



531 – Post-Implementation Report

Community:	Guachtuq
Country:	Guatemala
Chapter:	Worcester Polytechnic Institute
Project ID(s):	6871 WORCH-S-GUAT-00687
Submittal Date:	07/19/2016
Dates Traveled:	05/07/2016-05/23/2016
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Acknowledgements

The Project Leads and Mentor Team acknowledge that:

EMG The chapter reviewed the accompanying [531 – Post-Monitoring & Evaluations Report Instructions](#) for accurate completion of this report.

EMG The PMEL lead updated, the [901B – Program Impact and Monitoring Report](#) and it is submitted as a separate document with this report.

EMG The PMEL lead updated the [905 – Program Logic Framework](#) and included it as an appendix to the 901B report.

EMG The most current contact information is updated in this report and all other reports included with this submittal.

EMG If there were any health and safety incidents during the trip, a completed [612 - Incident Report](#) document is included as a separate document with this report.

N/A If this was the Final Monitoring & Evaluation trip for the Program, the [907 – Community Acknowledgment of Program Closeout](#) or another written acknowledgment of program closure was signed by the community partners and will be included with the eventual submittal of the [527 – Program Closeout Report](#).

531 – Post-Monitoring & Evaluation Report
Worcester Polytechnic Institute
Guatemala, Guachtuq, 6871 WORCH-S-GUAT-00687

Revised 11/2015

We, the project team leadership confirm that the above information and tasks have been completed and that this report accurately reflects our chapter's monitoring & evaluation (M&E) activities during the M&E trip.

Evelyn Grainger



July 15, 2016

Project Lead Printed Name

Project Lead Signature

Date

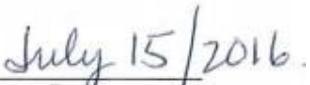
Or

Laureen Elgert

Faculty Advisor Printed Name



Laureen Elgert



July 15/2016

Date

It is the responsibility of the Responsible Engineer In Charge (REIC) to ensure that the team's Post-Monitoring & Evaluation report meets the typical engineering standard of care. I have reviewed the subject project. I am qualified by education and experience to design and evaluate this type of project. In my best engineering judgement, the monitoring & evaluation carried out on this M&E trip met a reasonable standard of care for a facility of this type.

Rodney Rookey



Rodney Rookey

July 15/2015

REIC

Printed Name

REIC

Signature

Date

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Part I –Administrative Information

1.0 Contact Information

Project Title	Travel	Name	Email	Phone	Chapter Name or Organization Name
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President		Katherine Picchione	kropicchione@wp.i.edu	(518)727-8024	EWB-USA WPI
Responsible Engineer in Charge	x	Rodney Rookey	rodrookey@gma il.com	(860) 982-6567	Centurion Waterproofing, Inc.
Traveling Mentor	x	Rodney Rookey	rodrookey@gma il.com	(860) 982-6567	Centurion Waterproofing, Inc.
Faculty Advisor (if applicable)	x	Laureen Elgert	lelgert@wpi.edu	508-831-5452	EWB-USA WPI
Planning, Monitoring, Evaluation and Learning (PMEL) Lead	x	Kerry Muenchow	kemuenchow@w pi.edu	(720)-878-1397	EWB-USA WPI

2.0 Budget

2.1 Project Budget

Expenses Category	Expenses
<i>Direct Costs</i>	
<i>Number of Travelers</i>	8
Travel	
Airfare (total)	\$4,626
Flight Insurance (total)	\$75
Taxi to/from BOS	\$335
Taxi to/from GUA	\$396
Travel Logistics Sub-Total	\$5,433
CeCEP (Lodging and Support)	
Transportation to Antigua	\$397
Antigua Hotel	\$45
Homestays	\$1,672
Translators	\$1,150
Monitoring	\$558
Other Materials	\$658
Food & Lodging Sub-Total	\$4,038
Contingency	
Medical Expenses	\$0
Local Taxis	\$0
Contingency Sub-Total	\$0
Project Materials & Equipment	
System Adjustments	\$500
Other Materials	\$120
Education	\$332
Water Quality Tests	\$388
Project Materials & Equipment Sub-Total	\$1,340
TOTAL	\$10,811

2.2 Professional Mentor Team Hours

Name(s) of Professional Mentor(s)	Pre-trip hours	During trip hours	Post-trip hours	Total Hours
1. Rodney Rookey	25	42	2	69
2. Laureen Elgert	35	120	2	155
3. Mark Johnson	6	1	2	9
4. Kevin Gebo	10	0	2	12
5. Mike Reiter	35	0	5	10
6. Pat Austin	35	1	2	38
7. Sarah Wodin Schwartz	15	0	2	17
7. Chris Sontag	20	0	2	22
8. Creighton Peet	15	0	2	17
9. John Bergendahl	5	1	0	6

3.0 Budget

Water Supply

- Source Development
- Water Storage
- Water Distribution
- Water Treatment
- Water Pump

Sanitation

- Latrine
- Gray Water System
- Black Water System
- Solid Waste Management

Structures

- Bridge
- Building
- Retaining Wall

Civil Works

- Roads
- Drainage
- Dams

Energy

- Fuel
- Electricity

Agriculture

- Irrigation Pump
- Irrigation Line
- Water Storage
- Soil Improvement
- Fish Farm
- Crop Processing Equipment

Part II – Pre-Assessment Report

1.0 Executive Summary

Engineers Without Borders-USA Worcester Polytechnic Institute (EWB-USA WPI) conducted a monitoring trip from May 7-23, 2016. The trip involved assessment of 34 rainwater harvesting systems which were previously implemented in the community within Water Supply Project 6871. Additionally, EWB-USA WPI ran an extensive certification program to educate community members in regards to maintenance and repair of the systems, helped community members make necessary repairs to their systems, and conducted water quality tests and analysis.

The May 2016 Monitoring and Evaluation Trip focused on three major goals: (1) to empower community members to independently operate and maintain the rainwater harvesting systems through a training and certification program; (2) to make minor system adjustments for the purpose of improving water quality, quantity, and access; and (3) to ascertain whether the community's goals have been met through continued project monitoring with water quality tests, interviews, system inspections, and focus groups.

The primary audience for the completed evaluation includes EWB-USA WPI, Comunitario Educativo Pokomchi (CeCEP), the community of Guachtuq, EWB nationals, other Guatemalan communities facing similar water security issues, and other EWB chapters. EWB-USA WPI will use this completed evaluation to determine whether the project has reached the point at which it can be closed out, and to analyze the end results for the purpose of determining potential areas of improvement in future projects. CeCEP will continue to use the evaluation to assist the community with maintaining the systems. Since the certification program was taught through CeCEP, and the system monitoring was completed by CeCEP representatives, many people at the NGO possess a wealth of knowledge on the maintenance and repair of the systems. This knowledge can be used to help community members maintain the systems. Additionally, CeCEP hopes to use Guachtuq as a model community to help other communities develop similar systems over time. Both CeCEP and the community members have continued to uphold the Memorandums of Understanding (MOU), and CeCEP is working with the community government called the Consejo Comunitarios de Desarrollo (CoCODE) and individual community members to address any changes related to the project. Additionally, this evaluation intends to assist EWB nationals and other chapters in understanding the impact an EWB chapter can have on a community, as well as how a chapter can handle technical successes and failures throughout a design process.

The program began in 2010 when EWB-USA WPI partnered with Guachtuq, a community that expressed lack of water security as a pressing problem. Prior to the project, community members gathered water from the *finca*, a concrete water basin located on private property at the bottom of the community. The Water Supply Project is the only open project in the Guachtuq program. EWB-USA WPI has partnered with the local NGO, CeCEP, which provides cultural information, translators, work space, and communication with the community when the team is not in Guatemala. EWB-USA WPI identified individual rainwater harvesting systems as the most technologically and culturally appropriate solution to the problem. Following identification of this solution, EWB-USA WPI worked with community members to build systems with 34 families. The first two systems in the community were built in January 2013. In January 2014, the systems built in 2013 were modified, and two more systems were constructed. In May 2014, eight additional systems were built. To finish the implementation phase, 22 systems were constructed in May 2015. Since the final implementation, a team from CeCEP has visited the community every two weeks to

monitor the systems, updating EWB-USA WPI on status of systems and problems that arise in the community.

Several tasks including the certification program were completed with the intention of educating the community for a future without an EWB-USA WPI presence. These programs were intended to empower the community with the knowledge of how to perform system repairs and modifications. The state of the systems and the project process followed by EWB-USA WPI were evaluated through system inspections, water quality tests, focus groups, interviews, and community meetings. Physical modifications to the systems included small repairs that were completed with the help of family members. The design of some multi-tank systems was changed slightly to allow for the tanks to be separated for cleaning. This design was created jointly by community members and EWB-USA WPI. Community members drove the completion of the separation of tanks and repairs using knowledge gained from both the certification program and past implementation trips.

Data was collected through system inspections, water quality testing, interviews, and focus groups. This data was collected for every year of the project and was compiled and compared to show overall changes since EWB-USA WPI began working with the community. System inspections and water quality testing were completed on all homes where EWB-USA WPI to collect data. Interviews and focus groups were held to gather data on social impacts of the project. Individual interviews were completed with three families as well as five focus groups were held with the men, women, children, COCODE and CeCEP to learn about the community and NGO's perspective of the project.

EWB-USA WPI is now entering a six-month monitoring period to ensure that the community can sustain the systems independently. In this monitoring period, EWB-USA WPI will be sending an associate of CeCEP, Edghar Gua, into the community to continue gathering data on the physical state of the systems. CeCEP will remain active in the community even after this period, continuing to uphold the MOUs signed with community members, mediating any conflicts or difficulties in conjunction with the CoCODE. The monitoring data will be used to help the club determine if the project objectives were met. If the club determines that the objectives have been met, then the club will close the project at the end of the monitoring period. If it is determined that this is not the case, then EWB-USA WPI intends to pass the project onto another chapter due to WPI's new travel restrictions to Guatemala.

2.0 Scope and Scale of Completed Evaluation

2.1 Primary Purpose

The purpose of the May 2016 Monitoring Trip was to assess whether the 34 rainwater harvesting systems previously implemented by EWB-USA WPI are meeting the community's needs. This entails providing improved water quality, quantity and access as well as ensuring that community members have the skills and knowledge to maintain their long-term sustainability. EWB-USA WPI utilized a variety of methods to determine if this goal has been achieved and will continue to assess through the in-country monitoring team. The trip focused on intensive education and communication with community members, providing insight to where EWB-USA WPI could improve in future projects and promoting best maintenance practices for the future.

2.2 Evaluation Scope

The scope of the evaluation on the monitoring trip was to study both physical and social factors contributing to the achievement of the community goal. The overall intention of the evaluation was to determine whether the project had been developed sustainably enough to remove the continued presence of EWB-USA WPI. Quality of the water was determined through continued water quality testing of the EWB-USA WPI systems and the *finca*. This evaluation changed from the original plan, as some systems lacked water or were not utilizing the filter as anticipated, but achieved the same intended goals of observing the water quality change over time and continued comparison of new systems and the water from the finca. The executed water quality testing also studied the impact the filters had on the existing systems. Improvements to the quantity of water available to the families was determined through system inspections, interviews, and focus groups. Physical inspections showed EWB-USA WPI the quantity of water remaining in the system during a dry season, indicating a family's tendency to ration. Access to water was evaluated through social and physical observations as well as focus groups with community members.

2.3 Evaluation Scale

The evaluation intended to study all 34 rainwater harvesting systems and measure the community's capacity of maintaining and repairing the systems. These tasks ultimately determine whether the community families developed the specific skills and knowledge needed to maintain their water systems. All 34 systems were assessed to an extent. Social limitations did not allow for a full assessment of all systems and two systems were not in working condition at the time of the evaluation.

Six focus groups were conducted which yielded a wider scale of results than expected while planning the trip. The sample groups included the partner NGO CeCEP, the community government known as the Consejo Comunitarios de Desarollo (COCODE), a group of men, children, and two groups with women from Guachtuq.

Three individual home interviews were conducted during the trip. This was a decrease from the planned 16, because many of the answers were the same or similar to information previously collected by EWB-USA WPI travelers. The team felt that the individual interviews completed were not contributing new information to the monitoring indicators.

Water quality testing which included Coliert, petrifilm and turbidity testing was conducted on all systems that had available water and were willing to provide a sample to EWB-USA WPI. While the scale of the water quality testing did not change, the testing plan changed as only 7 of the 34 systems still had filters.

EWB-USA WPI had intended to continue testing with filters on the system but this was not necessary as many families already removed their filters.

The certification programs were completed with an even higher attendance and enthusiasm than EWB-USA WPI predicted. The technical certification program, with 10 attendees, covered the design and construction of gutters, tanks and connections, and filter/first flushes. As a result of a suggestion from the men's focus group, the program was condensed into two days instead of the original three. While the lessons were combined the material taught was not reduced. A one day program then focused on the women of the community, with 28 attendees, working on maintenance and basic repairs.

3.0 Evaluation Framework

3.1 Data Collection

Individual Family Interviews:

Three individual family interviews were conducted with Abelino, a translator and professor who works with CeCEP, translating from Pokomchi to Spanish. Each interview lasted between 30-90 minutes. Questions asked during the interviews aimed to gather opinions on:

- How EWB-USA WPI teams worked within the community
- How community members interacted with their systems
- The direct impact of the systems have had on the water security of the families
- Any indirect social impacts of the system on the community

The families selected for individual interviews had aspects of their system that that merited specific conversations. Two of the families chosen, House 4 and House 10 had completely full tanks although it was the end of the dry season, showing a greater aptitude for water rationing. The other family, House 23a, had unsuccessfully tried to move their system independently of EWB-USA WPI due to personal preferences and new construction on their house.

Focus Groups:

The team held six focus groups with specified demographics relating to the project. The table below outlines the focus groups held and the planned structure for these focus groups can be found in Appendix B.

Focus Group	Number in Attendance	Focus	Language
Women of the Community (Top of Community) (Bottom of Community)	6 12	To evaluate the impact of the systems on community members, to determine their level of satisfaction with the project and understand their perspectives on small repairs and maintenance, to evaluate the certification program	Pokomchi
Men of the Community	5	To evaluate the impact the systems had on community members, to understand social impacts of the project, to determine their level of satisfaction with the project, to learn their perspective on the project process, especially the implementation, and understand how confident they feel to maintain and repair the systems independent of EWB-USA WPI	Pokomchi
Children of the Community	~ 40	Evaluate the level of knowledge the children of various ages have on the systems, to determine their level of involvement in maintenance and repair of the systems and determine any social changes that may have resulted from the implementation of the systems	Pokomchi/Spanish
COCODE	4 of the 6 elected officials with approximately 20+ bystanders	To evaluate the project process and the impact that EWB-USA WPI had on the community overall, to determine if the community believed the project was successful and able to be sustained in the future without the support of EWB-USA WPI	Pokomchi
CeCEP	3; Susy, Abelino, Edghar	Evaluating the EWB-USA WPI project process to improve future project relations with an NGO. Understand where the NGO thought the team had weaknesses and strengths	Spanish

Table 1 Focus Group overview and turnout from participants

System Inspections:

EWB-USA WPI conducted system inspections on all 34 rainwater harvesting system using a data collection sheet that can be found in Appendix C. The inspection collected data on the physical state of system components, water levels in the tanks, visible turbidity in the water, and the overall system functionality. Team members also documented any problems or system malfunctions during these visits. During initial system inspections, brief interviews were conducted to collect information regarding water usage, system maintenance and system repairs. Each system was inspected a final time by EWB-USA WPI on the last day in the community without a formal inspection sheet. This provided community members with a final opportunity to ask the team questions about the functionality of their personal systems.

Water Quality Testing:

EWB-USA WPI carried out turbidity tests and bacterial tests on every system. A portable turbidity meter was used to measure the turbidity in water samples taken from every system with water. For homes with the filters still attached, the turbidity of the water was tested both with the filter on the system and without the filter. Bacterial tests were completed with petrifilms and Colilert tests and then pocket incubated for 22 hours. These were completed once for every system that had water in the community as well as water from the *finca* tap and open basin. Water quality was also completed to show the difference between the quality of water in the tanks EWB implemented and the tanks implemented in a previous government project. The team counted the E.coli colonies on each petrifilm and observed the fluorescence of the Colilert tests to assign a risk level to water from every system.

3.2 Results from Key Questions

Throughout the trip, many key questions were addressed in order to determine if the project goals had been achieved and also to gain additional insight as the EWB-USA WPI chapter begins its next project. These questions addressed several stakeholders, including: EWB Headquarters, EWB-USA WPI, the COCODE, and the men, women, and children of the community. The questions include:

For EWB-USA Headquarters:

1. What is the long term sustainability of this project?
2. What are the benefits and drawbacks of a project completed on an individual basis?
3. What were some of the impacts of the EWB-USA WPI team and project on the community?
4. What was the importance and role of the NGO in this project?
5. What is the reasoning and justification for closing out the project?
6. What lessons have the chapter learned from this project and how will they be applied to future trips?

For EWB-USA WPI

1. Is the community capable and willing to maintain the systems on their own?
2. Are individuals who completed the certification programs qualified and recognized within the community?
3. Did water security improve in the community in the eyes of the club and the community?

For the CoCODE

1. Have there been changes in community leadership since the installation of the systems?
2. How has the COCODE contributed to the community in regards to water security?
3. What will the roles of the COCODE be in the future?

For the men and women of the community:

1. Do the men/women have a sound understanding of how the systems work and the proper maintenance and minor repair techniques?

2. Do the men/women feel comfortable with their role in regards to the systems?

For the children of the community:

1. Do the children have a basic understanding of tank function, proper maintenance, and repair techniques?

The answers, data collected, and justifications for these questions are included below in Appendix D.

3.3 Results & Results Presentation

The results from the various data collection methods and minor system modifications are categorized by topic below. The way in which EWB-USA WPI presented these results to various stakeholders is included at the bottom of each section.

Continuous monitoring through staff at CeCEP enabled EWB-USA WPI, CeCEP and the community to communicate about the project progress. This includes presenting results from the previous EWB-USA WPI trips. The monitoring method EWB-USA WPI set up also allowed community members and CeCEP to ask EWB-USA WPI any technical questions that occurred and for EWB-USA WPI to respond via the in country monitoring team or through the travel teams each trip.

Physical System Inspection

EWB-USA WPI's first few days of physical inspections gathered a large amount of data of the state of the systems. The systems were found to be generally clean with only 5% of the systems being categorized as having so much dirt on the bottom that visibility was a problem. 68% of systems were reported to have little to no dirt at the bottom of the tanks. Additionally nearly 60% of the tanks inspected were reported to have clear water.

Water storage results were positive as Guatemala is currently facing one of its worst droughts. Monitoring took place at the end of the rainy period with many reports of famine caused by drought in local news. Of the 62 tanks monitored in the community that were incorporated into the EWB-US AWPI systems, more than 40% of the tanks were at least half full. Of 29 homes physically inspected for water level, 55% of the tanks were at least half full.

During physical inspections families were briefly interviewed. 100% of families interviewed reported that they continued to boil their water, as advised by EWB-USA WP. All of the families reported that they no longer used the finca for drinking water and only one person interviewed reported that they used the finca water for cooking. Tables summarizing the system inspection data can be found in Appendix D.

Result Presentation:

These results gathered in the first few days of the monitoring trip guided EWB-USA WPI's education sessions and communication with the community. Many maintenance and cleaning problems were identified and able to be solved or proper education implemented to mitigate future problems. Additionally these results highlight many of the positive outcome of the project, such as improved water storage, water conservation practices families have developed and individual family care and ownership of systems, will be communicated to sponsors and potential club members who may be interested in joining EWB to show the impact of EWB-USA projects.

