

# CHICHICA AQUEDUCT SYSTEM

## NGOBE-BUGLE COMARCA, PANAMA DESIGN FALL 2011

### TMC Mission Statement

"With a combined focus of ethical responsibility and cross-cultural understanding, TMC strives to be a leader in the efforts to expand access of clean water."

### Background

The project site is located in the mountainous village of Chichica, Panama, as seen in the map below. Approximately 200 households receive water from two functioning spring boxes but with the population expanding, there is a need for more water. There is a Water Committee consisting of four board members who are dedicated to the maintenance and expansion of the community's water system.



Location of Project

Currently, the village collects water from two spring boxes which are directed to a 10,000 gallon storage tank. Two years ago, the village of Chichica received a grant to build another water system to supplement their current supply. A contractor was hired to design and construct an intake structure, pipeline and storage tank. The new system has a 20,000 gallon storage tank. The intake structure is built adjacent to a dam that is located where two streams converge. The PVC pipeline failed shortly after the system was turned on. After several attempts to fix the system, the contractor abandoned the project. Our goal was to determine why the current system did not function and how it could be modified to supply the new tank with water.

### Project Scope

The project included:

- Analysis of the issues of pressure, exposure to the elements, and water hammer associated with the pipeline
- Modification of the current intake structure to avoid sediment buildup
- Analysis of the water quality

### Data Collection Methods

We determined that a survey of the existing pipeline would need to be conducted in order to determine the elevation and pressure differences from the intake structure to the collection tank. We used an abney level, compass, and GPS unit to collect this data. The existing intake structure needed to be rebuilt to prevent sediment buildup. Therefore, measurements were taken of the intake structure. A functional chlorinator and sand filters were found on site. To determine the water quality, a 3M Petrifilm Testing Kit was used to test several sources of water in the area.



