

Document 522

POST-ASSESSMENT REPORT

CHAPTER: [Tufts University](#)

COUNTRY: [Ecuador](#)

COMMUNITY: [El Cristal](#)

PROJECT: [Tufts EWB Ecuador Project](#)

PREPARED BY

[Anna Chute](#), [Daniella Dominguez](#), [Andrew Espinosa](#), [Maren Frisell](#), [Russell Hyatt](#), [Douglas Matson](#)

09/28/2010

ENGINEERS WITHOUT BORDERS-USA

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**Post-Assessment Report Part 1 – Administrative
Information**

1.0 Contact Information

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2.0 Travel History

Dates of Travel	Assessment or Implementation	Description of Trip
Summer 2006	Assessment	Establish Relationship with FBU. The students performed health surveys and assessed how the community could be helped.

Summer 2007	Implementation	Implemented a back-up water storage system at the hacienda. Water quality testing and health surveys in El Cristal. Community decided that water quality was an issue and wanted to collaborate with EWB.
January 2008	Implementation	Additional water testing. Students learned that the community was in the process of building a slow-sand filter in the main water system.
August 2010	Post-Implementation Assessment	Assessed EWB-Tufts impact on community. Evaluated government funded slow sand filters.

3.0 Travel Team

Name	E-mail	Phone	Chapter	Student or Professional
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Douglas Matson	Douglas.matson@tufts.edu	617-627-5742	Tufts EWB	Professional

4.0 Safety

4.1 Safety Incident Reports

There were no health and safety incidents

5.0 Budget

5.1 Cost

Expense	Total Cost
Airfare	
On Ground	
Materials	
Other	
Total	

6.0 Project Location

Longitude: 8°20'W

Latitude: 0°13'N7

Post Assessment Report Part 2 – Technical Information

1.0 INTRODUCTION

The following sections describe the completed tasks performed on the post-assessment trip that occurred in August of 2010 in El Cristal, Ecuador. EWB-Tufts has been working with the community of El Cristal since 2006, at which time the local NGO, FBU, introduced EWB-Tufts to El Cristal. Since then, EWB-Tufts has returned to El Cristal three more times and the county government funded the construction of a slow sand filtration unit. On this trip we conducted community health surveys with community members, performed water quality tests to measure the impact that the slow sand filter has had on their water, and held community meetings to share our results with the community.

2.0 PROGRAM BACKGROUND

The Tufts EWB group began working with the community of El Cristal in Ecuador in 2006. The agricultural community consists of roughly 120 families, relatively spread out in a very rural, mountainous area. The purpose of the first trip was to establish a solid relationship with our NGO contact in the area, Fundación Brethren y Unida (FBU), as well as to assess the possibilities of implementing a green building design for future trips. Water quality testing was also conducted on the community's drinking sources, and community health surveys were conducted with community members.

By 2007, the Ecuador EWB group had identified water as one of the main problems in the community that we would be able to help with. In the summer of 2007, six students, one professor, and his wife returned to Ecuador with a primary goal to develop a relationship with the community, identify its needs, and jointly define a project for the next year. Additionally, the team had designs for a rainwater collection, storage, and a bio-sand filtration system to prototype and use for educational dissemination at FBU's hacienda. The group was met with welcome arms in El Cristal, and built two prototypes of the household bio-sand filter during their stay. The group again collected water quality tests, and were able to share the results during a community meeting. All of the water sources were seriously contaminated, and the community was able to visibly see the poor quality of their water by the sheer number of bacterial colonies that had grown on the water testing films. These tests were given to the community.

Between our 2007 and 2008 trips, El Cristal, empowered with knowledge and evidence about their water quality, were able to bring these results to their local government in order to improve their water situation. The local government devoted \$25,000 to the

construction of a large slow sand filter that serves roughly half of the community. By the 2008 trip, the slow sand filter was under construction but had not been completed. The travel team was able to collect water quality data indicative of the rainy season.

The purpose of the 2010 trip was to conduct follow-up community health surveys, water quality testing, and work with the community to ensure the project's sustainability. This trip served as a post-implementation evaluation of the impact EWB-Tufts had on El Cristal. Community surveys were administered to measure any improvements in the health of the community members as well as to determine any changes in perceptions of the importance of potable water. The effectiveness of the slow sand filters were assessed through water quality testing.

