CONTINUED IMPLEMENTATION – PRE-TRIP PLAN

Executive Summary	
Community:	Ait Bayoud, Bizdad
Country:	Morocco
Chapter:	Columbia University
Submittal Date:	5/18/18
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Scope of Work for the project (50 words) [1]	Design and implement a water distribution system, including well, filtration system, storage tanks, distribution locations, and all the piping in between, to two communities, Izgouaren and Ilguiloda. Utility power will be extended to the well site power the pump. Concrete storage tanks will be installed at the chateau site and piping will bring water from the well to the chateau and from the chateau to two distribution sites, one in Izgouaren and one in Ilguiloda.
Scope of Work for the trip (100 words) [2]	On this implementation trip, key well tests and water quality tests will be conducted; the temporary distribution site will be refurbished; and the nearest utility power line will be extended to the well, so that well pump can be operated without use of a 3 phase generator. This will allow for water to be pumped to the temporary distribution site via the local pump control panel at the well site..
Proposed Next Step (100 words) [3]	After this trip, the Columbia chapter will construct the rest of the pipeline using less expensive but higher quality HDPE piping from the well to the chateau site and construct the concrete storage tanks at the chateau site, so that water distribution can move from the temporary distribution site to the closer chateau site. The potential for selling the existing low quality, galvanized steel piping will be explored.
Describe Recent Contact with Community, NGO, and in country partners. (100 words) [4]	Primary contact is through the Peace Corp volunteers (PCVs) Keanna Cohen and Chris Bull who meet with community members about once a month. We are also in contact through WhatsApp and email with local contractors and engineers who provide important information on local resources and technologies. We meet with the Water Association for Izgouaren and Ilguiloda within the Ait Bayoud Development Association (ABDA) every trip. The date of last contact with the community was on 03/20/18, when the PCVs and local engineer Lahsan met with the Water Association and

	surveyed the project location to get a second contractor estimate for completing the project.
Describe the Chapters current fundraising goals and milestones. (100 words) [5]	The program is fully funded for this trip through EWB USA's project grant, corporate sponsorships, past fundraisers, and Columbia University's Dean's Travel Fund. The chapter will be applying again to internal grants and seeking more corporate sponsorships for the Winter trip in order to complete the pipeline from the well to the chateau site.
☒ [6]	**IS THE PROGRAM STILL ON TRACK TO MEET THE EWB PROJECT EXPECTATIONS?**

Privacy: EWB-USA may release this report in its entirety to other EWB-USA chapters or interested parties. Once the report is approved any member in Volunteer Village will be able to find and view the plan. Please do not include personal or sensitive information.

Project Timeline [1]			
Major Milestone	**Previous Date [3]**	**Current Date [3]**	**Description**
Program Adoption Date	01/06/14		
Previous Project in Program Date Constructed [2]	06/26/13		Foot Bridge in Ait Bayoud
Completed Assessment Trip	1/19/14		Survey of project locations
Completed Assessment Trip	8/23/14		Survey of project locations, bridge maintenance
Completed Assessment Trip	1/18/15		Drilled well, map piping routes.
Completed Implementation Trip	9/5/15		Began laying pipes and constructed chateau foundation
Completed Implementation Trip	1/16/16		Continued laying pipes, searched for leaks
Completed Implementation Trip	8/5/16		Laid pipe, installed well pump, televised inside of well, first time pumping water
Completed Implementation Trip	1/14/17		Piping pressure testing, bridge maintenance
Completed Implementation Trip	8/22/17		Bridge maintenance, installed temporary distribution site
Planned Implementation Trip	Not Previously Planned	7/15/18	Water testing, power line extension, bridge maintenance
Planned 2nd Implementation Trip	Not Previously Planned	12/30/18	Finish pipeline from well site to chateau site and move temporary distribution tanks to chateau site
Planned 3rd Implementation Trip	Not Previously Planned	7/14/19	Construct concrete storage tanks at chateau site
Planned M&E Tip	Not Previously Planned	12/29/19	Monitor and evaluate usage of chateau site and condition of water distribution system

Table of Contents

1. Project Description

1.1. Project Background and History

Morocco Program of CU-EWB was founded in December 2010 when Columbia alumna and Peace Corps Volunteer Nina Morency-Brassard reached out to CU-EWB with a potential project in Ait Bayoud, Morocco. In addition to the Peace Corps Volunteers, we are also partnered with the Ait Bayoud Development Association, headed by the Rais (locally elected political leader). This association has helped us to get community members involved in the project. Local men assist by providing labor for the installation of the water system. By helping us setup the system, these community members are simultaneously acquiring a sense of ownership of the system as well as deeper technical knowledge for maintenance. With this knowledge, the villagers of Ait Bayoud will be able to independently service the water distribution system in the future.

Each summer and winter since we began this project officially in 2014, several students from our organization have traveled, with at least one professional engineering mentor, to Morocco to work on installing the distribution system and to continue building a relationship with the community. The system that we designed is composed of a well, a chateau (water storage tank) with a filtration and purification system, and piping to connect the well to the chateau to spigots located at the centers of Ilguiloda and Izguoaren. Our program installed the well in January of 2015 and we are currently working to complete the pipeline. In August of 2017, our program constructed a temporary water distribution site.

