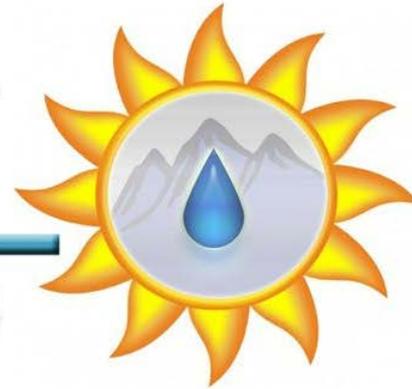


**H**ARD BODY  
ENGINEERING



## Water Distribution System – Hato Pilón, Panama

Angella Mickowski, [amickows@mtu.edu](mailto:amickows@mtu.edu)

Rebecca Bender, [rmbender@mtu.edu](mailto:rmbender@mtu.edu)

Cheriese Radionoff, [cnradion@mtu.edu](mailto:cnradion@mtu.edu)

Kelsey Maijala, [kbmaijal@mtu.edu](mailto:kbmaijal@mtu.edu)



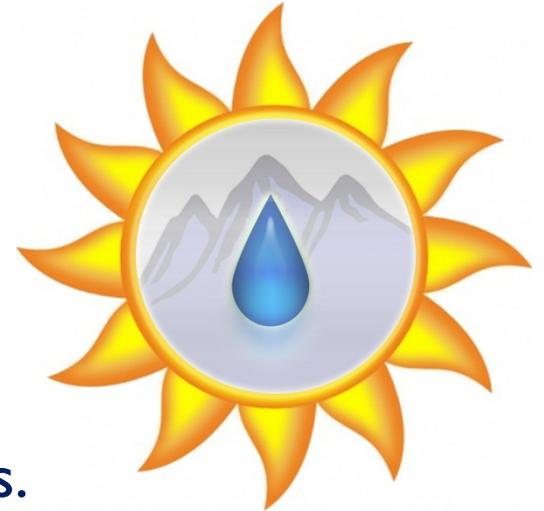
# Outline

- Motivation
- Community background
- Data collection and analysis
- Cost estimate
- Environmental Impact Assessment
- Conclusion
- Works cited



# Motivation

- We are students looking for practice.
- We are professionals with useful skills.
- Clean water is considered by many to be a human right, and we have an opportunity to promote that right.



# Community Background

- Political center of the Hato Pilón region
- Education up to the eighth grade level
- Artisan crafts
- Subsistence farming: beans, maize, rice
- Three months of dry season
- Four basic neighborhoods, one with running water



# Data Collection

- Water quality tests
- Flow estimates
- Topographical land surveying
- Initial Constraints
- Population and water use data



# Visual Observations

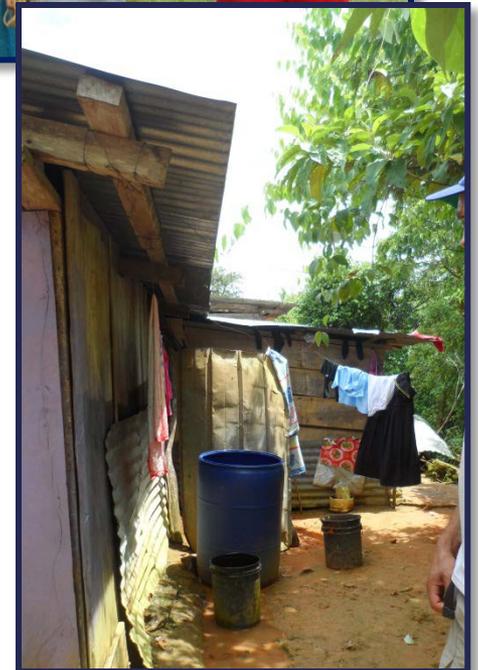
- **Community layouts**
  - Four communities
  - Important buildings
  - Paths and terrain
- **Basic organization**
  - Municipal center
  - Committee system
- **Examination of existing system in Hato Pilón Abajo**
  - Installed five years ago by the municipal government



Photos By: Team Hard Body

# Demographics and Current Use

- Population: 256 people
  - Average size: 6-9 people
  - 47 household requested taps
- Current Use
  - 3.5 gallons per person per day
  - Design goal: 20 gallons per person per day
- Current water sources
  - Some rainwater catchment
  - River water for household tasks and hygiene
  - Some walk up to 20 min for clean water



# Proposed Spring Source Water Quality

- **Good water quality**
  - 0 *E. Coli*
  - 22 CFU / 100 mL of total coliform counts
  - 20 CFU / 100 mL aerobic bacteria
  - Turbidity ~ 1 NTU
- **Sufficient water quantity**
  - Estimated flow rate 24 gal/min
  - Volumetric flow exceeds estimated water consumption

