DEVELOPING SUSTAINABLE WATER DISTRIBUTION SYSTEMS IN RURAL PANAMA

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  Civil Engineering

TEAM CANDELA
iDesign 2011

iDesign

12/06/2011

PRESENTATION OUTLINE

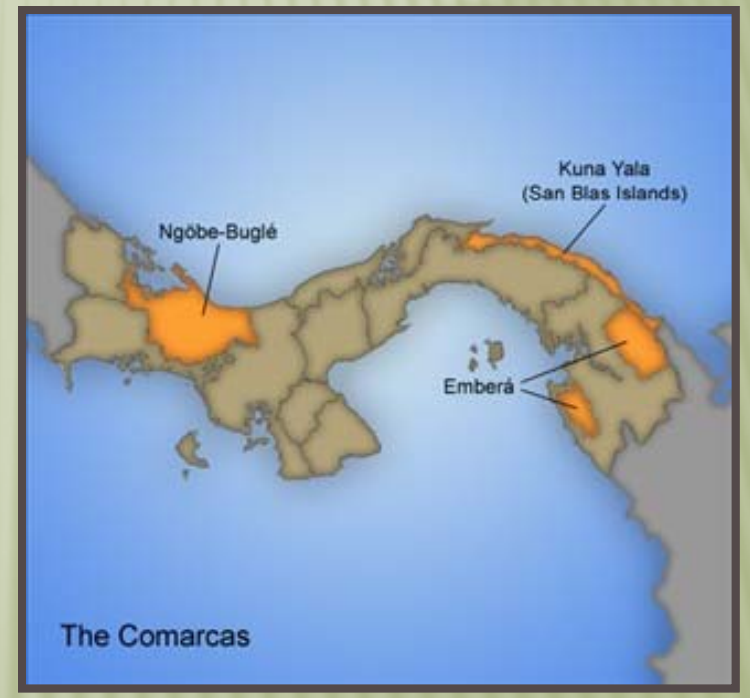
- Project Abstract
- Goals and Objectives
- Community Background
- Methods
- Analysis
- Project Recommendations
- Material Quantities and Project Cost
- Timeline
- Project conclusion
- Acknowledgements
- References

PROJECT ABSTRACT

- Michigan Tech International Senior Design Program (iDesign):
  - Investigation of water distribution system in Candela, Panama
- Objective:
  - Improve water distribution for Candela
- Final design recommendations (short term and long term):
  - 3 Spring Boxes
  - 2 Water Storage Tanks
  - PVC pipe replacement
  - Installation of a solar power pumping and chlorinators
- The total cost estimate: $12,400

COMMUNITY BACKGROUND

- Community:
  - mountainous village of Candela
  - indigenous Ngöbe-Bugle tribe
- Comarca:
  - Indian Reservation in the United States
- Ngöbe-Bugle tribe:
  - consists of approximately 190,000 people
  - six other tribes of indigenous people in Panama



CANDELA, PANAMA

- Candela:
  - 250 people
  - 2 hour hike from the nearest road
  - Within the Talamanca mountain range
- Homes:
  - built out of bamboo walls, corrugated metal roofs, and dirt floors

THE CANDELA COMMUNITY

Economic Background:

