Solola, Guatemala

ENGINEERS WITHOUT BORDERS USA

KANSAS CITY PROFESSIONAL CHAPTER

Assessment Report

Introduction

The last week of June 2008 EWB-KC represented by Roxanne Alamos and Nick Sutko traveled to Solola, Guatemala. The EWB group was invited to travel along with Heart to Heart International, ACONANI, and the Rotary club as they installed Biological Sand Filters (BSF) at several schools, as part of their Water, Hygiene and Sanitation Promotion program.

The trip was an introductory trip to assess sanitary issues at several schools in Solola. The schools were selected by ACONANI based on their needs and willingness to cooperate. The schools are located in various communities in and around Lake Atitlan which include San Pablo la Laguna, San Juan la Laguna, Panajachel, San Andres Semetabaj, San Antonio Palopo, and Santiago Atitlan. EWB's objective at each school visit was to assess the current sanitary conditions and to identify any other engineering needs. Solola, Guatemala is currently not a sanctioned EWB project, however the visit was conducted with the intention of establishing an EWB project in partnership with the organizations involved (Heart to Heart, ACONANI, Rotary) by providing technical expertise and direction in conjunction with their Water, Hygeine and Sanitation Promotion program.

The following sections are a synopsis of the assessments conducted at each school.

EOUM ALDEA PATANATIC
EWB Assessment

Date Visited: 06/25/2008
Municipality: Panajachel
Contact: Elva Eleonora
School Representatives Present: Moises Perez (parent) & Donald Arnoldo (teacher)
# of Students: 278
Boys: 141
Girls: 137

Stated Concerns:

The school representatives stated their concern with the current sewage system that drains directly to a tributary of Lake Atitlan untreated and were worried about the health of the lake and the community. They stated there were too many kids for two bathrooms and that the system often clogged and often overflows onto the basketball court. Trash collection or solid waste disposal and material for disaster or emergency relief were also mentioned as items of concern.

Water Supply

Existing Conditions:

Source: Spring water – 10 to 15 km away
# of taps: approx 7
# of BSF**:** 3

The existing water source is a fresh spring located 10 to 15 km away. The school has a regular and consistent source of water. There appeared to be no temporary water supply storage available at the school. Their existing water line runs inside a sanitary pipe and needs to be relocated due to the high potential for contamination.

Possible Solutions:

The existing waterline needs to be relocated and removed from the sanitary sewer pipe. This can be easily accomplished using pvc pipe and finding an alternate connection route. Rain harvesting may be an alternative for increasing their existing water supply

Information Needed:

Roofing material
Existing waterline schematic

Figure 1. Waterline (white pvc pipe) entering the sewer pipe (orange pvc pipe).

Sanitation

Existing Conditions:

# of toilets: 7
Boys: 3
Girls: 4
Teachers:
Disposal Systems: Piped system to tributary of Lake Atitlan

The sanitary system currently consists of a piping system that outlets to a tributary of Lake Atitlan, with no treatment. Three families located upstream are also connected in to the system. The piping clogs regularly and overflows into the school's basketball court.

Possible Solutions:

The school owns some property nearby and they'd like to look at some form of treatment using the property available. There is another school close by (North of this building) and they would like to see a project with a sewer line to both schools. They suggest construction of a line north of the channel in an area where it won't be as susceptible to hurricane damage**.** To alleviate clogging the pipe's existing grades should be verified to ensure proper flow. Treatment possibilities and feasibility should be the number one priority for public and community health reasons.

Information Needed:

Topography
Wastewater quantities
Percolation test
Treatment possibilities (souce/community)

Figure 2. Wastewater outfall location for school's sewage.

Figure 3. Sewer piping carrying sewage to Lake Atitlan.

Other Issues

The community stated their desire to have additional materials for disaster relief. They currently have a first aid kit, but have no materials for emergencies or emergency rescues.