3.0 TRIP DESCRIPTION

The travel team arrived in Ecuador on August 17. Two days were spent in Quito, and one day in Otavalo gathering supplies and acclimating before the journey into the mountains to get to El Cristal. Once there, a community meeting was held to let the residents of El Cristal know what we would be doing during our stay. Water quality testing was also started without delay. Water from the slow sand filters was sampled before it entered the filter, after it entered the filter, and as it flowed through the filter bypass (which has been turned on periodically). In addition, water at the source streams of San Francisco and La Florida higher up in the mountains was sampled. Samples from the slow sand filters were taken twice almost daily, morning and evening, although the sampling at the sources was only performed once. The filter operators from El Cristal, and the neighboring community of Peñaherrera also gave the engineers a demonstration of their usual technique for cleaning both the pre-filter near the sources and the slow sand filters near the town.

Water quality testing was performed within two hours of the samples being collected in the makeshift laboratory set up in Carlos Ruiz's dining room. These were performed in the morning, around 8 o'clock, and then repeated later on in the evening at around 7pm. The Petri dishes containing bacteria from the water samples were then incubated for a period of 24 hours. After this time, the number of fecal coliform colonies and the number of E. coli colonies were counted and recorded.

In between sampling the water, four members of the travel team (Daniella, Anna, Andy, and Mrs. Matson) would perform health surveys. Multiple households were surveyed, as well as the community nurse at the local health clinic. Community members were asked about such topics as illnesses they have suffered recently and their beliefs on the cause of said illnesses. Afterwards, this data was compiled and stored as a single document.

When all the desired water quality tests and community health surveys had been

performed, and the data was compiled, the engineers in the group worked on suggestions as to how the operation and cleaning process of the slow sand filters can be improved. These suggestions were based on the bacterial tests performed, the observed cleaning techniques of the filter operators, and suggestions given by Mark Youngstrom, an expert in slow sand filtration that the team consulted via Skype during the trip. A second community meeting was held to share these suggestions, and the filter operators were also personally debriefed with information pertinent to their individual positions. After leaving El Cristal, two more days were spent in Quito before departing for the United States.

4.0 COMMUNITY INFORMATION

4.1 Description of Community

El Cristal is a very small, rural community in the south eastern sector of the Esmeraldas province of Ecuador consisting of about 1000 people. El Cristal is six hours by bus (60 miles) north of Quito, and is located in the foothills of the Andes. The region is very mountainous and the center of El Cristal is at approximately 9,000 feet above sea level.

El Cristal is an agricultural community that focuses mostly on subsistence farming. However, some families generate an income by selling crops such as coffee and fruta del árbol, which are sold in larger towns and cities outside of the village. Many families have animals on their farms such as cattle, pigs, horses, chickens, ducks, and guinea pigs. These animals are raised for eating, for providing milk and eggs, and sometimes for breeding and selling.

Residents of El Cristal usually get married and have children at a relatively young age. Children attend school in the town center through seventh grade. Afterwards, most children commute to Penaherera (a neighboring town) for high school. The majority of children do not pursue higher education and stay home to work with their parents and start families of their own. If able to attend university, the closest tertiary school is located in Otavalo (a large town 3 hours away by bus). We found family ties to be important to the people of El Cristal. Many residents stay in El Cristal and interact frequently with their families, which may stay in El Cristal or move to nearby towns or even as far as Quito or El Oriente to pursue job opportunities. One of our hosts said that she never leaves El Cristal, but that her grown children come visit her frequently from elsewhere.

We felt very welcome in the community, and everyone was friendly to us during our stay. We introduced ourselves to the community upon arriving, which enabled both us and them to feel comfortable while we did our work there. We feel that our work was well received, that the majority of the community was interested

in our work, and that the community is concerned about the quality of their drinking water.