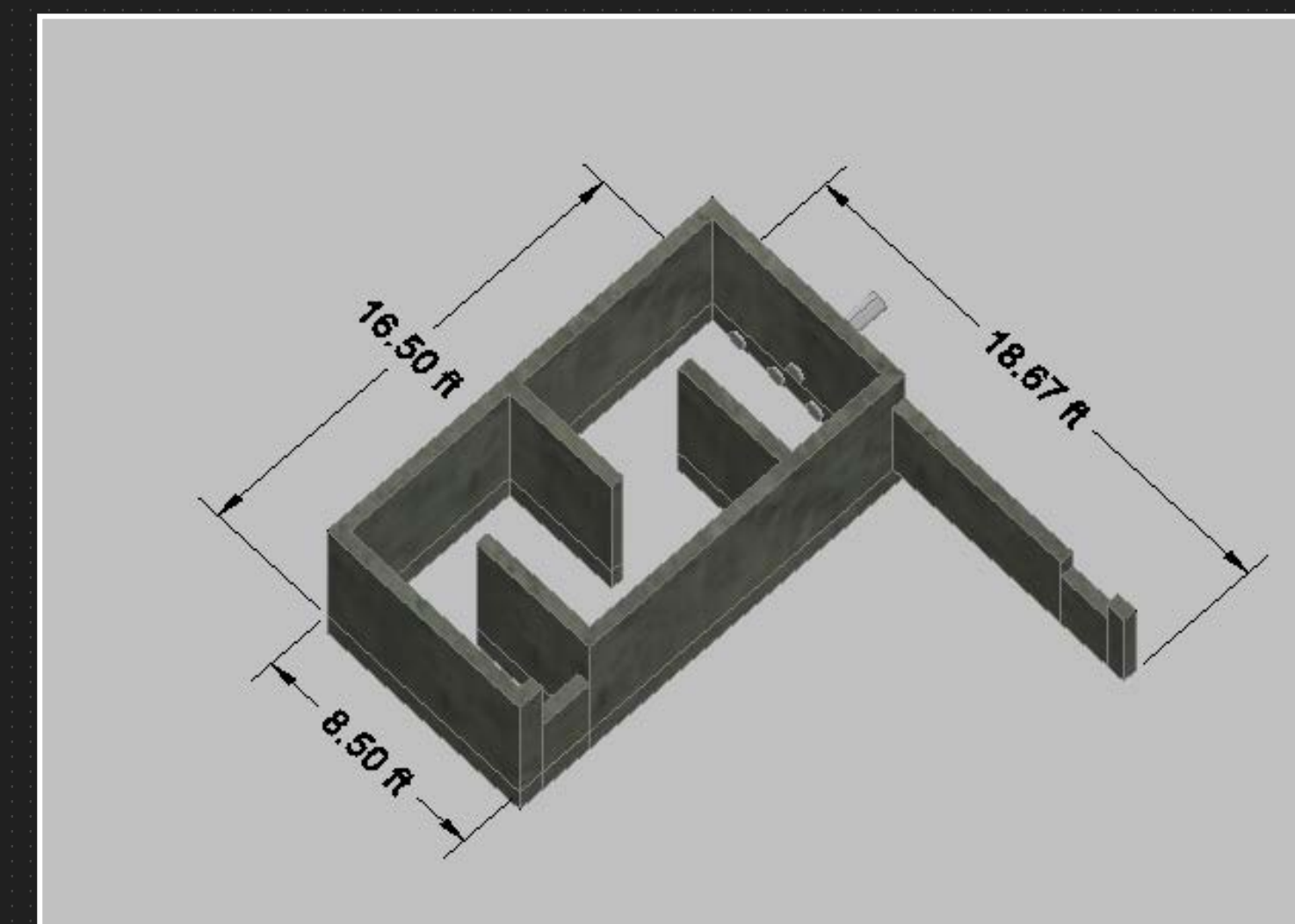
Pipeline routes to storage tanks

### Intake Structure Design

It is recommended that a new intake structure be constructed and the existing intake structure removed. The existing structure can be seen below (left). In the final design, the existing dam will be used, and all the existing pipes through the dam will be closed. The new structure will be placed on the west river bank. An AutoCAD drawing of the structure is shown below (right). The structure consists of an intake entry perpendicular