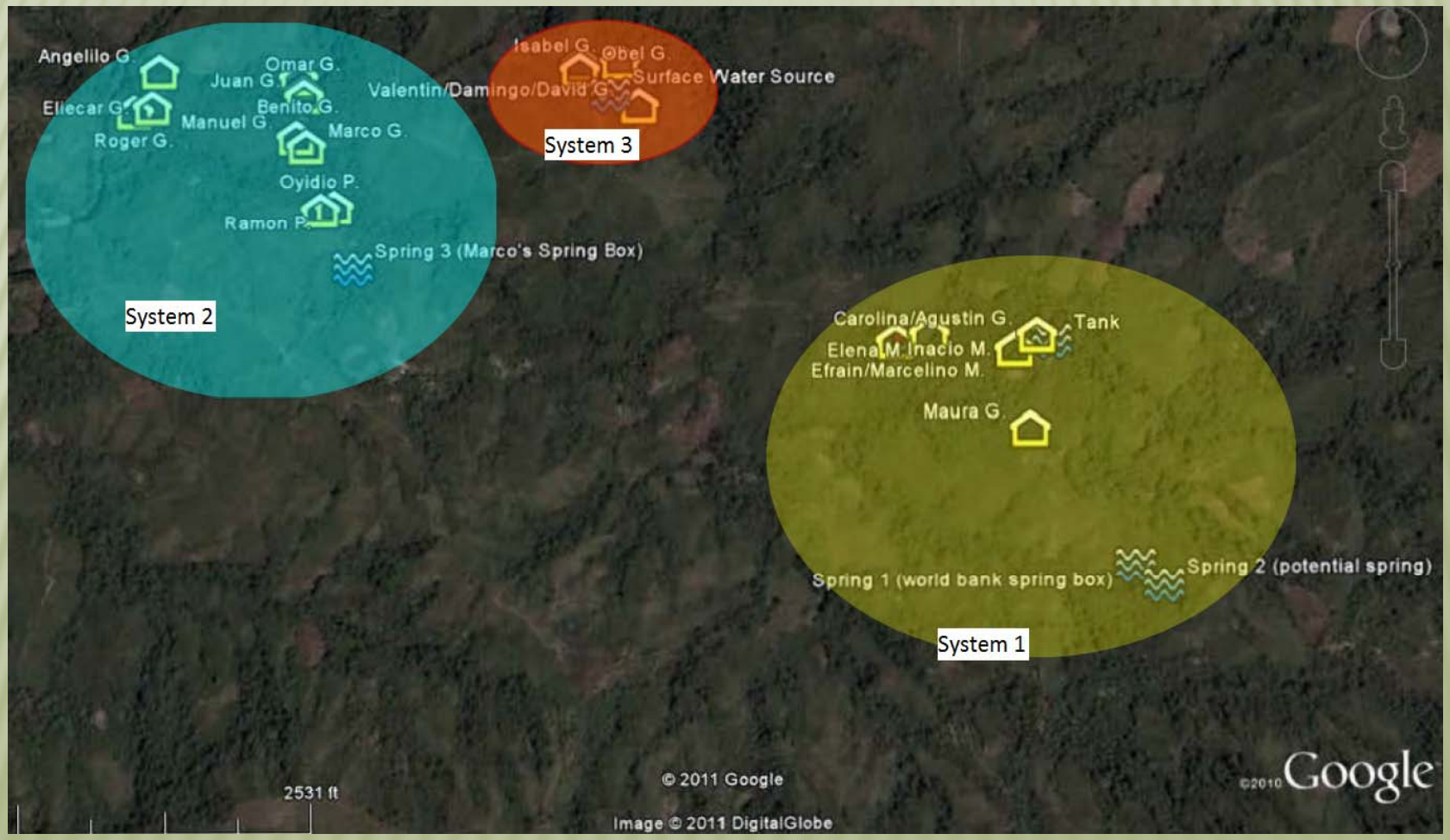
- Subsistence farming
- $50 /month from government given to women
- $1 per year for access to the local health center
- $0.25 monthly fee to the water committee for water system (half of the community)