EOUM PARCELAMIENTO XOQUIC
EWB Assessment

Date Visited: 6/25/2008
Municipality: San Andres Semetabaj
Contact: Raul Garcia
School Representative(s) Present: Raul Garcia
# of Students: 350
Boys: 170
Girls: 180

Stated Concerns:

Raul stated that the water supply was inconsistent and not available some days. He collects water in the afternoon for classes the next day. The water often is available at nights, but the school has limited storage capabilities. The school does have government built bathrooms, but they can only be used when water is available. The bathrooms remain locked when school is not in session. Several other items that were addressed included the kitchen's lack of ventilation, the need for a meeting place, and the desire to build a library. Raul stated that the community is very involved and has a desire to see their city grow!

Water Supply

Existing Conditions:

Source: Stream/Spring water 14-17 km away
# of taps: 1 in old kitchen and 5 located in bathrooms
# of BSF**:** 3

The school does not have an adequate source of water. The municipal line that supplies the school often only runs at night when the students are not present. The school does have a Rotoplas tank above the bathrooms, but does not appear to be functioning properly. This appears to be due to a missing float.

The town has purchased land in hopes of constructing a groundwater well. The well location was not visited, but with further investigation may be a feasible water source. The clinic next door has a RotoPlas tank which is used for water storage. It was not noted if the clinic's water supply was sufficient.

Possible Solutions:

The first project should include fixing the school's existing water supply. This could be accomplished by fixing and/or increasing the school's water storage capabilities. This includes fixing the damaged Rotoplas tank and/or assessing the water demands of the school. The additional storage will allow the school to store the water that comes at night, which can then be used throughout the following day.

Rain harvesting may be a feasible solution if a metal roof is constructed between the two buildings. The existing roofs consist of material that would have to be investigated to ensure that the rainwater would not become contaminated; due to the possibility of asbestos in the roofing. However, rainwater harvesting could always be implemented and used for greywater applications.

Information Needed:

Water demands
Material of existing roofing
Possible well data

- location
- supply
- connection
- etc.

Figure 4. Rotoplas tank located at clinic adjacent to the school.

Figure 5. Roofs at school that could possibly be utilized for rain harvesting.

Sanitation

Existing Conditions:

# of toilets: 4
Boys: 2
Girls: 2
Teachers: N/A
Disposal Systems: 2 pit latrines and septic/cesspool system

The school has two pit latrines that are utilized in case of emergency or when the school bathrooms do not have adequate water supply and/or are locked. The school has a bathroom building that is separate from the classroom buildings. The school's bathroom was built by the government (Social Investment Fund). It includes a cesspool/septic system that appears to have two separate holding tanks. It was assumed that ground infiltration was utilized for disposal or the outlet works. No outlet pipe or leach field was located. Raul stated that the system does not overflow and has never been cleaned out. Due to the bathrooms limited use this seems appropriate.

Possible Solutions:

The existing sanitary system appears to be functioning properly at the existing load being placed in the system. However, as water supply issues are resolved the daily loads will increase posing possible overflow concerns. The septic/cesspool system should be cleaned out and its capacity analyzed.

Information Needed:

Wastewater quantities
Septic tank conditions/dimensions
Percolation tests

Figure 6. Emergency pit latrines.

Figure 7. Bathroom building located adjacent to the classroom buildings.

Other Issues

The school's kitchen is not properly ventilated. The women who cook complain about the existing conditions. We have an individual on our project team who has completed work in Antigua, Guatemala installing ventilation systems in homes. This same or similar approach could be applied to renovate this kitchen.

Figure 8. Fire pit located in building between classroom buildings.

The community desires to have community meeting location. The current meeting hall is too small. The possibility of constructing a sheet metal roof between the two classroom buildings is a possibility. Heart to Heart mentioned they had used Strickland Construction on these types of projects in the past, and that they could be possibility for this application.

Raul also mentioned his wish to construct a library. The school does own vacant land surrounding the school that could be used for the location of a new public library.