4.2 Community/NGO Resources and Constraints

El Cristal is primarily an agricultural community. The majority of residents do not steady incomes, and thus do not have very much money. The local NGO with whom we work, Fundación Brethren y Unida (FBU), is a non-profit organization that works hand-in-hand with agricultural communities throughout rural Ecuador. Their main work includes rural development projects that are meant to strengthen local community relations. As an organization, they manage these projects, as well as train local leaders to foster improved social development in the regions they work in. The people of El Cristal and Intag in general have been perpetually harassed by mining companies looking to exploit the local mineral resources. FBU has shown a great concern for the environment, however, and have yet to allow any such company to operate in the region.

We were well-prepared for the trip and were not constrained by our situation as a result. We were able to set up a temporary lab in one of our host family's houses in order to conduct water quality testing, and we brought all supplies with us that we would need. The town has electricity, so we were able to plug in our incubator and store our water quality testing supplies in refrigerators. We did have to return to Otavalo in order to communicate via Skype and email with Mark Youngstrom, a slow-sand filtration expert that works for Otter Creek Engineering in Vermont. There is no internet access in El Cristal, and limited cell phone reception. Mark is helping us with our project since he specializes in large-scale slow sand filters.

4.3 Community Relations

Tufts EWB has an ongoing relationship with El Cristal that goes back to 2006 when a team first traveled to the town. The team has generally been received very well by the residents of El Cristal, and has intended to keep as many community members involved in the project as possible through the two community meetings held during the trips. Community participation and input has been a very important aspect of these trips since the beginning, and it was the community who originally communicated that it was the water system they wanted help with.

While back in the USA, contact has been maintained with Carlos Ruiz, our community liaison and also an employee of the local municipality, since the first trip. He has helped immensely by arranging housing for the group in the town and

conveying the group's recommendations for the water system to the municipality of Cotacachi. Tufts EWB hopes to maintain the positive relationship that has been established with El Cristal to avoid any unnecessary obstacles for future travel teams.

4.4 Community Priorities

It is a priority of the community, as well as us at EWB-Tufts, to ensure that the community has access to clean water. We found that the community is genuinely concerned about the quality of their drinking water. Around 30 adults came to each of our community meetings to ask us questions, discuss the status of their water filtration system, and hear our recommendations for how to improve the current quality of their water. The topic of chlorination came up multiple times, and we found in our community health surveys that some residents recognize that the water is still not completely pure and ready for drinking directly from the tap. We also found that the number of families boiling their water to be used for drinking and cooking increased significantly, showing an awareness and concern about the relationship between water quality and health. Our trip was productive and successful because we were able to directly address the main priority of the community by working to improve their water quality.

5.0 DATA COLLECTION AND ANALYSIS

5.1 Summary of Data

Water quality testing:

The water quality tests provided us with information on how the filters were functioning. We collected samples from the main water sources, the water before and after it went into the filter, in addition to samples from various houses that were connected to the system. To test the quality of the water, we performed bacteria and turbidity tests. The turbidity tests showed that the filter was pretty efficient in working as a particle remover; however the bacteria tests showed that it is not as good in removing bacteria, as several E. Coli and Fecal Coliform colonies were found in the before and after samples. This is probably due the fact that the cleaning system for the filter that is now in place does not allow the growth of the bio-layer, which is in charge of killing the bacteria in the water that goes through the filter.

The above information shows that there is a lot of room for improvement of the filter, especially in the cleaning process. We realized that they need to work on creating a new

system to clean the filter, which is a project that we will continue to work on. All technical data can be found in our internal trip report also sent along with this document

Community Health Surveys:

We compared the surveys that were done three years ago to the ones that we took during this trip. We asked community members to provide us with information on certain health conditions they may have experienced in the past three months. In total we completed 20 surveys, interviewing 19 adults who had a total of 18 kids among them. We also interviewed a nurse at the community clinic in El Cristal who gave us a more accurate account of the people who went into the clinic presenting certain symptoms. Overall, there were fewer reported cases of diarrhea and stomach problems after the filters were implemented, however there was an increase in flu like symptoms. The results are summarized in the tables below.