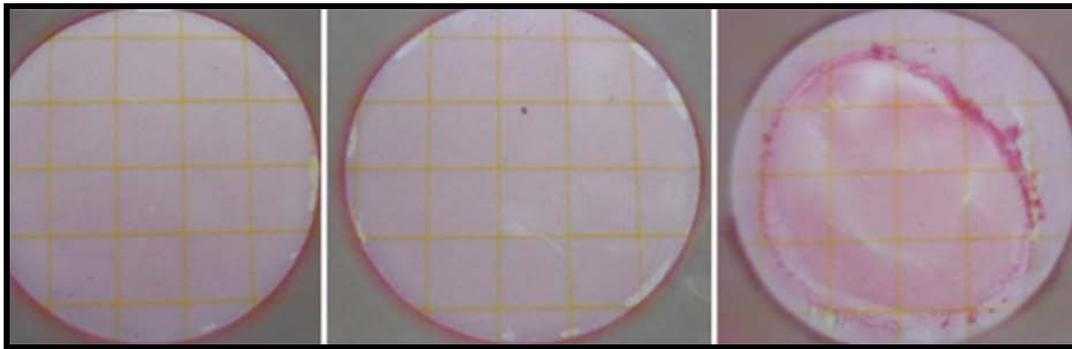


Photo by Team Hard Body

# Surveying Topographical Overview

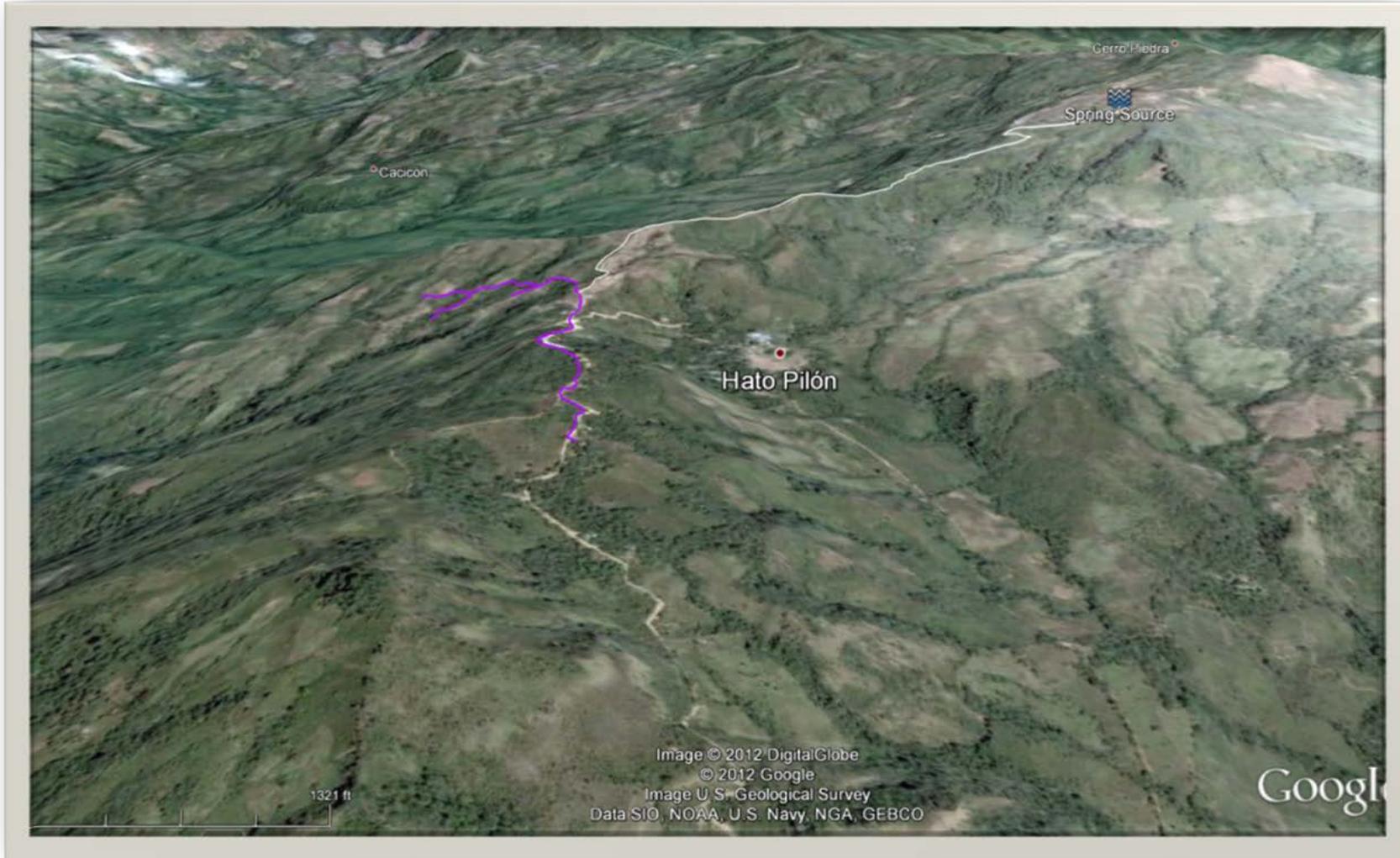


Image courtesy of Google Earth Pro

# Hato Pílon Arriba



Image courtesy of Google Earth Pro

# Cerro Peña



Image courtesy of Google Earth Pro

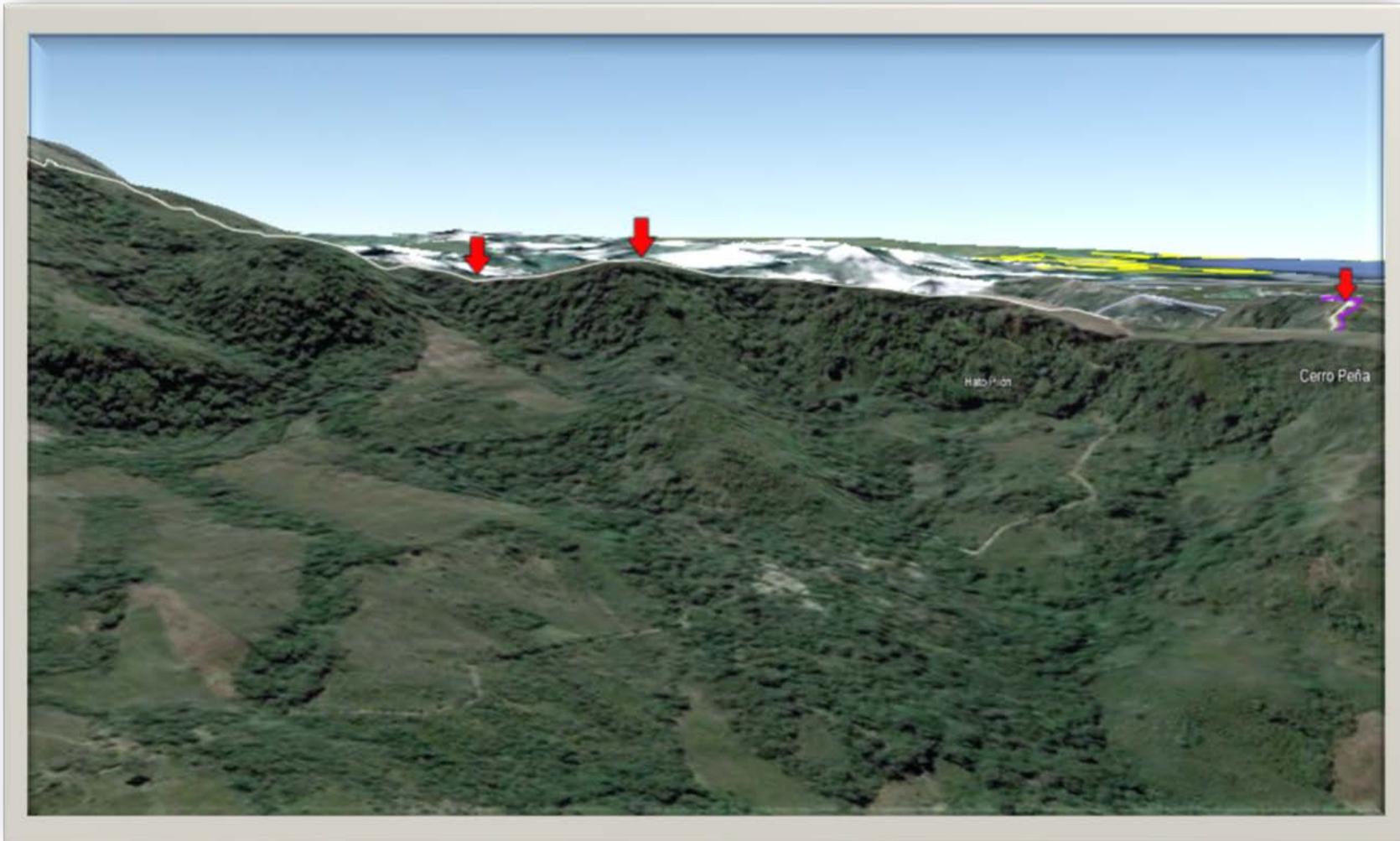
# Cerro Mesa



Image courtesy of Google Earth Pro

