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# Water Quality Assessment: Estero de Plátano, Ecuador

Culminating Experience

Washington University in St. Louis

## Abstract

Obtaining clean water is a daily struggle in many parts of the world, including the community of Estero de Plátano, located in a rural area of the Ecuadorian coast. In collaboration with the Yanapuma Foundation, a two pronged water quality assessment was completed in the community using household surveys and bacterial cultures. The household surveys were designed to capture information on current knowledge, attitudes and practices in the community, while bacterial cultures using Coliscan EasyGels were used to identify *e.coli* and fecal coliforms. This design provided quantitative information about the level of contamination of different water sources, which allowed for the classification of water sources as contaminated or clean. The assessment showed that there has been a significant increase in the use of clean water sources since previous assessments in 2009. However, some of the existing water and waste management systems are deteriorating due to a lack of maintenance. Overall, there is a relatively high level of knowledge about clean water and hygiene, but room for improvement remains. Water from both of the rivers in the community and the water piped to homes was positive for fecal coliforms and *e. coli*. However, water from a newly installed purification system and the sample of bottled water were free of both. Although access to clean water has improved and there is a relatively high level of knowledge about water and hygiene in the community, it remains very important to continue health education and ensure continued access to clean water.

## Background

Ensuring the availability of clean water is one of the most important priorities of public health practice in developing nations. The World Health Organization (WHO) defines water sources as improved and unimproved. Improved sources include household connections, boreholes, and standpipes among others. Unimproved sources include sources likely to be contaminated, was well as vendor provided water. (WHO, 2011) Worldwide, 884 million people do not use improved sources of drinking water (WHO, 2010).

Although access to clean drinking water is improving in Ecuador, many people are still forced to use contaminated water sources, especially in rural areas. According to WHO, 91-100% of homes in Ecuador use improved water sources (2010), but another report by WHO/UNICEF estimates that only 50% of rural homes have running water, illustrating the urban/rural divide (2010). Additionally, water systems in Ecuador sometimes pipe water directly from lakes or rivers without treatment, so although household connections are considered an improved water source by WHO, they remain an unsafe source of drinking water in Ecuador.

Untreated water may contain any number of microorganisms such as protozoa, parasites, bacteria, and viruses. Ingestion of water contaminated with microorganisms can cause a variety of health problems, although diarrheal disease is the most common consequence. Although great strides have been made in increasing access to safe drinking water, diarrheal disease remains the second leading cause of death worldwide for children under the age of five (WHO, 2009). In Ecuador, diarrheal disease accounts for 1,700 deaths per year, more than any other environmental factor (WHO, 2007). Some of the most common

causes of diarrheal disease, especially in developing nations like Ecuador, include rotavirus, *Campylobacter*, enterotoxigenic *E. coli* (ETEC), shigellosis, and typhoid fever (WHO, 2010).

Infection with *Helicobacter pylori* through drinking water is also an emerging issue in public health. *H. pylori* is a bacteria associated with gastritis, ulcers, and stomach cancer and is very prevalent in Ecuador, with some studies putting seroprevalence rates as high as 63% (Gomez, et al., 2004). The transmission routes for *H. pylori* are not well understood, but evidence suggests that it is able to grow in water and that fecal-oral transmission is likely (van Duynhoven & de Jonge, 2001). Drinking water has been identified as a reservoir for *H. pylori*, where it has found to survive chlorine levels of 0.5 mG/L (Al-Sulami, Al-Tae, & Juma'a, 2010).

Ecuador is also home to the oil industry and water sources have been shown to contain petroleum hydrocarbons at unsafe levels (San Sebastián, et al, 2001). Farming is another common occupation in Ecuador and contamination with pesticides has also been identified as an issue.

## Setting

Estero de Plátano is a small community on the rural coast of Ecuador. The population is between 600 and 700 people, with approximately 120-130 households. The area is characterized by extreme poverty, low education, and limited access to health care. The Yanapuma Foundation has been working with the community since mid 2008. (Yanapuma Foundation, 2009).

Most homes have had running water since 2005, but until 2010 the source was untreated river water. The Yanapuma Foundation collaborated with a local organization to begin treating the water with chlorine in 2010, which should decrease the presence of microorganisms. However, several microorganisms can survive in chlorine such as norovirus, *H. pylori*, and *Cryptosporidium*. The water system is unreliable and sometimes will stop

working for days at a time. Residents have also reported that the water at times appears contaminated, as indicated by a strange color and smell. This may be due to a lack of maintenance and cleaning of the water tanks. (Yanapuma Foundation, 2009) According to a public health survey in 2009, the two rivers in the village serve as a main or supplemental source of water (Julmisse & Preciado, 2009). It is a common practices to wash clothing in the river, which introduces fecal contaminaton and phosphates into the water.

Yanapuma conducted two separate public health evaluations in 2009, both of which addressed water issues. The questions used in the 2009 household survey and the results of the water analysis are attached in Appendix A. No follow-up or evaluation has been done since that time. Previous reports indicate that most residents understand the need to treat their water, but that there are few that actually do so (Yanapuma Foundation, 2009).

Yanapuma has recently collaborated with a local nonprofit, Agua Muisne, to install a water purification system. Residents of Estero de Plátano and surrounding communities can purchase 20 liter bottles of water from this system for 25 cents, which is approximately 75% cheaper than typical market prices. A Water Director was hired from the community who is responsible for selling water and cleaning and maintaining the system. The salary for the Water Director is $10 per day and comes directly from water sales. Therefore, it is necessary to sell 40 bottles of water per day in order for the Water Director to be paid her salary. Any sales above $10 per day are to be used for system maintenance.

## Methodology

The two methods used to evaluate water quality in Estero de Plátano were a household survey and bacterial cultures of common water sources. The household survey was designed to answer the following questions:

1. What are the most common sources of water for drinking, bathing, cooking, and washing?
2. What, if any, measures are taken to treat water in households in the community?
3. What is the level of knowledge about water safety?
4. What are the barriers to obtaining clean water?
5. Has the new water system increased access to clean water?
6. What is the prevalence of gastritis and diarrheal disease?
7. Is there any correlation between the prevalence of water-borne diseases and water source or treatment?