Water Quality

The EWB-USA WPI team completed water quality tests at all of the homes in the community unless the systems did not contain sufficient amounts of water or have family members present. The data collected was used in conjunction with the existing water quality data to determine the overarching quality of the water in the community and the change in water quality over time. A risk level was assigned to each of the water sources using the World Health Organization (WHO) risk levels, ranked from 1 to 5, using the Colilert and petrifilm tests with 1 being a low risk and 5 being a high risk as explained in the table below.

Risk Level	<i>E. coli</i> /100 ml	Colilert MUG+	# <i>E. coli</i> Colonies on Petrifilm	CODE	Notes
Conformity with drinking water standard	<1	-	0	1	Clear
Low	1 - 10	-	0	2	Yellow, does not fluoresce
Moderate	10 - 100	+	0	3	Yellow, Fluoresce, No colonies on petri film
High	100 - 1000	+	1 - 10	4	Yellow, Fluoresce, 1 - 10 colonies on petri film
Very High	>1000 ml	+	>10	5	Yellow, Fluoresce, >10 colonies on petri film

Table 2 Organization's Guidelines for Drinking Water Quality (2nd Edition)

Government Tanks

A water quality analysis was completed to show the comparison of the government tanks before and after EWB-USA WPI helped families modify their existing tanks to a closed system design. The goal of this evaluation was to show whether the closed systems improved water quality as they were intended to do as well as indicate whether the existing tanks in the community had the same level of cleanliness as the tanks implemented by EWB-USA WPI. The table below includes data from systems with government tanks, showing their changes in risk level after the implementation of the EWB-USA WPI closed system. The data set was too small to perform statistical analyses. However, results indicate that after EWB-USA WPI implemented the closed system water quality improved for the majority of systems. The results of water quality tests on government tanks can be found in Appendix E.

Home #	Year Implemented	Risk Level Using WHO Standards (1 low risk, 5 high risk)	
		Before EWB system	EWB system
2	May-15	2	4
4	May-15	1	1.5
6	May-15	1	1
10	May-15	3	1
23a	May-15	2	2.5
21	May-14	1.5	1
30	May-15	2	1
31	May-14	2.8	2.4
32	May-15	2.8	1
40	May-15	2	1

Table 3: A comparison of risk level using WHO standards from pre and post implementation. 1 indicates low health risk water and 5 indicates high health risk. The number is an average of all test results risk level.

House 2 however was an outlier of this data set, the only government tank not to improve in water quality between pre and post implementation. This may be attributed to the fact that the tank had very little water at the time the water quality test was taken. It was also found that in the tanks dirt covers the part of the bottom of the tanks indicating that the tanks may not have been cleaned recently, increasing the chances of bacterial contamination.

EWB-USA WPI Water Source Compared to Original Water Source

The aim of a second analysis was to show that the implementation improved water quality at each home in comparison to the *finca*, their original water source. Risk levels from each year of the *finca* basin was tested were compared to average risk levels of EWB-USA WPI systems. Since EWB-USA WPI did not have a comparable amount of data from May 2014 and January 2014 water quality test, they were excluded from the graph, however all data can be seen in Appendix F.

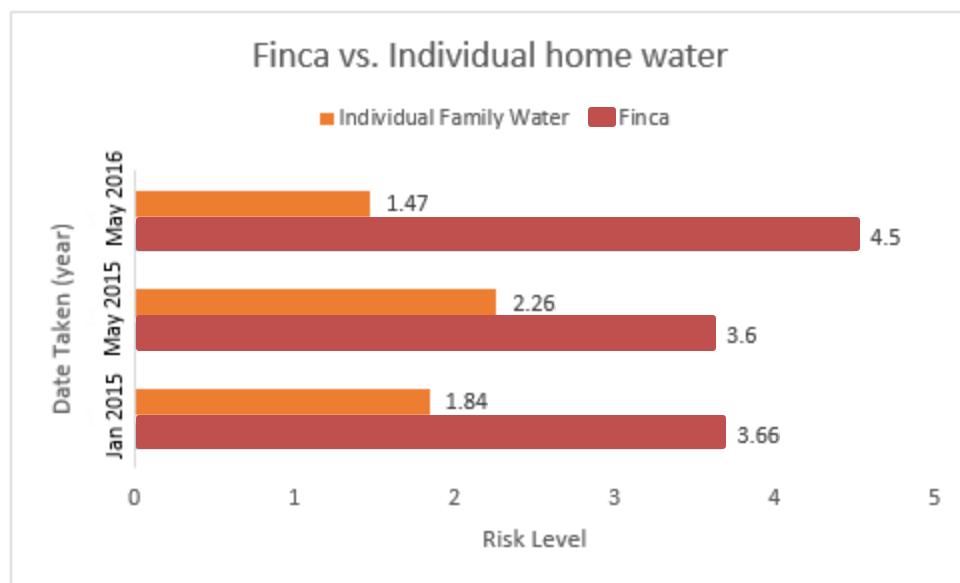


Figure 1 Comparison of *finca* and rainwater harvesting system water quality. 5 indicates high risk, 1 indicates low risk using the WHO rankings which can be found in Table 2

These data indicate that implementation of tanks provided a better quality water for the community. The graph indicates that shows that the overall risk level averages of the homes have not only stayed lower than the *finca* level, but have decreased since our initial data collections. This decline of water quality risk indicates the communities increased attention and awareness of water quality topics frequently discussed by EWB-USA WPI.

Correlation between Cleaning Practices and Water Quality

Before leaving the country, EWB-USA WPI cross referenced the physical monitoring results with the water quality results to determine homes that were seeing increased risk levels. The travel team inspected homes with poorer reported water quality and suggested ways in which families could improve their maintenance or water practices. This noticeable difference in maintenance between families, seen in system inspections and expressed by community members, was a poignant reminder of the importance of uniform and substantial maintenance education. While some family members were willing to clean and maintain their systems to ensure they had a closed system with the highest possible quality of water, some homes did not exercise the same level of care. While EWB-USA WPI has been able to provide a higher potential quality of water, it is up to the families to attain it. EWB-USA WPI intends to keep this in mind when developing a future project in a different community. Travelers continued to remind families to boil their water, and Edghar Gua intends to continue to provide maintenance and education reminders throughout the continued monitoring.

Results Presentation

The water quality data was explained to CeCEP and community members as additional reasoning to why their system water is safer than the water from the *finca*. The majority of the water quality results were explained verbally to CeCEP and the community members. This was done through the certification program and more generally during the final community meeting. This was used to show that the filters were not

removing bacteria to disprove the local misconception. EWB-USA WPI has used these results to determine that the water quality has improved and that water quality will not limit the club from closing out the project in the near future.

Filters

In the initial implementations, cellulose cartridge filters were installed on every tap in the community. These filters are not designed primarily to remove sediments. If they are not replaced regularly, they can degrade water quality, providing a place to grow more bacteria, and impeding the water flow from the faucet. As a result, prior to the May 2016 trip, EWB-USA approved a replacement disc filter that discourages bacterial growth, and is easier to clean and maintain without degrading the filters ability to separate sediments. The filters approved did not remove bacteria, only aimed to decrease turbidity by filtering out sediment, dirt or other debris collected inside the tank more effectively than the existing cartridges.

The travel team first worked to collect more information with regards to the cellulose cartridges to support the data presented in the 530 pre-trip report. Petrifilm and Colilert tests were used to analyze the effect the filters were potentially having on water quality as well. These data were then able to be used to see if the filters were degrading over time, adding bacteria to the systems as they got older. While there is some evidence that the filters degraded water quality over time, there is also contradicting data that shows the filters decreased the risk level. This lack of trend shows filters can help remove bacteria if well taken care of, but they can also add bacteria if not maintained and replaced regularly. Since the amount of sediment and bacteria in each system is unique to each home, it was difficult to draw specific conclusions about the filters in general. After careful consideration, the team was able to determine that the filters presented a greater likelihood to be detrimental to the system than to be helpful.

The table below shows the average water quality risk level from each year EWB-USA WPI tested water quality at homes 4, 5, 9, 10, 16, 18, 21, 26, 27, 28, and 31. This data exemplifies the potential for filters to be harmful to the water quality, part of the reasoning for the filters to be removed. In addition, individual samples of all of the homes can be found in Appendix G.

House #	Filter off May 2014	Filter on January 2015	Filter off January 2015	Filter on May 2015	Filter off May 2015	Filter on May 2016	Filter off May 2016
4						1	2
5		1	n/a	1.5	n/a	No filter	1
9		2	n/a	2	n/a	No filter	2
10					n/a	1	2
16				2	2	No filter	1
18				2	n/a	No filter	1
21		2	n/a	1.5	n/a	No filter	1
26		2	2	2.5	3.5	2	1
27	1.67	n/a	2	n/a	2	n/a	1
28		2	n/a	2	n/a	No filter	1
31				2	2	2	3

Table 4: Comparison of water quality with filters on and off the systems, where n/a indicates that a test was not taken, a blank box indicates the system was not yet constructed for testing to occur and no filter indicates that the family was operating the system without the filter attached or the filter was not available for testing.

While some filters, such as house 4, which was newly implemented in 2015 and has shown great care for their filter continues to have improved water quality as a result of filters being included in the system, filters provide the opportunity for bacteria to grow. The pictures below show the variability in relation to the care families take of their filters.



Figure 2: Cleanliness of filters (Top) A filter 2 years old with little care from family. (Left) A filter 1 year old with family caring for filter with large amounts of staining but still functional. (Right) A filter with visible organisms growing in the filter cartridge.

The water quality data collected by the travel team with regards to the bacteria present in the systems confirmed EWB-USA WPI's decision to remove the cellulose cartridges, regardless of what they would be replaced with, and reinforced the data previously presented in the 530.

The team then worked to study the in country options for disc filters to replace the existing filters. The disc filters, similar to the cellulose, were also designed to remove sediment and not bacteria. To establish a baseline necessity for the new filter, prior to purchasing and implementing, the travel team conducted turbidity testing on each of the systems. EWB-USA WPI suspected that the amount of sediment present, the turbidity level, was high due to the blocked flow of water reported by families using the cellulose filters. Contrary to that belief however, turbidity test results indicated that the amount of turbidity leaving the tap was minimal. For systems that did not have a filter the average turbidity was 4.98 NTU, with the maximum turbidity being 25.57 NTU. For systems that still had their filters on, the average turbidity was 36.02 NTU, well above the average without filters. While this correlated well with the club's decision to remove the cellulose filters, it brought into question the necessity of the disc filters as a replacement component in the system. All of the Turbidity results from each house in the community can be found in Appendix H.

Since the level of sediment in the systems were much lower than expected, EWB-USA WPI revisited the decision to add them to the system. After collaborating with club members and mentors in the United States, as well as members of CeCEP, the club decided that to suggest the removal of the cellulose filters without

a replacement was the best option for the systems. Since the majority of homes had already removed the filters previous to the travel team's arrival, CeCEP agreed that it would not be perceived as a contradiction to previous education, and instead as an improvement due to increased knowledge and information over time.

Results Presentation:

EWB-USA WPI first presented results of the filter testing to CeCEP since they strongly supported the idea of implementing new filters. People at CeCEP had the misconception that the cellulose filters were intended to remove bacteria and misunderstood that the proposed disc filters would also not remove bacteria. EWB-USA WPI explained the filter and turbidity results, showing that only the minimal amount of turbidity would be removed. With this understanding, CeCEP and EWB-USA WPI determined that implementing the disc filters was not appropriate for the system. CeCEP then worked with EWB-USA WPI to understand the risk the cellulose filters pose to water quality of the systems. This information was discussed with community members at the certification program. Slides were included in the lesson plans that showed the degradation of the filters and examples of petrifilms with harmful bacteria that was cultured from filters in the community. Many community members had the same misconception about the filters as CeCEP. While most families knew that the filters were not helping their system, they would only put the filters back on prior to EWB-USA WPI inspection. The importance of boiling water was also repeated to remind community members. This information was repeated at the community meeting and in individual conversations for people who did not attend the certification program.

Payments

CeCEP has been responsible for collecting the payment of 5% of the system as stated in the MOU signed by each families. EWB-USA WPI paid for 100% of the system expenses upfront and created payment plans for families to pay their 5% of the system cost. EWB-USA WPI checked CeCEP's records to determine the percentage of families who had paid their 5% of the system expense. As the MOU stipulates that the payments should be completed within a year of the implementation. EWB-USA WPI found that 16 of 34 families had entirely paid off their systems and 8 families had not begun making their payments. EWB-USA WPI does not feel confident in closing out the project until a larger portion of the community members have finished their payments. The payments symbolize ownership of the systems and the willingness to financially invest in these systems. The first table below shows the range of payments that families had completed. The second table shows the implementation year and the average percentage of payments made. It can be seen that as more years have passed since implementation the average percentage of payments made has increased. This however does not take into account the number of houses implemented per trip. Full payment records and documentation can be found in Appendix I. An example of a payment record can be found in Appendix J.

Percentage Range of Payment Made	Number of Houses
100	16
99-75	5
74-50	2
49-25	3
25-1	0
0	8

Year of Implementation	Number of Houses Implemented	Average Percentage of Payments Made
Jan-13	2	100
Jan-14	2	95.2
May-14	8	73.2
May-15	22	54.5

Result Presentation

With the updated payment information, the team reminded individual families of the payment, including the exact amount they still owed. The team found that community members either did not remember they had a payment due or were still saving to make the payment. The team publicly recognized and congratulated all of the families who had paid their 5% in full at the final community meeting. The COCODE was upset to learn that not all families had finished making their payments and wanted to have the names of the families to remind them to make their payments. Since payments were being made to CeCEP, it was decided not to release these names to the COCODE and leave CeCEP with sole responsibility of reminding community members to make their payments. EWB-USA WPI will be following up with CeCEP over the course of the next six month monitoring period to ensure that every family has completed their payments prior to project closeout.

MOU Agreements

The MOU agreements were not changed and no new MOUs were signed on this trip. However, the travel team was careful to reiterate both to the community government, community families, and CeCEP the importance of upholding all points of the contract, even as EWB-USA WPI was finishing their active role in the project.

During these conversations, and through meetings in the community and CeCEP, concerns were raised over who would become officially responsible to uphold the specific points of the contracts that EWB-USA WPI was previously responsible for. Through discussions with EWB-USA WPI, CeCEP, and the COCODE, a formal agreement finalizing the transfer of responsibility was created. This document, found in Appendix K, splits the responsibility between the COCODE and CeCEP, giving CeCEP the final power in making decisions regarding the implemented systems. The document transferring responsibility for the project was read and presented to the families at the final community meeting. Also at the meeting, the important points of the contracts, such as payments and maintaining residence in Guachtuq, were reiterated.

This document has already been utilized with one family leaving the community shortly after the travel team's departure. Prior to leaving, the family handed over the components of their system to the COCODE and CeCEP, setting a strong precedent for any issues which may present themselves in the future. CeCEP and the COCODE worked together to determine where the tank should be repurposed. CeCEP however will have the final say in this decision.

Certification Program

A three day certification program was created prior to traveling for the men of the community, intended to help them make repairs to their systems and better repair their systems. A one day program for the women was also developed, focusing on general maintenance and repairs. The focus of the lessons were based on

the monitoring data collected by Edghar Gua, a volunteer with CeCEP, who visited the community every other week to monitor the systems. The certification program was focused on common problems experienced by the community members and cleaning practices that community families were observed to follow least often.

While materials for the certification programs were created prior to travel, the PowerPoints meant to guide the classroom instruction were edited to reflect specifics such as new ball valves needed for the separation of tanks, common problems identified by the team, and feedback from CeCEP. In conjunction with Abelino, the professor and translator that EWB-USA WPI works with at CeCEP, the slides were edited and translated to be taught directly in Pokomchi. Additionally, the technical certification program was reduced to two days from the original three after feedback from the focus group conducted with the men of the community. The classes were held in a local college and lunch was provided for all of the community members who attended. The classroom portion, which included physical demonstrations using the new ball valves, cutting and gluing pipe, and using teflon tape, were well received in both the men's and the women's programs. The technical certification program was attended by 9 people both days, including one woman from the community. Each member who participated in both days received a diploma for each day and a certificate for the completion of the entire program. An example diploma and certificate can be found in Appendix L. After the classroom portion, attendees were split into two groups in order to complete related repairs on systems in the community. The families had previously given permission for their systems to be used as part of the program, and some homeowners joined the program participants in listening to explanations of the needed repairs. Many of the men expressed their excitement to be able to work on systems in the community, practically applying lessons from the classroom portion and demonstrating what they were already capable of. Even after the planned repair time was done, many of the men stayed with the EWB-USA WPI team to help complete minor repairs on other homes and continue applying their knowledge gained in the certification program.

The women's program saw a much higher attendance with 28 women. Each woman who attended the program received a diploma for their participation. In interviews with attendees after the program, many of the women were ecstatic about what they had learned. When asked in the focus groups what they enjoyed most in the program and what they learned from it, many women echoed their excitement about learning how to cut, sand and glue PVC tubes and fittings. As a result of the certification program, many said they are no longer afraid to try and fix, or rearrange, their own system. They all reiterated that they were grateful for the opportunity to learn more and understand about their systems. The attendance sheet for the men's and woman's certification program can be found in Appendix M and the revised outline (modified from the 530 in collaboration with Abelino) of the program can be found in Appendix N.

Everyone who received a diploma at the final community meeting was incredibly proud of being able to come up and be recognized for what they had put in time to accomplish. Community members were encouraged to observe who had received the training and certification and go to those who were certified to ask for help if a problem arises with their system.

Result Presentation

Through the Certification Program, EWB-USA WPI communicated a great deal of monitoring information to the community. This included pictures of unidentified systems that had followed and not followed maintenance and cleaning instructions. The entire program was covered with CeCEP first to ensure CeCEP had the information that was taught in case they were ever asked for help with repairing a system. Additionally, this ensured that all of the most common repairs were covered in a manner that CeCEP agreed

was appropriate. The results of the Certification Program were seen in the graduation held for participants in the final community meeting. Community members received recognition for their attendance and participation.

Children's Focus Group

A children's focus group was held in the community building with approximately 40 children. This was many more than originally expected, with additional children who were not part of the EWB-USA WPI program in attendance. This made some of the planned activities irrelevant to them, skewing the data the travel team intended to collect.

The travel team found that many of the activities planned were not appropriate for the number of children who attended. Additionally, with the large age range of children and a lack of initial responsiveness, it was more difficult than expected to obtain data from the group. The most effective activity for gaining information about the impact of the systems on the children's life was when they were instructed to draw a picture of where they get water from. Many of the children drew Rotoplas tanks and other parts of the systems. Families who practiced water conservation had children who drew pictures of both the *finca* and rainwater harvesting system. A young boy who also attended the certification program drew a very detailed drawing of the system which showed the amount of information he retained from the classes.