Information Needed:

Kitchen dimensions
Allowable span of Strickland roofing systems
Library wishes

EOUM 21 DE SEPTIEMBRE DE 1821
EWB Assessment

Date Visited: 6/25/2008
Municipality: San Antonio Palopo
Contact: Vincentes Perez, Principal
School Representatives Present: Vincentes Perez, Principal
# of Students: 505 (300 not able to enroll)
Boys: 282
Girls: 223

Stated Concerns:

Vincentes stated the two biggest problems were the sanitary system and the lack of space. The septic system overflows often, and sometimes classes have to be cancelled due to the foul conditions. Because of the lack of space, the school has to turn down about 300 students a year. Vincentes stated it is his dream to have a clean environment for his kids and also to expand the school.

Water Supply

Existing Conditions:

Source: Stream – 125 km away
# of taps: unknown
# of BSF**:** 4

The water supply at the school is consistent and good supply. There were no stated water supply concerns. There appeared to be no water storage system. However, it was stated that the lake water was used in times emergencies or shortages.

Possible Solutions:

Rain harvesting may not be an option for this school due to the material of the roofing, however should be investigated further.

Information Needed:

Roofing Material

Sanitation

Existing Conditions:

# of toilets: ? (Bathrooms locked)
Boys: ?
Girls: ?
Teachers: 1 (3rd floor)
Disposal Systems: Septic/Cesspool system

The sanitary system in its current condition is not functioning properly. There are student bathrooms on the second floor and a teacher's restroom on the third floor. Both of these restrooms are piped to a cesspool system located underneath the basketball court. It is uncertain if the pipes become clogged or if the capacity of cesspool is exceeded. It was assumed that with the amount wastewater created daily that the cesspool system is undersized. The septic system had been cleaned out three years ago.

The school has begun constructing a new bathroom with six new toilet locations. The bathroom is not complete and still needs toilets. No new septic tank has been constructed. Vincentes stated that when the new bathrooms are completed the other bathrooms would be replaced with classrooms.

Possible Solutions:

The solution is to rehabilitate the old bathroom/cesspool system and finish the new bathrooms. It is recommended that both bathrooms be fully operational with an additional septic tank system if needed; the school will need these facilities if it ever plans to grow.

Information Needed:

Cesspool conditions/dimensions
Wastewater quantities
Area available for new septic system
Percolation tests

Figure 9. Location of existing cesspool system.

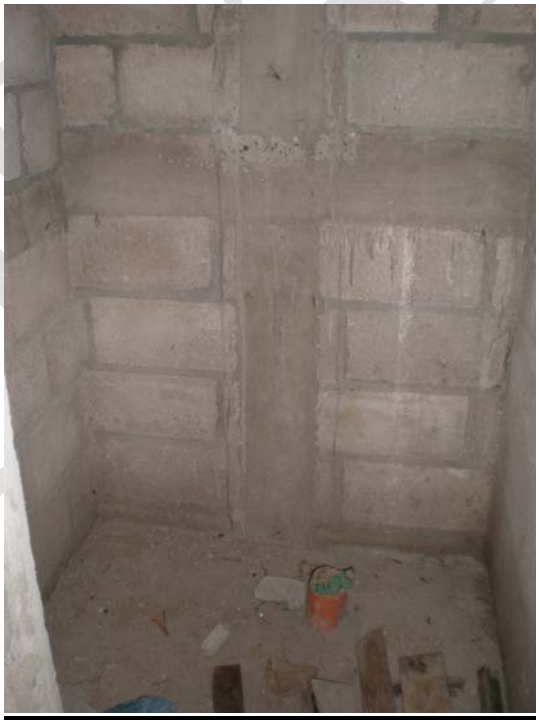

Figure 10. Toilet location in new bathroom.

Other Issues

The school does have flattop roof on a portion of the school. This location could be used for expansion and additional classrooms if structurally feasible. Vincentes stated he has a set of plans.

Figure 11. Location of possible expansion.

Information Needed:

Structural assessment
Building plans (if available)

EOUM CERRO DE ORO
EWB Assessment

Date Visited: 6/26/2008
Municipality: Santiago Atitlan
Contact: Angelica Ajanel, Principal
School Representatives Present: Angelica Ajanel, Manuel ?, and Dolores ?
# of Students: 180
Boys: 88
Girls: 92

Stated Concerns:

Angelica showed concerns that the kitchen smelled of sewer at times, there was limited light and ventilation in the bathroom, and the roof leaked over the kitchen/pantry area. Angelica has official building plans/blue prints for expansion of the bathroom building with associated building costs. She considers her school the school of the future and knows that her students are the leaders of tomorrow!