1.2. Project Context

Izgouaren and Ilguiloda are the most impoverished dwars, (villages) in the region of Ait Bayoud. The villages are located on a high plateau without any surface water features or shallow groundwater. Therefore, they must walk to the nearest potable spring, a trip that typically takes three hours and involves a steep 300ft descent from the plateau that the communities are located on. During the dry season this journey must be made several times a day in order to secure enough water to meet their needs. In August of 2017, we installed a temporary water distribution site fed by the well that was installed in 2015. The temporary water distribution site consists of one 1500L settling tank and one 1000L storage tank. Due to lack of utility power, the system has not yet been utilized because an expensive, complex 3 phase, 380 V generator would be required.

1.3. Project Goals and Objective

The main project goal of Columbia University EWB Morocco is to provide clean water to the communities of Izgouaren and Ilguiloda. The goals are to provide a reliable and clean source of water, to have a distribution system in place to allow for ease of access to the water, and to educate the community on the importance of drinking and using clean water instead of the contaminated water used now from nearby springs.

The summer 2018 implementation trip has two key objectives toward meeting the goal of a reliable and safe water source for the communities. First, we will work with the local power utility to extend utility power to the well site. The well pump is currently inactive due to a lack of power. Second, the temporary distribution site that was created to provide immediate access to clean water until the full pipeline can be finished will be refurbished. These two objectives for the implementation trip work toward our project goals, but are not permanent solutions. Further implementation will be needed to improve accessibility to the water supply. This will be accomplished by finishing the pipeline and building permanent distribution sites in each of the communities.

1.4. Scope of Work

The scope of the project is a water supply and distribution system in the two communities of Izgouaren and Ilguiloda. The water is being supplied from a borehole in the northwestern most portion of Ait Bayoud. The site is in a favorable location for the region's aquifers, is a reasonable distance from the two communities, and is within the domain of the commune leader. The water will be transported to the communities using a pipeline. The pipeline will transport the water to a high point near Ilguiloda. From there a gravity fed distribution system will be created to make distribution points within the communities. This meets the issues identified by the community by providing clean and readily available water in quantities large enough for drinking, bathing, cooking, and other daily tasks.

1.5. Summary of Alternatives Analysis

Columbia University EWB Morocco project aims to provide a sustainable source of clean, accessible water that can be used by the communities of Izgouaren and Ilguiloda on a daily basis for all their water needs: drinking, cleaning, bathing and providing for domestic livestock. The communities we are serving have to gather water from a spring located in the riverbed. This requires hiking up and down a plateau for several hours a day. This time is often taken away from children's and women's days. Therefore, the growth and progress of these communities are stalled as other necessities, such as healthcare and education are not given the proper attention.

Six alternatives were considered for a solution to the drinking water problem and after a thorough analysis it was decided that the most feasible idea would be to drill a new well near the northwest boundary of Ait Bayoud, where the aquifer is more suitable for groundwater production.

The alternatives examined were the following: (1) use existing spring as water source and pump to new water tower in dwar, (2) hand dig a well near the spring; pump to new water tower in dwar, (3) use a drilling rig to drill a well near the spring; pump to new water tower in dwar, (4) deepen a partially completed well north of the spring, (5)

drill a new well near the partially completed well in between Ilgelouda and the spring, (6) drill a new well near the northwest boundary of Ait Bayoud, where the aquifer is more suitable for groundwater production.

For each method several factors were considered, as follows: technical feasibility, possibility of environmental and health issues, financial viability, social and cultural issues, and education requirements. The first five alternatives were eliminated because of political opposition from the president of the community and concerns for using a central site for the water source. The spring is the lifeblood of the downstream communities and any activities that could adversely impact the spring (e.g. drilling, excavation, groundwater withdrawal) are not supported by the community. It would also be very difficult to get materials and machinery to and from the spring site. Although the idea of drilling a well in-between Izgouaren and Ilguiloda was considered, previous failed well drilling projects by the community and our knowledge of the local hydrogeology.

Despite the fact that the location of the well in Alternative 6 is farther away from the community than the Alternative 5 well site, we currently believe Alternative 6 is the best option for the following reasons:

1. The hydrogeology professor that we consulted with has performed extensive studies of the hydrogeology in the area. He is confident in the ability to find water in the area at a replenishing rate that will exceed the estimated water demand.
2. The well was drilled successfully, is productive when the pump is operational, and the only needs to be further developed and tested.
2. The site of this option is in a more productive aquifer region than that of Alternative 5 due to the nature of the underlying geology.
3. There is less risk of well fouling due to marl at the Alternative 6 well site. Well site 5 is in an area subject to well fouling due to marl.
4. The site is within the political border of Ait Bayoud, so is within the domain of the president. We also have the support of the community of Tinilft, which is close to this site.

1.6. Project Team

The project team consists of student members on the water and piping teams of the Morocco Program in Columbia University's chapter of EWB, led by water team leads Vanessa Hansen-Quartey and Alice Wu and piping lead Donald Swen; REIC Colin Barrett; mentors Robert Prager, Larry Bentley, Tim Bowden, and Camille Rubeiz; and faculty advisor Mohamed Haroun.