Where possible, questions on the household survey were similar to or the same as those used in 2009 to allow for comparison with previous results. The household survey was completed for 20 households. The community consists of four main areas: the town center, the highway, the outskirts, and an area across the river. These areas differ in income, practices, and attitudes. Surveys were done in each section, with the number of surveys being proportional to the percent of the total population living in each area. This sample composes approximately 17% of the total population. Only one member of each household was interviewed, which was the female head of household when possible. All surveys were conducted in Spanish. The survey is attached in Appendix B in both Spanish and English.

Bacterial cultures were completed for six water sources using a Coliscan Easy Gel testing kit, which have the capacity to culture *E.coli* and other fecal coliforms. Samples taken from the river were taken from the two areas where the community frequently gathers water. Cultures were completed for the following water sources

1. Boiled Water (control)
2. Río Piedra
3. Río Grande
4. Piped Water
5. New Water System (Agua Muisne)
6. Bottled Water

Water samples were taken all within one hour of each other and the cultures were prepared immediately following collection. The samples were cultured at room temperature

for 48 hours. Photos of all cultures were taken at the start of the 48-hour period, as well as at 24 and at 48 hours and are included in Appendix C. Although contamination by petroleum hydrocarbons and pesticides is an important issue in Ecuador, financial limitations did not allow for testing for these contaminants.

## Results

### Bacterial Cultures

Of the six bacterial cultures completed, three were positive for *e.coli* and other fecal coliforms. The sample from Río Grande contained six colonies of *e.coli* and 30 to 40 colonies of other fecal coliforms. The culture from Río Piedra contained more than double the amount of *e.coli*, with approximately 14 colonies, but contained approximately the same number of colonies of other coliforms. The piped water was slightly less contaminated, with only three colonies of *e.coli* and 20 to 30 colonies of other fecal coliforms. As expected, the boiled water, which was meant to serve as a control, contained neither fecal coliforms nor *e.coli*. The water from the newly installed water system and the bottled water were negative for fecal coliforms and *e.coli.*

There have been some changes in bacterial contamination since the last cultures were completed in 2009. While the samples from the river had similar levels of contamination, the previous culture of piped water was negative for fecal coliforms and *e.coli* (Yanapuma, 2009). This is especially surprising since the piped water is now being treated with chlorine.

### Household Surveys

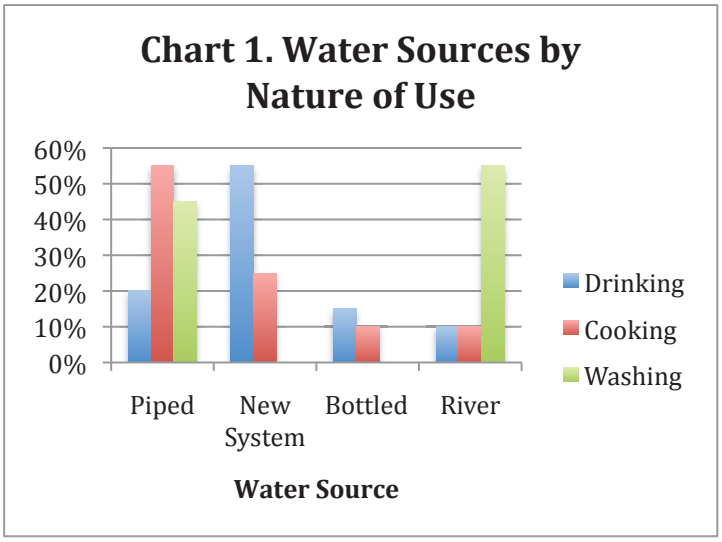
*Current Practices*

Twenty household surveys were completed during the week of May 23. In the majority (75%) of households, the respondent was the female head of household. Other respondents

included male head of household (15%), daughter (5%), and transsexual head of household (5%). The average household size of respondents was six members.

For this analysis, water from either of the rivers or the piped system is considered contaminated, while water from the new system or other bottled water is considered clean. The main source of drinking water was the newly installed water system, with 55% of respondents reporting it as their primary source. However, 20% of respondents reported using piped water and 10% reported using river water, both of which contain *e.coli* and fecal contamination. Only 15% of respondents reported using bottled water from a source other than the new system. The use of contaminated water sources increased for water used for cooking, with 55% using piped water and 10% using river water. Only 25% reported using water from the new system for cooking, while 10% reported using other bottled water. Water used for washing dishes and clothing was exclusively from contaminated sources.

Families in the outskirts of town reported the lowest use of clean water sources for drinking water, at only 33%. Families in the center of town and on the other side of the river had much more frequent use of clean water sources, at 80% and 100% respectively.




Compared with the public health report conducted in 2009, the percent of families using clean water sources such as the new system and other bottled water has increased considerably. In 2009, 47.7% of respondents reported using piped water and 40.5% reported using river water (Julmisse & Preciado, 2009). However, this

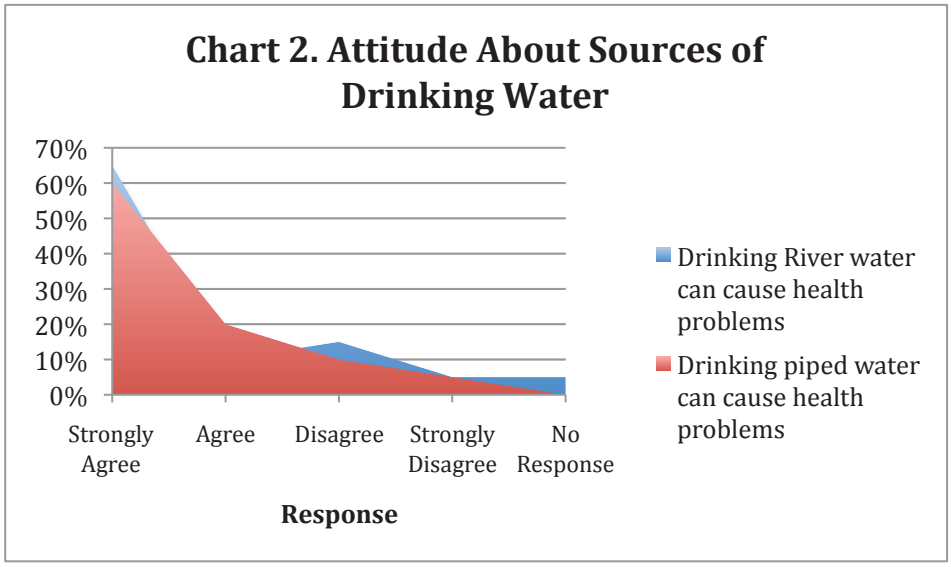
survey did not allow the dinstinction of different water sources for different uses such as drinking and washing, so the results should be compared with caution.