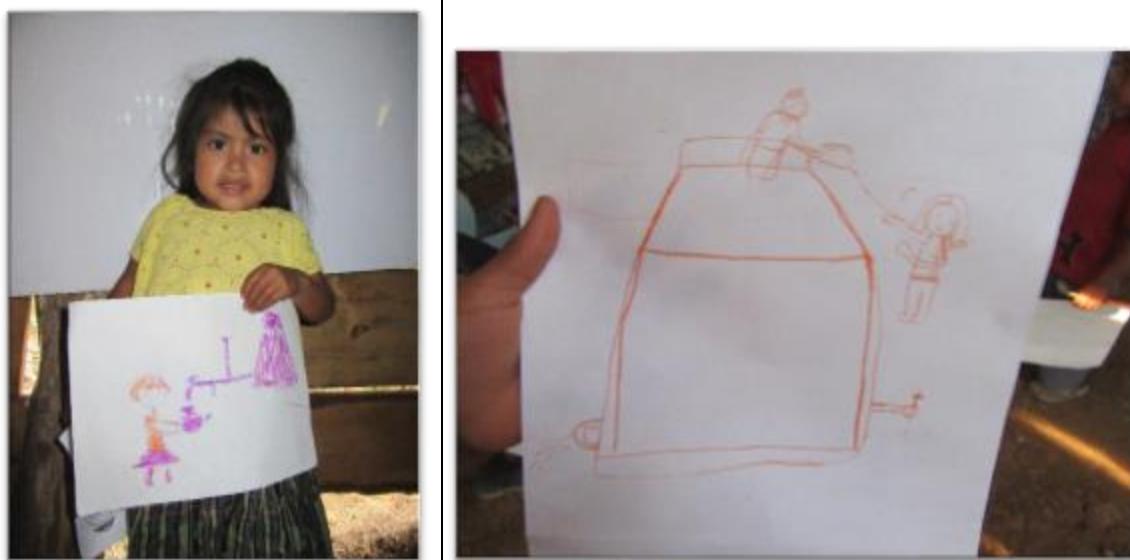


Figure 3 (Left) A young girl with her interpretation of getting water out of an EWB-USA WPI system (Right) A young boy's drawing of himself cleaning the inside of the tank



Figure 4 A girl around age 12's drawing showing both the EWB-USA WPI system. Her family practices water conservation and still uses the finca frequently for non-potable uses such as bathing and washing clothing



Figure 5 A boy who also attended the certification program who drew what he had learned about the different parts of the system. The water bottle is even included in the first flush drawing.

The children were also encouraged to create skits that demonstrated how they took care of their systems. This activity showed that many children were involved in the proper cleaning process of their systems. Through their skits, it was evident they knew that chlorine, soap and rags should be used for cleaning. During this activity, they also showed the cleaning of gutters and tubing, not just the tanks, illustrating the importance of the closed system over just acquiring tanks.



Figure 6 Children acting out how they clean the EWB-USA WPI system

Results Presentation

The travel team will share the results of the focus group with members of the club planning future children's activities. Splitting the age groups to make smaller focused groups could've possibly provided better information. Additionally, beginning with an activity that does not require immediate dialogue between the person running the group and the children may have been more effective.

Men/Women Focus Group

In order to get feedback and insight on different aspects of the project process, such as the payment method, monitoring, community relations, community leadership, the certification program, and other topics, the travel team conducted several focus groups. This included two focus groups with the women, and one with the men. A women's focus group was held separately at the top and bottom of the community. This kept women who were related, or very familiar with each other in the same groups. The men's focus group was held in the community building in the first week that the travel team was in the country.

One result from the men's focus group was that the participants were able to describe how they felt gender played a role in the maintenance of their families systems. The men in the group viewed the women's responsibilities to consist of anything external on the systems, such as filters and the outside of the tanks. They view their own roles to consist of anything internal, such as the inside of the tanks and gutters. In terms of system maintenance, the men recognized that each family's water quality is affected by how well they maintain their system. Another major result was the observance of informal and formal community leadership. The men suggested that instead of creating a separate governing body (such as the Water Committee), it would have been more effective to create a smaller group within the COCODE (an already established governing body) in order to deal with water security matters. Notes from the Men's Focus group can be found in Appendix O.

The woman's focus group also presented a wide variety of results. The first was that the women were happy with the payment system and understood that without EWB, the cost of the systems would have been prohibitive. With regards to the monitoring process, they found the constant reminders to continue to properly maintain the systems incredibly helpful. The women emphasized the impact of the certification

program because prior to the classes, they had no formal training on how to maintain or repair their systems. Another major take-away was that the women noticed an improvement in community relations since EWB-USA WPI began the project. Neighbors are willing to share water for cooking and drinking with each other and the community has been "uniting" according to one woman. Additionally, many of them voiced an appreciation for the freedom and flexibility the tanks have given them. They are no longer forced to go to the *finca* several times a day. One woman explained that she still goes to the *finca* to socialize, but is able to do this by choice, and does not need to bring back any water. Notes from the Woman's Focus Group can be found in Appendix P.

Results Presentation

In the fall of 2016, the travel team will present a lessons learned presentation to the rest of the EWB-USA WPI chapter. The opinions of the men and women of the community are crucial to analyze in order to determine how the project went in the eyes of the community and then consider their perspectives when approaching the new project for the coming years.

COCODE Focus Group:

EWB-USA WPI worked closely with the COCODE on this past trip to promote the local government as a place where community members could go in the event that there were issues with any system. EWB-USA WPI conducted a focus group with the COCODE to determine their perspectives on the project process, but also to determine if the COCODE felt that they would be successful in their new role after EWB-USA WPI ended their involvement with the project.

The COCODE informed EWB-USA WPI that the water committee had become an obsolete entity in the community. Only one member of the water committee was mentioned to still be actively involved in aiding families with their systems. This was partially attributed to lack of involvement from the president of the water committee, as well as their informal formation. As an alternative, the COCODE discussed the option of adding a sub-group to operate in place of the water committee and take on responsibilities to oversee the maintenance of the implemented systems. While the original purpose of the water committee was to separate the responsibility from the existing government, the COCODE felt this led to the water committee's lack of influence in the community.

When asked about the future of the project, the COCODE was adamant that the community members would be able to maintain their systems with their help. However, the government voiced significant concern that a few members of the community did not understand the value of the systems that had been implemented since they were paying so little of the total cost. This led to some families being less motivated to perform proper maintenance. The president of the COCODE compared the attitude of these members to that of caring for a notebook; if the notebook was lost, there would be little concern because the cost to replace a notebook is so cheap. This same attitude is dangerous to have in regards to the implemented systems, as the price of a system without subsidization is not affordable to most of families living in the community. It was suggested through this statement that EWB-USA WPI did not communicate the total cost and value of the systems appropriately to all community members. The COCODE noted that this was not a fault of the project, and it was a personal choice if the members in the community chose against maintaining their system, as many systems were in very good condition.

Towards the end of the CoCODE focus group, the government presented EWB-USA WPI with a formal petition to continue implementing new systems for several families who had moved into the community after the team's last implementation trip. The fact that the CoCODE had presented the petition on behalf of
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the new families suggested that the government body was more than willing to look out for the welfare of its community members, and would likely be willing to provide help in the event that a family had issues with their system function. EWB-USA WPI wrote a response to the petition stating that they were unable to assist at the time. The petition and response to the petition can be found in Appendix Q & R.

Results Presentation

The feedback gathered from the COCODE will be taken into account when presenting a lessons learned document to the EWB-USA WPI chapter in fall of 2016. The data collected from the focus group will be important to consider going forward as it will provide a blueprint for how best to work with local governments going forward and how to best reduce negative social impacts on a community as a whole. The travel team will encourage future travel teams to ensure the total cost of the system is clearly communicated to the community members.

CeCEP Focus Group:

EWB-USA WPI has worked with CeCEP since 2011 and conducted a focus group to gather their perspective of the project process and outcome of the project. The team had an hour and a half focus group with CeCEP that gathered the following results.

CeCEP found that the respected relationship between EWB, CeCEP, and the community was crucial to the project completion. Having the three parties so closely integrated and informed was incredibly beneficial. CeCEP also informed the travel team that having some consistency in travel members between different travel teams was essential to effective project process. They found that having two or more people who had come before on each team made the working dynamics between CeCEP and the travel team increasingly effective. In their perspective it was especially helpful that some mentors had been on travel teams for many years of the project providing continuity to the project while students were constantly changing. This continuity helped develop trust between the relations and improved communication.

Another question asked was if CeCEP thought that the goal of the project was met. They responded that they thought the goal was 50% met, because now the project is dependent on the initiative of the families that have the systems to do what is required to maintain and clean it. They admitted that they don't think that all of the families will put in the work to sustain the systems at their peak effectiveness, but that it is their personal choice that EWB-USA WPI and CeCEP cannot control. They suggested that giving instructions for repair and cleaning with a stronger emphasis on why (such as personal health) would make families value the systems, and their maintenance more. They believed that the certification program also may have helped some of the community members feel more ownership over their systems. CeCEP found that EWB-USA WPI teams had a very strong sustainability mindset which was especially demonstrated through the certification program. This mindset helped community members complete the repairs which would ultimately help sustain the systems and overall project.

One of the things CeCEP suggested that EWB-USA WPI could have improved was communication. Many set-backs on the May 2015 implementation trip were a result of poor communication. The responsibility of communication in-country was put on one person working with CeCEP and that person did not properly communicate with the rest of the NGO. Especially with the large scale up that occurred on that trip, more resources and people were allocated on the EWB USA-WPI side, but not on the in country team. They suggested including more contacts in the communication instead of one person to lighten the load on one responsible party. Especially with a larger project scale, it is the role of the club to ensure that everything is thought is planned well in advance to allow time for proper communication and comprehension.

Additionally, they believed that part of this communication problem was that it was almost exclusively conducted through email, a less common method in Guatemala. If communication had been through Skype or over the phone its possible there would be fewer misunderstandings. This potential lapse of pre-trip communication could've been a contributing factor to difficult relations with the local Rotary Club.

Finally, CeCEP agreed with the CoCODE that the formation of the Water Committee in the project was not effective. They believed that another point of authority should not have been created when there was already an existing governing body. While the COCODE did not seem like a trustworthy organization at the time the project was initiated, creating another governing body within the community created additional problems.

Results Presentation

The travel team intends to share these lessons with the club through a lessons learned presentation in the fall of 2016 to inform new members and people who will be engaged in beginning a new project. The feedback from CeCEP will be taken into consideration when working with a new NGO, especially in the beginning stages of establishing a new relationship with a new NGO.

Home Interviews:

The travel team conducted three home interviews with community members at house 4, 10 and 23. The results of the interviews were very similar to interviews completed in past years. The most informative statements made by community members are included in the table below. Full interview notes can be found in Appendix S.

Topic	Statement
Water Quality	<ul style="list-style-type: none">the woman of the house thinks that the water from the tank is of better quality than that from the finca because many people use the finca and get the water dirty. On the other hand, she knows exactly what is going in and out of her own systemnoticed more sediment in the pot after boiling finca water than after boiling tank waterthinks that water from the rain is cleaner because it comes directly from the sky, thus the tank water is cleaner than finca water
Project Impact	<ul style="list-style-type: none">the community had previously been overlookedgoing to the finca takes 1-1.5 hours every trip so the wife now has more time to do tasks around the house and take care of the kids
System Maintenance	<ul style="list-style-type: none">if it starts raining in the middle of the night, the father will get up and go clean out the gutters so that they get every drop of water in their system
Project Process	<ul style="list-style-type: none">a frustrating aspect is that a small number of people did not show up all the time or did not complete their full service time
Certification Program	<ul style="list-style-type: none">wondering why the days of the certification program were split by gender, wanted to come to the "men" days of the certification programif a neighbor asked for help, he would help although this has not happened in the past

Results Presentation

EWB-USA WPI intends to use these results to talk about the success and community involvement when talking about the project. These families provided positive feedback and showed the highest level of care for their systems.

Separation of Tanks:

EWB-USA WPI's plan for the separation of tanks intended to improve water security and quality by enabling community members to more easily clean one tank at a time was modified slightly upon arrival to the community. After seeing that House 33, the house of Angelina Quej, had completed the separation of tanks independent of EWB-USA WPI it was evident that community members had the technical knowledge and problem solving skills to improve their own water security through small modifications to the existing system. The family had used ball valves similar to EWB-USA WPI's plan, however they used one per tank to increase the ability of water storage. This gave an increased ability to the families to be able to have precise control over their water usage in addition to enabling them to separate individual tanks from the rest of the system for cleaning, opposed to bringing the tanks' water level to equilibrium before emptying.



Figure 7: Picture of House 33's two valve separation completed independent of EWB-USA WPI

The team was able to find similar valves to the ones that the club had originally studied back in the USA, and the valves arrived early enough to be included in the certification program. Since these ball valves had additional unions attached on both sides and a removable ball it was important that each house that was receiving a separation fully understood what they were receiving. The certification program for both the men and women demonstrated how the ball valve came apart and could be loosened or tightened to enable the handle to twist more easily. Many of the separations were completed in the afternoon of the certification program and family members assisted with the installation of the valves at every home where they were applied. Additional education was completed during the implementation of the separation, often facilitated by community members, who were able to show off knowledge they had gained about the valves in the certification program. These community members who attended the certification program, often showed the ability to lead a successful separation independently as well.



Figure 8: (Left) A completed EWB-USA WPI separation of tanks with two ball valves (Right) Men in the field component of the certification program completing a separation of tank with the oversight of a traveler.

Due to this display of understanding of the construction skills already possessed by the community members, the decision was made to leave behind valves for systems which were too full to have the separation completed during the timeframe of the trip. This included two houses, who will be visited by CeCEP as part of the final six months of monitoring to ensure the separations are completed properly. As a result, all of the houses that were qualified for, and desired a separation were able to receive them, a total of 22 out of the 34 systems currently present in Guachtuq.

Other Communities

Many of the surrounding communities have requested EWB-USA WPI to assist with developing similar projects within their communities to improve water security. Susy, the leader of CeCEP, has taken on a leadership role in working with these communities. She is encouraging the COCODE of Guachtuq to work with her to use Guachtuq as a model community for the potential presented by rainwater harvesting systems. The systems have proved to be able to provide water security in Guachtuq and recognizing this, she believes other communities in these mountainous areas outside of San Cristobal could benefit from a similar initiative led through EWB, CeCEP, or other local organizations.

The intention of CeCEP to help other communities by using Guachtuq as a model community of how to implement rainwater harvesting systems was communicated by Susy at the final community meeting of the trip. The COCODE will be facilitating meetings in which leaders of other communities can come and see the systems implemented in Guachtuq, and assist in informing the new communities of the next steps they need to take.

4.0 Roles and Responsibilities

Name	Role/Title & Responsibility	Anticipated In-Country Tasks	In-Country Tasks Completed
Laureen Elgert	Social Science Mentor	Development and execution of focus groups and interviews.	Laureen completed interviews and focus groups with individual families as well as with groups of men, the CoCODE, women and

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Name	Role/Title & Responsibility	Anticipated In-Country Tasks	In-Country Tasks Completed
	Focus Groups and Interviews	Organization of collected information.	CeCEP. Laureen helped to facilitate communication during meetings with Spanish.
Rodney Rookey	Technical Mentor/REIC Technical Inspection/ updates	Inspection of all existing systems. Leading community members to execute system updates	Rodney assisted with in depth system monitoring to identify the problems with the systems and created action plans to repair systems through either the certification program or individually with community members. Rodney worked to find valves that would work for the separation of tanks.
Evelyn Grainger	Project Lead	Coordinate all project, monitoring, and evaluation efforts in the community. Execute community meetings to communicate updates on the project	Evelyn oversaw and contributed to the various aspects of the monitoring trip, ensuring the project was on track to be completed during the trip. Evelyn coordinated the different daily activities with both the team, community members, CECEP and translators. Evelyn executed community meetings and large discussions with stakeholders such as CeCEP and the COCODE. Evelyn also worked to communicate information to club members and mentors in the USA to get feedback and suggestions on various problems that arose to help with the decision making process throughout the trip.
Amanda Gatz	Veteran Traveler Water Quality	Take water quality tests at selected homes and locations in the community, analyze results and maintain the field incubator.	Amanda modified the water quality testing plan to evaluate the effects of filters on the water quality risk level and the current status of the water levels in the community. Additionally, Amanda helped with system repairs and separation of tanks.
Aaron Pepin	Veteran Traveler Filters & Repairs	Inspection of all existing systems and leading community members to execute system updates and replace existing filters with new filters.	Worked on the inspection of each of the systems and performed short monitoring interviews with each of the families. Helped execute the separation of tanks and the repairs completed inside and outside of the certification program.
Andrew Petit	Health and Safety Officer Separation of tanks	Work with families to implement the separation of tanks on appropriate homes	Andrew assisted with the physical inspections of several systems, and was involved with developing and implementing necessary repairs on the systems where problems were observed. Andrew, furthermore, was responsible for leading community members in

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Name	Role/Title & Responsibility	Anticipated In-Country Tasks	In-Country Tasks Completed
			adding two additional ball valves to many systems so that individual tanks in a system could be isolated from one another.
Alana Sher	Health and Safety Officer Certification & Education	Work with Abelino to execute Certification Program and work with individual family members to improve community knowledge of maintenance of systems.	Alana helped collect and conduct the coliert, petrifilm, and turbidity water quality tests. Alana also worked with other members of the travel team to complete system inspections and separation of tanks on qualifying houses. Additionally, Alana helped to prepare the men and wotechnical certification program as well as the children's focus group and also attended these programs.
Kerry Muenchow	PMEL Lead Interviews & Focus Groups	Execute interviews and focus groups with selected groups and individuals within the community and organize the resulting data	Kerry completed individual interviews with four families and conducted focus groups with children, women, and men in the community as well as a focus group with CeCEP. During focus groups and interviews, Kerry facilitated translation from Spanish to English for non-Spanish speaking team members. Kerry also worked with Abelino to communicate the objectives and outline of the Certification Program.
Sucely Ical Lem	Executive Director of CeCEP Organization of trip logistics	Work with Evelyn to ensure project completion and logistical functionality.	In addition to the anticipated work of organizing homestays, translators, community meetings and other necessary trip details, Sucely was instrumental in ensuring the monitoring trip examined and assessed all current and potential problems. She worked with the team to explore different options for replacement filters that would potentially be able to remove bacteria although the team did not find one appropriate for the project. Sucely assisted EWB-USA WPI with transitioning the responsibilities of the project to CeCEP and the CoCODE in a formal way. Additionally Sucely remained active in learning about the technical aspects of the project, enabling her to communicate with other communities on how to implement a project similar to the one in Guachtuq in their communities.
Abelino Cal	Translator and Teacher at CeCEP	Execute a rainwater harvesting system maintenance certification program	Abelino worked with Kerry to modify and execute the certification program to ensure it was culturally appropriate, relevant to system problems from previous monitoring, and

Name	Role/Title & Responsibility	Anticipated In-Country Tasks	In-Country Tasks Completed
	Certification program instructor	for members of the community.	engaging to the community members participating. Abelino advertised the program in the community to encourage more community members to attend. He successfully taught all three days of the certification program. Additionally, Abelino translated for many of the interviews and focus groups as well as for the children's focus group. Abelino contributed a wealth of knowledge regarding the project process in the interview held with CeCEP.
Edghar Gua	Translator & In-Country Monitoring	Translate for interviews, focus groups, or for update teams in the community.	Edghar filled the role of translator and community expert for the trip. Having been responsible for the monitoring of the systems for the past year he knew many of the community members and existing problems with systems in the community.

5.0 Difference Between Planned and Actual Evaluation

5.1 System Evaluation/Modification

Implementation of Filters: EWB-USA WPI had originally planned to implement disc filters to replace the existing cellulose filters. The disc filters are designed to remove turbidity which EWB-USA WPI suspected was high due to the slow water flow reported in the in-country monitoring. However, when the team studied turbidity samples, as shown in Appendix H, the results showed minimal turbidity levels present in the existing systems. The team, with ongoing advice and counsel from water quality experts in the United States, determined that the filters didn't remove sediment at a fine enough scale that would produce a difference in the existing water quality. Therefore, the introduction of a new filter would produce a potential for a certain amount of risk, with less improved functionality than anticipated.