# Initial Observations

- Highs and lows not ideal for a gravity-fed system



# Water Collection

- Spring Box: protects water seeping from ground surface

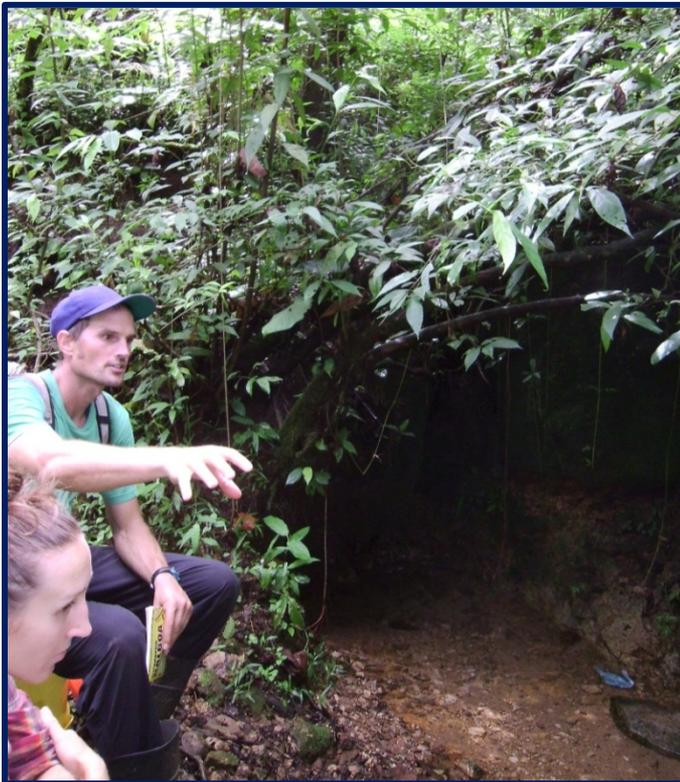
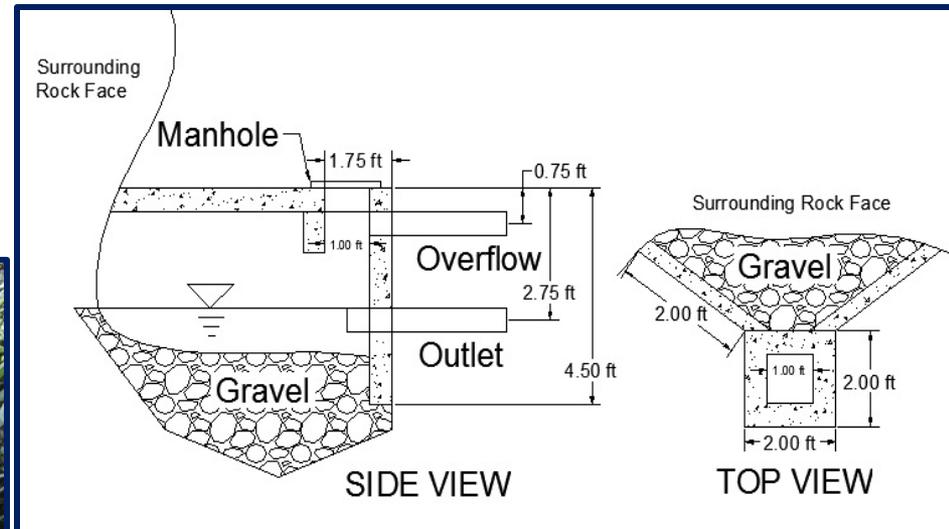


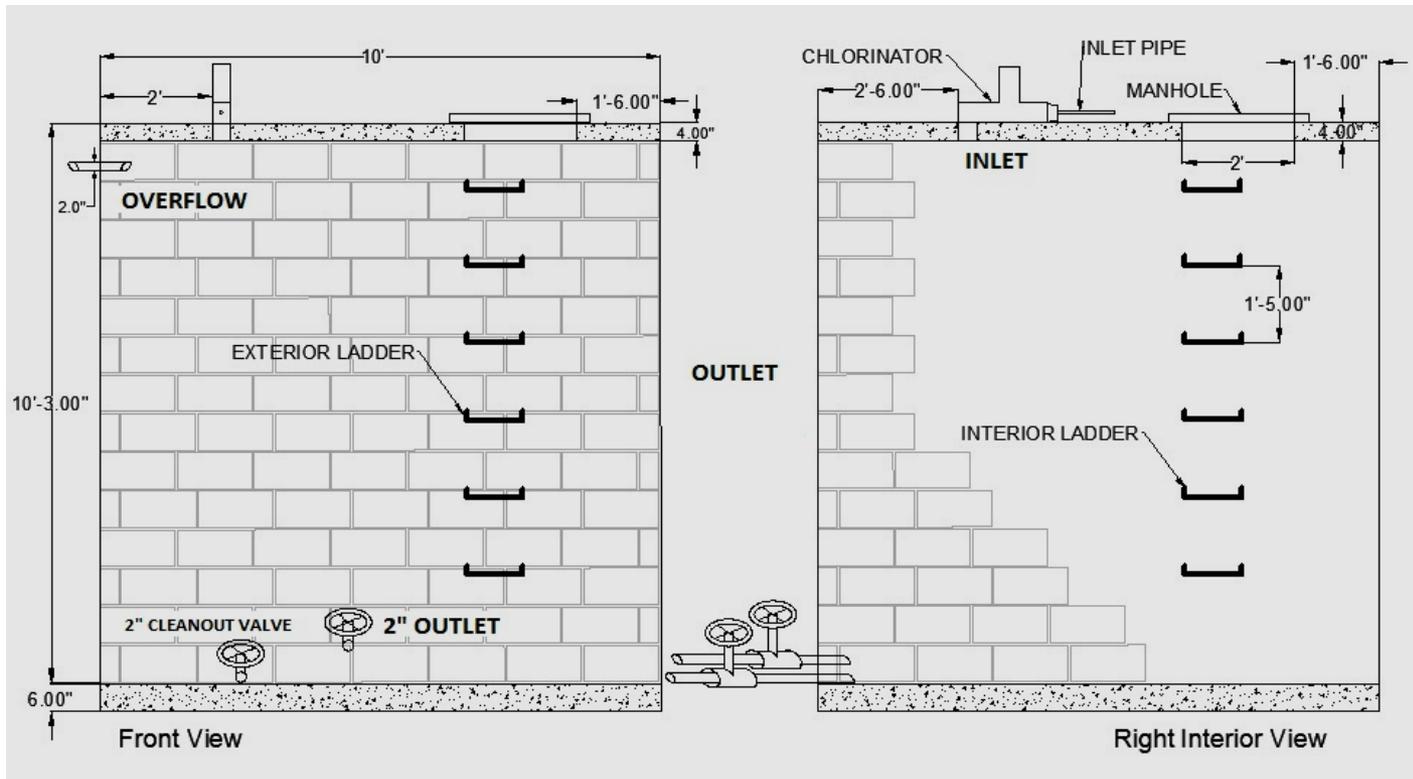
Photo by Team Hard Body



Created by Rebecca Bender

# Water Storage

- **Storage Tank:** holds enough water to meet pressure and supply needs for one day