Very few respondents reported doing anything to prepare water prior to its use. In three households, drinking water was boiled before consumption. However, this represents only half of the households that reported using contaminated drinking water. Only one of the 13 households that reported using contaminated water sources for cooking reported boiling water prior to using it.

The disposal of bathroom waste has also changed considerably since the previous report. In 2009, 66.7% of respondents reported using a septic tank for waste disposal, 11.7% reported using a hole, and 1.8% burned the waste (Julmisse & Preciado, 2009). The percent of respondents burning their bathroom waste has increased to 35%, while those using a septic tank decreased to 30%. The use of a hole for disposal has also increased, from 11.7 to 25%.

*Knowledge and Attitudes*

The majority (65%) of respondents strongly agreed that drinking river water without treating it could lead to diarrhea or gastritis. This number decreased slightly to 60% when the same question was asked about piped water. While the majority of respondents did agree with the statement regarding river water, 5% strongly disagreed and 15% disagreed with the statement illustrating that some people in the community do not associate the consumption of untreated river water with illness. This decreased slightly for piped water, with only 5% strongly disagreeing and 10% disagreeing.



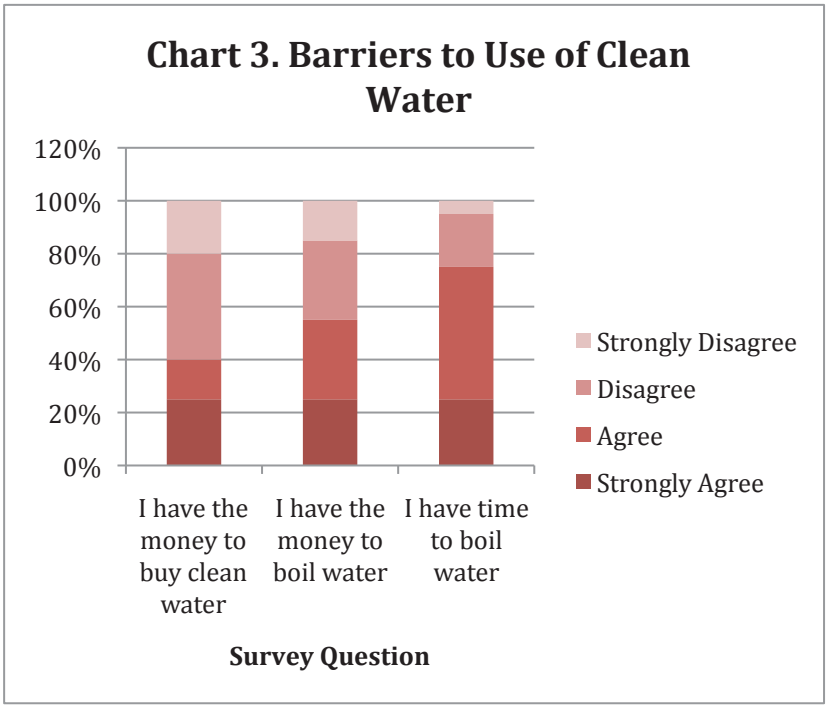

In contrast, 100% of respondents strongly agreed that it is important to wash your hands before eating and after defecating. Positive attitudes about hand washing were reflected in reported hand washing practices as well. Of the 18 respondents who reported preparing food on the day of the interview, 100% reported washing their hands with soap before preparation. Similarly, 100% of respondents reported washing their hands before eating, and 95% reported using soap. There was no pattern of difference in attitudes and knowledge in the different areas of town.

*Barriers to Access*

The majority, 80%, of respondents reported having access to running water in their home, while 10% reported having access just outside their home. One family reported having access to running water 100 meters from the home, while one family reported have no access to running water.

Several questions examined the influence of the potential barriers of money and time for access to clean water. Of the families interviewed, 20% disagreed and 40% strongly disagreed with the statement that they had the money to buy clean water. Money appeared to be less of a barrier to boiling water, a less expensive alternative. Six respondents (30%) agreed that they had enough money to boil water, while 25% strongly agreed. However, 45% disagreed or strongly disagreed with the statement, indicating that money remains a barrier

for boiling water for almost half of the respondents. Time is less of a barrier to boiling water, as 75% of respondents agreed or strongly agreed that they had sufficient time to boil water




The installation of the new water purification system has increased the use of clean water. A quarter of respondents reported that their use of clean drinking water has increased since its installation, and 10% reported an increased use of clean water for cooking.

Despite significant progress, access to water still remains a problem in this community. The majority of respondents agreed that it is difficult to obtain pure water, with 35% agreeing and 35% strongly agreeing. Interestingly, over half of the respondents reported that they do not worry about the water they use in their household. This is an interesting contradiction in attitudes that should be investigated further.

*Health Outcomes*

Health outcomes from consuming water contaminated with microorganisms was measured by the prevalence of diarrhea in the month preceding the survey. The average number of cases of diarrhea in the month per household was 0.60, with a range of zero to four. Twenty-five percent of households reported at least one case of diarrhea in the past month. Gastritis and stomach cancer were used as health indicators for *h. pylori* infection. Gastritis had an even lower prevalence than diarrhea, with an average of 0.45 cases in the past month

per household. Reported numbers of gastritis cases ranged from 0 to 5 and 20% of households reported at least one case of gastritis in the past month. There were no reported cases of stomach cancer within the past five years within any the households interviewed. Additionally, no pattern of correlation emerged between water sources and preparation and the prevalence of diarrhea, gastritis, or stomach cancer.

## Discussion

### Deterioration of Existing Systems

The bacterial cultures and household surveys revealed some patterns that point to the deterioration of the piped water system and the septic tanks in the community. Samples from the piped water system taken in 2009 were not positive for fecal coliforms, but the samples taken for this analysis were positive for both fecal coliforms and *e.coli.* Given the results of the bacterial cultures, it is likely that any purification system that was previously in place is no longer functioning. Additionally, the chlorine being added to the water system is either no longer being added or is not at a concentration that effectively kills bacteria.

Compared with surveys done in 2009, the percentage of households using septic tanks to dispose of waste from latrines has greatly decreased, while the number of families burning latrine waste has increased. Many families use latrines that were provided by the Ecuadorian government that included septic tanks. However, there is no one currently responsible for maintenance of these latrines. According to Andrew Kirby, Executive Director of Yanapuma, families have begun to report that their septic tanks have filled up and they are not aware of a sanitary way to empty them (2011). Therefore, families have turned to burning the waste from their latrines as an alternative.