Water Supply

Existing Conditions:

Source: Well - near lake
# of taps: ?
# of BSF**:** 3

The school obtains their water by tapping into the mayor's building water line next door. Their own tap was broken/filled in during construction. The source of their water comes from a groundwater well downstream near the lake and is pumped uphill. Weekly their water supply goes out due to electricity or supply shortages. The school does have one RotoPlas tank for temporary storage and appears to be in working condition. The students do have access to the tank and have removed the lid at times. Some sort of security measure should be taken to limit the tank's accessibility.

Possible Solutions:

Establishing the school's own municipal tap should be first priority. Also, based on the school's water demands additional storage may be needed. Rain harvesting would be an easy addition to the schools water supply. The school has a tin roof and a gutter system all ready in place.

Information Needed:

Water demands
Location of nearest municipal line

Figure 12. The school's roof and gutter system.

Figure 13. The school's Rotoplas storage tank.

Sanitation

Existing Conditions:

# of toilets: 1 teacher; 4 student
Separted by grade; not boys and girls
Disposal Systems: Septic/cesspool system

All of the school's current wastewater goes to a septic/cesspool system. According to Angelica there is no overflow problem, just an odor problem. This is likely due to the fact the kitchen wastewater pipe is connected to the bathroom wastewater pipe which continues to the septic tank.

Possible Solutions:

A simple solution to the odor problem would be to insert some sort of backflow prevention (flap-gate) in the kitchen's waste pipe and to properly ventilate the bathrooms. If expansions are made to the school, the current septic system should be analyzed to ensure its capacity can meet the school's demands.

Information Needed:

Wastewater quantities
Septic system conditions/dimensions
Percolation test

Figure 14. Typical bathroom stall.

Figure 15. Septic system inlet box.

Other Issues

There are plans for an expansion of the bathroom building including the addition of the second floor. During the expansion of the building many of the stated problems could be remedied; the odor problems from the bathroom, leak in roof, and the limited light in the bathroom. For the time being the roof could be easily patched as necessary.

Information Needed:

Review of construction drawings

EOUM ENRIQUE GOMEZ CARRILLO
EWB Assessment

Date Visited: 6/27/2008
Municipality: San Juan la Laguna
Contact: Carlos Chavajay Batz
School Representatives Present: Carlos Chavajay Batz
# of Students: 265 (1000 people use school per day)
Boys: 140
Girls: 125

Stated Concerns:

Carlos stated several concerns such as lack of school supplies, student malnutrition and attendance; however, the biggest infrastructure/engineering concern was the existing sanitary system. The school has one bathroom with four toilets and there is no separation of boys and girls. The septic system overflows regularly.

Water Supply

Existing Conditions:

Source: Unknown
# of taps: N/A
# of BSF**:** 3

There were no stated concerns with the water supply. The source of the water was not identified. During the site visit water was available. The PVC piping in the water tap had a small crack; therefore water had to be tuned off and on each time it was needed. Carlos stated he was going to fix the problem when the supplies arrived.

Possible Solutions:

Rain harvesting is a possibility at the school. The roof is flat and concrete, and has a gutter system. Further investigation of possible contamination is needed.

Information Needed:

Monitor water supply to ensure supply is constant and available.

Figure 16. Location of school tap and location of septic system.

Sanitation

Existing Conditions:

# of toilets: 4
Boys: no separation
Girls: no separation
Teachers: n/a
Disposal Systems: Cesspool/septic system

As stated the existing sanitary system is regularly overloaded. The facilities at the school are not capable of handling the amount of wastewater created at the school. Carlos stated that the space underneath the stairwells could be possible locations for new bathrooms. There is limited area outside the school grounds for leach fields or extra septic systems. There is one 20' x 8' area that could be used; however, would have to be investigated because of structural issues.