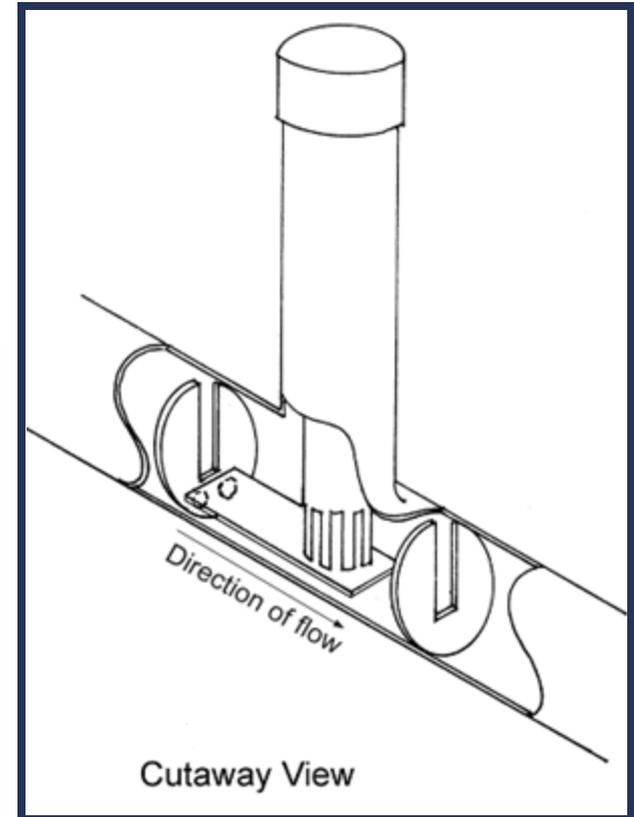
Created by Rebecca Bender

# Water Treatment

- In-line chlorinator
- Less than \$100



Design and photos courtesy of Compatible Technology International



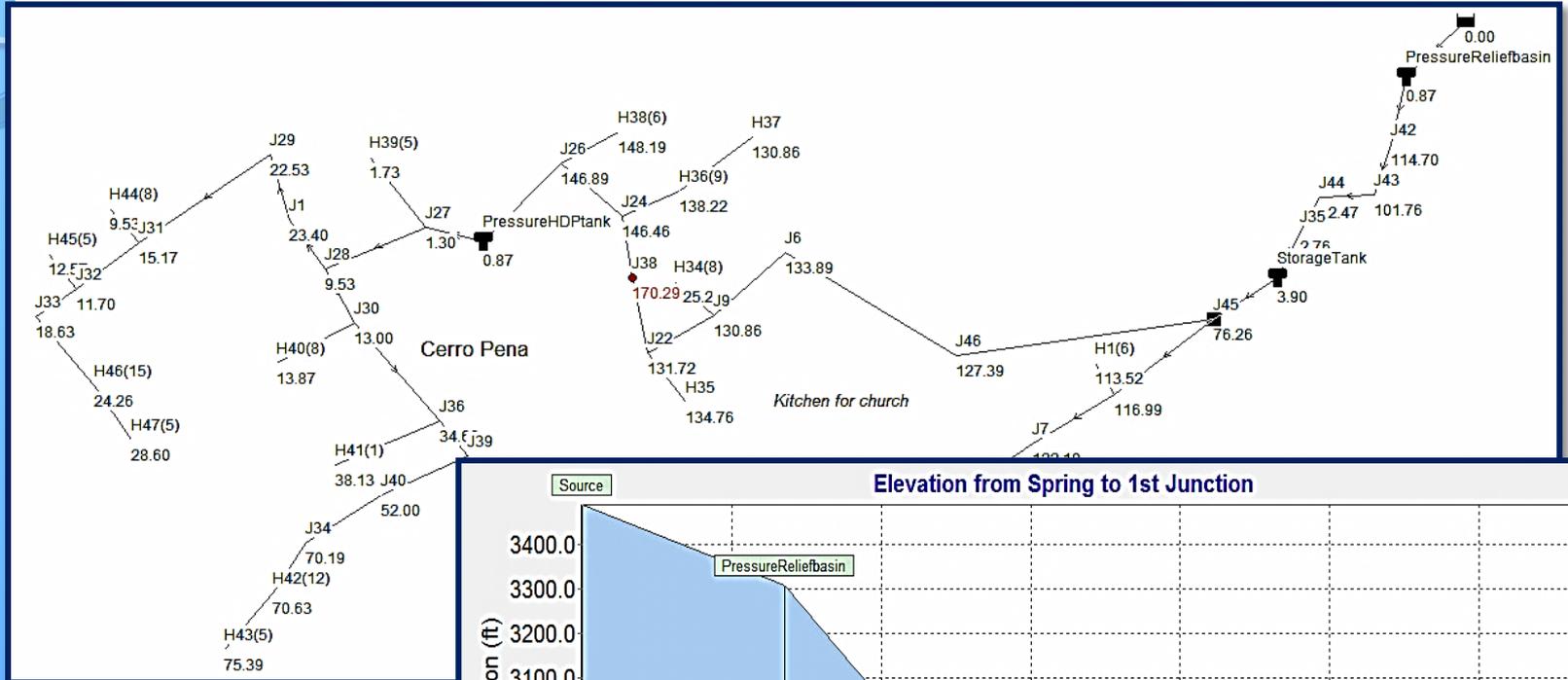
# Why Chlorine?

- Potent Germicide
- Taste and Odor Control
- Biological Growth Control
- Chemical Control