1.7. Community Partners

The Ait Bayoud Development Association (ABDA) was originally responsible for the water distribution system and for working with our chapter on the project. A new water association was formed outside of the ABDA, with approval from the Rais, to take over responsibility for the water distribution system. The water association consists of residents of Ilguiloda and Izgouren who have a direct interest in the project and can better manage the water distribution system compared to the ABDA, which is responsible for all of Ait Bayoud. The water association is in charge of raising funds

for the community's contribution to the project, acting as a liaison between the community's desires and the chapter, and eventually taking responsibility for operation and maintenance of the water distribution system. All project decisions are approved by REIC Colin Barrett. Any changes to the project from the original proposal will be communicated to the water association for feedback and approval. The Peace Corp volunteers (PCVs) are crucial liaisons between the chapter and the community. In between trips, they meet with local contractors and engineers for surveying and cost estimate and carry out small tasks for the project, such as checking on the condition of the temporary distribution site. The PCVs are also crucial for handling the logistics required before a travel team arrives, sharing their knowledge of the people and the area around the community, and communicating with the community in the local language Darija.

1.8. Reference Projects (Conducted by EWB-USA)

1.8.1. CCNY Honduras Project

In 2012, the CCNY Chapter of EWB conducted a water distribution project in the Milla Tres Community of Honduras. A previous water distribution system existed, but the spring from which it was sourced was made inactive by an earthquake; leaving the residents at the lower part of the village to source from a different source and the people at the top without water. An alternatives analysis was conducted for the system type, possible sources, tank location, pipe route, conduit materials, dam materials, tank materials, and treatment and filtration options. It was determined that a gravity driven system would be best, with the tank foundation made of concrete and the conduction line being made of PVC with steel and cast iron sections. The community's piping route was chosen and the water management system would include a chlorine treatment. The team was met with problems such as designing their system to withstand major rainfall and the elevation change. These problems were solved by designing a spillway for the water containment site and by using a piping route recommended by the community that mitigated extreme elevation change.

1.8.2. Boston Professionals Honduras Project

The Boston Professionals EWB Chapter conducted a water distribution project in the villages of Colonna, Maraquito, Aguacatillo in Honduras. The system had many issues such as pipe deterioration and that it did not reach many communities far from the source. Since the communities did not have enough money to extend the pipeline to their area, they were only able to collect water from these far away areas. Some alternatives that were considered were 1 tap stand shared by 3 villages, a tap stand in each village, a tap stand and tank in each village, and household delivery. The preferred alternative was the single tap stand for the 3 villages because it is easiest and cheapest to construct, it is in a central location to the 3 villages, and it is key to the construction of the other alternatives.

1.8.3 EWB Engineering Service Corps

EWB Engineering Corps has partnered with water engineer with CH2M based in Chicago to repair half a dozen water pumps in Ethiopia. Villagers didn't have a choice but to walk for six hours every day in order to collect water in tanks that they would then carry on their

backs. The villagers did not have the proper tools needed for the maintenance and repairs of the hand pumps, which could have caused severe injuries or dropping the water pump in the well. In one instance, the community had previously tried to raise a 150-foot column of pipes, but the pipes fell back into the well. The Engineering Corps repaired the pumps, preventing their fall in the well.

2. Design

2.1. Description of Existing Infrastructure

The current water distribution system consists of a 140-meter-deep well approximately 2 miles northwest of the nearest dwar (Attachment A: Figure 1) that was drilled and cased in January 2015. The well was constructed by the MogaBuilding Drilling Company. The well is located on the property of a community collaborator A memorandum of understanding as well as a land easement was drafted and signed by the community collaborator (Mohammad) to ensure that the well remains a public resource. Initial data along with past hydrology studies of the region indicates that the water supply is potable. More rigorous tests will be conducted on this trip.

4560 feet of 2” diameter galvanized steel pipe has been constructed between the well and chateau site.The total length of pipe in this section will be near 9700 feet when completed. The pipe is installed in a shallow trench and encased in concrete at two road crossings but is mostly installed above ground. The majority of the pipeline is not buried because the rock and soil is too difficult to excavate. Foot traffic and livestock can easily step over the pipe as the dirt and rocks covering the pipe are only 6-8" above grade (Attachment A: Figure 5).

In Summer 2015, a concrete foundation was laid down at the tank site. The August 2016 trip saw the completion of an electrical room built at the well site by the community and the installation of a purchased pump. No permanent components were installed during the January 2017 trip. The pump was run continuously to develop the well and assess the quality of the water. Water samples were collected for turbidity and other preliminary water quality data.

On the most recent trip in Summer 2017, a settling tank (1500 L) and storage tank (1000 L) were installed as a small scale temporary distribution site (Attachment A: Figure 8), which will allow the community to begin accessing water in a limited capacity once the nearby power line is extended to the pump on this trip. The settling tank was designed to address turbidity, allowing water usage for purposes outside of human consumption, such as for livestock. This site can provide drinking water once more rigorous tests are conducted on this trip.

The two tanks are supported with one rectangular foundation made of cinder blocks and mortar. The foundation was designed to tilt in two planes, with the settling tank at a greater elevation than the storage tank, such that any sediment that accumulates would go towards the corners of the tanks. Turbid water is allowed to settle in the settling tank, then the non-turbid water can be transferred from the settling tank to the storage tank. Ball valves at the bottom of both the settling and the storage tank allow sediment to be drained. The discharge valve on the storage tank serves

a dual purpose, first in draining any excess sediment that was not removed during the settling process, and second in allowing the community to draw from the tank as a source of clear water.

