

The May 2007 trip to Los Toros, Dominican Republic fulfilled all of the U.S. Los Toros Foundation's (LTF) water committee goals for this particular visit: surveying, testing, education, and planning for the future. This report contains a summary of new data gathered from the May 2007 trip and lays out a plan of action for future water-related work.

Surveying

On this visit the water committee was assisted by two students from the Marquette University chapter of Engineers Without Borders (EWB). With their help it was determined that the majority of Los Toros' population has access to running water in their homes or just outside of their homes from taps (*llaves*). There is a small group of homes near Los Toros' baseball diamond that do not have access to water near their homes. It was also determined that there are a number of homes that do not have valves to control the *llaves*; consequently water pools up near their homes. The danger of pooled water is the potential for mosquitoes and other disease vectors to breed and spread malaria or other diseases.

Another problem related to the absence of valves is a decrease in water pressure in the village's water system. Some parts of Los Toros have water constantly flowing out of their valve-less *llaves*, while others have virtually no water coming to their taps due to the lack of pressure. It seems likely that installing *llaves* where they are needed would help alleviate the water pressure problems.

Los Toros' water source and aqueduct were revisited. New information was discovered regarding the infrastructure of the aqueduct and the source of the aqueduct's water. While it was not confirmed, the village plumber indicated that the aqueduct's water comes from both a river and a natural spring. These two sources mix together. From there the water can either flows

directly into the aqueduct or is filtered through a large sand filter in the river bed. This sand filter must be “turned on” manually and is therefore, rarely used.

During the January 2007 trip, the aqueduct was understood to consist of a pipeline and two separate collection tanks along the aqueduct that only serviced Los Toros. This information is incorrect. The aqueduct serves four communities including Los Toros. The two tanks serve two communities each—the smaller of the two serves Los Toros, in addition to Las Guanabanas. The larger tank serves Tabara Arriba and another community. It was also discovered that there are not one, but two separate chlorination points for this aqueduct—one for each tank. These chlorination points are defunct. Breaks remain in the aqueduct and until fixed will prevent effective disinfection of the aqueduct’s water.

Additional GPS mapping points were collected on this trip. These points demarcate the “corners” of the village of Los Toros and points of interest along the aqueduct. These points will allow more detailed maps of Los Toros to be drafted for future community planning.

Perhaps the most important surveys conducted were the in-home water and health surveys. The responses to these EWB surveys will direct the water committee’s efforts. The finding of most concern from these surveys is the inconsistent use of proper water filtration techniques among the homes surveyed. Improper use ranged from using less than the recommended amount of chlorine to disinfect the water, to using vinegar to disinfect the water, to using both vinegar and chlorine in combination. Despite the educational program put on by Los Toros’ water committee after the arrival of 50 new individual home filters in March 2007, many of Los Toros’ residents are putting their health at risk because they are improperly purifying their water.

A preliminary investigation into the construction of latrines was also conducted. Different stages of the construction process and ways of digging and filling (or not filling) the latrines were documented. The focus of this particular trip was on improving drinking water, so little was done regarding latrines and sanitation. However, further investigations as to how latrine construction practices may be affecting drinking water will need to be conducted in the future.

Other miscellaneous water-related sites in Los Toros were surveyed on this visit. A well was located in the northeastern corner of the village. This well was reportedly drilled by the Dominican Republic's water utility, INAPA, but does not appear to be in use. The natural spring located during the January 2007 trip was revisited. Testing of the water from the spring revealed it is unsafe to drink. Ways to improve the water in this spring for possible human consumption have yet to be discussed. One solution might be to "trap" the spring in a concrete box in order to prevent the water from being contaminated by animals and runoff from a nearby field. Finally, an agricultural irrigation pipeline was discovered. It appears to originate from somewhere (unknown) to the southeast of Los Toros. The pipeline enters the village in the southeast as well. It leaks and is in disrepair, but there appears to be substantial water pressure (enough to force the water uphill). Perhaps this pipeline could be tied into the current water infrastructure in Los Toros in order to increase overall water pressure.