Table A (information gathered from community surveys)

	Condition	Before filters (3 yrs ago)	After filters
Gastrointestinal complaints	Diarrhea and dehydration	85%	41%
	Stomach problems	69%	57%
Other common complaints	Flu	54%	79%

Table B (information from clinic nurse)

Condition	Number of patients
Flu	<u>+30</u>
Parasites	<u>+13</u>
Cough	<u>+13</u>
Fever	<u>+8</u>
Headache	<u>+3</u>
Diarrhea	<u>+2</u>

We also asked people if they took any extra precautions to further purify their water, to which 47% said that they boiled their water, compared to only 15% three years ago. This shows that there is an increased consciousness about waterborne illness, however these types of diseases are still present in the community.

- Key community members related to the project:
 - o Carlos Ruiz: Main leader of the community

- Guillermo Enriquez: Filter operator
- Enrique Sinbaña: Filter Operator

5.2 Mapping

Initial mapping of the community has previously been performed in the summer 2007 trip. During this trip, GPS coordinates were taken for locations of households, roads, and water system components including source streams, capture tanks, and distribution tanks. No elevation data has been measured on any previous trips and no elevation data has been measured on this current trip. Topographical land surveying would have been ideal, but was impractical due to physical constraints. The water system of El Cristal is spread out and performing a complete topographical land survey would have taken up much of the travel team's time and energy. The hike to the capture tanks and source streams of each of the three water systems takes at least one hour with much of the way lacking any easily walkable path to set up surveying equipment. Ultimately, the accurate topographical data obtained from extensive land surveying was not necessary for the set goals of this trip of assessing the effectiveness of the already-in-place slow sand filtration unit and quantifiably determining the impact EWB-Tufts had on the community after working with the community for four years.

5.3 Monitoring and Evaluation Data

During our time in El Cristal, we wanted to evaluate the health status of the community and see how the public perception of the community's health had changed since our last trip to El Cristal (2008). From the health surveys we also gained a qualitative analysis of how the use of the filters affected public health. Below is a list of the findings from the health surveys:

- The general sanitation of El Cristal was good. People regularly washed the containers in which they store water with soap and water. Most people only cooked food that would be eaten that day, and stored extra in a refrigerator or fed the leftovers to dogs and pigs. Garbage disposal methods included composting food remains and burning trash.
- Clean water is a high priority for the people in El Cristal. They also mentioned that they were concerned about the status of the filtration system. Opinions varied about whether or not the addition of the water filtration system has improved the health of the community, although our results suggest a notable improvement (see next bullet.)
- The reported cases of diarrhea and stomach problems decreased from 85% to 41%

and 69% to 57% respectively. These numbers show a positive decrease in reported illness that relates directly to water sanitation. Although the reported cases of both diarrhea and stomach problems are at a lower percentage than they were at from our previous trip, the high level of sickness is still an issue. We suspect that the decrease in reported cases is partially due to the implementation of the filtration system that occurred between our last trip and this one.

- Almost half of the community boils their water to purify their drinking, cooking and cleaning water. This shows that people understand the connection between dirty water and sickness and are aware that boiling their water kills harmful bacteria. Awareness about this issue has increased substantially since last time we did the surveys two years ago, which shows a promising trend.
- Most people said that they have enough water for all of needs throughout the year. However, people said that sometimes there is not enough water when the operators clean the tanks and when heavy rain damages water pipes. People also noted that sometimes dirty water (containing sediments) flowed from the taps after rain storms and when the operators clean the tanks.

6.0 PHOTO DOCUMENTATION

Andy and Russ discussing filter function with the operators

Doug Matson, and Daniella discuss amendments to the tank cleaning operation with all three cleaners and Carlos Ruiz

Anna organizing and translating health surveys

Doug Matson proposing a new method for filter cleaning

Maren gathering a sample of sand from the filter

7.0 PROJECT ASSESSMENT AND FEASIBILITY

Analysis of the data collected through health surveys and community input in the two community meetings held during the site visit, EWB-Tufts found that the incidence of common illnesses caused by contaminated water such as diarrhea and dehydration and stomach problems had decreased significantly compared to data taken before the water