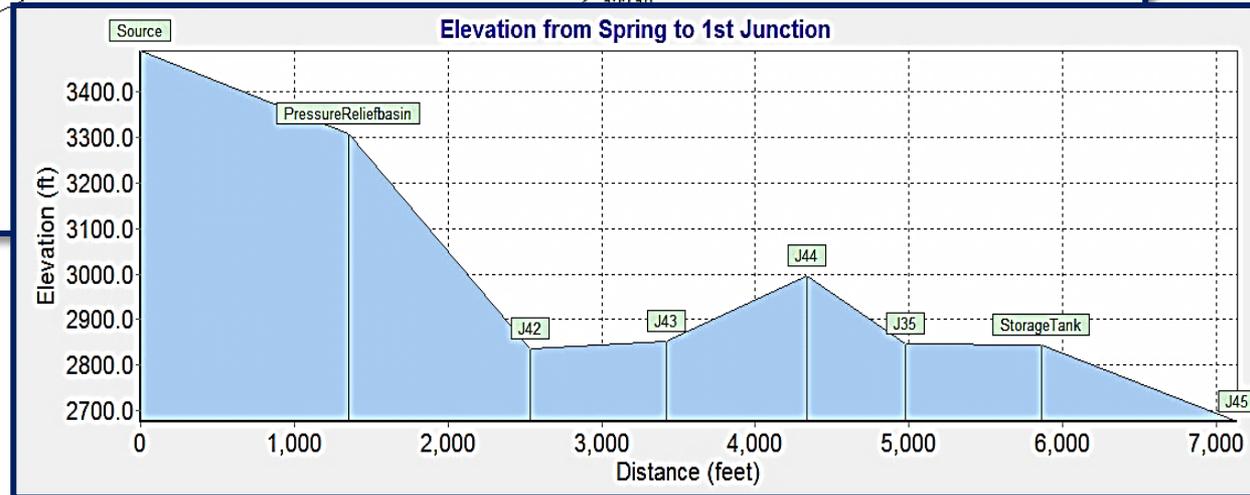


Photo courtesy of: <http://www.honyam-chemical.com>

# EPANET Hydrology Model



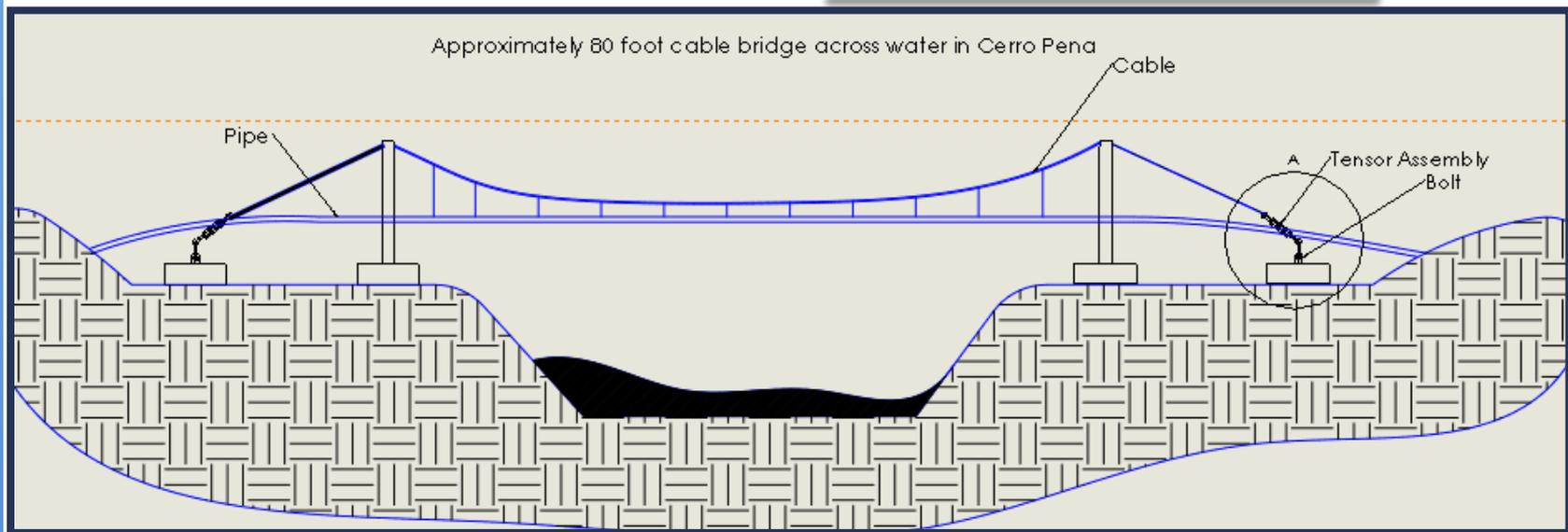
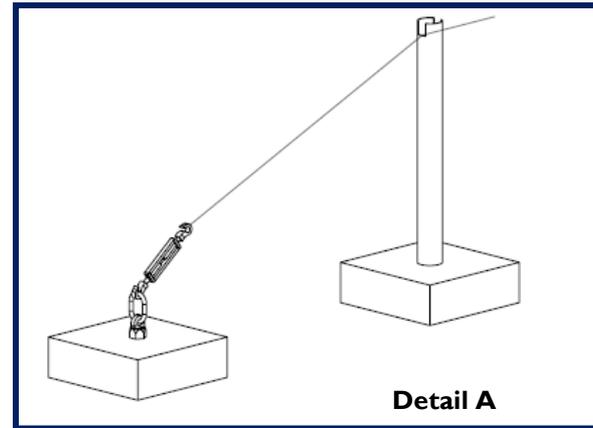
Difficulties include overcoming elevation changes