Water Quality Testing: EWB-USA WPI originally planned to take water samples from all of the houses in the community with the existing cellulose filters on, without the existing filters, and with the new disc filters. This plan changed as the team discovered only seven homes still had their filters in use. Additionally, after EWB-USA WPI determined the disc filters were not an appropriate alternative, the amount of tests required was drastically reduced. EWB-USA WPI modified the testing plan to ensure each system that contained water was tested, with and without the filter if applicable.

Separation of Tanks: The separation of tanks was originally planned to be executed using one valve in the piping which connects the individual tanks. However, during the initial system inspections, the travel team found that one of the women in the community had already separated her system. This existing separation was completed with two valves, enabling her to more finely control the water level in each of the tanks in her system. EWB-USA WPI studied both options with assistance from technical mentors on the trip, and in the United States and decided to follow the lead of the community member and use two

valves. During the separation, it was found that some of the systems were too full to be properly separated, therefore, at two homes, the materials necessary for separating the tanks were left to these families, along with a thorough explanation of how to complete the separation, and assurances CeCEP would be back to monitor the proper construction.

5.2 Social Evaluation

Children's Focus Group: Extensive planning was put into creating a program that would both engage the children as well as provide the club with knowledge regarding water usage, water conservation, and system maintenance. There were several activities that were planned, such as asking the children questions like "do you clean the tanks, wash clothes, wash dishes, etc" and they would give a pebble to someone acting out the activity. This was difficult to collect data for, because most children handed pebbles to everyone. The program was modified to focus primarily on one planned activity in which children drew pictures of where they got their water from.

COCODE Focus Group: While questions and themes were prepared for this focus group, the main component of the focus group turned into the petition that the community created asking for EWB-USA WPI to continue working on the project. While the focus group didn't collect all of the information originally desired, the unforeseen petition led the team to write a formal response to the COCODE included in Appendix R.

Interviews: Originally the team planned to conduct 10-15 interviews with individual families in the community. However, not only was it difficult to find times when members of the community were available, a lot of the desired information was gained during the interview portion of the system inspections, the focus groups, and the certification program. The team then realized that all of the interviews were not necessary. Therefore, only four individual house interviews were completed.

6.0 Photo Documentation



Figure 9 (Left) The Certification program held with nine participants from the community led by the professor from CeCEP, Abelino.(Right) Community members participating in a cutting and gluing demonstration as part of the certification program.



Figure 10 (Left) Community members participating in the second half of the certification program, performing a repair on House 36. (Right) Community members explaining to a system owner how the valve for the separation of tanks works.



Figure 11 (Left) The travel team having a conversation concerning project process with the local NGO, CeCEP. (Right) The system of Teresa Yuja, House 22, after the separation of tanks was completed.



Figure 12 (Left) Travel team members playing with children of the community at an end of the project celebration thrown by the community. (Right) The community members gathering with the travel team for a picture at the end of the trip.

7.0 Lessons Learned

After working with Guachtuq for seven years, EWB-USA WPI learned many lessons from the rainwater harvesting project. The overarching theme is that EWB-USA WPI should increase community involvement in the project from the onset to ensure its sustainability after completion.

Community Education

During the May 2016 trip, the certification program emphasized the importance of incorporating learning sessions throughout the entire duration of the project. Conducting learning sessions throughout the project gives community members a better understanding of the system, the reasoning behind the designs, and a greater sense of ownership. During the project it is important to include community members of all ages and genders in the learning process to encourage this feeling of ownership. The pride experienced by the women of the community was especially evident since their involvement in previous learning sessions had been marginal. EWB-USA WPI found that in the early stages of the project, women and teenagers were not given as much of a role since they were not directly involved in the construction of the systems. This was later recognized as a shortcoming to the project because both parties did not see themselves as critical stakeholders.

Community Cooperation in Project Design

It is important to allow community members to collaborate on the design of the system in the field. When completing the separation of tanks, EWB-USA WPI had the homeowner participate in the process and direct the location of the valves. This lesson was exemplified by the changes to the protocol for the separation of tanks initially designed by EWB-USA WPI as a result of observations in the community. In Guachtuq, water is not wasted and community members do not want to dump out gallons of water to clean the tanks. By incorporating the community member's idea to other systems we were able to use the social mindset into the incorporation to the separation modification.

Positive Relationship with NGO

EWB-USA WPI recognizes the importance of the NGO perspective throughout the project. During the focus group with CeCEP, an area for improvement mentioned to EWB-USA WPI was not including the CCODE and not working directly through the leaders of CeCEP throughout the entire project. During this focus group, CeCEP did compliment EWB-USA WPI by recognizing our club efforts to respect the culture and creating a collaborative relationship with the NGO. CeCEP highlighted our efforts for continuity and creating relations by always including multiple veteran travelers on each trip. Additionally, CeCEP appreciated that we had at least one Spanish speaker on each travel team, who collaborate with CeCEP throughout the entire project process. In the future EWB-USA WPI recognizes that the communication with local leaders, such as NGO, should continue to be inclusive and culturally appropriate, while working on more open communication to get honest feedback in the more developmental stages.

Reliable Access to Local Supplies

While all of the parts of the system were available in Guatemala, EWB-USA WPI learned that replacement parts could have been found more easily in the local area of Guatemala if more research had been conducted about the availability of parts. The systems were built using 1.5" pipes and adapters, where 2" piping and adapters are more common in Guatemala. While EWB-USA WPI was able to help the community source 1.5" piping from a larger city nearby, if 2" pipes were used for the entire system it would have been easier for community members to replace. It is crucial to have a good understanding of the supplies available in country prior to implementation in order to be able to easily make repairs and enable community members to easily make repairs.

8.0 Project Phase

Project Type	Implementation Continues	Monitoring & Evaluation	Complete
Water Supply			x

9.0 EWB-USA Project Monitoring

9.1 EWB-USA Project Status Table

Project ID	Project Type	Project Discipline(s)	Date of Completion	Functionality			Periodic Maintenance	Demonstration of Community Capacity
				0-50%	51-75%	76-100%		
6871	Water Supply	Water Storage	5/22/2015		x		Yes	Yes

9.2 EWB-USA Project Functionality Indicators

Project ID	Project Type	Project Functionality Indicator	Monitoring Result
6871	Water Supply	Number (or percentage) of	The community was generally satisfied with project procedures and outcome. Based on the gathered information

		community members satisfied with the project	from focus groups and the three individual interviews, a large majority of community members identified the implemented rainwater harvesting systems as beneficial for obtaining water security and alleviating time burdens. Women and children of the community especially benefited from the project, since the systems significantly reduced the need for them to go to the finca, giving them the opportunity to focus more on other responsibilities. The problems identified by community members were minimal and were mainly focused on minor flaws with the physical systems, which were subsequently addressed on the trip.
		Quantity of water available to each household during dry and wet seasons	When EWB-USA WPI calculated the amount of water each family's system would need to sustain their water consumption throughout the year, the chapter assumed the families would ration their water during the dry seasons. Since 22 systems were implemented a year ago, some of the families understood the importance of rationing their new water source, while others did not recognize the need to ration, since they had easy access to more water than ever before. In addition to the lack of proper rationing, Guatemala experienced a severe dry season this past year. Unfortunately due to this, EWB-USA WPI noted that the quantity of water for some systems was rather low or even empty. Regardless, there were 16 systems with at least one tank half-filled at the end of the dry season. EWB-USA WPI thus focused on educating community members on effective rationing procedures during the certification program. From the education and low water quantities this year, EWB-USA WPI believes that families will be more conscious of rationing water in following years. From analysis of previously gathered rain data, the team believes that enough water can be conserved with proper rationing methods to last a family throughout the dry season.
		Quality of the water at the water point	Water was generally found to be very clear inside of the tanks, with approximately 55 percent of tanks having no issues with water clarity. Of the other tanks, only 22 percent had water that was exceptionally dark, indicating a large portion of sediment on the bottom of those tanks. These observations were consistent with the turbidity results which, the average turbidity levels without filter cartridges were found to be 4.98 NTU. Water quality tests revealed that only 3 of 34 systems tested had water that was at a risk level greater than 1 per the World Health Organization guidelines. These water quality tests concluded that the original water source for the community, the finca, had a risk level of approximately 4 per the same guidelines. While taking into consideration the error

			factors that come along with field tests, the water quality data suggests that most systems implemented are working as intended. For the others systems, EWB-USA WPI worked to address the issues regarding the systems to ensure that the highest possible water quality is attainable going forward.
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9.3 Periodic Maintenance Indicators

Project ID	Project Type	Periodic Maintenance Indicator	Monitoring Results
6871	Water Supply	Level of cleanliness of gutters feeding a rainwater harvesting system	In general, the gutters feeding each rainwater harvesting system were free of large obstructions such as twigs or leaves leading EWB-USA WPI to conclude community members clean their gutters often. However, it was noticed that gutters at some homes were blackened by smoke and soot caused by poor ventilation of family stoves. Therefore, despite being cleaned often, several systems' gutters still appeared almost entirely black. EWB-USA WPI addressed this issue by modifying the positioning of the gutters at homes 26 and 23a so the gutters would be less affected by the smoke created by the stoves.
		Level of cleanliness of water storage tanks	As noted in the monitoring form in Appendix D, nearly 70 percent of tanks surveyed had either not dirty or just slightly dirty interiors, meaning very little sediment could be seen within most tanks. In addition, 85 percent of the tanks had clean exteriors and no insects living in them. However, several issues with maintenance were observed. For example, tank caps were unable to close properly at some homes. Since this will make it more difficult to keep the systems closed, this could lead to dirtier tanks in the future. While there is some reason for concern, EWB-USA WPI does not feel that this will be overly impactful on the project as there are other effective strategies to seal the top if the caps become fully inoperable.
		Observed evidence of routine maintenance on the system done accurately	In terms of cleanliness, EWB-USA WPI observed roughly 70 percent of tanks had very little or no sediment at the bottom, which is believed to be the result of cleaning and maintaining a system closed. Evidence of cleaning was especially apparent in the gutters, since most of the gutters that were observed had no obstructions in them and had perfectly placed mosquito netting over the downspout. In terms of general repairs, several systems around the community had minor cracks in their PVC piping that caused slight leakage of water and EWB-USA WPI observed attempted repairs with tape-like materials. While these repairs were not ideal long term solutions, it showed that

		without EWB-USA WPI	the community members were willing to put in the effort to repair systems. Maintenance of filter cartridges was quite poor. Most filter cartridges had been removed from the system, and those that remained were almost all either damaged or very dirty. As noted, this was more an issue with the filter design rather than community willingness to maintain them.
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9.4 Community Capacity Indicators

Project ID	Project Type	Community Capacity Indicator	Monitoring Result
6871	Water Supply	Community completed major repairs to the system accurately without EWB-USA WPI	EWB-USA WPI had the opportunity to observe a system that was separated before the travel team arrived in country. This process involves emptying the system in order to be able to cut apart the connecting piping and attach ball valves. In addition to the physical construction, it necessitates a strong and complete understanding of the design of the system and intent for the implementation.
		Chapter observed community members training others	In both of the certification programs, the valves used for the separation of tanks were explained and demonstrated to the members of the community. When the travel team moved through the community implementing the separations, members of the receiving family or their neighbors would step in to assist or take over and lead the cutting and reconstruction.
		Existence of broken components	Through the initial inspections, as well as the ongoing monitoring completed by CeCEP, issues were presented to EWB-USA WPI by the families of the community. What made these identifications important, was that the majority of problems pointed out were coupled with the families attempted solutions, successful or not. This shows the initiative, ownership, and responsibility for the systems by many of the community members, which is vital for the long term sustainability and impact of the project.

10.0 Next Phase of the Program

EWB-USA WPI has been working in collaboration with the community of Guachtuq since 2010 and has been able to work with them to improve their access to water of greater quantities and quality. The community families who were willing to be a part of the program have received their rainwater harvesting systems and have maintained their operation for a minimum of one year. The community as a whole has shown an incredible aptitude for learning new ideas and applying skills they already possess toward the achievement of improved water security.

As a result, EWB-USA WPI intends to enter a six month monitoring period with CeCEP to ensure that none of the changes made in this past trip, including the separation of tanks, cause any unanticipated problems
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with the ongoing maintenance of the systems. Additionally, the ongoing monitoring will serve as a final chance to observe the effect that the certification program and other educational programs have had on community members. The agreement signed with Edghar Gua of CeCEP for this continued monitoring is included in Appendix T.

If the six month monitoring period proves that the certification program and other educational were effective and that there are no large problems with the systems, EWB-USA WPI intends to close out the program and all projects within the program. This will involve the official handoff of all monitoring and upkeep responsibilities to the partner NGO and community government as well as the signing and submitting of the 907 Program Closeout form.

Appendices

Appendix A Signed 907 – Community Acknowledgment of Program Closeout

We are currently not closing out the project but during the final meeting with the COCODE and CeCEP as well as at the community meeting, the 907 was presented. The NGO, CeCEP will be getting the final signature on the 907 report in the coming months when monitoring proves it is appropriate to close out the project.

Appendix B Focus Group Questions

Men's Focus Groups Questions

Probing Questions

1. What do you do if there is a problem with your system?
 - Assess knowledge of the system/try to determine system “experts” in different familial groups
 2. Have you had to make any repairs on the systems? (yours or others in the community)
 - Did you do it yourself?
 - What materials did you use?
 - Where did you get the materials?
 3. Who is responsible maintaining the system?
 4. How are the responsibilities surrounding the system distributed throughout your family?
 - a. who is responsible for emptying the first flush
 - b. who is responsible for cleaning the tanks
 - c. who is responsible for getting water
 5. How do you think the construction teams worked in building the systems?
 6. What do you think about the project process?
- payment scheme/prices
 - CeCEP monitoring
 - house selection process
 - WPI presence in community
7. What do you think of the certification program?
 8. How have the systems impacted your life?
 9. How has the water board been involved in the process and the community?

Direct Questions

1. Is there a specific person responsible for fixing the system? Who usually fixes the system?
2. Do you ever repair your system? What materials did you use to repair your system? Where did you get the materials to fix your system?
3. Is a different person responsible for maintaining the system and repairing the system, or is a single family member responsible for both?
4. Who is responsible for emptying the first flush? Who is responsible for cleaning the tanks? Who is responsible for getting water?
5. What would you suggest to improve in the project process?
6. How did you like the payment scheme and the price of the system? How do

you like CeCEP monitoring the systems? What did you think about the house selection process for determining who got the next system? What do you think about the EWB presence in the community?

Women's Focus Group Questions

Probing Questions

1. How do you like your system?
2. Who is responsible for maintaining the system?
3. How are the responsibilities involving the system distributed throughout your family?
4. How have the systems impacted your life?
5. Do you have enough water to meet your needs?
6. How interactive has the COCODE been in the process?
7. How has the water board been involved in the process/the community?
8. What do you do if there is a problem with your system?
9. What do you think about the project process?

Direct Questions

1. Are there problems with your system?
How easy is your system to operate?
How has having the system changed your/your family's life?
2. How often do you clean the tanks/filter?
Who collects the water? How often?
How much and what maintenance has been done on your system? How much work do the kids do in cleaning the system?
3. Who is responsible for emptying the first flush? Who is responsible for cleaning the tanks and the filter?
4. Has there been a shift in your daily tasks? Do your kids have more time to go to school? Do you have more time to do tasks around the house or to work?
5. Is there more water at any point in the year? Do you ever have to go the *finca*

- to get enough water to meet your family's needs?
6. Has there been a change in the COCODE leadership throughout the process?
 7. How has the water board involved or is the water board involved in anything related to your system?
 8. Is there someone in your family who has made a lot of repairs on a certain part of your system?
 9. What can the WPI team improve with respect to the project? What did you like about the project process? How do you like having CeCEP monitoring your system?

COCODE Focus Group Questions

Probing Questions

1. Are community members happy with the systems?
2. What is your role in the community as an organization?
3. Has your role changed with the implementation of the systems?
4. How has EWB WPI presence affected the community?
5. What do you think about the project process?
 - o payment scheme/prices
 - o CeCEP monitoring/translating/facilitating communications
 - o house selection process
6. Has water security in the community improved?

CeCEP Focus Group Questions

Goals:

- To evaluate the project process, on the community as an entity
- To understand the role and presence of EWB-USA WPI in the community
- To gain insight into the project strengths and weaknesses as seen by the NGO facilitator

Location

- CeCEP

Probing Questions

7. Overall, how would you describe the experience of working with EWB-USA WPI? What went well? What did not go well?
8. How effective was communication between EWB-USA WPI and CeCEP? How could communication be improved?
9. Do you feel that the original goals of the project have been met? How well?
10. Do you feel that the community members are prepared to operate and maintain the rainwater harvesting systems on their own? How well prepared?
11. What do you think the long term impacts of the project will be?
12. Does CeCEP plan on doing any future work in relation to this project? If so, what?

Appendix C: Data Inspection Sheet
 Formulario de Monitoreo Ingenieros Sin
 Fronteras-USA WPI
 Numero de Casa:
 Fecah:

<u>Tinacos:</u>	Sí	No
¿Los tinacos están quebrados o desconectados?		
¿Los tinacos faltan las tapas?		
¿Las tapas están mal puestas/no están bien cerradas?		
¿El rebalse tiene un lugar que captura el agua para capacidad adicional?		

25%				
50%				
75%				
Lleno				

Si hay problemas con los Tinacos escribes notas aquí:

Cuan sucio están los tinacos (cuando hay más de un tinaco, enumerar los puntos donde apliquen y la numeración de los tinacos sigue del canal de bajada al rebalse)

- No hay suciedad
- Hay muy poco suciedad al fondo
- Hay suciedad que cubra parte del fondo
- Hay suciedad al fondo que hace que no se puede ver al fondo

Si tienes notas sobre la suciedad de los tinacos o el agua las escribas aquí:

Cuan sucio está el agua

- El agua está claro
- El agua está oscuro, pero aún se puede ver el fondo en parte
- El agua está oscuro y no se puede ver el fondo

Otra suciedad

- Hay suciedad en los tinacos a los lados o en la tapa
- Hay insectos en el tinaco
- Otros animales

Nivel del agua en los tinacos (marque si los tinacos son separados o de concreto)

	Tinaco 1	Tinaco 2	Tinaco 3	Concreto
Vacio				

Si tienes notas sobre el nivel de agua las escribes aquí:

Si hay problemas con la base las escriba aquí:

Base: la base está (marque todos que apliquen)

- Rajada
- No existe (la pancha de concreto)
- Faltan bloques
- Deslizandose por erosión
- Hay otro problema que hace que no funcione bien

Si hay problemas con el chorro las escriba aquí:

Chorro:

Que Chorro se usan?

- De Plastica
- De metala

	Plastica Sí	Plastica No	Metala Sí	Metala Sí
¿El chorro está conectado?				
¿El agua sale bien de los tinacos (del chorro si hay)?				
¿Hay sedimentos en el agua que sale de los tinacos?				