The water from the well enters the settling tank through a 2.5" HDPE capped pipe that runs parallel inside the tank. Inside the tank, the pipe has holes drilled in order to slow the velocity of the water entering the tank and therefore prevent disturbing the sediment at the bottom of the tank. On the opposite end of the tank, an opening was drilled to serve as an outlet for overflow and to allow ambient pressure into the tank. This overflow was covered with netting to prevent insects and small creatures from entering the tank. An opening for connecting the settling tank to the storage tank was drilled below the overflow and closed off using a ball valve. When the settling tank is full and the sediment has settled (5-8 hours), the ball valve at the bottom of the tank is to be opened to allow the sediment to drain out. The sediment ball valve is connected to a 3-meter tube that goes into the ravine. The settled water enters the storage tank and can be drawn at any time by turning on the ball valve at the base of the tank. If there is still sediment in the water, then the water is to run until it runs clear.

2.2. Description of Proposed Facilities

2.2.1 Extending the Power Line

The local utility will bring overhead 3 phase, 380 V, 50 hz electricity from a line located approximately 500 feet from the well site. Electricity will be routed from the pole mounted, utility provided meter to the control panel. The design and control strategy is documented in the drawings (Attachment A: Figures 4 and 9). Voltage drop calculations are not provided with the calculations as the cable sizes were selected from the pump manufacturer's guideline. The 4 mm^2 conductor used for this project has a capacity between a #10 and #12 in US wiring. A #12 is rated 25A per NEC. At 380V/3PH pump motor draws approximately 8.3A in each phase.

The most time consuming portion of this task is setting up meetings with the local utility provider, through the community leader (the Rais). The PCVs have been tasked with working with the Rais to have an initial meeting and site visit scheduled on their calendar prior to the travel team arriving in country.

2.3. Calculations

Since we decided to ultimately switch from plastic to concrete storage tanks at the chateau site (Section 2.4), the sizing of the storage tanks for the chateau site (Attachment E: Section 4.c) was clarified for future construction by specifying the thickness of the tank walls to be 0.75 ft, yielding an unchanged inner diameter of 6 ft and an outer diameter of 6.75 ft. The total holding capacity of the storage tanks is unchanged. With the new dimensions and material of the storage tanks, we revised the structural calculations for the chateau foundation (Attachment E: Section 4.e). The total weight of the storage tanks and the maximum water held in them was determined to be 151,255

lbs. This weight sits on two circular areas of radius 6.75 ft on the foundation. That area of concrete can take a maximum load of 164.8 million lbs, so the total weight of the storage tanks and water will be much less than the maximum load. Thus, the chateau foundation is still structurally sound for our revised chateau site design (Attachment A: Figure 6 and 7).

2.4. Material Specifications

The material for the storage tanks at the chateau site was changed from plastic to concrete to ensure longer longevity of the tanks, since plastic degrades quicker under the strong Moroccan sunlight. It will be cheaper for the community to repair cracks in concrete than to replace cracked plastic tanks. Moreover, concrete is the material typically used for water storage tanks in the region, so there are plenty of contractors in the region who can construct the tanks. The concrete will be built to withstand 3,000 psi. The tanks will be sealed inside with a water sealant to prevent water absorption by the concrete. The exact concrete mixture ratios and the rebar requirements are in the process of being determined with assistance from mentor Tim Bowden, since the chateau storage tanks will not be implemented on this trip. We are also communicating with the local contractors in Morocco to verify that the material requirements we settle on will be available in country.

3. Schedule

3.1. Schedule overview

3.1.1. Geospatial Mapping of Pipeline Route

In order to ensure accurate calculations, we will conduct a survey of the pipeline using a head-mounted gopro camera and a GPS receiver in order to ensure accuracy of the updated map and to confirm observations made along the pipeline.

3.1.2. Thermal Expansion Testing and Pipeline Surveying

In order to confirm theoretical thermal expansion values and current calculations, we will conduct a thermal expansion test on the current galvanized steel pipeline. This will occur by measuring the length change of the pipe at different temperatures during the night and middle of the day. In addition, we will also survey the current pipeline in order to study the state of the pipes and determine if this is in agreement with our current calculations and plans.

3.1.3. Anchoring Testing

We will test anchoring methods for future implementation in the pipeline. This will encompass learning how our methods will be implemented in Morocco by learning how to best drill in the ground for future rebar usage and if cement casts are appropriate for this pipeline.

3.1.4. Power Line Extension

There is a utility power line running near the well site, but not close enough to use to power the pump. We will work with the community leaders and utility company to extend the power line to the well site to power the system. A qualified electrician will be hired locally to perform any needed electrical connections between the utility meter and the pump control panel.

3.1.5. Well and Water Quality Tests

The water quality tests we have completed in the past are inadequate to deem the water safe for human consumption. We will need to take water samples from the well and have a government well-certifier run tests to verify that the water is safe for the community to use.

