Evaluation of the Lagunitas Project

Engineers without Borders-Lafayette College
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The Lafayette College Engineers without Borders program has been working hand in hand with community members of Lagunitas, Honduras to plan, develop, manufacture, install, and integrate a clean, safe drinking water system. This system will largely benefit the 270-person village by providing safe drinking water for all along with freeing up crucial time to be productive in other areas associated with survival. The key for this project is sustainability; improving today without compromising tomorrow.

The Lagunitas project physically began with a site assessment performed in May of 2004. Based on data collected during this time, technical designs began the following fall ensued by another trip to Lagunitas in January 2005 to collect more data due to insufficiencies of the first trip. The final design was completed in late May 2005 and professionally reviewed by an advisor and the Technical Advisory Committee (TAC). In August 2005, the first trip to begin implementation of the design was made, but encountered difficulties based on discontent of the community with the distribution design. A revised plan was then made, followed by the construction completed by community members led by a hired foreman in January 2006.

Another component of the project implemented through trips made in August 2005 and January 2006 focused on educating the community about their new water system, health and sanitation issues, water conservation, and watershed protection. This task was performed through workshops and manuals given to various groups within Lagunitas. The contribution of these educational programs to the overall plan was incredibly significant and in some ways just as important, if not more, than the physical implementation of the water system.
Sustainability

Sustainability according to K.J Zieba (1996) in general refers to “development that meets the needs of the present without compromising the ability of further generations to meet their own needs”. It is a concept that integrates considerations for society, economics, and the environment in all instances. The United States Environmental Protection Agency (USEPA) has launched a unique grant program based on these three aspects called P3—People, Prosperity, and the Planet. The purpose of this program is to encourage future generations of scientists and engineers to advance the principles of sustainability by giving undergraduate and graduate students the opportunity to design and implement systems that will foster the ideas of sustainability in various parts of the world.

Task

The goal of our group was to evaluate and critique the numerous aspects associated with the finalized Lagunitas water project in order to improve for future endeavors in the region, mainly the La Fortuna water project. An evaluation of the sustainability through the EPA’s P3 criteria was also performed in order to develop an unbeatable design for the La Fortuna water system for the P3 grant program in May 2006.

Site Assessment Critiques

Collecting data is perhaps the most important and extensive process in the development of any water system similar to that implemented in Lagunitas. While there is extensive physical information that must be attained including quality and quantity of the water source, topography and conditions of the land, and the locations of houses, there is also social information that is imperative to the overall design. The social information collected through surveys and
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communications with various community members and leaders includes information on families, living conditions and practices, health information, community organization and political structure, and land ownership. Identifying the community’s interests, desires, and, most importantly, needs through these communications is the foundation for the entire technical solution.

**Determine the proper procedure and practice before going to Honduras.**

On the first site assessment trip in May 2004, the team conducted a land survey, and rather than using a standard surveying procedure, they created their own. The student surveyors utilized a Theodolite, which is a device that provides an accurate means to acquire x, y, z coordinates of a particular point. (However, this method can result in large errors; therefore, the level difference should have been utilized.) Instead of setting up over a point, shooting several others and then back sighting to the original point, they shot two points, went to a third (different from the original) and back sighted both. On return to Lafayette, they found that the new procedure made the calculations almost impossible. Part of the problem was that the surveyors were relatively inexperienced. Therefore, it is critical to practice the proper procedure beforehand, so that everyone knows what is going on.

**Gather GPS points while surveying.**

GPS points aren’t incredibly accurate, depending on the number of satellites you can get access to, and the quality of the GPS, accuracy can be several meters off the correct location. However, the GPS data is a good way to double-check the survey points while they are being taken, so that simple errors (reading or recording the wrong digits) can be immediately exposed. Also, this method is a good way to quickly obtain a spatial picture of the entire area being assessed.
**Calculate angles and distances in the field.**

While surveying linearly, every point depends on every previous point, so an error anywhere will corrupt every other point from then on. One way to reduce the chance of errors in the field is to do the calculations while surveying (checking and rechecking the data every day in the field), which would make any substantial error immediately apparent. It would also alert the surveyors to procedures that make these calculations exceedingly difficult.

