunitario Educativo Pokomchí (CECEP), el comité de agua de dicho proyecto y los estudiantes 'Ingenieros sin Fronteras'. Se espera que en los próximos años el proyecto sea finalizado de manera exitosa, y así sea posible mejorar la calidad de vida de los beneficiarios.

Es así como los siguientes individuos se reúnen el día de hoy para celebrar el presente convenio del proyecto de colección de agua: Sucely Ical Lem, quien representa al CECEP(titular de documento de identificación 2615 127731603); Cristóbal Laj Cojoc, presidente del comité de agua (titular del DPI, 2200 90777 1603); y el señor ______________________________ quien se identifica con el documento de identificación ______________________________.

En este convenio se denominará beneficiario a la persona que reciba los beneficios directos del proyecto. El propósito de este convenio es procurar que el beneficiario cumpla con los lineamientos de uso y cuidado del sistema de colección de lluvia. Dichos lineamientos serán los siguientes:

1. El beneficiario participará voluntaria y activamente en la gestión e implementación del proyecto. Colaborará de la misma forma para el monitoreo del mismo.
2. El beneficiario será el único responsable del sistema de colección de agua. Esto significa que le dará mantenimiento continuo al sistema. Este sistema incluye: canales, tinacos, cemento y techo. El objetivo del mantenimiento es que el sistema permanezca en buenas condiciones.
3. El beneficiario de comprometerá a mantener el sistema de agua en su vivienda por un lapso de diez años. De lo contrario, el beneficiario deberá cancelar la totalidad del valor del sistema (en base a factura y costos de mano de obra). Dicha cancelación la hará el Centro Comunitario Educativo Pokomchí (CECEP).

El beneficiario se encuentra conforme con las condiciones planteadas, se compromete a seguir estos lineamientos y asume la responsabilidad de éstos en el la fecha de

______________________________.

| | | |
|---|---|---|
| Cristobal Laj Cojoc | Oscar Laj Lem | Sucely Ical Lem |
| Presidente Comité de Agua | Beneficiario | CECEP |

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The group of students 'Engineers Without Borders' has worked with the community of Guachtuhq since 2009. They have helped providing the necessary resources and have helped install a system of pluvial water, in order for the beneficiaries to count on a reliable resource of water. The students of Engineers Without Borders hope that they are able to carry out this project so that the majority of the families from the community are benefitted. This Project will be executed along with el Centro comunitario Educativo Pokomchí (CECEP), the water committee of this Project and the students 'Engineers Without Borders'. It is expected that in the following years the project will be successfully finalized. In this way, it will be possible to improve the life quality of the beneficiaries.

It is in this way that the following people get together on today's date to celebrate the present agreement of the Project of Water Collection: Sucely Ical Lem, who represents the CECEP (her number of identification is 2615 127731603); Cristóbal Laj Cojoc, the president of the water committee (whose identification number is 2200 90777 1603) and Mr. _____________________, whose identification number is ___________________________.

In this agreement the beneficiary will be denoted as the person that receives the direct benefits of the Project. The purpose of this agreement is to have the beneficiary comply to the guidelines of usage and care of the system of collection of rain. These guidelines will be the following:

1. The beneficiary will participate in a voluntary and active basis in the arrangement and implementation of the Project. The beneficiary will collaborate in the same way monitoring the system.
2. The beneficiary will be the only one responsible for the system of collection of water. This means that there will be continuous maintenance of the system. The system includes: a roof, cement, canals and tank. The objective of the maintenance is that the system remains in good conditions.
3. The beneficiary is compromised to have the system of water in his house for a lapse of ten years. If not, the beneficiary will have to pay the total value of the system (in accordance to the bill and hand labor). The cancellation will be done by the Centro Comunitario Educativo Pokomchí (CECEP).

The beneficiary agrees to the set conditions, he compromises to follow these guidelines and assumes the responsibility of them in the date of _______________________.

| | | |
|---|---|---|
| Cristobal Laj Cojoc | Oscar Laj Lem | Sucely Ical Lem |
| President of the Water Commitee | Beneficiary | CECEP |

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Este contrato representa un acuerdo entre: el beneficiario de la comunidad de Guatchthu'Uq, Ingenieros sin Fronteras y CECEP.

Se instaló un sistema de agua, de valor total de __________________, el (fecha) __________________. La siguiente lista muestra un desglose del valor total del sistema:

Base ___________________

Rebalse ___________________

Primera lluvia ___________________

Tinacos ___________________

Misceláneo ___________________

Este contrato implica 3 compromisos más allá que los que están indicados en el acta:

1. Yo pagaré un 5% de este costo, que es de _________________. Lo pagaré: en un plazo o en 12 cuotas mensuales de _______________ que entregaré a CECEP, a Susy Ical Lem el primero de cada mes.
2. Yo me comprometo a apoyar las instalaciones futuras que hacen Ingenieros sin Fronteras en otras casas de la comunidad de Guatchthu'Uq.
3. Yo me comprometo a no vender el tinaco por el mínimo establecido de 10 años. Si decido venderlo o si salgo de la comunidad, tendré que comprar el tanque de CECEP a un monto que disminuye cada año. La siguiente tabla incluye el precio el tinaco en el periodo de diez años.

| Años después de la instalación | Precio del tinaco (quetzales) |
|---|---|
| 0 | 2400 |
| 1 | 2160 |
| 2 | 1920 |
| 3 | 1680 |
| 4 | 1440 |
| 5 | 1200 |
| 6 | 960 |
| 7 | 720 |
| 8 | 480 |
| 9 | 240 |
| 10 | 0 |

Este contrato es firmado por los siguientes colaboradores:

Cristobal Laj Cojoc
Presidente Comité de Agua

Oscar Laj Lem
Beneficiario

Sucely Ical Lem
CECEP

**Museo Katinamit**
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This contract represents the agreement between: the beneficiary of the community of Guatchthu'Uq, EWB and CECEP.

A system of water was installed, with the value of ______________________, the (date) ________________.
The following list shows the breakdown of the total value:

Base ___________________

Overflow ___________________

First flush ___________________

Tank ___________________

Miscellaneous ___________________

The contract implies 3 specific commitments beyond the ones that are indicated in the Act:

1. I will pay a 5% of this cost, that is _______________. I will pay it: all at once or in 12 monthly payments of __________________ that I will hand in to CECEP, to Susy Ical Lem the first of every month.
2. I am committed to support the future installations that EWB makes in other houses in the community of Guatchthu'Uq.
3. I am commited not to sell the tank in the minimum established time of 10 years. If I choose to sell it or if I leave the community, I will have to buy the tank of CECEP at an amount that diminishes every year. The following table indicates the price of the tank in the 10 years:

| Years after the installation | Price of the tank (quetzales) |
|---|---|
| 0 | 2400 |
| 1 | 2160 |
| 2 | 1920 |
| 3 | 1680 |
| 4 | 1440 |
| 5 | 1200 |
| 6 | 960 |
| 7 | 720 |
| 8 | 480 |
| 9 | 240 |
| 10 | 0 |

The following collaborators sign this contract:

Cristobal Laj Cojoc
President of the Water Commitee

Oscar Laj Lem
Beneficiary

Sucely Ical Lem
CECEP