3.1.6. Cleaning and Maintaining Temporary Distribution Site

The temporary distribution site has developed some minor problems that will need to be fixed. The tanks collected sand and rocks inside that need to be cleaned out, the ropes securing the tanks need to be replaced, and some cracks in the foundation may need to be patched.

3.1.7. Testing Temporary Distribution Site

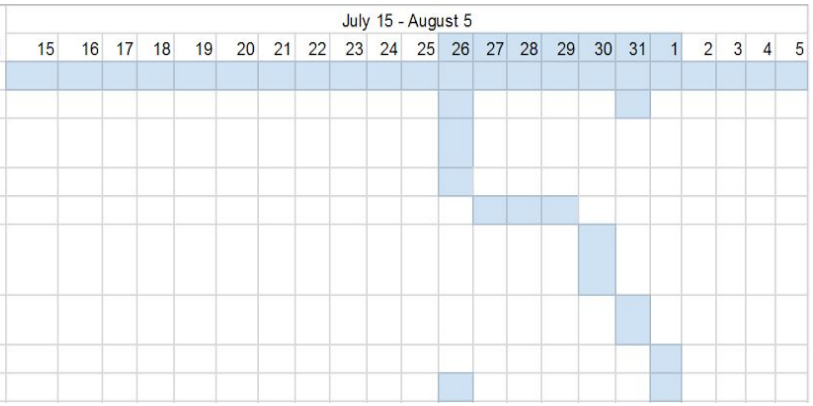
The temporary distribution site has not been tested since it was built, so we will need to run the system to test the distribution site. We will run through the procedure of filling the tanks, allowing the water to settle, and dispensing clean water.

3.1.8. Community Education

Significant time will be allocated to ensuring that all parties involved, the community members, university students, and mentors are thoroughly informed on every decision in the process. Meetings will be scheduled to educate the community on the various decisions that have been made, specifically the scope of the project and the reasoning for the location of the drilled well.

3.2. Work Breakdown Structure

Number	Task	Resource	Start	End	Duration
1	General Health & Safety Considerations	EWB Members	7/15/2018	8/5/2018	22 days
2	Geospatial Mapping of Pipeline Route	EWB Members	7/26/2018	7/31/2018	2 days
3	Thermal Expansion Testing and Pipeline Surveying	EWB Members	7/26/2018	7/26/2018	1 day
4	Anchoring Testing	EWB Members	7/26/2018	7/26/2018	1 day
5	Power Line Extension	Local Utlity Company	7/27/2018	7/29/2018	3 days
6	Well and Water Quality Tests	Morocco Mininistry of Mines, Energy, Water and Environment	7/30/2018	7/30/2018	1 day
7	Cleaning and Maintaining Temporary Distribution Site	EWB Members	7/31/2018	7/31/2018	1 day
8	Testing Temporary Distribution Site	EWB Members	8/1/2018	8/1/2018	1 day
9	Community Education	EWB Members	7/26/2018	8/1/2018	2 days



3.3. Detailed Task Description

3.3.1 Geospatial Mapping of Pipeline Route

In order to accurately design the pipeline, it is important to gather more comprehensive geospatial data along the pipeline route. Equipped with a GPS receiver to confirm accuracy with the proposed pipeline route and a head-mounted gopro camera, a travel team member will walk the proposed pipeline route, qualitatively and quantitatively assessing the nature of terrain (i.e. rocky, degree of vegetation), slope of terrain, shading, natural and artificial obstacles, and any additional observations they find significant. Also, time permitting, the travel team member could walk other potential pipeline routes depending on community preference, conducting the same suite of assessments. The gopro film will serve as a record for confirming the geospatial nature of the pipeline after-the-fact (without direct access to the pipeline, i.e. out of country). The travelers are trained in operating the GPS prior to leaving for the trip, and are equipped with the GPS manual while in the field.

3.3.2 Testing Thermal Expansion

The piping team hopes to confirm theoretical thermal expansion values it calculated, and plans to implement the following procedure with said materials:

Note: Some of the steps listed below must be completed at night, when temperatures are cool, in order to determine the possible expansion of the pipeline as it gets warmer.

Materials:

- Tape measure
- Thermometer/temperature measuring device (optional)
- Some type of physical weighted marker (to be placed next to a pipeline on rocky terrain)
- Camera/phone/other photography device

Procedure:

1. Locate the end of the pipeline.
2. Pick a night with clear weather.
3. When dark, place a weighted marker immediately adjacent to the end of the pipeline.
4. Record the time that the marker was placed (and if possible, the temperature at that time).
5. Take a picture of the marker next to the pipeline.
6. The next day, return to the end of the pipeline at high noon with a tape measure.
7. Measure the distance that the the end of the pipe has moved from the weighted marker (backwards or forwards, but it will probably have moved forwards from night to day).
8. If possible, measure the temperature that the distance was calculated at.
9. Take a picture of the expanded pipe.

The travelers have been briefed on the procedure and will be trained on how it should be completed at the water team training.