**Allot enough time to do the housing/health survey.**

There were two health evaluation surveys done for Lagunitas, one during the May 2004 assessment trip, another during the January 2005 assessment trip. Both these surveys left something to be desired. On the first trip, the team only spent one day to collect health information, and they were understandably rushed. The first few houses they spent a long time talking to the inhabitants, and were able to get some good, useable information. As the day went on, they rushed through the process, such that they gathered very little information at the last few houses, just the number of people living there. This was largely due to the lack of a map that contained the location of the houses in Lagunitas, which made it hard to determine which house corresponded to which interview/survey.

**Ask open-ended questions.**

On the second trip, they sent a local kid from Lagunitas around to every house to fill out a health questionnaire. This survey was also rushed, but they got more useable information from the different sources. One of the things the team found, though, was that the answers they received from the questions depended on how the questions were asked. One of the questions asked was “Has anyone in the house gotten sick from drinking the water?” Every household said no, but they may not associate diseases like diarrhea and stomach aches with dirty water. If they
had asked open ended questions such as “What are the most common illnesses in your family?” they would have probably received much more useful information.

Also learned in Lagunitas, were that when asking questions to compile statistics, it is important to ask questions that can be quantifiable. This can be done by asking people to quantify their sickness and health with a scale of 1-5 or something similar. For example, when asked how much water they retrieve daily, answered contained units of buckets and pails. However, difficulty arises because one does not know the difference in size; therefore one does not know how much water was obtained.

Another lesson is that it is good to have a native speaker asking the questions. It puts the people surveyed more at ease with the questions asked. Even though the questions should be asked by a Spanish speaker, an individual who speaks English should tag along to record other findings at the home.

Furthermore, the community survey serves as an opportunity to let everyone know about the planned project and perhaps gain additional interest and participation from village members.

One of the most important aspects of the Lagunitas project was the cooperation between the Lafayette team and the community, and more importantly, the education of the community members. Throughout the two trips there were a total of six workshops that discussed various topics.

The first trip in August, 2005 consisted of two workshops which focused mainly on watershed management. The first workshop was for the Water Board and concentrated on keeping records, balance sheets, etc. The team consistently used the phrase “Maybe you should do this,” instead of strictly telling them what to do. This was very effective because it created a cooperative environment. The Water Board was also given ‘homework’ to complete in between the two trips. Such work included finding a plumber and deciding on fees for the system.
Appendix A. Lessons Learned from Lagunitas  

The second workshop was for the adults, and also focused on watershed management, although erosion was also discussed. For example, they were taught how to cover up the pipes and how to clean out the valves.

The second trip (January 2006) to Lagunitas included four workshops, the first, again, being with the Water Board. Here, manuals (written in Spanish) were handed out and discussed, which included instructions on maintaining the system and its surroundings. Clear pictures made it easy for members to better understand the manual.

The adults’ workshop in January 2006 was much more detailed than the one in August 2005 and here manuals were also handed out. These manuals were requested by the community, which shows a great interest in the system. Previous workshop plans included a lot of writing, which created problems since there is not a high literacy rate in Lagunitas. At this workshop, many pictures were incorporated, relating to maintenance of the system and also about general water management. The adults seemed to learn a great deal from this workshop because at the end of the session, when asked questions, they responded with the correct answers.

One negative aspect of this workshop is that for some reason (maybe a cultural difference) the men waited outside while the women went inside and learned. Although there was at least one member of each family represented at the workshop, this may pose a future problem (unless the women are fully capable of fixing the necessary problems). Another problem with this workshop was that money issues were not discussed. In the future, there should be time spent on discussing why it is important that the community members pay for the system, plumber, etc.

The final two workshops were for the children and included an age group of 4-8, and another for ages 9-15. These sessions focused on water management only and included activities
such as mazes, pictures, and coloring. The children were extremely excited to attend the workshops, and the team felt that they learned a lot. The team also left instructions for the children’s teacher to further educate them on water management. One negative aspect of the children’s workshops was that there was a group of young adults (ages 16-18) that were not included. In the future, a workshop of some sort is needed for this age group.

Although the most recent trip was in January 2006, and there is no information about effectiveness, the general responses from the workshops are the members have learned and understand about the system and about water management. This is very important because in order for the Lagunitas system, or any system in general, to be sustainable, education and community cooperation is essential. Aside from a few changes that could be made, the Lafayette team was successful in the workshops they provided for the community.

Were the Water Rights of the spring and watershed attained appropriately and successfully? Lack of knowledge about the government’s ability to intervene in water distribution projects to secure land around the spring led to a fairly ambiguous contract with the local land owner entangling EWB to several “commitments”.