Burning waste in an open area is considered open defecation by WHO, the least improved form of sanitation (WHO, 2010). Although studies have shown that short-term

exposure to burn pits does not have negative health effects (Armed Forces Health Surveillance Center, 2010), there is little information on the health consequences for long-term exposure. Additionally, burning human waste increases human contact with fecal matter and has negative environmental consequences.

**Current Practices**

Although differences in wording between household surveys done in 2009 and this survey make comparison difficult, it does appear that the number of families using clean water sources has increased considerably. It also appears that the percentage of families drinking clean water is higher than would be expected in this setting. In a similar knowledge, attitudes, and practices (KAP) assessment in neighboring Peru, 75% of respondents reported drinking untreated water, compared to only 30% in Estero de Plátano (Quick, et al., 1996). Yanapuma has been working in this community for three years promoting the use of clean water sources, so this increase is not surprising. The installation of the new water purification system and subsequent availability of clean water at greatly reduced prices has also increased access to clean water. However, the current sales of water are not sufficient for the Water Director to be paid her full salary or to provide funds for system maintenance, so Yanapuma and Agua Muisne are working to promote the new system and increase sales. Given the small size of Estero de Plátano, other communities will also need to buy water from the system in order for it to be sustainable.

Very few families treat their drinking water prior to using it, but since the majority of families get their drinking water from clean sources so this is not of great concern. It is more concerning that 65% of families get their cooking water from contaminated sources and only 5% report treating it in any way.

**Knowledge and Attitudes**

Although the majority of respondents agree that there is a connection between drinking contaminated water from the river or piped system and subsequent health consequences, a significant minority still disagree. Changing social norms and ideas about drinking water is a slow process likely to take several generations and continued work is necessary. The literature has shown that practices often lag behind knowledge and attitudes, so changing attitudes is only the first step in changing practices (Quick, et al., 1996).

In contrast, it is clear that the community members are well aware of the importance of hand washing. While responses to the survey questions regarding hand washing indicate that hand washing is very common, my own observations in the community indicate that hand washing before cooking and eating remains rare. It is very likely that social desirability bias had an impact on the responses to questions regarding hand washing. Therefore, it is fair to say that while the knowledge of the importance of hand washing is well developed in the community, there is still work to be done in making frequent hand washing a normal practice.

**Barriers to Access**

The main barrier to access of clean water sources remains economic, both for buying clean water and for preparing water from contaminated sources. While time does present a slight barrier to boiling water, its influence does not appear large. Although the installation of the new water system has decreased the economic barriers to obtaining clean water, several families that I spoke to stated that buying water still creates a financial hardship at the reduced price.

**Health Outcomes**

The prevalence of diarrhea and gastritis were lower than expected given the number of families relying on contaminated water sources for drinking and cooking. The percentage of families reporting a case of diarrhea in the past month was 25%, compared to 26.9% in a

similar study in the United States (Sandler, et al., 2000). It is likely that respondents were somewhat unwilling or embarrassed to talk about cases of diarrhea in their homes. In the case of gastritis, a lack of knowledge about symptoms may have reduced the ability of respondents to recognize cases. In the future, key informant interviews with the nurse and doctor at the Health Subcenter in the community would be helpful to gain more information about health outcomes.

**Strengths and Limitations**

A considerable strength of the assessment was the prior knowledge of the community and local dialect. This knowledge ensured that the language used in the household survey was easily understood by respondents and increased the accuracy of responses. The prior knowledge of the community was also important in putting the responses in context and understanding their implications.

Another strength of the assessment was the relationship between the researcher and both the Yanapuma Foundation and Agua Muisne. Staff from both foundations had the opportunity to provide input and advice on the creation of the survey and the overall assessment design. Additionally, this relationship will allow the researcher to share the results with these foundations so that they can be used to inform their work in the community and ultimately benefit the community members.

An unfortunate limitation is that the responses to household surveys were likely impacted by social desirability bias. While this can be an issue in any survey, the prior relationship of the interviewer with the community decreased anonymity and increased the effect of social desirability bias. The low incidence of diarrhea may have been impacted by reluctance to discuss the subject due to embarrassment. Social desirability bias may also have impact these answers as well due to reluctance to discuss health problems in the family with

an outsider. Defining diarrhea in a way that is clear over cultural and language barriers also creates an obstacle to gaining accurate results. The President of Agua Muisne, Alexander Harding, has also acknowledged the difficulty of gaining accurate data regarding diarrhea in household surveys in this setting (2011). In the case of gastritis and stomach cancer, a lack of access to health care reduces the likelihood that respondents are able to obtain a diagnosis for gastritis or stomach cancer. Many people choose not to go to a doctor until a situation is very grave, and a generally low level of health literacy exists in the community, decreasing understanding of diagnoses.

Coliscan Easygels are a good tool for use in the field, but are not as accurate as a laboratory analysis. In a comparison with another field testing kit, 3M Petrifilm, Coliscan Easygels were less similar to laboratory results than the Petrifilm for *e.coli* (Stepenuck, et al, 2011). However, another study examining field tests recommended the use of Coliscan Gels in combination with another field testing system (Chuang, Trottier, & Murcott, 2011). However, this same article cautions that no field testing kit should be used alone due to overally limitations of field-testing kits. Therefore, although the results of the bacterial cultures provide important information about the safety of water sources in the community, a full analysis should include a combination of testing methods.

## Conclusion and Recommendations

In the past two years, Estero de Plátano has seen both progress and regression in terms of water and hygiene. While access to and use of clean water has increased in the community, the disposal of human waste is an emerging problem as current systems deteriorate. In order to maintain access to clean water, it will be necessary to increase consumption of water from the new purification system. If this is not possible, the system will not be sustainable and access to clean water will return to previous levels.

Additionally, although knowledge and attitudes are also improving in the community, it is still important to reinforce the importance of clean water and proper hygiene practices. Reinforcing the importance of using clean water will also be an important part of increasing and maintaining consumption from the new water purification system. There are a variety of ways to reinforce these principles and many organizations such as the World Health Organization offer materials for workshops and health promotion.

Finally, the deterioration of existing systems must be addressed in order to prevent regression in the disposal of human waste. Ideally, the government body responsible for the maintenance of the existing septic tanks could be contacted to address the issue. Additionally, education on the environmental and health effects of improper disposal could be helpful in this area.