3.3.3 Testing Anchoring Methods

For any future implementation of piping to occur, anchoring methods must be tested to determine how the various methods perform with given stresses. Travel team members will anchor small sections of left over HDPE pipe with a concrete-rebar anchoring system and, potentially, an earthen berm anchoring system. The team will assess how the anchoring process went, determining potential pitfalls for full pipeline construction. The team will first speak with local suppliers who have previously supplied the team with rebar and concrete in order to acquire supplies. Then, the team will drill the rebar (cast in concrete around the exposed pipeline circumference) into the soil. The team will test how well the anchoring system holds up to forces equivalent to the calculated lateral deflection forces (the team will apply said forces, most likely by hand). The travelers will be trained in how to accomplish this task at the water training meeting.

3.3.4 Power Line Extension

The task is described in Section 2.2.1, and will be executed by the local utility company.

3.3.5 Well Tests

Well tests will be executed by the Moroccan government employees, who will certify the well as safe for human consumption if the water quality tests yield positive results.

A drawdown test of the well will be conducted in order to determine the decline of well flow as a function of time, at unrestricted discharge. This is done by height of the water level using an electric sounder at a specified time interval. When the well is at the minimum acceptable water height the drawdown will stop and the rate of recharge will be recorded at regular time intervals using the electric sounder.

In order to prepare the water for human consumption, tests need to be performed to determine coliform content, total dissolved solids, metal content, pH, and nitrates. Finding the size of sediment particles and the turbidity is also an important step in determining the best method of filtration once a permanent distribution site is built. Once the tests are completed, a plan can be made with regards to filtration, purification, and chlorination. The travelers will be trained in how the tests will be conducted and their role in ensuring the tests are accomplished.

3.3.6 Cleaning and Maintaining Temporary Distribution Site

There has been some environmental wear on the current distribution site, and small repairs need to be made. This includes replacing the ball valve that was in the discharge position of the storage tank, and replacing the netting that was placed on the overflow outlet to prevent bugs and contaminants from entering. The netting needs to be more tightly secured this time to better ensure it will not come loose again.

There is currently sediment and other debris inside of the tanks that must be cleaned out (and possibly disinfected) thoroughly before any water testing can be completed. This would most likely involve scrubbing out the tanks manually, as well as flushing them out with water multiple times and allowing them to drain completely. Disinfection would probably involve dissolving chlorine tablets in the water during one round of the flushing out process.

The ropes securing the tanks to the foundation have gone missing, so we will need to replace the ropes securing the tanks. Additionally, there is one cracked cinder block and one displaced cinder block in the foundation of the temporary distribution site that we will need to replace with new cinder blocks.

3.3.7 Testing the Temporary Distribution Site

Because the community has experienced delays in securing a source of electricity for the pump, the temporary distribution site has yet to be tested or used by the community. The team aims to test the temporary distribution site to confirm that the procedure works once the power line is extended to the pump on this trip. Community members have already been educated in the operating procedure, but if the test reveals that changes to the procedure must be made, the community members will be informed of the new changes.

To begin the procedure for testing the temporary distribution site, the settling tank, which is the first tank that the piping is connected to, will be filled by opening ball valve A (Attachment F: Figure 1) and turning on the pump. To determine how long it takes the water to settle, every hour, the team will open the top of the settling tank and visually inspect the water for clarity. If necessary, water samples may also be taken from the top of the tank. Once the water is settled, the clear water will be moved to the storage tank by opening ball valve B. To test how clear the water is after settling, a gallon bucket, containing volume markings, will be placed under the dispensing valve E to collect the initial water until the water runs clear. The team will measure the volume of unclear water lost and take a water sample to test the turbidity of the settled water versus the unsettled water. The

distribution site water sample will be provided to the contractor along with the water sample straight from the well. Lastly, the sediment left in the settling tank will be drained by opening valve C until the water runs clear and collected in a bucket placed underneath the valve. If there are significant difficulties to the original procedure, then the appropriate changes will be made, and community members will be informed.

3.3.8 Community Education

A meeting with the members of the Water Association will be scheduled in advanced to the date, and the team will be prepared to start the discussion with questions regarding satisfaction with the project thus far and points that are of concern and need clarification. Through the aid of the PCVs, there will be ongoing discussion with the association about why the well was drilled in its particular location, expectations in regards to cost allocation on their end, and the scope of the project and what our chapter came to accomplish.

3.4. Schedule Analysis

3.4.1. Advance Task Scheduling

3.4.1.1. Geospatial Mapping of Pipeline Route

In order to conduct this task we must have a GPS receiver and head-mountable gopro prior to the trip in order to bring in country. The team will purchase these supplies prior to the trip.

3.4.1.2. Power Line Extension

The director of the Peace Corp Volunteers in Morocco is assisting our PCVs in arranging appointments for the local utility company to survey the location before our trip and to extend the power line during our trip.

3.4.1.3. Well and Water Quality Tests

The PCVs will contact the government agency in charge of well certification and arrange the appointment for government employees to come to the well site and conduct the well and water quality tests.

2.4.1.4. Testing Temporary Distribution Site

The PCVs will let the Water Association and community know, which day we will be testing the temporary distribution site, so that the community can come learn the operation procedure and use the water for livestock.

3.4.2. Critical Path Analysis

3.4.2.1. Anchoring Construction and Testing

The team will first install the anchoring by drilling the rebar (cast in concrete around the exposed pipeline circumference) into the soil. The team will then test how well the anchoring system holds up to forces equivalent to the calculated lateral deflection forces (the team will apply said forces, most likely by hand).