Testing

Testing of Los Toros' water for coliform bacteria was done and confirmed that the water in Los Toros is unsafe to drink. Tests all the way from water at the source of the aqueduct to water filtered by in-home string filters revealed that there are harmful bacteria present in Los Toros residents' water. Two methods of testing for coliforms were used: Millipore's Coli-count

method and Micrology Laboratories' Coli-scan EZ-gel method. Many testing sites had water tested with both methods. In nearly all cases the results for both methods (bacteria was present in the water) were the same. This suggests that both methods are reliable.

Samples were incubated in a small incubator (Big Apple Herpetological Inc's Hovabator: Thermal Airflow Model) purchased for this trip. The incubator was purchased with the intent of maintaining a constant temperature for the coliform colonies to grow in—something recommended by the manufacturers of our testing methods. This more or less constant incubation temperature helped to insure the validity of the results of our samples. However, because electricity in Los Toros is unreliable, the temperature of the incubator would quite frequently drop (possibly invalidating our results after all). The incubator will be used for similar water tests during future visits or for future testing programs designed to maintain the quality of Los Toros' water. It is currently being stored at Los Toros' clinic; personnel there have been instructed as to how it should be used should they decide to use it for medical tests.

A new water filtration protocol was developed at Marquette University after controlled laboratory tests revealed that the previously recommended protocol (old protocol) was not adequately disinfecting the water. The new protocol was tested only once in Los Toros, but produced results that replicated those found at Marquette (i.e. zero coliform colonies were found in the sample). This finding was further backed up when tests of water filtered in Los Toros using the old protocol revealed the water was not safe to drink. This demonstration indicated that the new protocol is superior to the old one and should be instituted across Los Toros immediately.

Education

During the visit, EWB and members of the Los Toros water committee and the water project director met with members of the Los Toros Foundation, the doctor and nurses of the Los Toros clinic, and officials from Plan International. The topic of these meetings was water purification education. During the visit, it was discovered that many residents of Los Toros were not using their in-home string filters correctly, despite a training session done by the Los Toros water committee in March 2007. Unfortunately, these families were trained on how to use the string filters using the old filtration protocol.

The old protocol directs filter users to fill the top bucket of their in-home string filter system with water and then add 25 drops (five drops per gallon of water in the bucket [capacity of the bucket=five gallons]) of chlorine to the water. The water then passes through the string and carbon filters. The water is then supposed to be safe to drink. Tests done in Marquette University's Water Quality Center found that this water was not free of bacteria and consequently unsafe to drink. It was hypothesized that the reason for this is that the water is not detained long enough in the top bucket for the chlorine to kill all bacteria present before the water passes through the filters. This discovery prompted development of a new filtration protocol.

The new protocol directs filter users to chlorinate (using five drops for every gallon of water) the water for one hour in a separate bucket prior to adding the water to the top bucket of the string filtration system. As long as the string filter has been disinfected before the first use, the water that passes through the filter using this new protocol comes out safe to drink. This new protocol was presented to village health officials, the Los Toros Foundation, and the water committee as the proper filtration method. The water committee continually emphasized that

this new protocol needs to be presented to filter users via classes, follow-up visits from Los Toros water committee members, and during routine check-ups by the doctor and nurses in the clinic. Until filters can be procured for all families an alternate water purification method is needed. A simple method might involve chlorinating water (five drops of chlorine per gallon) in a bucket for one hour and then pouring the water through a piece of clean cloth to remove any remaining particulate matter in the water. This method will not remove the taste of the chlorine, but the water will be safe for consumption.

Some possible methods of presenting this new protocol to the residents involve showing pictures of bacteria cultures of dirty and clean water samples, hiring a village artist to create a simple pamphlet of water purification directions for the literate and illiterate, and by having village health officials and the water committee explain that seemingly clean water may still contain disease-causing bacteria. This last point is most difficult to convey to those who have very little education and makes *continual* and *frequent* demonstrations of the new protocol all the more important. Village health officials, the water committee, the Los Toros Foundation, community leaders, church leaders, and youth groups could be charged with the task of educating residents about the benefits of properly purified water and the proper method (new protocol) for purifying water. Continual education throughout the village is the key to improving health in Los Toros and reducing gastrointestinal and skin diseases caused by unpurified water.