Estado del filtro 1: (cuando hay mas de un filtro, la numeracion sigue del canal de bajada al rebalse)

El cartucho del filtro está:

- Puesto
- No está puesto
- Perdido (no tiene)
- Roto

Filtro (la parte plastica) está:

- Conectado
- Desconectado
- Perdido (no tiene)
- Roto

Olor del filtro:

- De cloro o jabón
- Sin olor
- Con mal olo

Si hay problemas con filtro 1 escribes notas aqui:

Mucosidad:

- No hay mucosidad
- Hay mucosidad, pero el filtro esta blanco
- Hay mucosidad, pero el filtro esta gris
- Hay mucosidad, pero el filtro esta casi negro
- Hay demasiado mucosidad y no quiero tocarlo

Oscuridad del filtro (1 limpio – 5 sucio): _____

Estado del filtro 1:

El cartucho del filtro está:

- Puesto
- No está puesto
- Perdido (no tiene)
- Roto

Filtro (la parte plastica) está:

- Conectado
- Desconectado
- Perdido (no tiene)
- Roto

Olor del filtro:

- De cloro o jabón
- Sin olor
- Con mal olor

Mucosidad:

- No hay mucosidad/Hay mucosidad, pero el filtro esta blanco
- Hay mucosidad, pero el filtro esta gris
- Hay mucosidad, pero el filtro esta casi negro
- Hay demasiado mucosidad y no quiero tocarlo

Oscuridad del filtro (1 limpio – 5 sucio): _____

Si hay problemas con filtro 2 escribes notas aqui:Techo:

- Limpio
- Hay suciedad
- Ramas u hojas
- Otros objetos
- No puedo ver el techo (muy alto)

Connecciones:

	Sí	No
¿Hay connecciones que gotean?		
¿Hay tubos desconectados?		

Canales (marque todos que apliquen)

- Bien puestos y conectados
- Canal está perdido
- Canal está roto
- Union de canal está roto
- Union de canal está goteando
- Gutter clip está quebrado

Malla:

	Canal	Rebalse
Funciona bien		
Poco roto		
Roto		
Mal puesto		
Perdido		
No se puede ver		

Primera lluvia:

	1	2
Tiene agua		
Vacia		
Agua claro		
Agua tiene sedimentos		
Hay recipiente de agua		
Hay hoyo		
No hay hoyo		

Si hay problemas con el techo escribes notas aquí:

Si hay problemas con los conexiones escribes notas aquí:

Si hay problemas con los canales escribes notas aquí:

Si hay problemas con la malla escribes notas aquí:

Si hay problemas con la primera lluvia escribes notas aquí: Preguntas:

- ¿Hay problemas con el sistema? (tinacos, canales, tubos, primera lluvia, rebalse)
- ¿Hizo alguna reparación en el sistema? ¿Hay algo que no puede reparar?
- ¿Con qué frecuencia va al finca?
 - Veces por dia o semana:
 - Cantidad de gente que van cada vez:
- Como se usa agua de los tinacos? Del tanque concreto? De la primera lluvia? De la finca?

Uso	Tinacos	Concreto	Primera lluvia	Finca
Beber				
Cocinar				
Lavar trastes				
Lavar ropa				
Bañar				
Siembras/flores				

Otra (explicar)				
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- ¿Como usan la cubetita de EWB? ¿La usan correctamente?
- Como limpian....

	Tinacos	Filtro	Canales	Techo
Cloro/Jabon/ Pashte/Trapos/ Mano				
¿Con que frecuencia limpian?				
¿Ha limpiado desde la ultima vez?				

- Estan usando correctamente la primera lluvia? (riegan el agua despues de cada lluvia? Como usan el agua?)
- ¿Hierven el agua antes de tomar?
- ¿Han percibido una diferencia en el flujo del agua del sistema? (mas agua/menos agua/mas rapido/mas despacio/etc.)
- ¿Tiene sugerencia

Appendix D: Response to Key Questions

Stakeholder	Key Questions	Response & Justification
EWB Headquarters	1.) What is the long term sustainability of this project? 2.) What are the benefits and drawbacks of a project completed on an individual basis?	1.) The goal of this project was to bring increased quality, quantity, and access of water to the community of Guachtuq not just in terms of immediate relief, but long term sustainability. While conducting the initial system inspections, most families were able to point out problems with their systems and explain why this problem was occurring. Many families had also made an effort to resolve such issues by completing minor system repairs using plastic bags or other temporary fixes. Many families also conducted system modifications, one family even separated their own tanks using a valve similar to the valve the EWB-USA WPI team had researched. These system repairs and modifications were all indicators that the members of the community have a solid understanding of their systems and will be able to maintain them after EWB-USA WPI is no longer in the community. Additionally, some families are also capable of repairs and modifications. In order to further reinforce the importance of system maintenance in the community, the Travel Team conducted a men and woman's certification program. The men's program consisted of two classroom sessions in which the following topics were discussed: tanks and connections, filters and first flush, and gutters. Following the classroom session was a field component in which the attendees of the program helped to fix related problems on community members' systems. The women's program consisted of a review of system maintenance and small repairs. The participants repeatedly voiced their appreciation for the program because they now not only have the knowledge, but also the confidence to maintain their systems. This program, which built upon community members' existing knowledge will greatly contribute to the long-term sustainability of the project. Although not all community members are certified, a vast majority are and these people will be able to assist other members of the community.

Stakeholder	Key Questions	Response & Justification
	<p>3.) What were some of the impacts of the EWB-USA WPI team and project on the community?</p> <p>4.) What was the importance and role of the NGO in this project?</p> <p>5.) What is the reasoning and justification for closing out the project?</p>	<p>2. Many of the aspects of a project completed on an individual basis can be viewed as both benefits and drawbacks. For example, one benefit was that the systems were customized to fit the needs of the specific family receiving it. The midwife of the community received more tanks because she washed clothes for other families and used a lot of water for her job. However, since some families received more systems than others, it was difficult to explain this discrepancy to the community. Another drawback is that only families that lived in the community since the initiation of the project were able to benefit. During this trip, the travel team received a request to help build five more systems, this request will not be able to be met by EWB-USA WPI. Overall, most of the drawbacks stem from the fact that community members can only benefit from an individual-based project if their family is a benefactor of one of the systems. This is also a benefit because it ensures that families get out of their system what they put into it. Each family's system is no one's responsibility but their own.</p> <p>3. By providing a more convenient source of water to the community, many impacts have been observed. Women no longer have to take 6-8 daily trips to the Finca (previously the only source of water). Therefore, they have the freedom to plan out their days and have more time to accomplish other tasks, such as collecting firewood. Ultimately, the major impact has been increased flexibility in individual schedules.</p> <p>4. The NGO, CeCEP, was critical in carrying out the project. Throughout the past year, one of the contacts at the NGO would periodically go up to the community in order to fill out a monitoring form that the club had created. The NGO would often Skype</p>

Stakeholder	Key Questions	Response & Justification
	6.) What lessons have the chapter learned from this project and how will they be applied to future trips?	<p>with the PLEM lead as well as other members of the club to discuss the monitoring forms and other happenings in the community. Prior to close out, the NGO will continue this monitoring for six months. Additionally, due to the language barrier, the NGO was critical in helping the travel team conduct the certification program, interviews, focus groups, and community meetings.</p> <p>5. The goal of this project was to achieve improved water quality, quantity, and access. During the May 2016 Trip, these indicators were assessed through various tests and programs. In terms of water quality, the travel team conducted petrifilm, colert, and turbidity tests on all of the systems (that contained water) as well as the finca. Overall, the quality of the water in the systems was much better than the quality of the water from the finca. Additionally, over the years, the quality of the water in the tanks has actually improved (as a result of the team suggesting that the filters be removed from the systems). More on these indicators and results can be found in section 3.3 under the Water Quality Data portion. Now, not only does the community still have the ability to use the Finca, but they also have their own individualized systems. In terms of access, the systems are right outside (and in some cases, inside) the families' homes, which is more accessible than the Finca, which is at the bottom of the community and then even further down a hill.</p> <p>6. Throughout the project in Guachtuq, EWB-USA WPI learned many important lessons. These lessons include: increased community involvement, increased collaboration with the NGO, and a better understanding of the resources available in country. Further descriptions of these lessons can be found in Section 7, Lessons Learned.</p>
EWB-USA WPI	1.) Is the community	1.) The community's ability to conduct system repairs and modification on their own, and attendance at the

Stakeholder	Key Questions	Response & Justification
	<p>capable and willing to maintain the systems on their own?</p> <p>2.) Are individuals who completed certification programs qualified and recognized within the community?</p> <p>3.) Did water security improve in the community in the eyes of the club and the community?</p>	<p>certification programs are indicators that the community is capable and willing to maintain the systems on their own. Additional information on the long term sustainability and willingness of the community to maintain the systems on their own can be found in section 9.4, Community Capacity Indicators.</p> <p>2.) The community members who attended the certification program not only learned about and discussed the topics covered within the program, but were given hands-on experience. During the technical certification program, there was a field component during which a separation of tanks was conducted, as well as other minor repairs. During the wotechnical certification program, the women practiced taking apart the valves, and using teflon tape and PVC glue. Additionally, the participants were recognized at the final community meeting with certificates that explained their accomplishments.</p> <p>3.) In terms of water security, this goal was achieved in both the eyes of the club and the community. Water quality, quantity, and access was shown by the club to have been improved, and the community repeatedly voiced their appreciation for the work that was done.</p>
COCODE	<p>1.) Have there been changes in community leadership since the installation of the systems?</p> <p>2.) How has the COCODE contributed to the community in regards to water security?</p>	<p>1.) Prior to the implementation of the systems, the COCODE was the governing body. At the start of the project, the Water Committee was created to work with EWB-USA WPI. Therefore, the COCODE was originally excluded. However, the Water Committee proved unsuccessful in fulfilling the roles that EWB-USA WPI had outlined for them, and therefore, community leadership remained with the COCODE. CeCEP suggested that for future projects, not to create a new governing body.</p> <p>2.) Since the COCODE was originally not involved in the implementation of the project, it made no significant contributions in terms of water security</p>

Stakeholder	Key Questions	Response & Justification
	3.) What will the roles of the COCODE be in the future?	<p>during the time EWB-USA WPI was working with the community of Guachuq.</p> <p>3.) During the focus group with the COCODE, EWB-USA WPI outlined the roles that they will perform in the future. This mainly consists of serving as the first body that the community goes to with any problems. After that, if any problems or concerns that are not addressed the COCODE will bring these issues to CeCEP.</p>
Women of the Community	<p>1.) Do the women have a sound understanding of how the systems work and the proper maintenance and minor repair techniques?</p> <p>2.) Do the women feel comfortable with their role in regards to the systems?</p>	<p>1.) The wotechnical certification program reviewed maintenance and small repairs for the following topics: tanks and connections, gutters, the first flush, and filters. During the program, the women eagerly discussed the topics and even shared their own experiences. One of the women explained that she is away often for work, and she cleans her systems whenever she is home, because she may not be there when it rains. These are all indicators that the women of the community understand how their systems work as well as the proper maintenance and minor repair techniques.</p> <p>2.) After the certification program, the women repeatedly voiced their thoughts that they not only now have the knowledge to fix the systems, but also the confidence.</p>
Men of the Community	<p>1.) Do the men have a sound understanding of how the systems work and the proper maintenance and repair techniques?</p> <p>2.) Do the men feel comfortable with their role in</p>	<p>1.) During the technical certification program, the following topics were covered: tanks and connections, filters and first flush, and gutters. The men were very involved in the conversation during the classroom portion as well as the field portion in which actual repairs were conducted. Additionally, when repairs or the separation of tanks were conducted on individual homes, many men participated in these modification. These are all indicators that the men have a very good understanding of how the systems work and the proper maintenance and repair techniques.</p>

Stakeholder	Key Questions	Response & Justification
	regards to the systems?	2.) The men of the community repeatedly preached the importance of personal responsibility regarding maintenance of systems. One of the men (regardless of the time of day) gets on the roof and cleans the gutters as soon as it begins to rain. These are strong indicators that the men are comfortable with and have a strong understanding of their role in regards to the systems.
Children of the Community	1.) Do the children have a basic understanding of tank function, proper maintenance, and repair techniques?	1.) Several children attended the technical certification program and these children were eager and willing to participate in the classroom session and the field component. Even children who did not come to the certification program assisted members of the Travel Team during system repairs. It is evident that the children have a solid understanding of tank functionality, proper maintenance, and repair techniques.

Appendix D: System Inspection
Water Level In Tanks By House

House Number	Tank 1	Tank 2	Tank 3	Tank 4	Concrete	Above 50%
1	0	0				No
2	50	75				Yes
3	0	0	0			No
4	100	100	100			Yes
5	25	25				No
6	25	0	0		0	No
9	50	50	25	25		Yes
10	75	100	100			Yes
16	75	75				Yes
18	50	50				Yes
20	50					Yes
21	50	50				Yes
22	25	25				No
	100					Yes
23b	100					
23a	100					Yes
24	50					Yes
25	100					Yes
26	50					Yes
27	25	25				No
28	75	25			25	Yes
29	0					No
30	25					No
31	25	50				Yes
32	75	75				Yes
33	25	25				No
34	25	0	0		0	No
36	25	25				No
40	25	25	0	0		No
43	0	0				No

Overall Water Level Assessment

Water Level (%)	Total Tanks	% Of All Tanks
0	16	25.81%
25	20	32.26%
50	11	17.74%
75	7	11.29%
100	8	12.90%
Total # of tanks	62	

Number of Homes	At Least One Tank Above 50%	Percentage of Homes
29	16	55.17%

Water Source for Specified Activities

House Number	Drink	Cook	Wash Dishes	Wash Clothes	Bathe
1	tanks	tanks	tanks	tanks	tanks
2	tanks	tanks	first flush	finca	tanks
3	tanks	tanks	tanks	tanks	tanks
4	tanks	tanks	first flush	finca	tanks
5	tanks	tanks	tanks	first flush/finca	tanks
6	tanks	tanks	tanks	finca	tanks
9	tanks	tanks	tanks	finca	tanks
10	tanks	tanks	tanks	tanks	tanks
16	tanks	finca	finca	finca	finca
17	tanks	tanks	first flush	finca	first flush
18	tanks	tanks	tanks	tanks	tanks
20	tanks	tanks	other system	other system	other system
21	tanks	tanks	tanks	tanks	tanks
22	tanks	tanks	first flush	finca	tanks
23b	tanks	tanks	tanks	tanks	tanks
23a	tanks	tanks	tanks	tanks	tanks
24	tanks	tanks	tanks/concrete/first flush	concrete	tanks
25	tanks	tanks	tanks	tanks	tanks
26	tanks	tanks	tanks	tanks	tanks
27	tanks	tanks	tanks	tanks	tanks
28	tanks	tanks	concrete/finca	concrete/finca	concrete/finca
29	tanks	tanks	tanks	finca	tanks

31	tanks	tanks	tanks	first flush/finca	first flush/finca
32	tanks	tanks	first flush/finca	first flush/finca	first flush/finca
33	tanks	tanks	tanks	finca	tanks
34	tanks	tanks	tanks/first flush	finca	tanks
36	tanks	tanks	tanks	tanks	tanks
40	tanks	tanks	tanks	tanks	tanks
43	tanks	tanks	tanks	tanks	tanks

Summarized Data for Water Source for Specified Activities

	Total Responses	Tanks	Finca	Concrete Tanks	First Flush
Drink	28	28	0	0	0
Cook	28	27	1	0	0
Wash Dishes	28	20	3	2	7
Wash Clothes	28	12	14	2	3
Bathe	28	22	4	1	3

Cleanliness of Tanks (Interior)

House Number	Not Dirty	Little Dirty	Dirt Covers Part of Bottom	So Much Dirt Bottom Not Visible
1	0	1	0	0
2	0	0	1	0
3	0	1	0	0
4	1	0	0	0
5	0	1	0	0
6	0	1	0	0
9	0	0	0	1
10	0	1	0	0
16	0	1	1	0
17	0	0	0	0
18	2	0	0	0
20	0	0	1	0
21	2	0	0	0
22	2	0	0	0
23b	0	0	1	0
23a	0	0	1	0
24	1	0	0	0
25	1	0	0	0
26	0	0	0	0
27	0	2	0	0
28	0	0	0	0
29	1	0	0	0
30	0	0	1	0
31	2	0	0	0
32	0	0	0	0
33	1	1	0	0
34	0	0	3	0
36	0	1	0	1
40	0	2	2	0
43	2	0	0	0

Summarized Data for Cleanliness of Tanks:

Level of Cleanliness	Percentage Of All Tanks Observed
Not Dirty	37.50%
Little Dirty	30.00%
Dirt Covers Part of Bottom	27.50%

So Much Dirt Bottom Not Visible	5.00%
Total Number of Tanks Observed	40

Cleanliness of Tank Water

House Number	Water is Clear	Water is Dark, Bottom Visible	Water is Dark, Bottom Not Visible
2			1
4	1		
5	1		
6	1		
9			1
10	1		
18	2		
20			1
21	2		
22	2		
23b			1
23a			1
24			1
27	2		
28	3		
29	1		
30	1		
31			2
32			
33	1		
34			
36	2		
40			2
43	2		

Summarized Data for Cleanliness of Tank Water

Cleanliness of Water	Percentage	Total Number of Tanks Observed	
Water is Clear	59.46%		
Water is Dark, Bottom Visible	24.32%		
Water is Dark, Bottom Not Visible	21.62%	37	

Miscellaneous Data

House Number	EWB Bucket Used Properly	Boil Water	Tanks Damaged	Tanks Missing Caps	Tanks Improperly Closed	Overflow Leads to Additional Water Storage	Sides of Lids of Tank Dirty	Insects in the Tank	Other Animals in Tank
1	no	yes	no	no	no	no	no	no	no
2	no	yes	no	no	no	yes	no	no	no
3	no	yes	yes	no	yes	no	no	no	no
4	no	yes	no	no	no	yes	no	no	no
5	yes	yes	no	no	yes	no	no	no	no
6	no	yes	no	no	no	yes	no	no	no
9	no	yes	no	no	no	no	no	yes	no
10	no	yes	no	no	yes	no	no	no	no
16	no	yes	no	yes	no	no	no	no	no
17	no	yes	n/a	n/a	n/a	n/a	n/a	n/a	n/a
18	no	yes	no	no	no	no	no	no	no
20	no	yes	no	no	yes	yes	no	no	no
21	yes	yes	no	no	no	yes	no	no	no
22	n/a	yes	no	no	yes	yes	no	no	no
23b	yes	yes	no	no	no	no	no	yes	no
23a	yes	yes	no	no	no	no	no	yes	no
24	yes	yes	no	no	yes	yes	yes	no	no
25	no	yes	no	no	no	no	no	no	no
26	no	yes	no	no	no	no	yes	no	no
27	no	yes	no	no	no	yes	no	no	no
28	no	yes	no	no	yes	no	no	no	no
29	no	yes	yes	no	yes	no	no	no	no
30	n/a	yes	yes	no	yes	yes	yes	no	no
32	no	yes	no	no	no	yes	no	no	no
32	no	yes	no	no	no	yes	yes	no	no
33	yes	yes	no	no	yes	yes	no	no	no
34	no	yes	no	no	yes	no	yes	yes	no
36	no	yes	no	no	no	no	no	no	no
40	no	yes	no	no	yes	no	no	no	no
43	no	yes	no	no	no	no	no	no	no

Summarized Data of Miscellaneous Data

	Total of Responses	# of Yes	Percentage of Yes	# of No	Percentage of No
EWB Bucket Used Properly	24	4	16.67%	20	83.33%
Boil Water	26	26	100.00%	0	0.00%
Tanks Damaged	29	3	10.34%	26	89.66%
Tanks Missing Caps	29	1	3.45%	28	96.55%
Tanks Improperly Closed	27	11	40.74%	16	59.26%
Overflow Leads to Additional Water Storage	26	9	34.62%	17	65.38%
Sides of Lids of Tank Dirty	29	5	17.24%	24	82.76%
Insects in the Tank	29	4	13.79%	25	86.21%
Other Animals in Tank	29	0	0.00%	29	100.00%