Because this project involved taking water from a spring and distributing it through a physical system involving several construction projects on various separately-owned properties, attaining rights to the land containing and surrounding the spring as well as attaining permission to lay pipes through other properties is essential to the sustainability of the project. In the Lagunitas Water Project, permission for pipe construction through community members’ properties seemed satisfactory.

However, there were more complications related to the issue of Water Rights of the spring and surrounding land. The land on which the spring is contained is owned by a man named Oscar Amaya who does not live in Lagunitas, but in a community called “Corral Falso”, located about 4km from the spring and approximately 8-13km from Lagunitas. A contract was
signed with Mr. Amaya granting Lagunitas rights to the water source for an unspecified period of time as well as permission to fence and reforest the surrounding land and construct piping through his property. However, Mr. Amaya requested help in building a similar system as an exchange to the rights which EWB agreed to. This system would benefit his family and four others. He requested $400 for construction materials and PVC pipes. There was also an incident at the beginning stages of construction of Lagunitas, when members of the Corral Falso community used machetes to cut the pipes at the spring box and also the vegetation causing erosion.

It was later found through the Water Board Association that there exists a Honduran Forestry Law which protects the land in a 250m radius around the spring from grazing and tree cutting and which later makes this designated land federally owned. If there had been further research into governmental abilities to become involved in these water projects, this law could have been implemented during the initial project planning to avoid creating the contract with Mr. Amaya which tied EWB into providing funding and materials for his project. Even if this law did not exist, there could have been improvements on the lucidity of the contract with Mr. Amaya. The “help” that Mr. Amaya requested should have been clarified by placing numerical values on the limits on what would be given to him.

In reference to sustainability, actions taken regarding water rights did not close with a sustainable outcome. Rights to the spring were made under indeterminate conditions, meaning the land owner could retract these rights in the future, or make further demands for money, materials, or labor. Even though these conditions exist now, it still is possible to obtain government aid on this concern to permanently secure the land around the spring. This would
also federally protect the land deterring members from other communities from performing destructive actions against Lagunitas, easing social tensions.

**Design Critiques**

The EWB students at Lafayette College originally developed a water system that consisted of two separate water lines. One is on existing system that was already connected to several houses in the area. The other was a new line that would include the houses further away. Unfortunately, this design did not meet the demands of the Lagunitas village. Each member of the community wanted water to be delivered to their home through the “new” centralized system; therefore, the design was altered to meet the wants of the village. From here, the EWB students went back to the drawing board to develop a design that connected the existing spring with the new spring. However, this plan was not followed during the actual construction of the water system. The community members decided to dig a distribution line that connected all homes in Lagunitas to the “new” spring. As a whole, the community did not want to utilize the existing water system, even though it was operational.

**Engineers Without Borders-Lafayette College should have pressure tested the existing PVC piping in order to show the community that the existing water system was still “good” and properly functioning.**

Not only did the members of the Lagunitas village lack confidence in the existing water system, but each member of the community wanted to be able to utilize the “new” water system, since everyone was contributing equally to the project. Because the village inhabitants were under the impression that “old” equals “bad,” they were strongly opposed to the original design plan to have two separate water systems. However, if the pipes were pressure tested and proven to be intact and operational, then the original design of two separate water systems could have been implemented with the full support of the community. As of now, the student group does
not know how to perform this task in the Lagunitas environment; therefore, pressure testing must be researched. Also, it was necessary to better explain that utilizing the existing system in conjunction with the second water line would keep costs at a minimum and allow more to be done for Lagunitas with the remaining budget. Wash basins, yard taps, and rainwater catchments would have been constructed at each house in the community. By not pushing the benefits of the original plan, the Lagunitas community members were not convinced this was the best option.

**The student group must better explain the monetary limitations associated with the project to the village members.**

A major problem that occurred in this project is the fact that EWB-Lafayette College wired the entire materials budget to the community of Lagunitas to purchase a recommended list of supplies. This was done to have the materials on site in order to promptly begin construction of the water system once the students arrived in Honduras. However, the community decided to purchase extra PVC piping with the excess money to replace the piping from the existing water system. This was not originally taken into account in the materials budget. From utilizing the rest of the budget on piping, instead of its intended purpose, the community did not have sufficient funds to build a pila, or wash basin, for each member of the community as planned. Overall, it was necessary to better explain to the villagers that this is the amount of money that was accumulated for this project and more will not be provided or separate amounts of funds can be sent for separate projects that were being completed (in other words only send the money for what was needed immediately to move forward with the project). If the community members understood that there is a very limited budget, then the villagers would be more conservative in their spending in order to stretch the funds as far as possible.