Other issues that need to be addressed by the water committee and others in Los Toros via education are: sanitation, latrines, and household water purification. Hand-washing and proper cleaning of fruits and vegetables with purified water will lead to fewer infections and gastrointestinal diseases in Los Toros. Teaching residents to put covers over their latrine holes will prevent flies and other insects from getting inside. If latrines are not covered, insects can

travel to residents' food preparation areas (after spending time in the latrines) and land in their food, potentially spreading disease-causing bacteria. Residents should also be instructed to chlorinate the water they use for bathing, dish washing, and household cleaning. Skin diseases can be caused by impure water used for bathing and anything that can be eaten off of should be cleaned with purified water to prevent transmission of disease.

Future Planning

In terms of future planning, the Los Toros water committee would like to begin investigating the effectiveness of various types of ceramic filters. The idea was first presented to us by Tom Clasen, a leader in developing-world water purification methods and lecturer at the University of London. In our meeting with Plan International, it was brought to our attention that these filters are made and available in the Dominican Republic. The cost of a filter and bucket with tap is about RD\$ 450 and replacement ceramic filter elements cost roughly RD\$ 250. These elements should be replaced every 18 months. While more expensive than the string filters (RD\$ 360), they would likely end up being slightly less expensive because there would be no additional costs for chlorine with the ceramic filter setup.

The main advantage of ceramic filters is that they are incredibly simple to use—no chlorine needs to be added to purify the water. Once the water passes through the ceramic filter element, it is safe to drink. Additionally, it is not necessary to detain the water prior to filtration so that the chlorine can disinfect the water, as is necessary with the string filters. If ceramic filters can be verified as effective, the water committee would recommend pursuing funding for ceramic filters and distributing them on a wide-scale basis to all those who are in need of a reliable means of water purification in Los Toros.

Ceramic filters will provide a solid mid-term solution to water purification in Los Toros, but it would be advantageous to have a long-term solution. A long-term solution to water purification will be considerably more difficult to achieve. It is nearly impossible to completely overhaul the entire water distribution infrastructure in Los Toros (so that a purification system might be added to the existing set of pipes) due to the sheer number of breaks in the system. A more feasible solution would involve laying a new set of pipes along the main roads of Los Toros and having “clean water stations” that people could easily access and that would be within reasonable walking distance of most homes. At the origin of this system, there would be some type of filtration plant with the capacity to provide purified water to all residents of Los Toros. This system would provide residents with convenient, free purified water. In order to insure the integrity of this system, a water commission or utility would need to be set up to maintain the pipes and prevent individuals from tapping into the water system without permission.

A long-term solution such as “clean water stations,” and even ceramic filters in the interim are a long way off for Los Toros. In order for residents to remain as healthy as possible, there must be a short-term water purification solution. The best short-term solution for Los Toros’ water problems is for the water committee, doctor, nurses, and community leaders to educate the people of Los Toros on a *continual* and *frequent* basis about the importance of following strict water purification procedures. Following simple steps such as those mentioned in the previous section can lead to drastic improvements in residents’ health.

Finally, the issues of deficient water pressure, latrines, and waste disposal must be addressed in future visits. Possible solutions to deficient water pressure could consist of a water tower or series of water towers that would add additional pressure, installing working *llaves* in all homes to prevent loss of pressure, and adding a solar-powered pump to the water distribution

system. Proper latrine construction needs to be investigated and an effective way of measuring the effects of human waste on subterranean water tables needs to be found. The committee suspects it is possible that improperly constructed latrines may leach fecal waste into natural springs and contaminate these water sources. This suspicion needs verification before any future recommendations about latrine construction can be made.