Images from EPANET model developed by Angella Mickowski

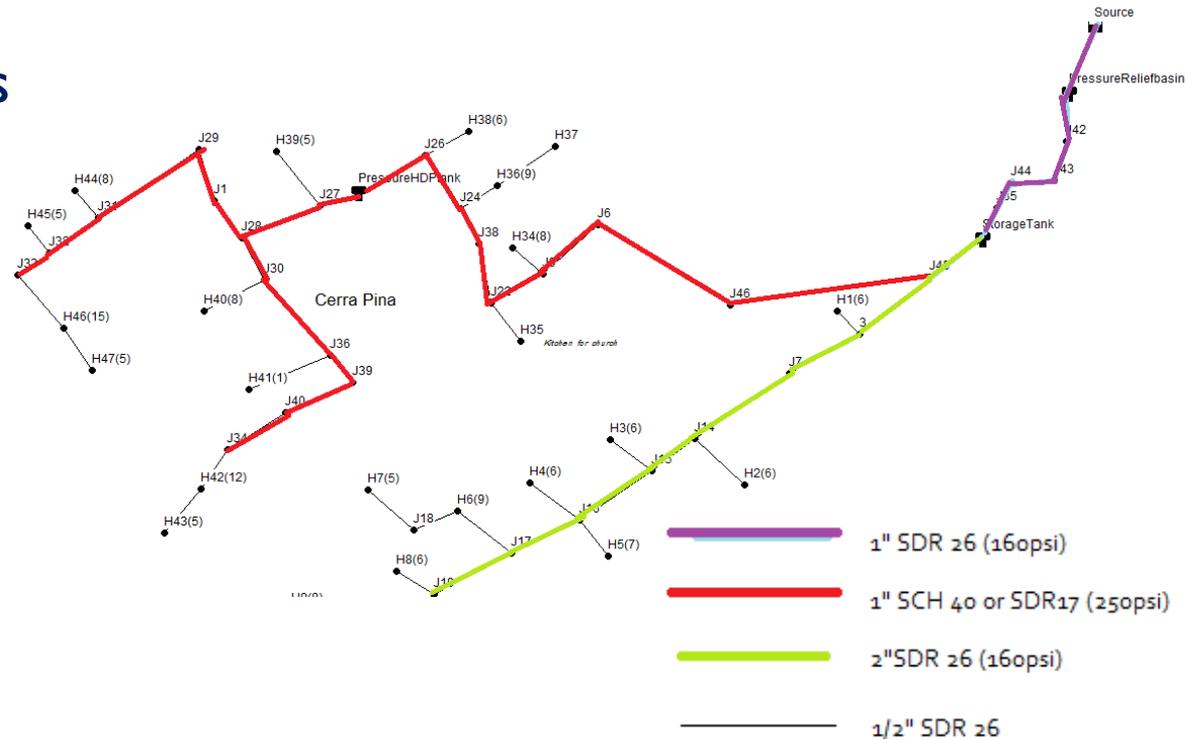
# Cable Bridge Assembly

- Overcoming a steep ravine and sharp turn along road



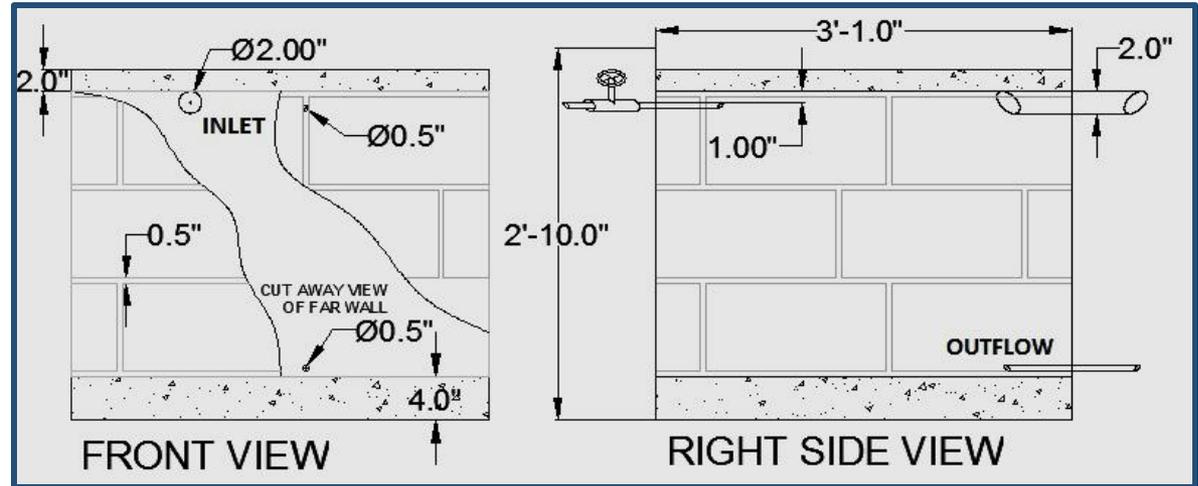
# Pipeline recommendations

- Distribution from spring source to homes
- Elevation challenges
- Route to be followed
- Protection
- High pressures
- Pipe selection
- Assembly

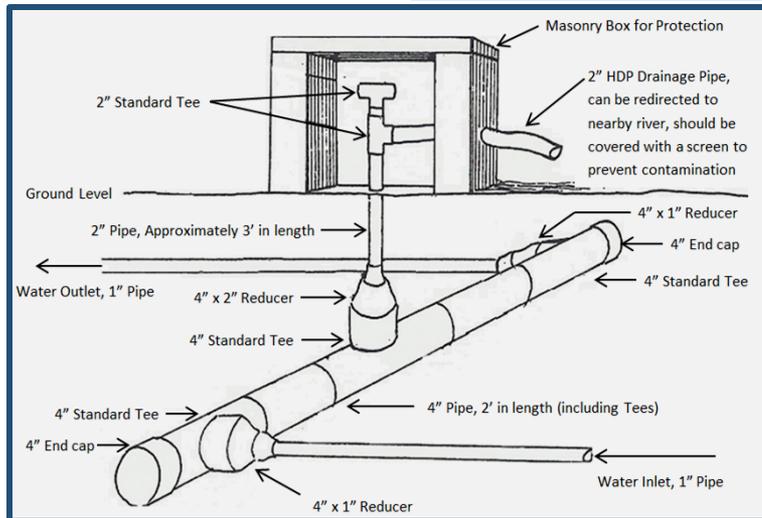


# Water Pressure Relief

**Break Pressure Tank:** Returns the system to atmospheric pressure



Created by Rebecca Bender

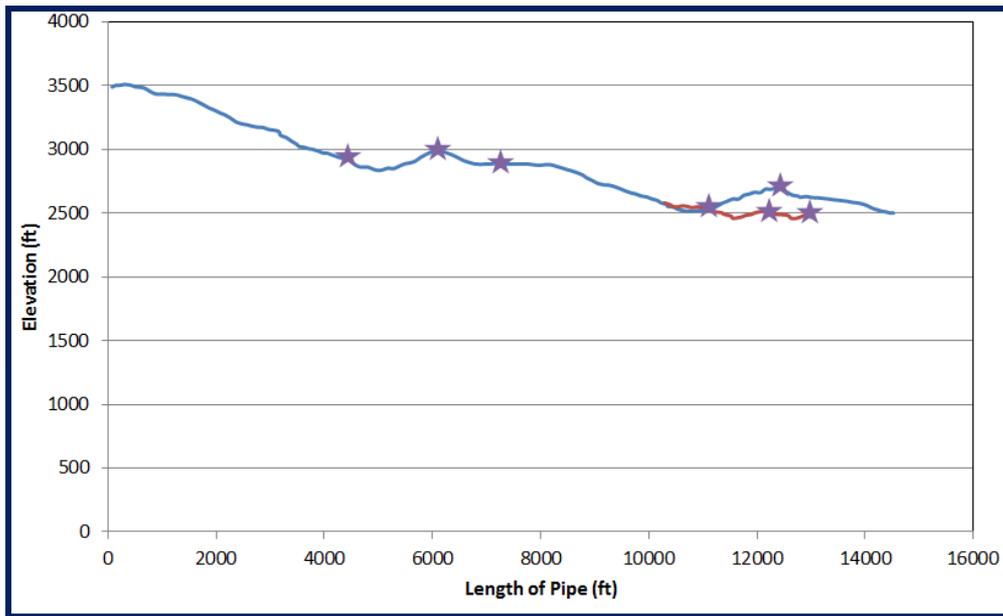


**HDP Break Pressure Tank:**  
Maintains some pressure, prevents contamination

Image courtesy of Thomas Jordan Jr.

# Air Release Valves

- To be used at high points
- Prevent blockage
- Can be assembled with simple materials



Created by Kelsey Maijala

## Air Release Valve Locations

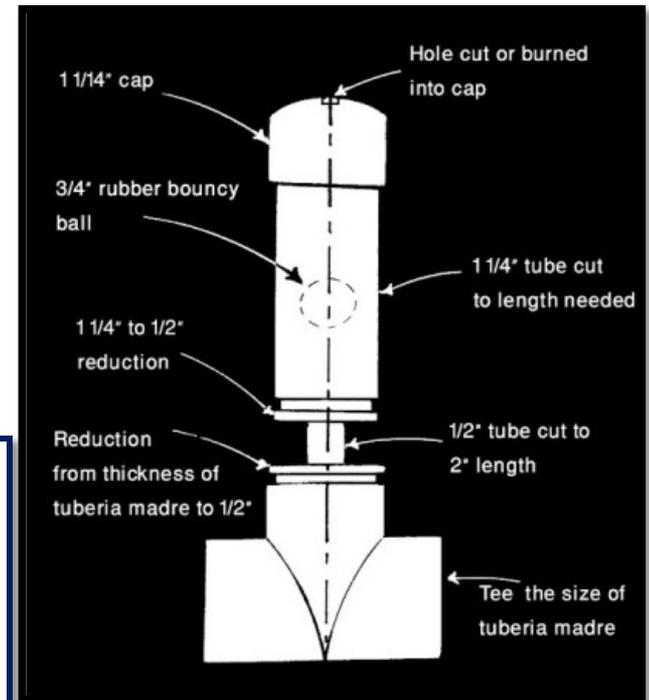


Image provided by Erica Jones

## Air Release Valve Construction

# Maintenance Valves

- Isolation for repairs
- Ball valves
- Locations
- Underground installation
- Water hammer considerations
  - If a valve is opened or shut too quickly, there can be a shock wave conveyed through the system
  - Location is critical