Also, this is directly correlated with the previous section. If the pipes were pressure tested, it would have proven to the community members that the PVC pipes were capable of
being re-used in the final design. Therefore, the villagers may not have felt obligated to purchase new piping to replace the older piping, which they viewed as “bad”.

**Communication, in several instances, proved to be a major hindrance in the design of the Lagunitas water project.**

Communication is vital to synchronize the design and implementation phase. EWB drew out the final design and sent it to the community, together with the money, and instructions of what to build. The community did not follow the instructions exactly, as explained above. EWB should specify more firmly what the money is for and communicate more frequently with the community to make sure that they know what they are building before actual construction began. To remedy this, a final design and construction meeting should be held with EWB, the community, and the foreman in attendance. Also, EWB, the community, and the foreman should stake the path line together. Overall, changes need to be made in terms of communication, since it is currently like playing the childhood game “telephone.” Information is passed from EWB members, who speak English, to a middleman (Porfirio) that speaks both English and Spanish to the villagers, who only speak Spanish. As you can see, information and plans may be slightly altered just in terms of translation, let alone the fact that Porfirio is not an engineer who easily understands the concepts being described and translated to him.

**The addition of the hypo chlorinator to the water system will clean the water of microorganisms; however the economic feasibility in the long-run has not yet been fully determined.**

There has not been enough research done on the effect of the community consuming non-chlorinated spring water. The addition of chlorine to the drinking water will not only change the taste, but it may not improve the quality of water from the community’s point of view, since they may have developed resistance to the microorganisms in the spring. However, once a spring box and a tank are built, microbial growth can occur, which may pose a problem. The chlorinator
prevents this from occurring. Furthermore, the cost of chlorine is substantial in the long run, which is estimated to be $130 a year. If the community as a whole has a bad year economically, are they capable of meeting the monetary demand to pay for the chlorine? Based upon visits to other communities, the water system tends to be something that is not maintained. The project will be more sustainable economically and environmentally if EWB can prove that the hypo-chlorinator can be excluded without significantly affecting the water quality.

**Construction Critiques**

The construction process was split into two phases. Phase one brought the water from the spring to the newly constructed storage tank. Phase two handled the distribution within the village (see attached as built drawings). The actual construction of the Lagunitas water system was overseen by a local foreman who had experience building similar systems in the region. Due to the foreman’s experience in local building practices, he was able to make field changes that we really don’t have the knowledge or experience to critique. The major instance of this is the heating and flexing of the PVC to make angles other than the prefabricated 90 degree elbows. Because of this, a lab experiment must be performed to evaluate the quality of the PVC after the heating and flexing.

**The actual construction of the distribution system does not leave room for easy expansion.**

The last houses on each distribution line are connected with elbow joints, not tee connections. This means that future construction in the region cannot be attached to the existing system. Also, there is no cleanout valve at the end of the distribution line. Without the ability to easily support the community’s expansion, the system will not be sustainable.
The actual construction does not include any of the pre-existing pipes.

This is a two fold problem. First, the lower spring is not connected to the distribution system. This means that the tank must be placed at a higher elevation to support the pressure needs to make the system work efficiently. The higher pressure causes more stress on the system, making it less durable. However, with knowledge of what the pressure needs will be, the proper PVC pipe can be utilized to withstand the expected pressures. The second problem is that the demand for the entire village is dependant on the one spring, with a lower than desired flow rate. Connecting to the lower spring would provide a more reliable water supply for the village and allow for expansion.

The pipeline is not adequately supported at steep inclines.

The higher pressure mentioned earlier puts more stress on the system, especially at places of steep incline and sharp bends. At the bottom of these inclines, the pipe should have a thrust block in place to keep the system from shifting; these were not installed. In the one area where there is a support, it is composed of wood; it should be a more permanent material, preferably concrete. The pipeline also needs to have an air valve at the top of each incline, and a cleanout at the bottom; there are a few places where these haven’t yet been permanently constructed. The temporary valves are adequate for a project in progress and sighting the locations, but should be replaced with proper valves as soon as possible.

There is no bedding underneath the laid pipe.