to the flow of the river. The amount of water entering the intake structure will be regulated by the spillway. The intake spillway will be built to the exact elevation and width as the spillway on the dam to ensure that no more than 50% of the river is diverted in the dry season. The walls will be 6" thick and reinforced by rebar. It has three evenly spaced baffles inside it to increase the flow length and settling time of the water.



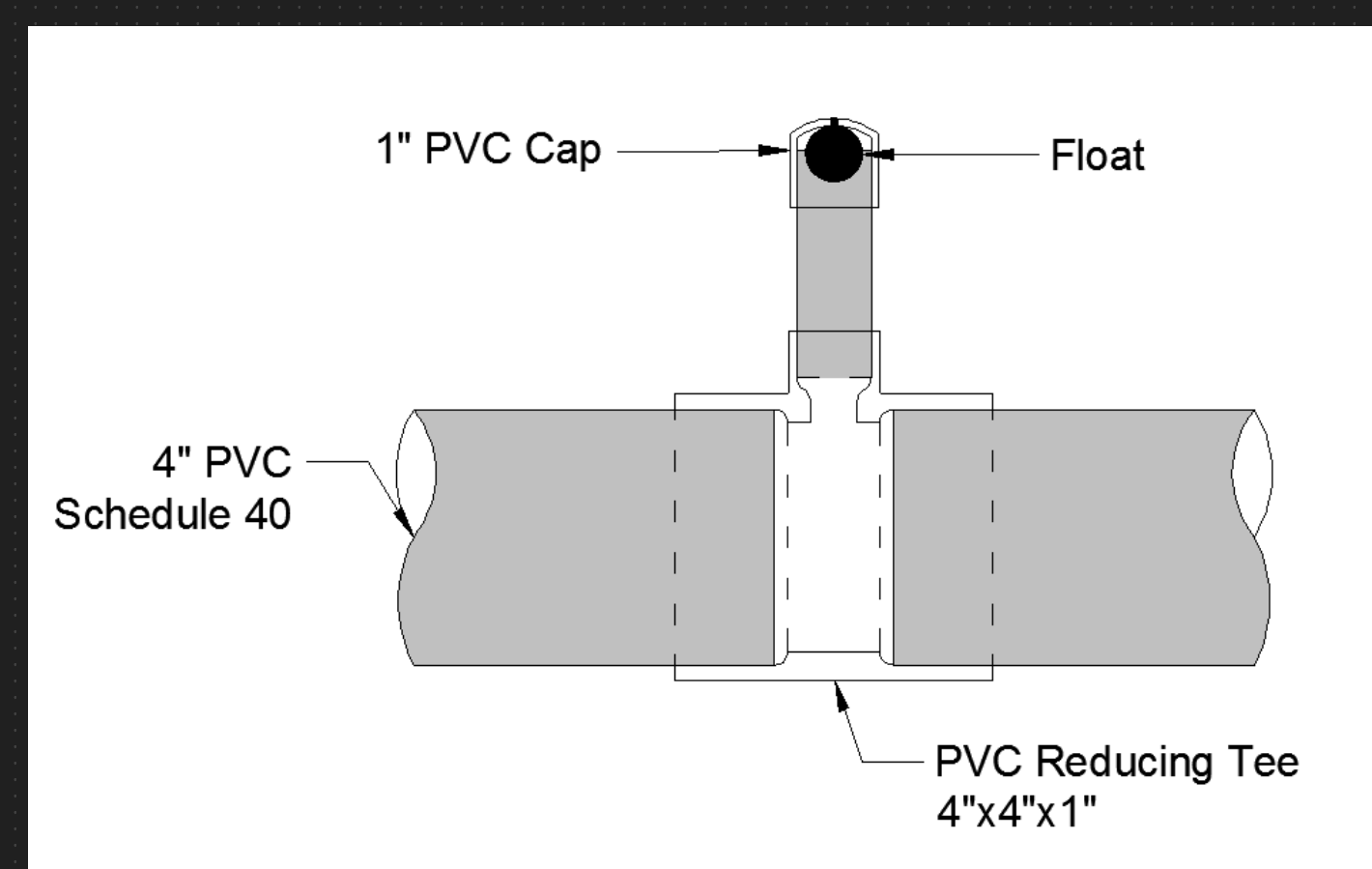
Existing small Intake structure attached to dam.