Appendix E: Government Tank Inclusion in Closed System Water Analysis

Tank	Jan-14	May-14	Jan-15	May-15	May-16
2 Government Tank Preimpl.				2 2	
2 Government Tank without filter					4
3 Government Tank				2 2	X
4 Government Tank with filter					1
4 Government Tank without filter				1 1	2
6 Government Tank without filter					1
6 Government Tank Preimpl.				1 1	X
7 Government Tank			3 2 2		X
7 Government Tank		2 1			X
8 Government Tank				2 2	X
9 Government Tank without filter		2 1 X			1
10 Government Tank without filter				3 3	1
18 Government Tank	2 2				
21 Government Tank	2 2	1 1	1 1 1		
21EWB tank without filter				2 2	
23a Government Tank 1Preimpl.					4
23a Government Tank 1without filter				2 2	
23a Government Tank 2 Preimpl.				2 2	
23a Government Tank 2 without filter					1
26 Government Tank			2 2 2		
26 Government Tank			4 4 X		
29 Government Tank	2 2		2 2 2		X
30 Government Tank with filter					1
30 Government Tank without filter			2 2 2		1
31 Government Tank	3 2	3 4 2			
31Government Tank 1Preimpl.				2 2	
31Government Tank 2 Preimpl.				2 2 2	
31Government Tanks (tap) no filter				3 3 3	
32 Government Tank 1Preimpl.				3 3	
32 Government Tank 2 Preimpl.				2 3	
32 Government Tanks (tap) no filter					1
40 government Tank 1Preimpl.				2 2	
40 Government tanks (tap) no filter					1
40 Government Tank 2 Preimpl.				2 2	

Appendix F: Implemented EWB-USA WPI Water Source Compared to Original Source

Source	Jan-14	May-14	Jan-15	May-15	May-16
1 EWB Tank with filter			1 1 1	2	X
4 EWB Tank with filter					1
4 EWB Tank without filter					2
5 EWB Tank without filter					1
5 EWB Tank with filter			1 1 1	2 1	X
6 EWB Tank without filter					1
8 EWB Tank with filter	2		2 1 1	2 2	X
9 EWB Tank with filter			2 2 2	2 2	X
9 EWB Tank without filter					2
10 EWB tank with filter					1
10 EWB tank without filter					2
16 EWB Tank with filter				1 3	
16 EWB Tank with filter				2 2	
16 EWB Tank without filter				2 2	1
17 EWB Tank without filter					3
18 EWB Tank without filter					1
18 EWB Tank with filter				2 2	
20 EWB Tank without filter					1
21 EWB Tank with filter			2 2 2	1 2	
21 EWB Tank without filter					1
23b EWB tank without filter					1
24 EWB tank without filter					1
25 EWB tank with filter					2
25 EWB tank without filter					2
26 EWB Tank with filter			2 2 2	3 3	2
26 EWB Tank with filter				2 2	
26 EWB Tank without filter			2 2 2	4 3	1
27 EWB Tank with filter	3 1 1		2 2 2	2 2	
27 EWB Tank with filter				2 2	
27 EWB Tank without filter					1
28 EWB Tank with filter			2 2 2	2 2 2	
28 EWB Tank without filter					1
29 EWB Tank with filter			2 2 2	3 3	X
29 EWB Tank with Filter				4 4	X
29 EWB Tank without filter				5 5	X
31 EWB Tank with filter				2 2	2
31 EWB Tank without filter				2 2	3
33 EWB tanks without filter					1
34 EWB tank without filter					1
36 EWB tank without filter					1
40 EWB tank without filter					1

Source	Jan-14	May-14	Jan-15	May-15	May-16
2 Government Tank Preimpl.				2 2	4
2 Government Tank without filter				2 2	X
3 Government Tank					1
4 Government Tank with filter				1 1	2
4 Government Tank without filter					1
6 Government Tank without filter					
6 Government Tank Preimpl.				1 1	X
7 Government Tank			3 2 2		X
7 Government Tank		2 1			X
8 Government Tank				2 2	X
9 Government Tank without filter			2 1 X		1
10 Government Tank without filter				3 3	1
18 Government Tank	2 2				
21 Government Tank	2 2	1 1	1 1 1		
23a Government Tank 1 Preimpl.				2 2	4
23a Government Tank 1 without filter					4
23a Government Tank 2 Preimpl.				2 2	
23a Government Tank 2 without filter					1
26 Government Tank			2 2 2		
26 Government Tank			4 4 X		
29 Government Tank	2 2		2 2 2		X
30 Government Tank with filter					1
30 Government Tank without filter			2 2 2		1
31 Government Tank	3 2	3 4 2			
31 Government Tank 1 Preimpl.				2 2	
31 Government Tank 2 Preimpl.				2 2 2	
31 Government Tanks (tap) no filter				3 3 3	
32 Government Tank 1 Preimpl.				3 3	
32 Government Tank 2 Preimpl.				2 3	
32 Government Tanks (tap) no filter					1
40 government Tank 1 Preimpl.				2 2	
40 Government tanks (tap) no filter					1
40 Government Tank 2 Preimpl.				2 2	
Finca at Weir	3 2				
Finca at Spring Box	2 2				
Finca Tap	3 3				
Finca Tap	3 3				
Finca Tap	3 3				
Finca Tap	2 3	4 4 5	4 4 3	3 4 4	4
Finca Tap	2 2	5 4 5			

Source	Jan-14	May-14	Jan-15	May-15	May-16
Finca wash basin discharge	4 4				
Finca basin		5 4 5			
Finca basin		4 4 4			
Water hole				4 3	

Appendix G: Water Risk Level Data with Filters On and Off

Source	May-14	Jan-15	May-15	May-16
1 EWB Tank with filter		1 1 1	2	X
4 EWB Tank with filter				1
4 EWB Tank without filter				2
5 EWB Tank without filter				1
5 EWB Tank with filter		1 1 1	2 1	X
6 EWB Tank without filter				1
8 EWB Tank with filter		2 1 1	2 2	X
9 EWB Tank with filter		2 2 2	2 2	X
9 EWB Tank without filter				2
10 EWB tank with filter				1
10 EWB tank without filter				2
16 EWB Tank with filter			1 3	
16 EWB Tank with filter			2 2	
16 EWB Tank without filter			2 2	1
17 EWB Tank without filter				3
18 EWB Tank without filter				1
18 EWB Tank with filter			2 2	
20 EWB Tank without filter				1
21 EWB Tank with filter		2 2 2	1 2	
21 EWB Tank without filter				1
23b EWB tank without filter				1
24 EWB tank without filter				1
25 EWB tank with filter				2
25 EWB tank without filter				2
26 EWB Tank with filter		2 2 2	3 3	2
26 EWB Tank with filter			2 2	
26 EWB Tank without filter		2 2 2	4 3	1
27 EWB Tank with filter	3 1 1	2 2 2	2 2	
27 EWB Tank with filter			2 2	
27 EWB Tank without filter				1
28 EWB Tank with filter		2 2 2	2 2 2	
28 EWB Tank without filter				1
29 EWB Tank with filter		2 2 2	3 3	X
29 EWB Tank with Filter			4 4	X

29 EWB Tank without filter			5	5	X
31 EWB Tank with filter			2	2	2
31 EWB Tank without filter			2	2	3
33 EWB tanks without filter					1
34 EWB tank without filter					1
36 EWB tank without filter					1
40 EWB tank without filter					1

Appendix H: Turbidity

House #	Tank Type	Y or N Filter	Turbidity Reading
2	Gov't	N	
5	EWB	N	
24	EWB	N	1.55
6	Gov't	N	0
6	EWB	N	2.594
40	2 Gov't tanks	N	0
40	EWB	N	6.88
16	EWB & gov't tank	N	0
18	2 EWB tanks	N	11.25
20	EWB	N	4.648
21	EWB & gov't tank	N	6.38
17	2 EWB tanks	N	11.34
23a	Gov't	N	7.39
23a	2 gov't tanks	N	0
23b	EWB	N	12.79
27	2 EWB tanks	N	5.13
28	EWB	N	4.977
33	2 EWB tanks	N	7.157
32	Gov't	N	0
34	EWB & gov't tank	N	1.44
Finca	From basin		8.725
Finca	Tap Drinking Water		0
4	2 Gov't	Y	4.087

House #	Tank Type	Y or N Filter	Turbidity Reading
4	2 Gov't	N	7.191
4	EWB	Y	4.284
4	EWB	N	5.503
6	concrete		5.998
9	2 EWB	N	5.72
9	2 Gov't	N	1.865
10	2 Gov't	N	7.492
10	EWB	Y	5.737
10	EWB	N	4.315
12	Concrete		5.226
24	Concrete		1.808
25	EWB	Y	6.097
25	EWB	N	3.802
26	EWB	Y	5.382
26	EWB	N	7.752
30	concrete		2.661
30	Gov't	Y	14.29
30	Gov't	N	6.614
31	Gov't	N	4.218
31	EWB	Y	10.29
31	EWB	N	6.695
36	2 EWB	N	3.901

Appendix I: Payment Records

House Number	Year Implemented	Amount to Pay (Q)	Amount Remaining (Q)	% Paid
1	Jan-14	336	0	100
2	May-15	326	0	100
3	May-15	305	0	100
4	May-15	362	192	47
5	May-14	374	0	100
6	May-15	365	65	82
7	May-15	260	0	100
8	Jan-13	182	0	100
9	May-14	435	0	100
10	May-15	560	560	0
12	May-15	73	73	0
16	May-14	254	29	89
17	May-15	400	400	0
18	May-14	374	264	29
19	May-15	300	93	69
20	May-15	273	273	0
21	May-14	200	50	75
22	May-15	436	0	100
24	May-15	234	234	0
25	May-15	257	0	100
26	Jan-13	232	0	100
27	Jan-14	387	37	90
28	May-14	212	112	47
29	May-14	217	118	46
30	May-15	410	210	49
31	May-14	228	0	100
32	May-15	76	76	0
33	May-15	410	0	100
34	May-15	345	0	100
36	May-15	395	0	100
40	May-15	585	285	51
43	May-15	432	432	0
23a	May-15	280	280	0
23b	May-15	241	241	0

Appendix J: Example Payment Record



Museo Katinamit

San Cristóbal Verapaz
Tel. (502) 7950-4896
cecep@intelnet.net.gt

RESUMEN DE GASTOS DEL PROYECTO PRO SISTEMA DE AGUA, COMUNIDAD DE GUACHTUC.

Fecha	Descripción	Monto del gasto	Total
03/03/2013	Tablas, lapiceros y fotocopias	Q 180.00	Q 180.00
26/03/2013	Pago de monitoreo, marzo 3, 10, 17 y 24	Q 1,000.00	Q 1,000.00
14/04/2013	Fotocopias	Q 15.00	15.00
22/04/2013	Fotocopias	Q 4.00	4.00
22/04/2013	Pago de monitoreo, marzo 31, abril 07, 14 y 21.	Q 1,000.00	Q 1,000.00
TOTAL			Q 2,199.00

INGRESOS DE CUOTAS DE FAMILIAS BENEFICIADAS

Fecha	Descripción	Monto	Total
09/01/2013	Cuota de 5%, Cristóbal Laj Cojoc,	Q 182.00	Q 182.00
21/01/2013	Cuota del 5 % Roberto Chacoj	Q 232.50	Q 232.50
TOTAL			Q 414.50

Abril 28 del 2,013.



Appendix K: Transfer of Responsibility document



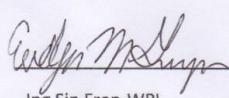
ENGINEERS WITHOUT BORDERS USA WORCESTER POLYTECHNIC INSTITUTE CHAPTER

San Cristobal Verapaz 17 de mayo de 2016.

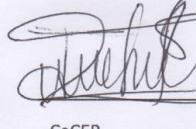
En mayo, 2016, el grupo de Ingenieros sin Fronteras-WPI, en colaboración con la comunidad de Guachtuq, concluyo la implementación de 34 sistemas de agua. Todos los acuerdos que se han firmados con las familias de Guachtuq han sido realizados. Ahora, como Ingenieros sin Fronteras-WPI se retira, este documento provee los asuntos para los próximos pasos del manejo y monitoreo de los sistemas de agua.

1. Según el convenio firmado entre cada familia e Ingenieros Sin Fronteras-WPI, el mismo documento manifiesta que la autoridad (sea - ISF-WPI o CeCEP), tiene el derecho a cobrar cualquier familia que sale de la comunidad entre diez años de recibir sus sistema de Guachtuq y lleva el sistema de agua a ese otro lugar, el precio completo del sistema le será cobrado. El precio total es el que está escrito en el convenio.
2. El COCODE se compromete a comunicar cualquier problema o inquietud a CeCEP, y a trabajar con CeCEP para resolverlo.
3. Al final del proyecto, cuando Ingenieros Sin Fronteras (ISF) – WPI se retira del trabajo en Guachtuq, transfieren a CeCEP (Museo Katinamit) toda la autoridad y el poder de tomar decisiones en relación al proyecto de sistemas de agua, como organización encargada del proyecto. La fecha de esta transferencia de autoridad ocurrirá el primero de enero, 2017.

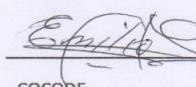
Les agradecemos a la comunidad de Guachtuq para la colaboración, hospitalidad y amistad que nos han ofrecido. Esperamos que los sistemas rinden agua en buena cantidad y calidad por las décadas futuras.


Ing Sin Fron-WPI

Evelyn Grainger
Presidente Ing Sin Fron
WPI, USA


CeCEP

Suelly Scal Tom
2615127731603


COCODE

Emilio Chen Gualim
Presidente COCODE
Guachtuq.



Appendix L: Example of Certification Program Diplomas and Certificates



Figure 13: An example of the certificates given to the community members who completed both days of the men's certification program



Figure 14: Example of a diploma given to participants who attended all three

**Appendix M: Attendance Sheet for the Certification programs
 Women's Certification Program Attendance**

No.	Nombre	No. de DPI	No. Teléfono	Firma
1	Herlinda Velasquez Xona			
2	Marcela Ical Molan			
3	Lucia Cal Sucum			
4	Elvira Choc Lem (D10.40)			
5	Marcela Toc Pop			
6	Adela Chen			
7	Alicia chen Toc			
8	Filomena Gualim Caal			
9	Rosa Gualim Caal			
10	Isabel Xona Sis			
11	Angela Aljardina Lem Ma (D10.**)			
12	Margarita Pop Jour			
13	Graciela Cardona Velasquez			
14	Isabel Cu Sis			
15	Carmelina Laj Yujca			
16	Marioica Cal caj (D10.**)			
17	Celestina caal Caj			
18	Isabeta Caj Pop			
19	Rosalio Molan Lem			

No.	Nombre	No. de DPI	No. Teléfono	Firma
20	Zoila Esperanza Ical Rojoc			
21	Catalina Marz Calat			
22	Eldiana Esperanza Xona Yujca (D10.**)			
23	Elvira Cal Chen			
24	Elsa Martha Yujca Lem			
25	Alejandrina Verónica Yujca Lem			
26	Teresa Yujca Lopez (D10.**)			
27	Anita Yujca Lopez (D10.**)			
28	Emilia Chen Gualim			
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				

Men's Certification Program Attendance

Appendix N: Outline of the Certification Program

Primer Día: Los tinacos y conexiones

Slide 1: Los tinacos y conexiones

-Como se puede definir un sistema cerrado?/Que es?

-Cuál es la importancia del sistema cerrado?

Mantiene limpio el agua

Previene de entrar suciedad externa

Previene de entrar mosquitos que pueden llevar enfermedades

Previene la entrada de otros bichos, arañas, etc.

-por qué son importantes los tinacos y conexiones?

- ¿Cuál es el propósito de los tinacos?

- Para almacenar agua - CANTIDAD? CALIDAD? Para acceso más fácil, más cerca, mas rápido, ahorra de tiempo!!!

Slide 2: Sistema Abierta

Ejemplos de un sistema abierto

Slide 3: Sistema Cerrada

Asegurar que hay malla sobre cada entrada entre los tubos y tinacos

Asegurar que la tapa de los tinacos es completamente cerrado

Slide 4: Los tipos de tinacos

- ¿Qué son los diferentes tipos de tinacos?
 - De concreto y de plástico

Slide 5: Partes de los tinacos

Partes de los tinacos

- ¿Qué son las partes diferentes del tinaco?
 - El rebalse
 - La base
 - El tinaco
 - Las conexiones

Slide 6: La Base

La base

- ¿Por qué tiene importancia la base?
 - Sostener los tinacos para que no rajen
 - Prevenir la erosión bajo de los tinacos
 - Levantar los tinacos para facilitar obtener agua del chorro

Slide 7: Entrada del agua

- ¿Cómo se conectan los canales a los tinacos?

- Agua fluya de la bajada del canal a los tinacos por tubos
- Hay una rosca que sella la entrada
- La rosca no se pega para permitir la separación del tinaco para limpiarlo
- Es necesario que la entrada del tinaco sea más bajo que la bajada del canal
- Se puede dirigir un tubo por algún ángulo por la usa de 3 ángulos de 90 grados

Slide 8: Rebalse interior

- ¿Cuál es el propósito del rebalse?
 - Permitir agua a desbordar del tinaco

Que llega al fondo del tanque!

El tubo adentro llega al fondo para chupar y botar el agua más sucio desde el fondo.

El tubo es pegado a la rosca (por rotoplas)

Slide 9: Rebalse exterior

Rebalse

- ¿Qué es importante para recordar en la construcción del rebalse?
 - La malla para prevenir la entrada de mosquitos-muy importante para mantener un sistema cerrada
 - Apuntarla hacia abajo para que el agua fluya del sistema
 - Mover el agua lejos del tinaco para prevenir la erosión
 - Cortar un hoyo en el codo del tubo para no crear un sifón
- ¿Cómo decide donde cortar el hoyo para el rebalse?
 - La curva inferior del codo debe ser inferior al menor dentro del labio de la entrada

Slide 10: Ejemplos del interior de los tinacos

Hablar acerca de los niveles de suciedad de los dos tinacos y la importancia de limpiarlos

Slide 11: Algunas conexiones

Cuál es el propósito de las conexiones?

Más conexiones permiten más flexibilidad para dirigir el agua a otro lugar

-más conexiones corresponde con más lugares a gotear

Cuando está usando conexiones y está poniendo tubo entre los conexiones, queda como cinco pulgadas entre los conexiones, para que si necesita cambiarlo, puede cortar el tubo y mantener la medida que necesita para añadir un conexión nuevo

Slide 12: Como puede tener más flexibilidad

Con un codo, está restringido por solo el ángulo que tiene el codo.

Pero, con dos codos, se puede tener algún ángulo que quiere en solo una dirección (como vertical u horizontal)

Con tres codos, puede tener algún ángulo que quiere en las dos direcciones (como verticales y horizontales)

Slide 13: Tubos largos/conexiones largos

Si hay una conexión con un tubo muy largo, usar palos con alambre de amar para apoyarla

Slide 14-22: Separación de los tinacos

-Esa es una reparación para permitir la limpieza de los dos tinacos sin perder agua

-El equipo de ISF va a realizar los cambios en los próximos días

-Habrá una válvula por tinaco

-hay una unión en cada lado de la válvula

-Usar las dos válvulas para regular el agua

-abrir la primera válvula y cerrar la segunda para llenar solo el primer tinaco. Entonces se puede usar el agua solo del segundo tinaco y cuando esta

Vació, limpiarlo.

-abrir las dos válvulas para igualar el nivel de agua en los tinacos y luego, cerrar la primera válvula. Solo usar agua del primer tinaco y cuando esta

Vació, limpiarlo.