While Estero de Plátano is making significant strides in the areas of water and hygiene, continued attention to these areas is crucial. Given the small size of the Yanapuma Foundation, it is important to develop and nurture collaborations with other non-governmental organizations and government agencies. Diarrheal disease is still a significant cause of mortality in Ecuador and remains a risk in this community. Changing attitudes and practices is an slow process and requires constant reinforcement.

## References

Al-Sulami A.A., Al-Taee A.M., Juma'a M.G. (2010). Isolation and identification of helicobacter pylori from drinking water in Basra governorate, Iraq. *Eastern Mediterranean Health Journal.* Sep;16(9):920-5.

The Armed Forces Health Surveillance Center, The Naval Health Research Center, & The U.S. Army Public Health Command (Provisional). (2010). *Epidemiological Studies of Health Outcomes Among Troops Deployed to Burn Pit Sites.* Washington, DC.

Chuang, P, Trottier, S. & Murcott, S. (2011). Comparison and verification of four field-based microbiological tests: $H_2S$ test, Easygel, Colilert, Petrifilm. *Journal of Water, Sanitation and Hygiene for Development, 01.1:* 68-85.

Gomez N.A., Salvador A., Vargas P.E., Zapatier J.A. & Alvarez J. (2004). Seroprevalence of helicobacter pylori among the child population of Ecuador. *Revista Gastroenterol Peru*, Jul-Sep;24(3):230-3.

Harding, Alexander. President of Agua Muisne. Personal Communication, June 2011.

Julmisse, M., & Preciado, M. (2009). *Public Health Report: Assessing Community Health in Estero de Plátano, Ecuador* La Comunidad de Estero de Plátano, Fundación Yanapuma,. Quito, Ecuador.

Kirby, A., Executive Director of the Yanapuma Foundation. Personal Communication, June 2011.

Quick, R.E., Gerber, M.L., Palacios, A.M., Beingolea, L., Vargas, R., Mujica, O., Moreno, D., Seminario, L., Smithwick, E.B., & Tauxe, R.V. (1996). Using a Knowledge, Attitudes and Practices Survey to Supplement Findings of an Outbread Investigation: Cholera

Prevention Measures during the 1991 Epidemic in Peru. *International Journal of Epidemiology, 25(4),* 872-878.

San Sebastián, M., Armstrong, B., Córdoba, J.A., & Stephens, C. (2001). Exposures and cancer incidence near oil fields in the Amazon Basin of Ecuador. *Occupational and Environmental Medicine, 58,* 517-522.

Sandler, R.S., Stewart, W.F., Liberman, J.N., Ricci, J.A., & Zorich, N.L. (2000). Abdominal pain, bloating, and diarrhea in the United States: Prevalence and and impact. *Digestive Diseases and Sciences, 45(6),* 1242-1254.

Stepenuck, K.F., Wolfson, L.G., Liukkonen, B.W., Iles, J.M., & Grant, T.S. (2011). Volunteer monitoring of *E. coli* in streams of the upper Midwestern United States: a comparison of methods. *Environmental Monitoring and Assessment, 174:* 625-633. DOI: 10.1007/s10661-010-1483-7.

van Duynhoven Y.T. & de Jonge, R. (2001) *Transmission of helicobacter pylori: A role for food?* Bulletin of the World Health Organization, 79(5).

WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation. (2010). *Estimates for the use of Improved Drinking-Water Sources.* Geneva, Switerland.

World Health Organization (2007). *Country Profiles of Environmental Burden of Disease.* Geneva, Switzerland.

World Health Organization (2009). *Fact Sheet No. 330, Diarrhoeal Disease*. Geneva, Switzerland.

World Health Organization (2010). *Progress on Sanitation and Drinking Water: 2010 Update.* Geneva, Switzerland.

World Health Organization (2011). *WHO Statistical Information System (WHOSIS): Access to improved drinking-water sources and improved sanitation (percentage).* Retrieved from http://www.who.int/whosis/indicators/compendium/2008/2wst/en/ on 7/7/2011.

The Yanapuma Foundation (Fundación Yanapuma). (2009). *Water, Sanitation and Hygiene (WASH) project: Estero de Plátano.* Quito, Ecuador.

## Appendix A: 2009 Household Survey and Water Analysis Results

**El 4 de junio**

**Cuestionario para Estero de Plátano**

La ultima vez que ud. recogió agua, de donde lo recogió?
Donde queda su agua y que tipo de recipiente usa ud.? Usa una cubierta? Cuando fue la ultima vez que limpió el recipiente? Limpió el recipiente con un esponja y lo restregó? Lo secó?

Como usa ud. ese agua, para beber? Lavar ropa? Para cocinar?

Ha tratado esa agua en alguna manera, como usando el cloro o hervirlo?

Puedes mostrar me como ud. saca el agua desde el recipiente? Usa algún cucharón? Está limpio el cucharón?

Ud. lava su manos antes de sacar el agua?

Cuantos veces al mes ud. tiene que comprar el jabón? Para que usa el jabón? Para lavar los platos? Para lavar su ropa? Para bañarse? Para lavar sus manos?

Ha preparado algún comida el día de hoy? Lavó sus manos antes de prepararla? Antes de comerla?

Como usa el bañó, y donde defeca ud.? La ultima vez que defecó, lavó sus manos después? Con el jabón?

Has visto algún ganado o chancho en el río? Ud. tiene sus propios animales? Son libre a pasar o caminar en el río?

Si era más saludable a tener sus animales en un corral en vez de ser libre a caminar en el rió, lo haría ud.? Si era mejor para el medio ambiente, lo haría? Si todo el mundo quedaron sus animales en un corral, lo haría?

Ud. o algún miembro de su familia tiene algún enfermedad o problema del estomago, como la diarrea? O cuando fue la ultima vez que algún miembro de su familia ha tenido algún problema así?

Ha visitado el centro de salud? Sabía que era un opción a visitarlo para sus enfermedades o problemas con su salud? Hay otros problemas comunes con la salud de algún miembro de su familia?