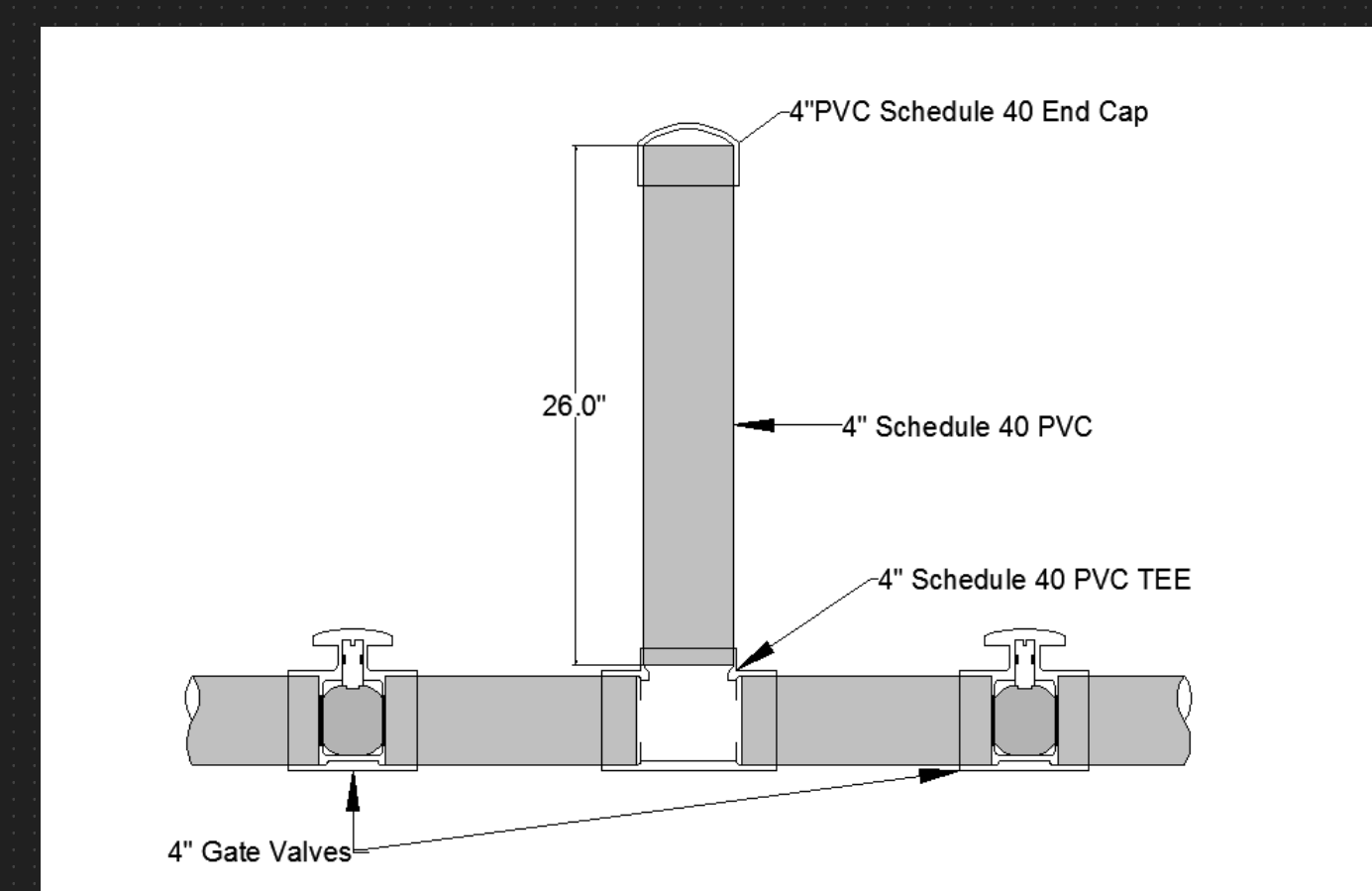
Intake structure design

### Pipeline Rehabilitation

Approximately a third (7550 ft) of the existing pipeline has been exposed to sunlight and fire from slash and burn farming techniques. This malfunctioning pipe section will be replaced with buried 4" Sch. 40 PVC pipe. In addition, 18 air relief valves will be added at the high points in the pipeline to prevent air pockets from blocking the flow in the pipeline. These valves are easily made from commonly found PVC material and have been successfully used on the other pipeline. The valves are shown in the below figure (left). In addition, a water hammer arrestor will be added near the storage tank to prevent damage due to pressure surges associated with closing the waterline. This can be seen in the figure below (right).



Air relief valve



Water hammer arrestor

### Water Treatment

From the 3M Petrifilm tests, high concentrations of coliform bacteria including E. coli were found present in the stream water. It is recommended that the village of Chichica restart their current chlorination system once the second system is repaired. It is also recommended that they purchase and utilize a chlorination testing kit over a period of 90 days to determine the effect of the number of tablets on the chlorine concentration within the tank. The sand filters already on site will be reconnected to filter out fine particles before water enters the chlorinator.

### Cost Estimate and Construction Schedule

The total cost of the project is expected to be \$4,800. The largest component of the cost is the pipeline replacement. A summary of the project costs can be seen in the table below. All costs were estimated using local prices in Panama found by local Peace Corps volunteers in the area. The president of the water committee will be in charge of overseeing the project and obtaining any additional funding. The construction of this project is expected to last 33 days and require five volunteers from the village to contribute each day. Additionally, a 90 day period of chlorine monitoring will follow the completion of the project.

Component	Cost
Intake Structure	\$1,060
Water Quality	\$40
Pipeline	\$3,070
Labor- estimated at \$1,300, but will be donated	\$0
<b>Total Cost</b>	<b>\$4,170</b>
<b>Total Cost + 15% contingency for unexpected costs</b>	<b>\$4,800</b>

### Conclusions and Recommendations

The final design report along with a construction schedule and maintenance guide will be sent to the Peace Corps Volunteers Jessica Rudder and Chris Kingsley. The existing intake structure should be removed and replaced with the new design that allows sediment to settle out of the water and is easier to maintain. The pipeline should have air relief valves installed at all the high points in the line and a water hammer arrestor installed near the closing valve. Additionally, 7550' of the line should be replaced with new pipe. This new section will replace the old pipe that has been damaged and is in the highest pressure region. Sections of the pipeline crossing steep gorges will be suspended by cables already in place and painted to prevent damage from sunlight. Lastly, when the system is fixed, the existing sand filters will be reconnected to the system as well as the inline chlorinator. Because of the high levels of coliform and E. coli present in the water, the residual chlorine concentrations will be monitored. This will ensure that the water from the new source is safe for consumption.

### Acknowledgements

Peace Corps Volunteers: Jessica Rudder, Chris Kingsley  
MTU Faculty: Brian Barkdoll, PhD. Martin Auer PhD.