Possible Solutions:

The solution is to rehabilitate the old bathroom/cesspool system and to construct additional bathrooms that connect to a separate sanitary system. It is recommended that both bathrooms be fully operational to handle the daily quantity of wastewater. The existing system will need to be cleaned and its capacity analyzed.

Information Needed:

Cesspool conditions/dimensions
Wastewater quantities
Area available for new septic system
Percolation tests
Dimensions of rooms under each stairwell

Figure 17. Possible location of additional bathrooms under each stairwell.

Figure 18. Existing septic system entrance box.

Other Issues

Other than the stated needs for school supplies and a healthy diet for the kids, the sanitary system and its capacity appears to be the primary concern. No other engineering issues were prevalent or stated. Stormwater drainage appears that it could be an issue, but Carlos stated the schoolyard drains adequately.

EOUM SAN PABLO LA LAGUNA
EWB Assessment

Date Visited: 6/27/2008
Municipality: San Pablo La Laguna
Contact: Juan Luis Mendez
School Representatives Present: Domingo ?, Janitor
# of Students: 922
Boys: 437
Girls: 483

Stated Concerns:

The stated concerns were minimal. The school representative had only worked at the school for several months and was still not familiar with the school's infrastructure and history.

Water Supply

Existing Conditions:

Source: n/a
# of taps: n/a
# of BSF**:** 4

The water supply was readily available during our visit. The source of water was never identified. The school has six Rotoplas tanks, however only three appeared to be in working condition. The tanks that were not functional appeared to be missing floats, lids, and piping.

Possible Solutions:

Assuming the water supply is sufficient and consistent the school has no immediate water supply problems. However, the school could increase their water supply storage and emergency supplies by simply fixing their existing infrastructure.

Rain water harvesting could also be an alternative at the school. It may be limited to grey water, however could be a critical component to their water supply.

Information Needed:

Itemized list of missing infrastructure components

Figure 19. Rotoplas tanks above bathroom buildings.

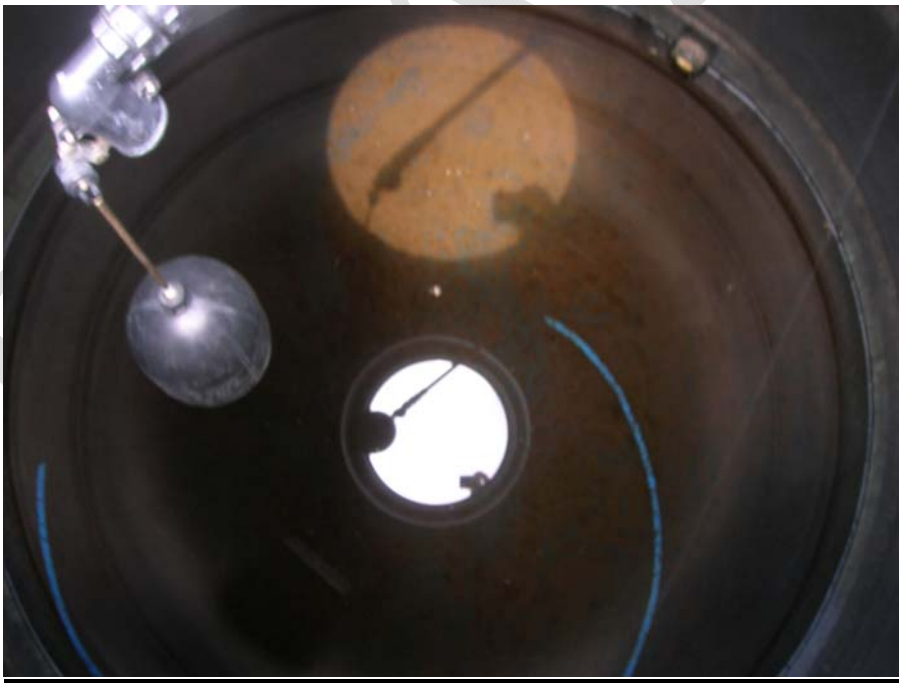

Figure 20. Empty Rotoplas tank with no water connection.