EMPRESA DE AGUA POTABLE Y ALCANTARILLADO
eapa
SAN MATEO ESMERALDAS

# PLANTA DE TRATAMIENTO

## LABORATORIO

## ANALISIS FÍSICO - QUÍMICO Y BACTERIOLÓGICO

Procedencia : Fundación YANAPUMA
Dirrección :
Fecha de Toma: 12/06/09 Fecha de analisis: 14/06/09

| ANALISIS FISICOS | Norma INEN | Río | Escuela |
|---|---|---|---|
| Temperatura °C | | 21,3 | 21,3 |
| pH | 6,5 - 8,5 | 8,21 | 7,93 |
| Color (U.C) | 5 – 15 | | |
| Turbiedad (N.T.U) | 5 | 3 | 6 |
| Conductividad (Umhos/cm) | | 203 | 194,2 |
| **ANALISIS QUIMICOS** | **Mg/lt** | **Mg/lt** | **Mg/lt** |
| Cloro residual | 0,3 - 1,5 | 0 | 0 |
| Anhidrido Carbónico libre (CO2) | | 2,5 | 8,2 |
| Carbonatos (CO3) | | 0 | 0 |
| Bicarbonatos (HCO3) | | 2,44 | 419,68 |
| Cloruros (Cl-) | 50 - 250 | 50 | 80 |
| Hierro Total (Fe+++) | 0,3 | 0,14 | 0,25 |
| Manganeso (Mn++) | 0,1 | | |
| Alcalinidad total (CO3Ca) | | 200 | 344 |
| Dureza total (CO3Ca) | 120 - 300 | 94 | 66 |
| Dureza carbonatada (CO3Ca) | | 94 | 66 |
| Dureza no carbonatada (CO3Ca) | | 0 | 0 |
| Aluminio residual (Al+++) | 0,25 | 0,198 | 0,173 |
| Calcio (Ca+++) | 30 - 70 | 36 | 18,4 |
| Magnesio (Mg++) | 12 – 30 | 0,97 | 4,87 |
| Sulfato (SO4-) | 50 - 200 | 18 | 9 |
| Amoniaco (NH3) | 1 | 0,52 | 3,64 |
| Fosfatos (PO4-) | 0,1 | 0,14 | 0,46 |
| Nitratos (NO3-) | 10 | 0 | 4,4 |
| Nitritos (NO2-) | 0 | 0 | 0,264 |
| Sólidos Totales Disueltos | 500 - 1000 | 133,98 | 128,172 |
| **ANALISIS BACTERIOLOGICOS** | | | |
| Colonias Totales/ml a 35°C (48hrs) | 0 | 30 | 21 |
| Indice de Coliformes Totales (NMP/100ml) | 0 | >240 | >240 |
| Indice de Coliformes Fecales N:P/100 | 0 | Negativo | Negativo |
| Hongos | 0 | Positivo | Positivo |
| Aerógenos | 0 | Positivo | Positivo |

**OBSERVACIONES:**

E. A. P. A. SAN MATEO
Planta de Tratamiento

JEFE DE LABORATORIO
Fecha 16.06.09

Ing. Rocío Avila B.
**JEFE DE LABORATORIO**

## Appendix B: Household Survey 2011

Estero de Plátano
Water Quality Assessment

### A. Normal Practices

1) Who are you?
   a. Name:_____
   b. Age:_____
   c. Position in Home:_____
2) With respect to water, what responsibilities do you have?
   a. Bringing water to the home
   b. Washing Dishes
   c. Cooking
   d. Other:_____
3) Who else lives in your home? (Put name, address, and relationship to you)
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____
4) Where do you get your water?

| | River | Water system | Bottled Water | | Rain Water | Tank | Other Place (specify) |
|---|---|---|---|---|---|---|---|
| | | | Sold | Old System | | | |
| To drink | | | | | | | |
| To cook | | | | | | | |
| To wash (hands, dishes, etc) | | | | | | | |

   a. Compared to before the installation of the new water purification system, how frequently do you use clean water in your home?

| | More Frequently | Same | Less Frequently |
|---|---|---|---|
| To drink | | | |
| To cook | | | |
| To wash (hands, dishes, etc) | | | |

5) How do you prepare water to use?

| | Boil | Add chlorine | No | Other way |
|---|---|---|---|---|

| | | | preparation | (specify) |
|---|---|---|---|---|
| To drink | | | | |
| To cook | | | | |
| To wash (hands, dishes, etc) | | | | |

6) How do you store water in your home after preparing it?

| | Tank with a top | Tank without top | Closed container with spigot | Other Place |
|---|---|---|---|---|
| To drink | | | | |
| To cook | | | | |
| To wash (hands, dishes, etc) | | | | |

   a. When was the last time you washed the container?
      i. _____
   b. Did you
      i. Use a sponge? Yes/No
      ii. Scrub it? Yes/No
      iii. Dry it? Yes/No
   c. How do you get the water from the container?
      i. Spoon
      ii. Cup
      iii. Something else: _____
   d. When was the last time you washed the item you use to get water?
      i. _____
   e. Do you wash your hands before you get water?
      i. Yes
         1. With soap? Yes/No
      ii. No

7) How many times a month do you buy soap?
   a. Hand soap: _____ times/month
   b. Dish soap: _____ times/month
   c. Laundry soap: _____ times/month
   d. Bleach: _____times/month

8) Have you prepared food today?
   a. Yes
      i. Did you wash your hands before preparing it?
         1. Yes
            a. With soap? Yes/No
         2. No
   b. No

9) Have you eaten any food today?
   a. Yes
      i. Did you wash your hands before eating it?
         1. Yes

a. With soap? Yes/No
2. No

b. No

10) Where is your bathroom?
   a. _____
   b. Do you defecate there?
      i. Yes
      ii. No
         1. Where do you defecate?
            a. _____
   c. The last time you defecated, did you wash your hands?
      i. Yes
         1. With soap? Yes/No
      ii. No

11)Where do you bathe?
   a. River
   b. In the house (with running water)
   c. Outside of the house(with running water)
   d. Outside of the house (with water in tanks or buckets)

12)How frequently do you wash items in the river?
   a. Clothing: _____ times/week
   b. Dishes: ____times/week

**B. Access to Water**

13)Do you have access to running water?
   a. Yes, in my home
   b. Yes, immediately outside of my home
   c. Yes, _____ meters away from my home
   d. No

14) Where is the waste from your latrine disposed of?
   a. Hole
   b. Septic Tank
   c. River
   d. Burned
   e. Outside
   f. Other:_____

**C. Outcomes**

15) In the last month, how many cases of diarrhea have you had in your house? (Specify the member of your household)
   a. _____