-Demonstrar como separar la válvula para limpiarla cuando no funcione

-Mostrar la válvula a la clase

Después de la separación, usar las válvulas para controlar donde fluye el agua

Cuando las dos válvulas están abiertas, el nivel de agua en los dos tinacos será el mismo

Cuando un tinaco vacía, cerrar la válvula y limpiar el tinaco

Usar las válvulas para crear un método de usar el agua y limpiar los tinacos cuando vacían

Slide 23: Demonstración de cortar y pegar los tubos

Demonstrar como cortar, lijar y pegar los tubos

Si estas pegando los tubos, usar lija en los dos lados (con los dos partes)

No pegar durante lluvia

Si cortando cerca de una conexión, asegurar que hay suficiente tubo de la conexión para conectar el tubo nuevo

Slide 24: Hoyo en el tinaco

¿Qué problemas han encontrado o han visto con los tinacos? ¿Cómo los reparan?

- Los tinacos gotean
 - Usar cinta u otros materiales para atascar y dejar la gotear
- Hoyos en el tinaco: como repararlos
 - Usar cinta u otros materiales para atascar el hoyo
 - No encender fuegos cerca de los tinacos porque se fundirán

Slide 25-26: Problemas con las conexiones

- Las conexiones gotean

- Usar cinta (teflon tape) u otros materiales (pegado)
- Si es posible, reemplazar la sección con nuevo tubo
 - Cortar y quitar la sección de la gotera
 - Secar la area y aplicar el pegamento
 - Pegar el tubo nuevo al tubo viejo

Despues del tiempo, el pegamento esta tan viejo, entonces, es possible que estas partes empieza a gotejar. Para resolver eso, si es posible, separar el conexión y el tubo, y pega nuevo.

Slide 27: La cinta de teflón

- Demonstrar como usarla para no gotejar las conexiones
 - mostrar cómo aplicar la cinta para no doblar en la conexión

Slide 28: Mantenimiento de los tinacos

Mantenimiento del tinaco

¿Cómo vacían los tinacos para limpiarlos?

- Usa una válvula con roscas
- Apagar la válvula
- Desenroscar una unión
- Habrá agua en un tinaco cuando se limpia el otro
- Conectar los tubos de nuevo y repetir en el otro lado

¿Cómo limpian los tinacos?

- Vaciar los tinacos
- Usar pashte con agua, jabon y cloro para limpiar
- Conectar el sistema de nuevo

¿Cómo obtener agua de los tinacos?

- Grifo/chorro en los tinacos

Segunda Día: Las primeras lluvias, los filtros y los canales

Slide 1: La primera lluvia

Introducción a la primera lluvia

- ¿Por qué tiene la sistema una primera lluvia?
 - Para quitar el agua y suciedad más contaminada que acumula en el techo y los canales
- ¿Cómo funciona la primera lluvia?
 - El tamaño está determinado por área del techo que se necesita limpiar
 - Se llena con el volumen de agua inicial
 - El agua hace subir a la botella hasta la cima para atascar el reductor cuando se llene

Slide 2: Arreglar la primera lluvia

- ¿Cómo se usa y que no el agua de la primera lluvia?
 - Usos correctos incluyen

- Regar plantas
- Lavar ropa
- Usos incorrectos
 - Echarla en la cubeta anaranjada de ISF
 - Beber
 - Cocinar
- ¿Qué papel juega la primera lluvia en el conjunto del sistema?
 - Quitar la mayoría de la suciedad del techo del agua
- Los canales sujetan al techo. Agua cae del techo.
 - Techo → Canales → tubos de PVC/primera lluvia
- ¿Por qué algunos sistemas tiene múltiples primeras lluvias?
 - Algunos techos no se puede conectar al sistema
 - Cada grupo de techos está calculado para determinar la capacidad de las primeras lluvias con respecto a tamaño y volumen

Slide 3-5: Partes

Piezas de la primera lluvia

- ¿De cuáles partes componen la primera lluvia? (Empezando a la cima) Usen el ejemplo de la primera lluvia y traigan cada pieza de la cuando se mencione
 - PVC T, 1.5" tubo, 1.5 x 3" o 4" reductor, 3 o 4" tubo, 3 o 4" x 1.5" reductor, 1.5" pipe, adaptador masculino enhebrado, clave, 1.5" tubo, codo de 45 grados.
- Solo se pega de un lado

Construcción de una primera lluvia

Usar las direcciones siguientes

Instalación de la primera lluvia

- ¿Cómo montarían la primera lluvia?
 - Conectar las conexiones "T" o "Y" al canal y tanque o tubo pluvial
 - Cortar un tubo de 3" o 4" para la parte principal de la primera lluvia
 - Pegar reductores a los dos lados y poner una botella vacía adentro el tubo
 - Al fondo, conectar una tapa con agujero (automático) o clave (manual)
 - Lijar y pegar conexiones que no sobresalen SALVO el reductor de abajo
 - Sostener la primera lluvia con un palo y amarrar con alambre
 - Asegurarse que hay soporte al reductor inferior y que llega al suelo

Slide 6: Construcción de la primera lluvia

Mostrar una foto de una primera lluvia y revisar las materias necesarias

- PVC de 3 o 4 pulgadas (naranja)

o Hay dimensiones diferentes en cada sistema. PVC con un diametro mas grande corresponde con una primera lluvia mas corta porque del volumen de agua que se puede guardar

- Un pedazo pequeno de PVC de 2 pulgadas
- Un reductor de 3" o 4" a 2" (dependiente en la dimension del PVC de la mayoria de la primer alluvia)
- Un redactor de 3" o 4" a 1,5" para el bajo de la primera lluvia
- 2 uniones de 3" o 4"
- Un pedazo pequeno de tubo de 1,5"
- 2 1,5" adaptador macho
- 1,5" valvula
- Pegamento de PVC
- Lija
- Opcional es 1,5" codo de 45 o 90 grados

2. Ensenar como construir una primer alluvia

• Cortat un PVC de 3" o 4" dependiente en el area del techo. Esta cantidad de agua va a lavar la mayoria de la suciedad del techo en el tubo

- Adjuntar todas las partes de la primera lluvia SIN PEGAMENTO (este es porque si hay un problema, puede arreglarlo sin romper algunas partes)
- Poner el pedazo pequeno de 2" PVC en el adaptor de 2" a 3" o 4"
- Poner este adaptor en las uniones de 3 o 4"
- Cortar las uniones de PVC al largo que quiera
- Poner el PVC en la segunda union
- Poner esta union en el reductor de 3 o 4"
- Poner este reductor en el tubo de 1,5"
- Arreglar el tubo de 1,5" en el adaptador macho
- Poner el adaptor en la valvula
- Opcional es conectarla al codo de 1,5"

Si quieres limpiar la primera lluvia, no se puede pegar un lado

Primeras lluvias mas largos quitar mas agua (pero agua sucia como esta desenado por el techo)

Sistemas con techos grandes necesitan primeras lluvias mas largos

Slide 7: Mantenimiento de la primera lluvia

Mantenimiento de la primera lluvia

- ¿Cuándo lavan Ud. la primera lluvia?
 - Despues de cada lluvia
- ¿Qué pasa cuando no se vacía la primera lluvia?
 - El agua contaminada fluye rectamente a los tanques la próxima vez que llueve
 - La solución es vaciar la primera lluvia frecuentemente

Slide 8-9: Problemas con las primeras lluvias

Problemas con la primera lluvia y soluciones

- ¿Cuáles son algunos problemas con la primera lluvia que les han ocurrido y cómo los mejorararía? - *Discurso con la clase*
 - Asegúrense los siguientes están incluido
 - Sustitución de las botellas
 - Desmonten la primera lluvia del lado no pegado y pongan nueva botella aplastada
 - Se aplasten para que no pierden volumen en la primera lluvia
 - La caída de la primera lluvia
 - Determinen por qué se cayó
 - Sujeten de forma más segura
 - Se atasca
 - Abrir la primera lluvia y lavarla
 - Laven frecuentemente
 - Se cae o se atasca la llave
 - Sustituyen la tapa metálica
 - Usen la válvula azul de Rótoplas cuando está desconectado
- Conexion entre el T de PVC y la primera lluvia se quebró. Es posible que sea necesario reemplazar la “T” conexión o es posible que solo se necesita pegarla.
- La primera lluvia se cayo. Reemplezar con pegamento y apoyarla con un palo y alambre de amarre

Slide 10-12: Los filtros

Cual es el propósito del filtro?

Filtros son para sacar 2 tipos de cosas del agua

1. Sedimentos, como arena, suelo, etc. Estos tipos de cosas no hacen dano a la salud
2. Bacteria, que causa enfermedades

Los filtros que vinieron con los tanques son diseñados a sacar los sedimentos, como arena, suelo, etc.,

NO son diseñados a sacar las bacterias del agua

Ademas, nuevas bacterias se cultivan en lo filtros entre usos.

ESTA bacteria puede contaminar el agua del tanque en vez de limpiarlo!

Slide 13: Petrifilms

-Cual son los contaminantes en el agua?

- la bacteria
- los sedimentos

Este es la prueba de agua que muestra si hay bacteria en el agua - se pone una gota del agua de los muestras de tomamos de SUS tanques - y los químicos en la prueba nos dice si hay bacteria en el agua...

Los puntos azules son bacterias malas
Se puede ver la diferencia ...
a la izquierda se vea una prueba de agua limpia - no tiene puntos azules
A la derecha se vea una prueba de agua sucio - con bacteria - tiene puntos azules.

Slide 14-15: Los filtros

Las pruebas que hemos hecho, muestra que los filtros se hace peor, las bacterias en el agua
Cuando se rompe la tela del filtro... aun un poco... ya no sirve para nada.

Entonces...

Los filtros son diseñados para sacar arena y suelo... NO BACTERIA
La bacteria se crece en los filtros entre usos y puede contaminar mas el agua que sale del tanque.

Sobre los ultimos años hemos hecho pruebas y hemos encontrado que hay mas bacteria en los tanques con filtros.

Hay menos bacteria en los tanques SIN filtros.

Recomendamos que se sacan los filtros de los tanques y que no los usan!

Slide 16: Los canales

Slide 17: Partes del sistema

Empiece con la diagrama de todo el sistema

Les pida a los estudiantes a identificar los canales en el sistema

- ¿Cuál es el propósito de los canales?
 - Para capturar la lluvia del techo y dirigirla a los tubos y PVC
- ¿Cómo funcionan los canales?
 - El agua del tech ova a los canales
 - El canal tiene un ángulo hacia la primera lluvia para dirigir el agua al PVC
 - La malla evita de la obstrucción del PVC
- ¿Qué ocurre con el tinaco cuando no funcionan los canales?
 - El agua no floja al tinaco
- ¿Dónde caben los canales en el sistema total?
 - Los canales están conectado al techo.
 - Techo---Canales----PVC, tubos----primera lluvia

Slide 18: Partes de los canales

- ¿Qué son los partes diferentes del sistema?
 - Canales
 - Gutter clips
 - Malla
 - Uniones
 - Tapaderas

Slide 19: Malla

- ¿Cuál es el propósito de cada parte con respecto a los canales?
 - ¿Cuál es el propósito de la malla?
 - Para dejar los mosquitos del agua

Slide 20: Sostenadores (gutter clips)

- ¿Cuál es el propósito de los gutter clips?
 - Para fijar y mantener el ángulo de los canales

Slide 21: Uniones

- ¿Cuál es el propósito de las uniones?
 - Para conectar los canales

Slide 22: Tapaderas

- ¿Cuál es el propósito de las tapaderas
 - Para prevenir el agua de fluir hacia el lado opuesto

Slide 23-24: Instalacion

- Cuál es el proceso que se usa para fijar los canales durante la construcción del sistema?
 1. Use una nivel de línea para evaluar el ángulo del techo y determinar la dirección del flojo del agua
 2. Corte los canales a la longitud correcta
 3. Mida el techo de la casa al borde
 4. Usa madera de 6x1 para construir los gutter clips
 5. Corta un hoyo en la madera como un lugar donde se fijan los canales
 6. Clave los gutter clips al edificio
 7. Usa la nivel de línea para mantener los gutter clips en un ángulo mínimo de 5 degradadas
 8. Ponga los canales en los gutter clips. Asegure que el borde del techo está sobre el canal
 9. Ponga malla sobre el PVC para evitar que los detritos entren en el PVC
- ¿Cómo ponen las fijaciones y soportes?
- ¿Cómo obtener el ángulo correcto del techo para capturar el agua?
- ¿Qué es el ángulo necesario para los canales?
 - a. 5 grados por lo menos, cuando se pone el agua en el canal, debe fluir hacia la primera lluvia. Si el ángulo es tan grande, el agua derramará.
- ¿Cómo se fijan los gutter clips?
- ¿Qué herramientas se necesitan para la construcción de los canales?

Slide 25: Problemas

- ¿Qué son los problemas típicas con los canales? ¿Puede o ha reparado el problema?

(Aquí están algunas respuestas. Si las respuestas siguientes no aparezcan en la discusión, las incluya en la conversación)

- Goteo
 - a. Asegure que los canales estén colocados correctamente en la unión y que la unión no está quebrado
 - b. Asegure que los canales no son rajados
- Canales atascados
 - . Asegure que los gutter clips no están rotos
 - a. Limpie los canales con frecuencia para quitar las hojas
 - Obstrucción del PVC por hojas y otros escombros que previenen el flujo del agua
 - . Limpie los canales con frecuencia para quitar las hojas
 - a. Tantas hojas causarán la malla a rasgar y disminuir la funcionalidad de los canales
 - Agua estancada en los canales
 - . Asegure que los canales están inclinados hacia la primera lluvia
 - Ángulo del techo
 - . Eleve el techo del centro
 - Ángulo de los canales y posición del borde del techo
 - . Asegure que los canales están puestos tan cerca o lejos del borde del techo que capturan el agua
 - Malla rasgada
 - . Limpie los canales con frecuencia para quitar las hojas
 - a. Compre malla con referencia a la lista de partes
 - Los gutter clips sueltos
 - . Clávelos de nuevo al lado de la casa
 - Se faltan las tapaderas
 - . Encontre otro material para bloquear el extremo del canal como una reparación temporal
 - a. Compre tapaderas con referencia a la lista de partes

Slide 26: Mantenimiento de los canales

- ¿Qué tipo de mantenimiento es necesario por los canales? ¿Cuándo debe hacerlo?
 - ¿Con qué frecuencia es necesario limpiar los canales?
 - Depende del sistema y el número de árboles que caen las hojas
 - ¿Cuándo es necesario reemplazar la malla?
 - Cuando está rasgada
 - ¿Cuándo es necesario reparar los gutter clips?
 - ¿Cuándo es necesario elevar el techo?

Slide 27: Práctica en la clase

Cómo reparar las uniones de los canales
-pegamento de PVC (más permanente)

Como poner la malla

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- importancia de un sistema cerrada
- donde obtenerlo
- asegurar que cubre todo el agujero

Slide 28-32: Problemas para identificar

Escena 2-muchos arboles sobre o cerca del techo

Les pregunta a los estudiantes...

- ¿Qué sería la diferencia sobre el mantenimiento entre sistema 1 y sistema 2?
 - Es necesario cortar los arboles
 - Es necesario limpiar los canales con más frecuencia

Escena 3-acceso al techo

Les pregunta a los estudiantes...

- ¿Qué sería la diferencia sobre el mantenimiento entre sistema 2 y sistema 3?
 - Se necesita una escalera para limpiar sistema 3

Escena 4-otros escombros en el techo (por ejemplo animales, tierra)

Les pregunta a los estudiantes...

- ¿Qué sería la diferencia sobre el mantenimiento entre sistema 1 y sistema 2?
 - Es necesario limpiar los canales de la casa con mas escombros en el techo con mas frecuencia

Tercera Día: El mantenimiento de las sistemas

Slide 1: Capacitacion acerca del mantenimiento

1. Uso del agua
 - a. Cuando no hay mucho lluvia, para que deben usar el agua de los tinacos y para que no debe usarlo?
 - i. Durante la estacion seca, usar el agua en los tinacos solo para tomar y cocinar y el agua de la finca para lavar ropa y trastes
 - b. Si hay mas suciedad en uno de los tinacos, usar ese agua para lavar ropa y trastes
 - c. Asegurar que el rebalse ir a un lugar donde se puede guardar el agua (no usar ese agua para tomar ni cocinar)
 - d. Con la separacion de tinacos en algunos sistemas, asegurar que no hay agua estancada (no guardar agua en solo un tinaco por mucho tiempo, cambiar cual tinaco se usan)
2. Mantenimiento bueno
 - . Reparar agujeros para no gastar agua
 - a. Asegurar que el sistema es cerrada
 - b. Limpiear los canales despues de la lluvia

Slide 2: Partes del sistema

Slide 3: Los tinacos y conexiones

-Como se puede definir un sistema cerrado?/Que es?

-Cual es la importancia del sistema cerrado?

Mantiene limpio el agua

Previene de entrar suciedad externa

Previene de entrar mosquitos que pueden llevar enfermedades

Previene la entrada de otros bichos, aranas, etc.

-por que son importantes los tinacos y conexiones?

- ¿Cuál es el propósito de los tinacos?

- Para almacenar agua - CANTIDAD? CALIDAD? Para acceso mas facil, mas cerca, mas rapido, ahorra de tiempo!!

Slide 4: Sistema Cerrada

Ejemplos de un sistema abierta y una sistema cerrada

Slide 5: Demonstracion como poner la malla

Una demonstracion como poner la malla sobre el lado de un codo

Slide 6: Los tipos de tinacos

- ¿Qué son los diferentes tipos de tinacos?
 - De concreto y de plástico

Slide 7: Partes del sistema

- ¿Cuál es el propósito de la primera lluvia?
 - Para quitar el agua más contaminada por los escombros del techo
 - No quita la bacteria
- ¿Cuándo es necesario limpiar la primera lluvia?
 - Despues de cada lluvia
- ¿Cómo se usan el agua de la primera lluvia?
 - Para lavar flores
 - Para lavar ropa
- ¿Que son los problemas con la primera lluvia y como repararlo?

Respuestas posibles:

- Se cayen
 - Poner un palo en la tierra que alcanza hasta la válvula, usar alambre de amar para asegurar la primera lluvia al palo
- Válvulas y conexiones quebrados
 - Reemplazar la válvula o la conexión
 - Para disminuir este problema, limpiar las primeras lluvias después de cada lluvia

Slide 8-9: Separacion de los tinacos

Una demonstracion como usar las valvulas nuevas

Slide 10: Mantenimiento de los tinacos

Hablar acerca de los niveles de suciedad de los dos tinacos y la importancia de limpiarlos

Slide 11-12: La primera lluvia

- ¿Cuál es el propósito de la primera lluvia?
 - Para quitar el agua más contaminada por los escombros del techo
 - No quita la bacteria
- ¿Qué son los problemas con la primera lluvia y como repararlo?

Respuestas posibles:

- Se cayen
 - Poner un palo en la tierra que alcanza hasta la válvula, usar alambre de amar para asegurar la primera lluvia al palo
- Válvulas y conexiones quebrados
 - Reemplazar la válvula o la conexión
 - Para disminuir este problema, limpiar las primeras lluvias después de cada lluvia

Slide 13: Mantenimiento de la primera lluvia

- ¿Cuándo es necesario limpiar la primera lluvia?
 - Despues de cada lluvia
- ¿Cómo se usan el agua de la primera lluvia?
 - Para lavar flores
 - Para lavar ropa

Slide 14: Demonstration como lijar y pegar y usar el Teflon

Si estas pegando los tubos, usar lija en los dos lados (con los dos partes)

No pegar durante lluvia

-Demonstrar como usarla para no gotear las conexiones
-mostrar como aplicar la cinta para no doblar en la conexión

Hacer una demonstración con la clase como lijar un tubo y pegarlo a un codo

Slide 15: Los Canales

Canales:

- ¿Cuál es el propósito de los canales?
 - Para recoger agua que cae del techo

Slide 16: Mantenimiento de los canales

- ¿Cómo limpian los canales? ¿Con qué frecuencia hacerlo?
 - Quitar escombros del bajada de los canales
 - 2-4 semanas
 - Limpiear el techco
 - 2-4 semanas
 - Limpiear el canal

- 2-4 semanas
- Cortar los árboles para disminuir la frecuencia de limpiar
 - 3 semanas
- ¿Que son las factores que influyen la frecuencia con que limpian los canales?