Sanitation

Existing Conditions:

# of toilets: 12 (three do not work)
Boys: 3
Girls: 4
Teachers: 2
Disposal Systems: Septic/cesspool system

The existing sanitary system consists of a septic/cesspool system. The system's entrance manhole could not be located. According to the school's representative the system does not overflow (verification needed). The school added new bathrooms during school's expansion and it was stated a new septic system was included (verification needed). The school has three bathroom buildings; two for students and one for teachers. Three of toilets in the teachers building do not function; it appears this may be due to the fact there is no water supply. The Rotoplas tank that supplies water to these toilets is not operating and has no water source.

Possible Solutions:

The sanitary issues are minimal. Fixing the water supply or Rotoplas conditions should fix the toilets that are not functioning.

Information Needed:

Cesspool conditions/dimensions/location
Wastewater quantities
Follow up discussion with principal

Figure 21. Typical bathroom stall.

Figure 22. The teacher's bathroom building.

Other Issues

No other issues or concerns were stated. A follow up discussion with the principle should be conducted to establish any other issues.

Assessment Summary

A summary of each school's assessment can be seen in Table 1. Each school was equipped with cistern-flush toilets. Having cistern-flush toilets completely prevents the passage of flies and odors and increases the health standards of bathrooms dramatically. In all schools except Panajachel the sanitary disposal system consisted of a septic/cesspool system. Panajachel has no storage/treatment system and pipes its wastewater directly to Lake Atitlan, which poses health and environmental issues.

All other schools have some form of septic/cesspool system. No outlet pipes were found at any of the schools, therefore it can be assumed that the systems were built to function as cesspools, with some sort of soakaway or infiltration design. The septic tanks generally received all cistern-flushed sewage and school wastewater. Septic/cesspool tanks are generally single or double compartment tanks that help separate and digest solid matter, and then dispose of the wastewater through infiltration or a sewer system. This sludge or solid matter accumulates in the tanks and needs to be removed on a regular basis. Also, as the septic systems age the infiltration capacity or the ability of the tanks to drain becomes minimal, which essentially creates a holding tank which can cause overflows and blockages. It is recommended that the conditions of each septic system be evaluated and sized so the wastewater loading and treatment capabilities are balanced and that a regular maintenance program be established.

Every school relied on the local municipality for their water supply. The water supply varied from school to school. Most schools have temporary storage capabilities in times of water shortage. The water supply directly affects the operating capabilities of the sanitary systems because of the use of cistern-flushed toilets. Without water, the sanitary system can not operate, therefore it critical that a constant water source be available at each school.

Some schools showed other needs that included the need for structural assessments, construction assistance, supplies, education, and proper ventilation. All these issues are no less important than sanitary and water supply issues, and should be prioritized and addressed as necessary. It should also be noted that each community could benefit from some form of solid waste education and/or proper disposal system. There appeared to be no community approach. Proper waste disposal is an integral component of any healthy community.

Table 1. School assessment summary table.

Sanitary System	**Panajachel**	**San Andres**	**San Antonio**	**Santiago Atitlan**	**San Juan**	**San Pablo**
Type	Piped (outfall lake Atitlan)	Cesspool/Septic Tank	Cesspool/Septic Tank	Cesspool/Septic Tank	Cesspool/Septic Tank	Cesspool/Septic Tank
Overflow	Yes	No	Yes	No	Yes	No
Additional Facilities Needed	Yes	No	Yes	No	Yes	No
Water Supply						
Source	Spring (10-15km)	Stream (14-17km)	Stream (125km)	Well (<2km)	n/a	n/a
Taps	7	6	n/a	n/a	n/a	n/a
Storage Capability	No	Yes	No	Yes	No	Yes
Consistent	Yes	No	Yes	No	Yes	n/a
Other Needs	Emergency relief materials, solid waste disposal	Kitchen ventilation, roof over courtyard, public library	Additional classrooms	Expansion of bathroom building	School supplies	n/a

Water Quality

During the visit several water sampling was conducted. These samples were analyzed for Iron, Total Nitrogen, and Total Coliforms. The water quality tests were conducted using a HACH AquaChek test kit and 3M Petrifilm E.Coli/Coliform Count (EC) plates. These types of tests were conducted only to get an estimate of the water conditions. Further testing should be conducted to get accurate results. It should be noted that many of the tests were conducted in less than ideal conditions.