HISTORY OF WATER DISTRIBUTION

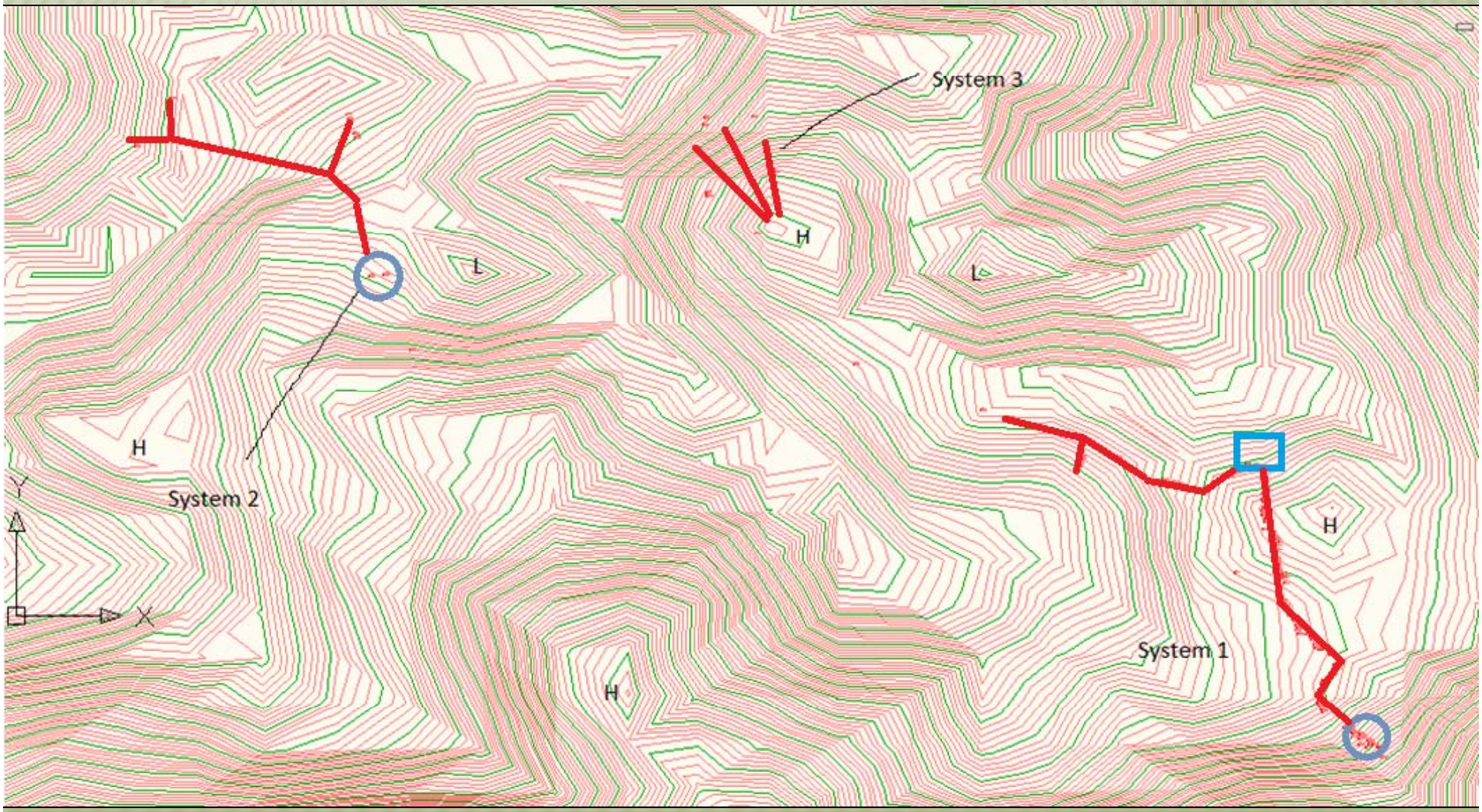
Candela maps drawn by community member Marco:

- Western Side of the Community (Left):
  - Water from System 1
  - Health center is labeled “centro de salud”
- Eastern Side of the Community (Right):
  - Water from Systems 2 and 3

COMMUNITY WATER DISTRIBUTION SYSTEMS



CURRENT SYSTEM:



SYSTEM 1

- In 1999, the World Bank funded a water distribution system
- Consists of a spring box, a water storage tank, and piped to houses
- Gravity fed from spring to house.

SYSTEM 2

- System 1 failed to supply water to the west of the community
- System 2 was made from salvaged pipe
- Utilizes a natural spring source and currently serves 11 homes.

SYSTEM 3

Five houses were still not receiving piped water in the community:

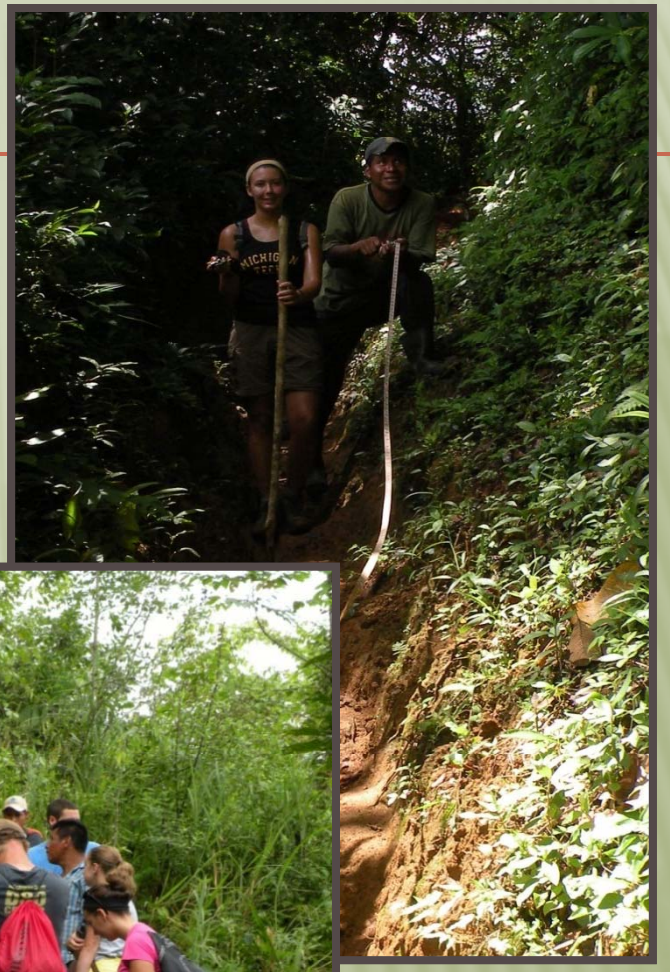
- Three homes are able to utilize surface runoff for about six months of the year
- Gravity fed from runoff water
- Remaining three houses collect water from System 3 and store it for later use