filtration system was implemented; rates of diarrhea and dehydration decreased from 85% to 41% of the population, while stomach problems rates decreased from 69% to 57%. At the same time, awareness of the risks of dirty water had increased significantly, as demonstrated by the fact that the number of people who reported boiling the water they use for drinking and cooking increased from 15% three years ago to 47% on this trip. These show promising trends in the health of the El Cristal population. In general terms, community members demonstrated an increased awareness in the importance of drinking and cooking with clean water on health and were taking measures to improve the quality of their water through household treatment and increased interest in raising funds for maintaining functioning of the centralized water treatment system. Leaders of the community understand the importance of reliable centralized water treatment on the development of their community. The community has already taken proactive measures by requesting and receiving municipal funding for the construction of the slow sand filter system and this proactive approach will be essential for the sustainability of the system. A water board exists and the community pays two operators to maintain the system year round. However, further organization of the Cristal water board and collaboration with the water board of Peñaherrera is necessary in order for the boards to function effectively in maintaining the water treatment system which serves both communities. Such efforts have been discussed during community meetings which EWB-Tufts attended.

The assessment of the slow sand filter system revealed that the system is not being used nor maintained according to design. The operators in charge of cleaning and maintenance of the filters revealed to EWB-Tufts that the filters would frequently clog especially in the rainy season. In addition, water quality tests of inflow and outflow water samples revealed that the filters were 99% effective at removing bacterial contamination. EWB-Tufts looked into the cause of the frequent clogging and inability of the filters to eliminate bacterial contamination of the water by at least 99%. The following was found during the assessment of the slow sand filters. The slow sand filter unit is operating at a superficial velocity 2.7 times higher than the maximum desired value of 0.238 m/hr. This is causing a huge stress on the filters. The community's current usage rate of 56m³/family/month is 2.24 times the contractual usage rate of 25m³/family/month. The current usage rate creates a huge strain on the operators due to the frequent need for cleaning caused by the high accumulation rate of silt. In addition, the current cleaning procedure necessitates the drying of the fine sand layer which inhibits schmutzedecke formation. The superficial velocity at contractual usage falls within the design standard range if both filters are operating simultaneously. At this rate with both filters operating, the slow sand filtration unit is properly sized. Accordingly the following recommendations were made to the community:

1. Never let the filter go dry as this kills the biolayer
2. Never run the bypass
3. Current water usage rate must be reduced
4. Change the cleaning procedures so that both filters can be run at the same time. If one filter is used, the community must cut back to the contractual usage rate perhaps by installing parallel drinking/non-drinking water lines. People without parallel lines should pay more than people without parallel lines.

EWB-Tufts provided recommended changes to the cleaning procedure and demonstrated these techniques to the operators. However, these new techniques can yet be improved by modifying the slow sand filters. *Thus, EWB-Tufts has decided to continue the project in Cristal and will prepare for an implementation trip by designing the modifications to improve cleaning operations. The feasibility of implementing these modifications must be studied by EWB-Tufts. However, in terms of the community's organization and proactive approach throughout the four year relationship EWB-Tufts has had with Cristal, EWB-Tufts is confident in the sustainability of the project and the community's ability to assist in construction, find funding, and maintain any additional system EWB-Tufts designs and proposes to implement.*

8.0 LESSONS LEARNED

- When performing water quality testing in the field the administer of the tests must realize the need to try as much as possible to keep the equipment and workplace clean. Proper measures must be taken when using boiled water as the control for bacterial testing. Trip, field, and equipment blanks should be used to ensure no contamination of the samples.
- Due to unforeseeable circumstances scheduled plans will be changed. Thus, it is always necessary to be continuously planning for future days of the trip in order to ensure that everything that needs to be done gets done. The travel team must meet daily to go over these plans.
- Bring 120% as much testing equipment as you think you will need. Petri dishes, broth packets and petrifilms get lost and broken or damaged easily. It is important to have a testing plan before departure, even though the plan is likely to change upon arrival. This way you have a good estimate of the amount of testing equipment that you will need.
- If you need refrigeration for testing equipment, call ahead to make sure it is available and to notify the hostel/hotel/accommodation owners. Also emphasize the importance of the refrigerator and make sure your equipment isn't thrown in a freezer!
- Bring a watch!

9.0 MENTOR ASSESSMENT

The mentor assessment written by Professor Matson will be sent at a later date. Professor Matson is currently writing the assessment but was unable to complete the mentor assessment at this time due to an unrelated matter that required his immediate attention.

9.1 Mentor Name (who wrote the assessment)

Professor Douglas Matson