3.4.2.2 Well Power

The power line must be extended before any tests can be conducted on the well and the temporary distribution site. The temporary distribution site will also be easier to clean if there is running water.

3.4.3. Schedule Threats

3.4.3.1. Geospatial Mapping of Pipeline Route

Issues that may affect the completion of this task may be rain, a lack of battery in either device, or a lack of memory in the camera.

3.4.3.2. Thermal Expansion Testing and Pipeline Surveying

Cloudiness, rain, cold weather, or other deviations from typical weather may alter the results of the test from the average amount of thermal expansion, so the team would want to conduct the test on a different day for ideal results.

3.4.3.3. Anchoring Testing

The supplies required for this test have previously been acquired at local vendors. In the unlikely event that these materials are unavailable at the local hardware store, the team will have to purchase the supplies in the city of Essaouira over the weekend.

3.4.3.4 Power

If the PCVs are unable to arrange for the utility company to survey the land before the travel team arrives, then the survey will have to occur during the trip before the utility company can extend the power line. The survey would push back all tasks that require power by a day and possibly require rescheduling the government well test.

If the local utility company is unavailable to extend the power line during the trip, then none of the tests for the well and the temporary distribution site can be completed and we will not be able to distribute water from the temporary distribution site until power can be extended during the next winter implementation trip.

3.4.3.5. Well and Water Quality Tests

If the government well-certifiers are not available to perform the tests during the travel dates, then water can not be distributed for consumption from the temporary distribution site.

If the water quality tests raise issues, the team will have to prioritize resolving the issues over other tasks, since distributing water is the primary goal of this trip. If the team cannot resolve the issue easily in country or the team runs out of the time to resolve the issue, then the temporary distribution site may not be able to be operated until the winter, when the next travel team can implement a solution.

3.4.4. Schedule Issue Mitigation

3.4.4.1. Geospatial Mapping of Pipeline Route

In order to ensure the completion of this task, the team may shift the order of tasks in the schedule if the weather hinders the completion of the task on the scheduled day. The team will charge each device prior to their usage. A new memory card will also be used in the camera to ensure no issues with this.

3.4.4.2. Thermal Expansion Testing and Pipeline Surveying

The team can complete this test on any day that the team will be walking to the well site, so if the weather is not ideal on the scheduled day, the team has many other options. The test takes only a few minutes, so changing the scheduled day will not have a significant effect on the rest of the schedule.

3.4.4.3. Anchoring Testing

In order to ensure that the team will be able to acquire the necessary materials in country, we will contact the local hardware store through WhatsApp before leaving for the trip.

3.4.4.4. Power

The PCVs are currently contacting local utility companies, 2.5 months in advance, so the chances of a delay are low. If power extension is delayed, the piping-related tasks and the cleaning and maintenance of the temporary distribution site will be complete first, while waiting. If power cannot be extended during the trip, the team will rent a generator to complete the tests for the well and the temporary distribution site.

3.4.4.5. Well and Water Quality

The PCVs will be scheduling the appointment with the government for the tests 1-2 month in advance, so the chances of a delay or unavailability should be low. In the case that well and water quality tests cannot be completed, the travel team will test the water quality themselves with a water testing kit that will be purchased before traveling and brought over.

4. Construction Budget

4.1. Material Quantity Takeoff

For the minor refurbishments to the temporary distribution site, we will need to purchase additional rope, cinder blocks, and screening material. To install the pipe anchoring we will be testing, we will need to purchase additional concrete and rebar. Refer to attachment C for this information.

4.2. Cost Estimate Summary

Unit prices have not changed, since we will be purchasing materials in country from the same local hardware store that we have been in contact with previously. The overall trip budget is $21,510, of which $15,300 is for travel and housing expenses, $1,210 is for program QA/QC costs, $500 is for the bridge project maintenance costs, and $4,500 is for the water project implementation costs. The majority of the water project implementation costs will be going towards water sample tests, well tests, and extending the utility power line and connecting it to the pump control panel.

5. Facilities Operations and Maintenance Plan

The temporary distribution site maintenance plan was added to the Facilities O&M Plan, in which the community will check the block foundation for cracks and displacement of cinder blocks; check for looseness in the screens covering the overflow piping; and evaluate the tank for cracks or fissures, any leaks from the input/output, and any sediment or debris. If such issues are found, the community will replace cracked cinder blocks and adhere them to the rest with mortar, resecure screens if loose or displaced, shutdown the system and call the engineer if the tank is cracked, and replace any leaking valves. The tanks will also be cleaned by rinsing the inside or turning on the pump to take out any sediment. If the sediment is clogging the outlet valve, then a community member will manually remove the sediment by entering the tank from the top and using a bucket to clean out the sediment. Afterwards, chlorinated bleach will be used to rinse the tank before use.

Additionally, operation instructions for the temporary distribution site were added, including a figure for the various valves to open and close. The operation consists of filling the settling tank, letting the water settle for 5-8 hours, moving settled water to the storage tank, distributing clean water from the storage tank, and draining sediment from both tanks. A typical daily operation would involve moving settled water from the previous day or previous operation of the system to the storage tank, distributing clean water, draining sediment from the settling tank, and refilling it with water to settle for the next day.