16) In the last month, how many cases of diarrhea have you had in your house? (Specify the member of your household)

   a. _____

17) In the last 5 years, have you had a case of stomach cancer in your family?
   a. Yes
   b. No

## D. Knowledge and Attitudes about Water

For the following statements, choose how much you agree or disagree

| | Strongly Agree | Agree | Don't know | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| If I drink water from the river without boiling it, I could have health problems like diarrhea or gastritis | | | | | |
| If I drink water from the faucet or hose without boiling it, I could have health problems like diarrhea or gastritis | | | | | |
| I have sufficient access to running water | | | | | |
| I have enough money to buy water if I want to | | | | | |
| I have enough money to boil my water if I want to | | | | | |
| I have enough time to boil my water if I want to | | | | | |
| It is difficult to get clean water | | | | | |
| I worry about the water we use in my home | | | | | |
| It is important to wash my hands before eating | | | | | |
| It is important to wash my hands after defecating | | | | | |

Estero de Plátano
Investigacion de la Calidad del Agua

**A. Costumbres Normales**

1) Quien es?
   a. Nombre:_____
   b. Edad:_____
   c. Posición en la Casa:_____
2) Con respeto al agua, que responsibilidades tiene?
   a. Llevar agua a la casa
   b. Lavar platos
   c. Cocinar
   d. Otra:_____
3) Quien mas vive en su casa? (ponga nombre, relacion, y edad)
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____
4) Donde recoge su agua?

| | El río | Agua entubada | Botellas/Pomas | | Agua de lluvia | Tanquero | Otro lugar (especifique) |
|---|---|---|---|---|---|---|---|
| | | | Vendida | Sistema Nuevo | | | |
| Para tomar | | | | | | | |
| Para cocinar | | | | | | | |
| Para lavar (manos, platos, etc) | | | | | | | |

   b. Comparado con antes de la instalacion del sistema nueva del agua, con que frecuencia usa agua pura en su casa?

| | Mas Frecuente | Igual | Menos Frecuente |
|---|---|---|---|
| Para tomar | | | |
| Para cocinar | | | |
| Para lavar (manos, | | | |

| | | | |
|---|---|---|---|
| platos, etc) | | | |

5) Como prepara su agua para usar?

| | Se hierve | Pongo cloro | No preparo | Otra manera (especifique) |
|---|---|---|---|---|
| Para tomar | | | | |
| Para cocinar | | | | |
| Para lavar (manos, platos, etc) | | | | |

6) Como queda el agua en su casa después de la preparación?

| | Tanque sin cubierta | Tanque con cubierta | Algo con spigot | Otro lugar |
|---|---|---|---|---|
| Para tomar | | | | |
| Para cocinar | | | | |
| Para lavar (manos, platos, etc) | | | | |

   a. Cuando fue la ultima vez que limpió el recipiente?
      i. _____
   b. Usó …
      i. Un esponja? Sí/No
      ii. Lo restregó? Sí/No
      iii. Lo secó? Sí/No
   c. Como saca el agua desde el recipiente?
      i. Cucharón
      ii. Taza
      iii. Otra cosa_____
   d. Cuando fue la ultima vez que limpió lo que usa sacar el agua?
      i. _____
   e. Se lava sus manos antes de sacar el agua?
      i. Sí
         1. Con el jabón?
            a. Sí
            b. No
      ii. No

7) Cuantos veces al mes tiene que comprar jabón?
   a. De los manos: _____ veces/mes
   b. Para los platos: _____veces/mes

c. Para ropa: _____veces/mes
d. Cloro: _____veces/mes

8) Preparó algún comida hoy día?
   a. Sí
      i. Lavó sus manos antes de prepararla?
         1. Sí
            a. Con el jabón? Sí/No
         2. No
   b. No

9) Comió algún comida hoy día?
   a. Sí
      i. Lavó sus manos antes de comerla?
         1. Sí
            a. Con el jabón? Sí/No
         2. No
   b. No

10) Donde está su baño?
   a. _____
   b. Defeca allá?
      i. Sí
      ii. No
         1. Donde defeca usted?
            a. _____
   c. La ultivez que defecó, lavó sus manos?
      i. Sí
         1. Con el jabón? Sí/No
      ii. No

11)Donde se baña?
   e. El rio
   f. En la casa (con agua entubada)
   g. Afuera de la casa (con agua entubada)
   h. Afuera de la casa (con ague en los tanques)

12)Con que frecuencia lavar en el rio?
   c. Ropa: _____veces/semana
   d. Platos: ____veces/semana

**B. Acceso de Agua**

13)Tiene acceso de agua entubada?
   e. Si, en la casa
   f. Si, inmediamente afuera de la casa
   g. Si, _____ metros afuera de la casa
   h. No

14) Adonde van los desechos de la letrina?

g. Hueco
h. Tanco septico
i. Rio
j. Quemarlo
k. Afuera
l. Otro:_____

**C. Resultados**

15) En el ultimo mes, cuantos casos de diarrhea ha tenido en su casa? (Especifique quien)

b. _____

16) En el ultimo mes, cuantos casos de gastritis ha tenidoen su casa? (Especifique quien)

b. _____

17) En los ultimos 5 años, ha tenido un caso de cancer del estomago en su familia?

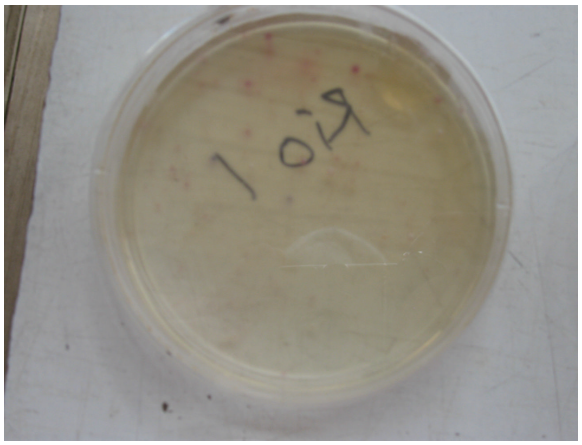
c. Sí
d. No

**D. Conocimiento y Actitud sobre Agua**

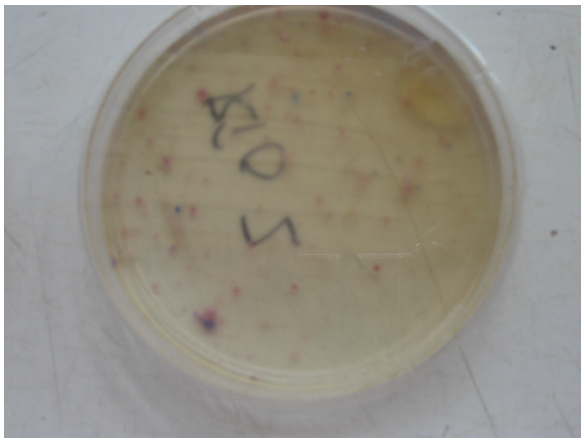
Por los declaros siguientes, diga si está de acuerdo o no de acuerdo.