Respuestas posibles:

- Los árboles
- Acesso al techo
- ¿Qué tipos de reparaciones se necesitan los canales?

Respuestas posibles:

- Malla rasgada
- Conexiones goteadas
- Gutter clips rotos
- Arreglar el ángulo del canal y el teccho
 - Más difícil

Slide 17-19: Filtros

Los filtros que vinieron con los tanques son diseñados a sacar los sedimentos, como arena, suelo, etc.,

NO son diseñados a sacar las bacterias del agua

Ademas, nuevas bacterias se cultivan en lo filtros entre usos.

ESTA bacteria puede contaminar el agua del tanque en vez de limpiarlo !

Cuando se rompe la tela del filtro... aun un poco... ya no sirve para nada.

Entonces...

Los filtros son diseñados para sacar arena y suelo... NO BACTERIA

La bacteria se crece en los filtros entre usos y puede contaminar mas el agua que sale del tanque.

Sobre los ultimos anos hemos hecho pruebas y hemos encontrado que hay mas bacteria en los tanques con filtros.

Hay menos bacteria en los tanques SIN filtros.

REcomendamos que se sacan los filtros de los tanques y que no los usan!

Slide 20: Petrifilms

-Cual son los contaminantes en el agua?

- la bacteria
- los sedimentos

Este es la prueba de agua que muestra si hay bacteria en el agua - se pone una gota del agua de los muestras de SUS tanques - y los quimicos en la prueba nos dice si hay bacteria en el agua...

Los puntos azules son bacterias malas

Se puede ver la diferencia ...

a la izquierda se vea una prueba de agua limpia - no tiene puntos azules

A la derecha se vea una prueba de agua sucio - con bacteria - tiene puntos azules.

Slide 21: Conservacion del agua

1. Uso del agua

- a. Cuando no hay mucho lluvia, para que deben usar el agua de los tinacos y para que no debe usarlo?
 - i. Durante la estacion seca, usar el agua en los tinacos solo para tomar y cocinar y el agua de la finca para lavar ropa y trastes
- b. Si hay mas suciedad en uno de los tinacos, usar ese agua para lavar ropa y trastes
- c. Asegurar que el rebalse ir a un lugar donde se puede guardar el agua (no usar ese agua para tomar ni cocinar)
- d. Con la separacion de tinacos en algunos sistemas, asegurar que no hay agua estancada (no guardar agua en solo un tinaco por mucho tiempo, cambiar cual tinaco se usan)

2. Mantenimiento bueno

- . Reparar agujeros para no gastar agua
- a. Asegurar que el sistema es cerrada
- b. Limpiear los canales despues de la lluvia

Appendix O: Men Focus Group Notes

Men's Focus Group-5/11

-what do you think about the organization of the certification program (specifically in reference to the splitting of days by gender)

- -women ask men questions
- -women cannot get on ladders or get on the roof for fear of injury. For this reason, men have to learn a little more
- -there is no other option besides men doing some tasks (like cleaning the roof)
- -women have a lot to do around the house and don't have time to spend three days in a class (have to take care of kids etc.)
- -women's roles: anything external on the system (filters, outside of tanks etc.)
- Men's roles: internal parts of the system (inside of tanks, gutters etc.)

General Opinions About Certification Program:

- -idea of certification isn't to learn how to fix every possible problem but is an intro to the systems to learn a little more
- -the program is well designed (topics split over days) because people can pick and choose which themes they need more help with
 - -if they already know a lot about one theme, they don't have to sit through an explanation
- -some people will only want the certificate/diploma but some want the experience

-Have there been changes in community relationships as a result of the project or systems?

- -the systems have a positive effect on the community
- -people have less fatigue from traveling to the finca
- -everyone has the same benefits now and cannot complain about sharing the finca
- -every design was made for a specific house which is much better than any government project
- -everyone is responsible for the maintenance of their own system and only their family is affected by their own actions regarding system cleanliness and function

Are there people in the community who are known as expert in certain areas of the system?

- the first systems implemented in the community didn't have filters so not everyone knew about them, but the next 3 systems built had the filters so people began to learn about them
- there's not really a specific person who knows everything in one area
- everyone knows some about each part

What did the water committee do? How did they help/hurt the project? Was it a good idea to form the body?

- the water committee needed some sort of external motivation to do/care about certain things
- community has not seen work from the group as a whole, only from Roberto
 - Roberto assumed the role of the committee

- there was a total lack of participation and involvement
- if a group was to form, it would eventually dissolve or be taken over by a single person

There was a suggestion that there be a commission or smaller group within the COCODE to deal with project considerations in the future

- inform about system care and maintenance
- find funds to create new/more systems

The COCODE has more weight, presence and respect in the community

- new COCODE elections in 2017

-Have there been any general technical weaknesses regarding the systems?

- general systems are good, only poor maintenance by specific families leads to problems

-all the systems started out good and functional so the families are responsible for problems with the systems

- first flush falling is one example of a problem not caused by the families

Appendix P: Women's Focus Group Notes

Women's Focus Group 1 (top of community)

What do you think about the payment system?

- -payment system was good
- -people are content with the payment system
- -would not have been able to buy the full system by themselves
- -payment was reasonable because they did not have to pay the full expense at one time
- -payment is symbolic of the systems they received
- -understands that the cost of the trips and the project was much higher than the cost of the systems alone (flights, lodging for team etc.)

How was the monitoring? What was the importance of the monitoring?

- -the monitoring was done was a reminder to care for the system
- -in some cases if something was broken or missing, it was able to be fixed
- -monitoring was important if families forgot how to care for a certain part of the system etc.

How will you remember how to do maintenance/repairs in the future?

- -learned about cleaning etc. through the certification program
- -never had training in relation to the system, so now have knowledge of system parts and how to do small repairs

Do you have neighbors who you could go to for help?

- -in some cases
- -would like to have more collaboration in the community

Have there been changes in community relations because of the project?

- -project has been helpful to our work routine
 - before, had to go to finca and care for kids. Were always worried about the kids
- -there hasn't really been any big conflicts, only a few annoyances
- -engineers have worked well in the community over the past 5 years
- -have been uniting as a community for 5 years

What do you do with more free time not going to the finca?

- -have more time to work
- -have more free time
- -have more time to get firewood
 - save money because can go collect firewood for themselves instead of paying someone else to get it for them

-What does it matter what activities we do in our new free time? I have options and choices. I am not forced to go to the finca

-House 5 (Filomena): don't have to force kids to go to the finca and kids have time to do homework and play

-Alicia: before, she'd have to get up at 4 to get water with the kids before school but now that she has the tanks, she can sleep longer (until 5 or 6) and can spend more time doing tasks around the house or relaxing

-has fixed leaks on system because wants to have all of the water possible

-makes purses in her free time

-House 3 (Celestina): would have to go down to finca 3x/day with her new baby because there was no water

-has learned to conserve water and keep it in other containers to conserve water

-husband is almost never home so she is in charge of her system

Since you received your system, when was the last time you emptied your tanks to clean them?

- -House 4: a month ago
- -House 10: 4 months ago
- -unknown house: tanks have never been empty, but family rotates water use in order to clean the tanks

House 10 shared some water with family in community

-family members with tanks often share water with each other (to drink and cook with)

-it is common to share water with family for drinking and cooking if there is some in the tanks

Any idea of how many times you have gone to the finca in the last year?

- -House 5 (Filomena): 2x after she cleaned the tanks, only went to finca to wash corn
- House 9: has not been to the finca all year (since implementation of system)
- Unknown House: only went one time when began to clean tanks
- Unknown House: has not been all year but shared water from tanks of another family member
- Unknown Houses: have not been all year

-House 4: goes to finca on occasion to talk with neighbors and to socialize with friends. Does not get any water.

-only likes to go because it is a choice to go, not something she has to do

Whose responsibility is it to clean, maintain and repair the systems?

- -everyone in the family participates
- -gutters: husband b/c are high up
- -kids mostly clean the insides of the tank

Another interesting point:

-there was mention that because of the systems, women can wash themselves, their families and their clothes so that they can look respectable. There was a sense of pride associated with looking clean and well put together

Women's Focus Group 2 (Bottom of Community)

- **What did you think about the payment plan, amount, payment schedule etc.?**

-payment is manageable and reasonable. Wouldn't have been able to buy tanks in whole at another point

- **How was the monitoring process?**

- -helped as a reminder to clean
- -every person is responsible to clean their own system
 - if a person wants to have clean systems they have to take it upon themselves to clean etc.
- -all have taken recommendations how to clean the systems
- -have to remind themselves to clean in the future without monitoring
- -plan to use conservation practices to schedule cleaning time
- it is always good to ask a neighbor when there is a problem with your system because they have different experiences and knowledge (ask Catalina who went to all days of certification)

How have systems affected community relations? Are the systems fair?

- -people don't have to get water from the finca
- -has bettered relations since everyone has their own place to keep water
- -not every family was treated fairly
- -not every family received tanks
- -not everyone got a system

-the idea was for everyone to have potable water

- -should've been that everyone got 2 tanks for full equality
- -should not matter if family already had tank that they bought with their own money

How many times have you been to the finca since the system has been implemented?

- -2x/day since tanks emptied in April
 - before, went a few times to conserve water
- -3x/day, 4 people/time right now
- -tanks have emptied 3 times during the year
- -tanks have emptied once
- currently goes to finca to conserve water for drinking and cooking
- tanks emptied 8 days ago
- first time they have been empty all year
- only went to finca previously to wash clothes and bathe before the tanks emptied

- tanks have saved time, and the time is used to rest and for free time
- -uses free time to get firewood

House 43: system has saved time and money because when the kids were young the family had to pay someone to wash clothes, get water etc.

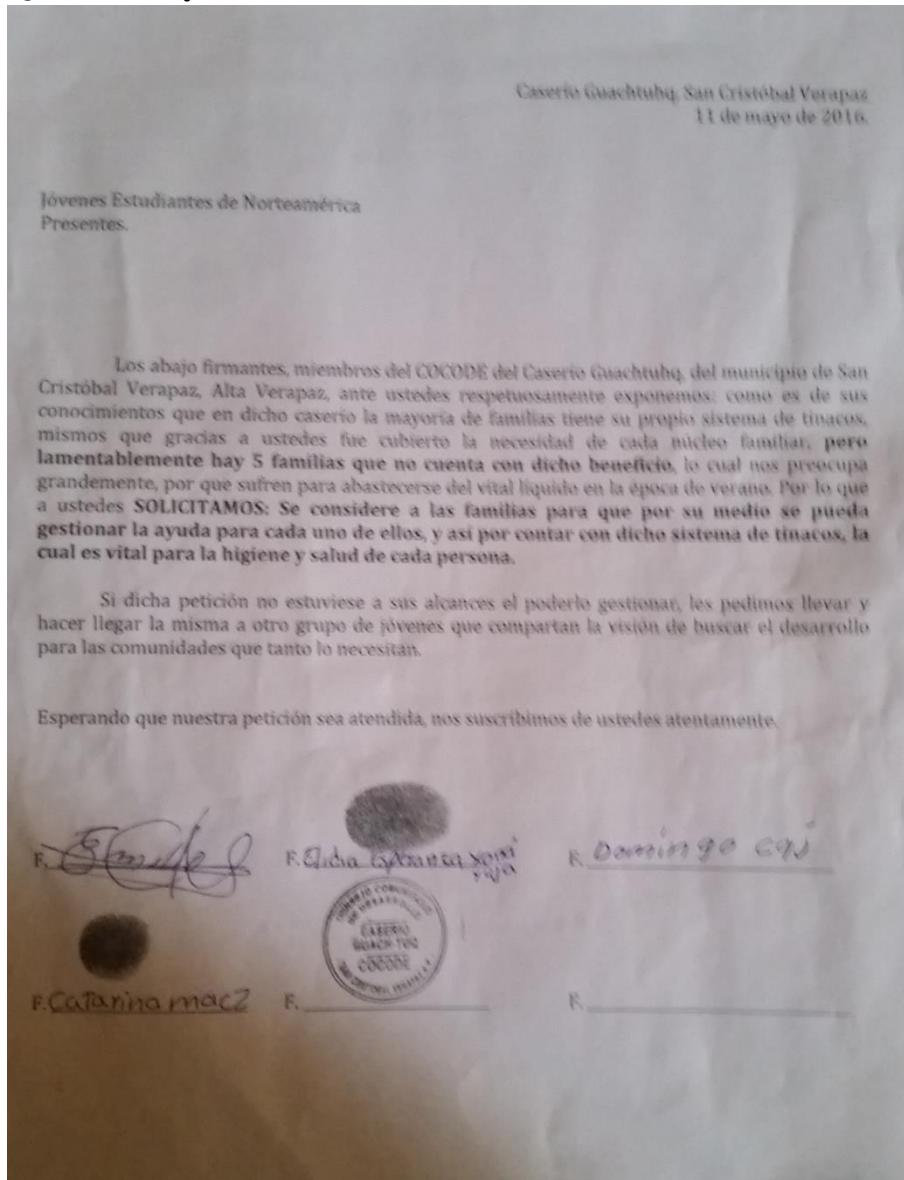
What are the roles of people in relation to the system?

- -women's role is to carry the water for cleaning
- -kids and men do the cleaning unless the men are away at work

What did you learn from the certification program?

- -how to sand and glue tubes
- -learned how to clean and maintain the systems
- -no longer have doubts to touch or fix system because they know more about how they are arranged and go together

Appendix Q: Petition by CoCODE



Appendix R: Petition Response



**ENGINEERS WITHOUT BORDERS USA
WORCESTER POLYTECHNIC INSTITUTE CHAPTER**

San Cristóbal Verapaz 17 de mayo de 2016.

Señores
Miembros del Órgano de COCODES
Comunidad de Guachtuq
San Cristóbal Verapaz
Presente.

Respetables Señores del COCODE:

Como grupo de Ingenieros Sin Fronteras-WPI, nos da mucho gusto comunicarnos con ustedes para responderles de manera formal la solicitud que nos presentaron personalmente el día 11 de mayo del presente año, en donde solicitan una ampliación del proyecto de sistema de agua para las casas adicionales. Fue un gusto haber recibido la solicitud de ustedes pero lamentablemente no está a nuestro alcance realizar la ampliación solicitada. Apreciamos mucho la confianza que han dado a nuestro trabajo y la amistad que encontramos en su comunidad. Reconocemos que la necesidad en Guachtuq es grande y creciente, pero por nuestra parte no podemos hacer ningún ofrecimiento, sin embargo, esperamos que puedan encontrar alguna solución de alguna otra organización.

No está demás hacerles saber que hemos disfrutado y valorado mucho el trabajo y colaboración en la comunidad de Guachtuq.

Sin más por el momento, nos suscribimos de ustedes miembros del COCODE de la comunidad de Guachtuq.

Evelyn Grainger
Presidente IST

Alana Sher

Andrew Petit

Aaron Pepin

Amanda Gatz

Kerry Muenchow

Laurin Elgert

Appendix S: Individual Home Interview Notes

House 4

Project Process:

- -overall the process was very good
- -WPI team worked well within community
- -liked working on build teams
- -a frustrating aspect is that a small number of people did not show up all the time or did not complete their full service time

System Maintenance

- (one of the best maintained systems in the community)
- -if it starts raining in the middle of the night, the father will get up and go clean out the gutters so that they get every drop of water in their system
- -father has made repairs on the system and says he feels comfortable with the system
- -has future plans to put in larger diameter PVC to ensure that the water doesn't backlog in the system
- -the sons mainly clean the tanks
- -the whole family has a day when they clean the system

Certification

- -thinks that the program is a good idea and important
- -planning to send a son every day (and did)
- if a neighbor asked for help, he would help although this has not happened in the past

Water Usage

- -stores more water to bathe, wash clothes (in jugs)
- -only uses water from tanks to cook and to drink

Water Quality

- -thinks water from the tanks is better than that from the finca
- -sometimes the tank water smells worse but this is the fault of the family because they haven't cleaned the system or the filter in a while
- -heats water for 10 minutes before drinking (comes to boil during this time)

Project Impact

- -project has helped improve the quality of life
- -before the project only had metal gutters supported by sticks which also fell
- -project has contributed a lot to family
- -the father can take any job that comes up now with more time (carpentry)
- -father can leave for a period of time to do jobs
- very thankful for everything and for following up on the project

- politicians come and offer a lot of improvements or projects in order to gain votes but this project was different because it actually delivered on the promise

Payment

-they fell behind on their payments sometimes (to CeCEP)

House 10

Project Process:

- -the wife is happy and satisfied with the process
- -some people on the build teams would only do certain parts or only come on certain days and that was frustrating, but in the end it all turned out alright

System Maintenance:

- -the older sons are responsible for cleaning the system
- -use a brush to go over surface 2-3 times and then uses chlorine and a rag to wipe the surface down
- -cleaned 20 days ago when it stopped raining

System Repairs:

- -if something broke on the system, her husband would have to fix it
- -husband does not like others working on their system
- -tank had a leaking elbow that they wanted help fixing

Certification:

- -husband was planning to participate in the certification program or send a son to participate all days
- -husband (Santiago) went both days to the certification

Water Usage:

- -went to finca one time when there was no rain for 3 days

Water Quality:

- The woman of the house thinks that the water from the tank is of better quality than that from the finca because many people use the finca and get the water dirty. On the other hand, she knows exactly what is going in and out of her own system

Project Impact:

- -the mother is thankful for the team
- -the community had previously been overlooked
- -going to the finca takes 1-1.5 hours every trip so the wife now has more time to do tasks around the house and take care of the kids

Payment:

- -the family just bought more land and so they had not started paying yet

House 23

Project Process:

- -the work with EWB-USA WPI has been great. EWB worked harder than the community

System Maintenance:

- -tried to fix a gutter but couldn't since a union was leaking and too difficult to fix
- -moved their tank placement, changed their system significantly
- -empty first flush after every rain
- -has cleaned tanks twice in the past year. (whenever they empty)
- -haven't cleaned the connected tanks because they have never fully emptied (family was excited for the separation of tanks)

Certification:

- -wondering why the days of the certification program were split by gender
- -wanted to come to the “men” days of the certification program

Water Usage:

- -don't use water from their first flush because it is too dirty
- -uses some water in barrels to store extra
- -drinks water from tanks in front of house because the roof that feeds those tanks is cleaner
- -uses water from tanks in the back to wash
- -always boils water before drinking it

Water Quality:

- -thinks that water from the rain is cleaner because it comes directly from the sky, thus the tank water is cleaner than finca water
- -noticed more sediment in the pot after boiling finca water than after boiling tank water

Project Impact:

- -wouldn't have been able to afford whole system without the subsidy from EWB WPI and they are very thankful for this reason
- -family has not been to the finca since the system was implemented
- -used to go 3-4 times/day

Payment:

- -liked payment system (had not paid)

Monitoring:

- -the monitoring process with Edghar and Alvaro was good and they were clear about their purpose

Appendix T: Monitoring Agreement with Edghar Gua