6. Community Based Organization CBO

Ultimately, the water system will be wholly owned by the community of Ait Bayoud, though maintenance responsibilities will primarily fall to the ABDA (Ait Bayoud Development Association). Since

the pipeline will be built on public land, the ABDA will not be the sole proprietors of the water system, and instead the water system will be owned by the entire community. The well site is on private land however a land easement was signed before construction of the well, giving permission for EWB and ABDA to utilize the site for water sourcing. However, the ABDA and the associated water committee will be instrumental in ensuring the maintenance of the water system. Virtually all community members are also members of the ABDA (and pay into the organization in the form of monthly dues). Thus, the ABDA will be responsible for collecting the funds necessary for maintenance as well as paying for electricity. We believe that the ABDA has demonstrated the organizational capacity and responsibility required for the maintenance of development projects, as they currently collect funds for and maintains the existing water distribution system in other dwars. In terms of maintenance labor, we have identified Rais Rashid (the president of the local commune), and Ahmed Zindine, the local mechanic, as capable of organizing and mobilizing community members for maintenance purposes.

7. Baseline Monitoring Data Collection

7.1. Baseline Data

7.1.1 CBO and Community Survey

The following questions are to be asked in the CBO and Community Survey:

1. How are your and other community members views about the distance of the temporary water distribution site, and of the proposed location for the final water site?
2. Given your views about the distance of the water distribution sites, how likely are you and other community members to use these these sites?
3. How many times a day would you say you and other community community members would use the temporary water distribution site?
4. Is there an existence of broken components of the temporary water distribution tanks or the electrical shed?
5. Please describe the level of cleanliness of the temporary water tanks.
6. Please describe your and other communities members comfort level in operating the temporary water tanks.
7. Are there any overall concerns you and other community members may have regarding the temporary water distribution system?

The CBO and Community Survey will be conducted during the scheduled meeting with the Water Association affiliated with the ABDA. The list of questions will be given to the Peace Corps Volunteers involved with our project who will have a translator translate the questions to the members of the association. The translator will then translate their answers for the travel team so that they can record the answers. The Peace Corps Volunteers will also translate any follow up questions the travel team may have to the community members responses.

7.1.2 Well Tests

As described in 3.3.4, the method of conducting the well tests is to obtain the results from the Moroccan Ministry of Mines, Energy, Water and Environment. A drawdown test is to be conducted

to determine the depth of the well, and tests relating to the quality of the water will be conducted to determine the next steps for processing the water.

7.1.3. Testing the Temporary Distribution Site

As described in section 3.3.5, when the power is installed or if a generator is used, the temporary water distribution system will be tested. The method for doing this is to simply run the system as designed, and to record the amount of time it takes the two tanks to fill and run through one cycle.

7.1.4 Geospatial Mapping of Pipeline Route

As described in section 3.3.1, the travelers will be equipped with a GPS receiver and a gopro camera will walk along the pipeline route and asses the terrain, and could do the same for other pipeline routes the community may prefer. This is to take place on July 26th, and will continue on July 29th if the tasks are not completed.

7.1.5 Testing Thermal Expansion

As described in section 3.3.2, the travelers. will locate the end of the pipeline and place a mark adjacent to it and record the time the mark was made. The next day, the distance the end of the pipe has moved from the mark and the temperature at the time will be recorded.

7.1.6 Testing Anchoring Methods

As described in section 3.3.3, the travelers will test this method of anchoring the HDPE pipe but using the force of the hand to the rebar that has been drilled in the soil.

7.2. Other Factors Contributing or Hindering Development

Research by the university student chapter is conducted through remote online research of NGOs, local and regional governments, or organizations that may be working in the projects location.

Any research that is done apart from the university student chapter is conducted by the Peace Corps Volunteers we work with, and this research is conducted in country by asking local community members and other trusted individuals about NGOs, local and regional governments, or organizations working in this community. During the academic school year, meeting calls are set up with the Peace Corps Volunteers who will go to the project site and conduct this research if needed.

Furthermore, the Peace Corps Volunteers are the points of contact regarding community relations. Negative sentiments towards the development of this project could hinder the relationship we have with the community, as well as deter the completion of the project. The Peace Corps Volunteers thus communicate with the the community to assess these sentiments, and plans for travel are affected by schedule time to meet with the water association to assess interest in the project and to explain its development.

7.3. Beneficiary Analysis

The beneficiaries, or the population in demand for water in this area, for this project are the 159 people of the Izgouaren and Ilguiloda communities, and their animals, as reported in Attachment E, section 3.a.1. This data was collected during the January 2014 assessment trip. To update this number, a census will be taken by the Peace Corps Volunteers going door to door in the Izgouaren and Ilguiloda communities and inquiring about their water consumption.

8. List of Attachments

Attachment A: Drawing Package
Attachment B: Schedule
Attachment C: Revised Construction Cost Estimate/ Material Takeoff
Attachment D: Revised or Additional Specifications - ***not used***
Attachment E: Revised Design Calculations
Attachment F: Revised Operations and Maintenance Plan
Attachment G: Signed Implementation Agreement
Attachment H: Original Implementation Plan
Attachment I: Revised Construction Safety Plan
Attachment J: Original Design Calculations