| | Estoy de acuerdo en lo absoluto | Estoy de Acuerdo | No se | No estoy de acuerdo | No estoy de acuerdo en lo absoluto |
|---|---|---|---|---|---|
| Si tomo agua del rio sin hervirla, podria tener problemas de salud como diarhhea o gastritis | | | | | |
| Si tomo agua entubada sin hervirla, podria tener problemas de salud como diahhrea o gastritis | | | | | |
| Tengo aceso suficiente a la agua entubada | | | | | |
| Tengo plata suficiente para comprar agua pura si quiero. | | | | | |
| Tengo plata suficiente para hervir agua si quiero | | | | | |
| Tengo tiempo suficiente para hervir agua si quiero. | | | | | |
| Es dificil para obtener agua pura | | | | | |
| Tengo inquietudes del agua que usamos en mi casa. | | | | | |
| Es importante lavarme mis manos con jabón antes de comer | | | | | |
| Es importante lavarme mis manos con jabón después de defecar | | | | | |

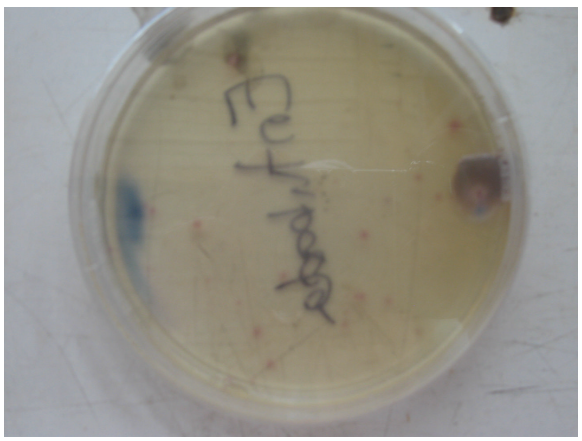
## Appendix C: Photos of Coliscan Cultures



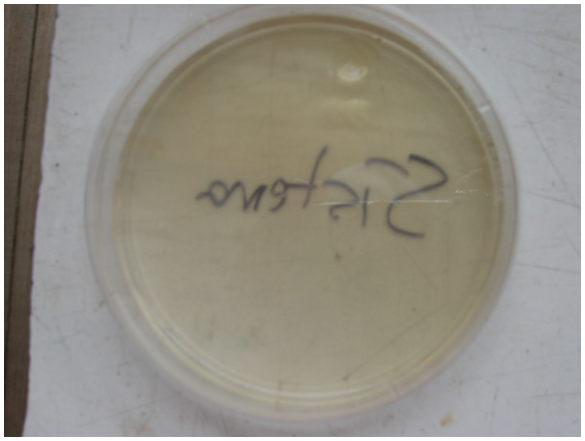
**Río Grande – 24 hours**



**Río Piedra -24 hours**



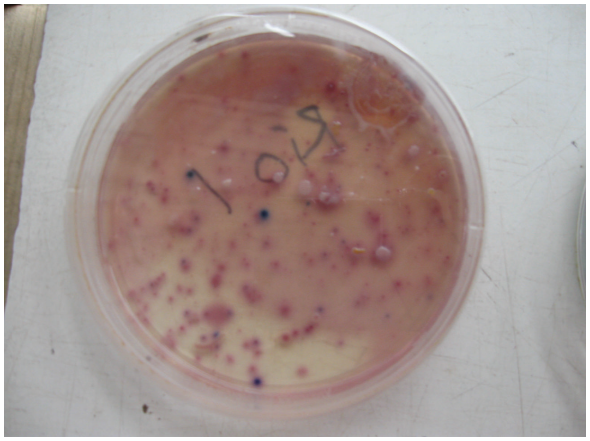
**Piped Water – 24 hours**



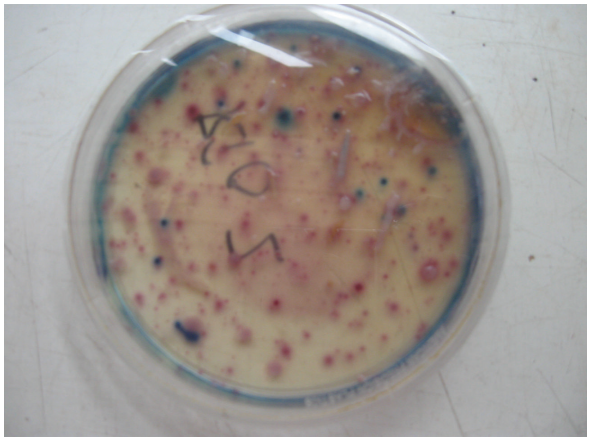
**New Water Purification System – 24 hours**

**Boiled Water – 24 hours**

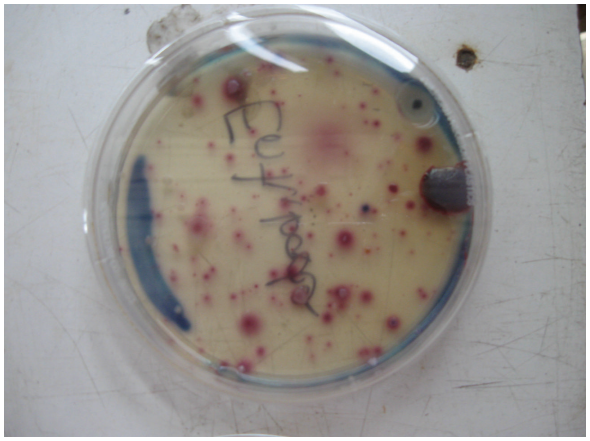
**Bottled Water – 24 hours**



**Río Grande – 48 hours**



**Río Piedra -48 hours**



**Piped Water – 48 hours**

**New Water Purification System – 48 hours**

**Boiled Water – 48 hours**

**Bottled Water – 48 hours**