The pipe is laid directly on the bottom of the trenches that were dug; there is no sand bed underneath it. This is another issue for the sustainability of the system. Sand bedding provides a uniform support for the load; therefore without the bed, the system is less durable in the long term.
There are several areas where the pipe is exposed.

There are several stretches of the pipeline where the PVC is uncovered. PVC pipe gradually breaks down if it is exposed to sunlight. Some of the uncovered areas are simply places where the construction was not completed before the site visit. There are a few areas though where the pipe segments cannot be buried, either because they span a stream, ravine, or are over rocky ground. These segments ought to be replaced with steel pipe or painted as quickly as possible. This will be more expensive up front, but it will increase the lifetime of the system and reduce the necessary maintenance. The segments that cross ravines could also be covered by plywood boxes, this is a less expensive alternative to steel pipe, but it increases the maintenance costs.

One area of the conduction line is lightly covered by soft earth.

On the conduction line from the spring, there is one area on a hillside that may be a serious maintenance issue. With no base underneath the pipe to absorb pressure and only light earth covering it, the pipe could easily be damaged by pressure from above. It seems like there is significant traffic in this area by livestock. Potentially, this poses a serious problem of the pipe being either damaged or uncovered.

Two houses are not connected to the system.

The two poorest houses in the village have yet to be connected to the distribution lines. It had been suggested that the families were considering moving closer to the rest of the village. This would make the connection to the distribution lines easier, since no long trunk lines would be necessary. However, no action has been taken to remedy this situation.
The yard taps are not adequately supported.

The yard taps were designed to have a concrete base at the elbow to bring them above ground. These bases were replaced with logs in the field. The logs are adequate for a temporary support, but a permanent base will be needed. The pipes that extend above ground are built on spec, but they still need some support above ground.

The lack of pilas makes the area near the tap potentially unsanitary.

We anticipate extensive use of the yard taps, not only for drinking but for cleaning and washing too. The lack of the pilas that were designed means that there is no system in place to deal with the wastewater from the cleaning and washing. This raises a potential sanitation issue that needs to be addressed.

Issues in progress.

Because the site visit took place while construction was still in progress, there are things that have not been completed yet that need to be watched. Most of these issues are located around the storage tank. The chlorinator still needs to be installed, and a bypass line still needs to be added. If these pipes are going to be PVC, they are going to need covering. This applies to the exposed pipe that wasn’t addressed earlier. All of the valves that are in place also need covering, including the check valves at each yard tap. It is also a good idea to have a stockpile of spare materials handy for maintenance purposes. This may not prove to be economically feasible, but some sort of covered storage area needs to be designed and built. Furthermore, an “as built” plot of the water distribution system needs to be completed. This can be accomplished by placing permanent stakes along the path line of the water system or GPS points can be obtained at spots along the path line of the water system then translated onto a map, creating a finalized construction map the implemented system.
**People, Prosperity, Planet (P3)**

In order to assess the overall sustainability of the Lagunitas water project, the following questions, developed by the EPA, must be answered: Does the proposed work integrate and sustain environmental protection, economic prosperity, and social benefits across scales in the developing world? Evaluation of Lagunitas through answering these questions allows for continual review and improvement.

**People**

**Provide environmental and economic outcomes that benefit society?**

Easy access to safe drinking water significantly reduces the amount of time spent for collecting drinking water. This extra time can be spent in other enterprises greater than subsistence farming. We do not yet know the long term economic effects of this project, but in the short term, the finances were acquired from donations and fundraising events.

**Meet the needs of the intended end user and is affordable?**

The community is in need of safe drinking water and the project brings drinking water to each home. The operating and maintenance fees are reasonable at 14-18 lempiras per person in the community, which will cover the costs of chlorine and replacement parts. However, outside factors can create economic stress that may make the chlorination of the water an unnecessary luxury.

**Meet basic needs such as food, water, shelter, energy, health care, education, and/or transportation?**

Workshops and manuals were very effective in educating the people on water management and maintenance of the system. Again, the distribution system allows more time to
be spent for productive activities like farming, therefore providing more food. It conserves
energy of the people when they don’t need to run to and fro collecting water.

**Uses energy and material resources effectively and efficiently through the life-cycle while reducing hazards to human health and the environment?**

The community did not use the materials budget efficiently. Instead of using pre-existing piping from the original system, the community members purchased new PVC piping to replace the already installed pipes. This was not originally incorporated in the budget plan. Therefore the community members ran out of money before being able to complete the entire scope of the project, i.e. better design yard taps. There are also several areas of the pipelines where steel piping should have been used instead of PVC to prevent early degradation of the system.