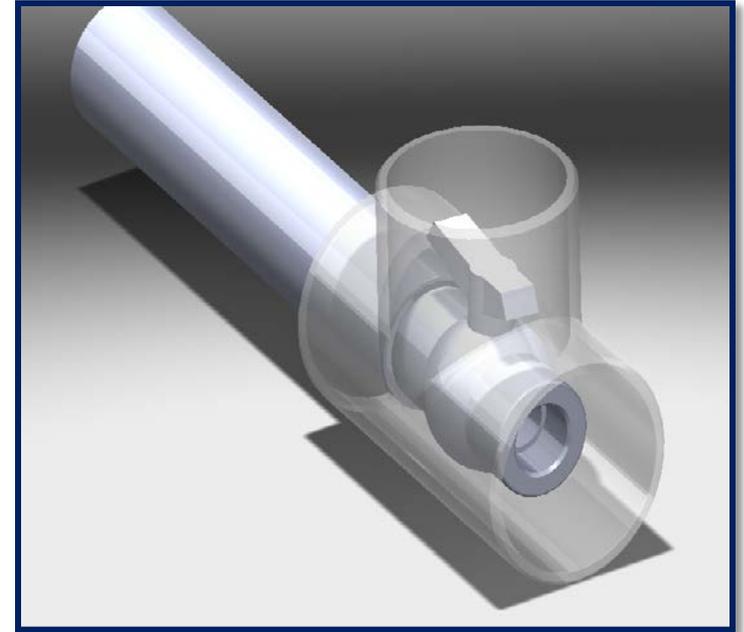


Image designed by Angella Mickowski

# Distribution Branches

- Flow reducers on branches
- Consistent water distribution
- Additional lock-out valves
- Spigot construction
- Support