The elements nitrogen and phosphorus are essential to the growth of microorganisms, plants, and animals, and are known as nutrients. Trace quantities such as iron are also needed for biological growth. These nutrient levels are good indicators of the health of streams and lakes and often times are good measures of how human urbanization is affecting the streams and waterways and the life that depends on them. The EPA has set a Maximum Contaminant Level for nitrate and nitrite levels in drinking water to 10 mg/L and 1 mg/L, respectively.

Coliforms are abundant in the feces of warm-blooded animals, but can also be found in the aquatic environment, in soil and on vegetation. In most instances, coliforms themselves are not the cause of sickness, but they are easy to culture and their presence is used to indicate that other pathogenic organisms of fecal origin may be present. Fecal pathogens include bacteria, viruses, protozoa or parasites. The Ministry of Public Health has set drinking water limits of 1.1 total coliforms per 100 ml and 0 forms of E. Coli.

Water sampling tests previously conducted by the Ministry of Public Health showed relatively high total coliform counts at San Pedro, San Juan, San Pablo, and Santiago Atitlan. The water tests conducted during our trip can be seen on Table 2. The sample results do not represent the entire water source; but represent the water quality at the sample location and time of the test. Water quality tests should be collected routinely as the water quality can vary spatially and temporally.

All of the samples EWB collected showed limited amounts of nutrients. Ironically, the only tests that showed any presence of total coliforms were the discharges from the BSF's; these included two samples at San Jaun and one at San Andres. No source water samples were taken at either site that can be used for comparison. No E. Coli tests could be deciphered because of the lack of illuminated magnifier.

Pathogenic microorganisms and their fate in BSF is not well established. However, without question they can be filtered out and captured on or in the biofilm (schmutzedecke) and sand. Competition, predation, absorption, and adsorption all reduce the number of coliforms; however, the filter's flow rate must be slow enough to allow these processes to occur.

Table 2. Water quality recorded during assessment trip.

Sample	Total Iron (mg/L)	Ammonia (mg/L)	Nirtrite (mg/L)	Nitrate (mg/L)	Total Coliform (per ml)	Total Coliform (per 100 ml)
Middle of Lake	0	0.25	0	0	0	0
Lake at Santiago Atitlan	<0.15	0.25	0	0	0	0
San Juan Tap	0	0.25	0	<1	0	0
Santiago Atitlan Tap (school)	0	0.25	0	0	0	0
Santiago Atitlan Tap (community)	0.15	0.25	0	0	0	0
San Pablo Tap	0	0.25	0	<1	0	0
BSF Samples						
Panajachel 001	0.15-0.30	<0.25	0	1	0	0
Panajachel 002	0.15-0.30	<0.25	0	<1	0	0
San Andres 003	<0.15	0.25	0	0	4	400
San Andres 004	0	0.25	0	0	0	0
San Andres 005	<0.15	0.25	0	0	4	400
SanJuan001	0	0.25	0	1	0	0
SanJuan002	0	0.25	0	<1	2	200
SanJuan003	0	0.25	0	<1	0	0

Drinking Standards per Ministry of Public Health: Coliform < 1.1 per 100 ml and no E.Coli present

Conclusion

Each school and community visited has its own separate needs, wishes, and conditions. Project implementation depends on many factors such as feasibility, cost, priority, community involvement, community ownership, and sustainability. All these factors should be addressed in the decision of how and where to allocate the resources of every party involved in the Water, Hygiene and Sanitation Promotion program.

EWB-KC has established a project team and is willing and eager to start working to improve the conditions in Solola, Guatemala. The project team consists of engineers from many disciplines such as civil, environmental, structural, and electrical engineers. The group is in the process of applying for acceptance from EWB-USA to establish Solola, Guatemala as a sanctioned EWB project.