**Prosperity**

**Considers both short-term and long-term needs?**

The project provides water to the people in the short-term, and it considers various factors like economy of population and wear and tear of the system so that it can still function in the long run. However, the implemented water system is suited for the existing village and does not account for future expansion of the community.

**Promotes prosperity across scales and directly benefits the local, regional, national, and/or world economy?**

This project was completed through the help of multiple regional and international organizations. However, the benefits are going to be strictly localized in the village of Lagunitas.
Appendix A. Lessons Learned from Lagunitas

**Planet**

**Reduces impacts on the environment and human health, diminish resource consumption, and/or directly benefit the environment?**

Although this project improves human health through easy access to clean, drinking water and educational workshops on health, sanitation and watershed protection, the absence of a grey water treatment system negatively impacts the environment and human health through contamination, which may increase illnesses and threaten agriculture in the region.

**Does not exhaust or degrade the local environment or shift the environmental impacts to another locality?**

At this time it is not known what the effects of diverting the water of the spring source are to the immediate area in terms of vegetation, aquatic life, and local fauna. Again, the increase in water usage and resulting increase in grey water discharge will have a negative effect on the local environment.

**Is less damaging or more beneficial to the health of natural systems than a traditional design?**

It will be more damaging than the pre-existing system due to the expansion of the distribution system. The same types of problems will be present but on a larger scale (i.e. grey water).

**Conclusions**

The chapter and team of engineers have grown along with the project, and there have been several lessons learned. One of the strong points of this project in terms of innovation and technical merit has been how well the team adapted to variable design conditions. Initially the project proposal included the construction of an irrigation and municipal water system for four different communities, La Fortuna, Mataderos, Lagunitas, and La Habana, but the goals and
project focus have evolved with time. Between the time Lafayette was assigned the project and
the initial site assessment, the team began to research and do some preliminary design work
based on the initial project proposal. That first year (2003-2004), the team focused their effort
on the villages of Lagunitas and Mataderos. However, during the first site visit, they found that
Mataderos was not what it appeared and that there was no project there. So right from the
beginning, their whole project conception was completely changed.

A better example of the cultural adaptability was the change in system design to suit the
desires of the people served. The initial design that the team went down to implement in summer
2005 cultivated a new spring approximately a kilometer away, as well as utilizing an older
system based off a closer spring. The spring currently in use was of roughly the same water
quality but too low to utilize gravity to serve all the houses, as the village of Lagunitas is located
on hilly terrain. They designed a system extending the service of the older source to the lower
households, and a new distribution system from the tank to serve the upper households.
However when they traveled to Lagunitas in summer 2005, they found this was a politically
unacceptable solution.

Construction of the spring box, center tank, and pipeline were already underway when
the engineers visited (plans were sent down ahead of time and a foreman was hired). The
villagers each contributed a certain amount of hours digging ditches and helping with
construction, and because they had all put the work in, they all wanted to be on the new system.
The Lafayette team explained to the villagers that the springs were of the same quality and that
having everyone on the one system would mean that the upper houses would have shortages
periodically, but the community decided in the interest of fairness that everyone should be on the
new system because they all put in the work, and since some water to the upper houses would be better than the no water currently.

They designed the tank out for ferrous cement – an inexpensive combination of cement and mesh wiring which they thought was a good fit and a local solution. However, on the January 2005 trip, they learned that most local tanks were made out of bricks and covered with cement, instead of being entirely cement.

Other lessons learned were more practical, such as ensuring trip participants know how to operate equipment before traveling to the site. On the initial site visit in summer 2004, eight students and faculty advisor Dr. David Brandes went to Honduras for the first time, and along with meeting the communities, testing water flow and quality, and conducting the baseline health survey, they took an initial survey of the land. The people conducting the land survey were relatively inexperienced surveyors, and the resulting data was less than desirable. This led to the need for a second site assessment and a complete resurveying of the land.

The second site assessment, however, gave the team to gather other necessary information, such as soil characteristics, local material cost and availability, and conduct a more thorough baseline health assessment of the community. Not only will some of the cost and material information be useable for the La Fortuna project, but also the experience of both trips will give the team a better idea of what information to gather on future assessment trips.