Flow Reducers for  
branches

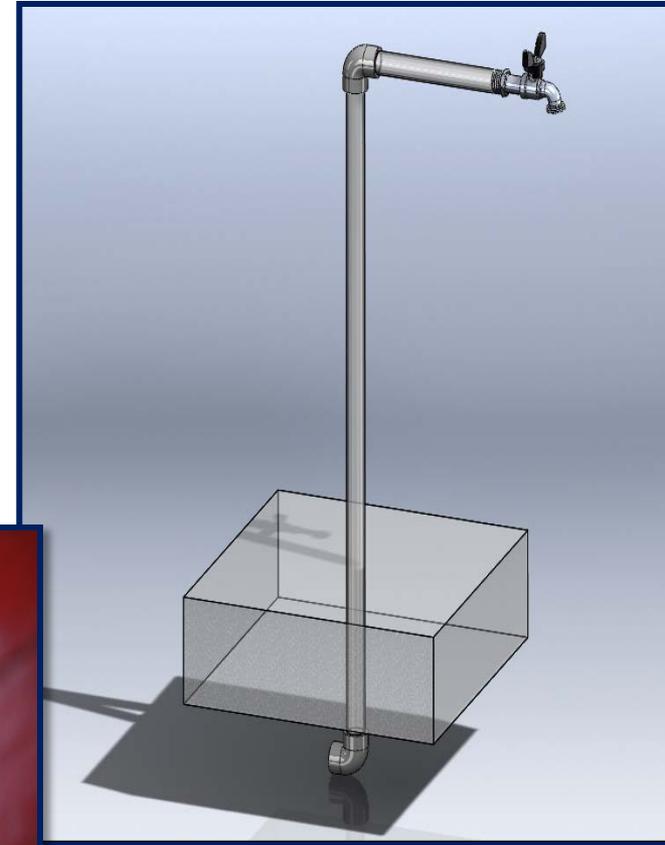


Image designed by Angella Mickowski

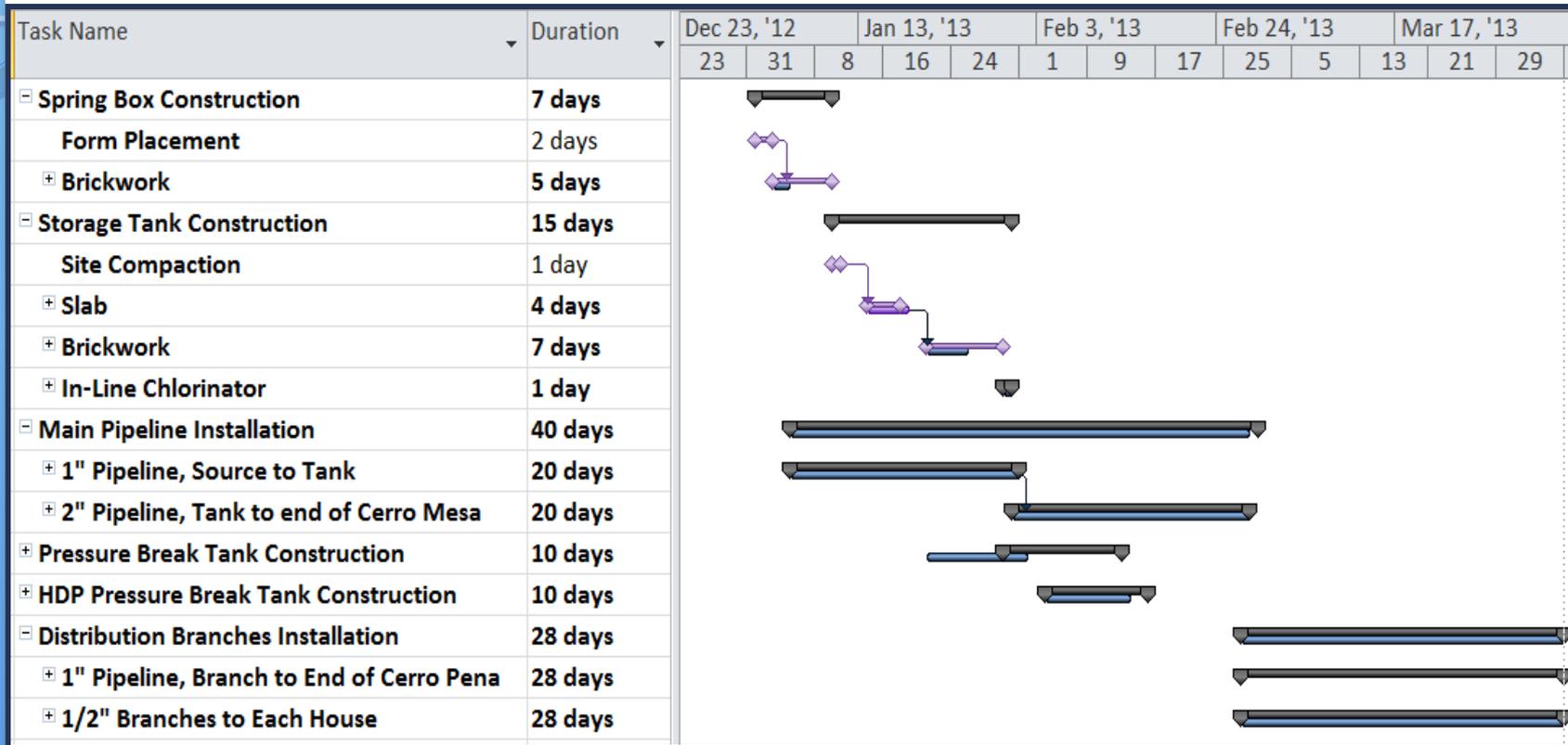
Example of Spigot  
Construction

# Estimated Cost

- Local materials  
\$ 7,965
- Skilled labor  
\$1,254
- Unskilled labor  
In Kind Service
- Cost for each spigot  
\$0.50 per month

<b>Materials</b>	
<b>Total Cost Per Unit</b>	<b>Cost</b>
<u>Spring Box Total</u>	\$121
<u>Main Pipeline Total</u>	\$4,552
<u>Pressure Break Total</u>	\$84
<u>Storage Tank Total</u>	\$745
<u>HDP Relief Total</u>	\$103
<u>Distribution Total</u>	\$1,933
<u>Chlorinator Total</u>	\$64
<u>Air Release Total</u>	\$364
<b><u>Total Materials</u></b>	<b>\$7,965</b>
<b>Skilled Labor</b>	<b>\$1,254</b>
<b>Unskilled Labor</b>	<b>\$0</b>
<b>All included</b>	<b><u>\$9,219</u></b>

# Construction Schedule



Created by Rebecca Bender

# Maintenance and Operation

- Standing water committee
- Storage tank and pipeline cleaning
- Chlorine replenishment
- Maintenance and pressure checks



# Environmental Impact Assessment

Law No. 41 Established July 1998

Regulated Activities Include:

- The use or discharge of water.
- Treatment of sewage and potable water.

Recommendations :

- Divert overflow back to nearest water source
- Compact after digging to prevent erosion
- Keep streams and creeks clear of extra fill

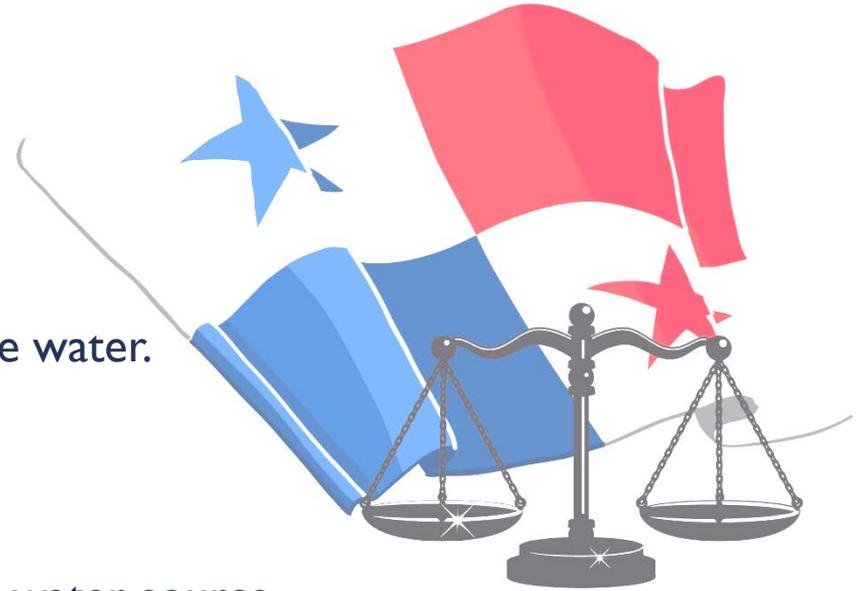


Image courtesy of Juliette Passer, Esq.

# Conclusion

Community needs  
Development capacity  
Engineering feasibility



# Acknowledgements

- People of Hato Pilón
- Faculty Advisors
  - Dr. David Watkins
  - Mike Drewyor (P.E.)
  - Dr. Brian Barkdoll
- Peace Corps Volunteers
  - Pete and Kelly Brands
  - Erica Jones

# Citations

- Central Intelligence Agency. (2012, November 14). *The World Fact Book*. Retrieved 2012, from International Organization for Migration: <https://www.cia.gov/library/publications/the-world-factbook/geos/pm.html>
- Corp., 3. (n.d.). *3M Petrifilm Aerobic Count Plates*. Retrieved August 22, 2012, from [http://www.3m.com/intl/kr/microbiology/p\\_aerobic/use3.pdf](http://www.3m.com/intl/kr/microbiology/p_aerobic/use3.pdf)
- Corp., 3. (n.d.). *3M Petrifilm E.Coli/Coliform Count Plate*. Retrieved August 22, 2012, from [http://www.3m.com/intl/kr/microbiology/p\\_ecoli/use3.pdf](http://www.3m.com/intl/kr/microbiology/p_ecoli/use3.pdf)
- Global Water. (n.d.). *How to construct a spring box*. Retrieved from [http://www.globalwater.org/pdf/Spring\\_Box.pdf](http://www.globalwater.org/pdf/Spring_Box.pdf)
- Hart, W. (2003). *Protective Structures for Springs*. Retrieved from <http://sites.tufts.edu/ewb/files/2010/04/Spring-Box-Design.pdf>
- HERNANDEZ VIRVIESCAS, M. T. (n.d.). *THE GENERAL ENVIRONMENTAL LAW OF THE REPUBLIC OF PANAMA*. Retrieved November 2012, from International Network for Environmental Compliance and Enforcement: <http://www.inece.org/5thvol2/virviescas2.pdf>
- Minority Rights Group International. (2008, December). *Panama Overview*. Retrieved November 2012, from World Directory of Minorities and Indigenous People: <http://www.minorityrights.org/?lid=4214#current>
- Pete and Kelli Brands, E. J. (2012, August 15-21). Ngobe aqueduct system. (T. Hard Body, Interviewer)
- Practical Law. (n.d.). *Environment Panama*. Retrieved November 18, 2012, from Practical Law Company: <http://environment.practicallaw.com/1-508-1137?q=&qp=&qo=&qe=#a917491>
- Sarviel, E. (1998). *Construction Estimating Reference Data*. Craftsman Book Company.
- Thomas D. Jordan, J. (1980). A handbook of gravity-flow water systems. In J. Thomas D. Jordan. Intermediate technology Publications.
- United States Environmental Protection Agency. (2012, August 16). *Drinking Water Research*. Retrieved August 2012, from United States Environmental Protection Agency: <http://www.epa.gov/nrmrl/wswrd/dw/epanet.html>
- Unknown. (n.d.). Air Valve components. Erica Jones.

# Questions ?