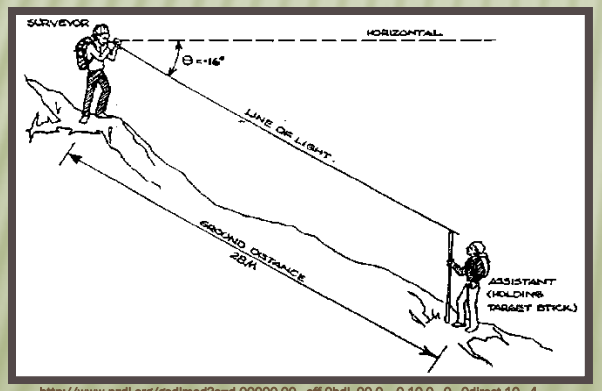
OVERALL COMMUNITY GOALS

- Needs for improved water systems:
  - Access to running water year round
  - A method to treat water
  - A way to keep animals/crustaceans out of the water storage tank and piping system.

METHODS

- Abney Level Surveying
- GPS Mapping
- Water Quality Tests
- Community Surveying





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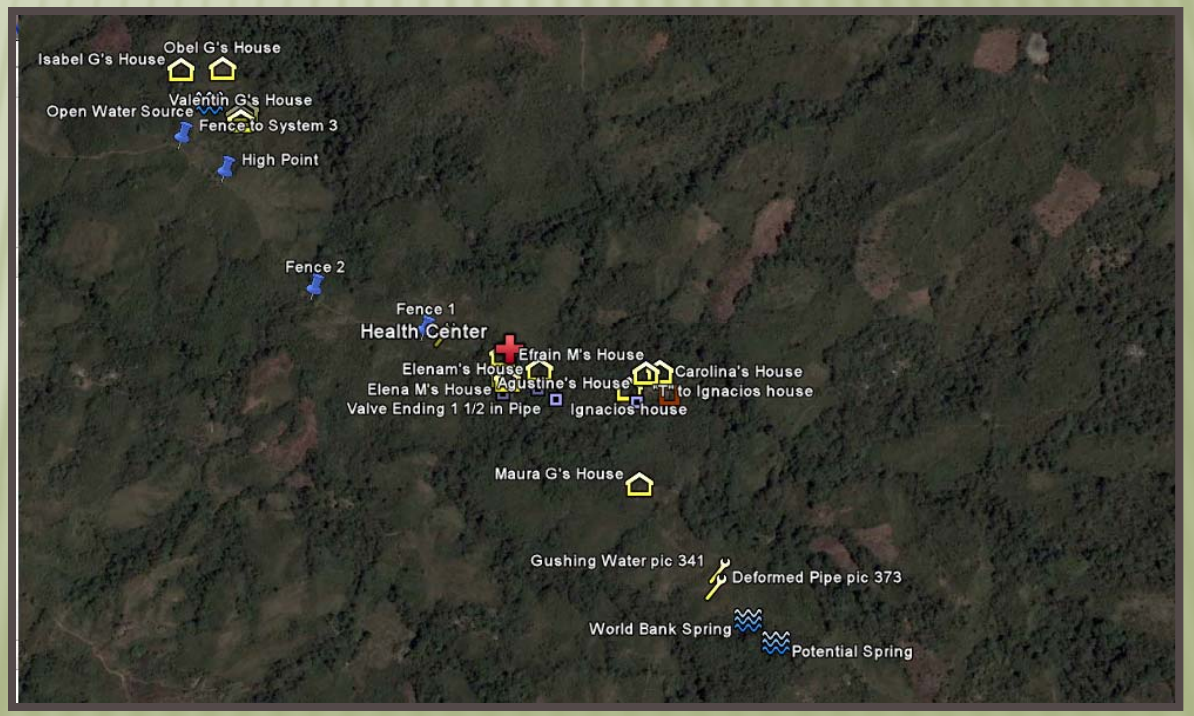
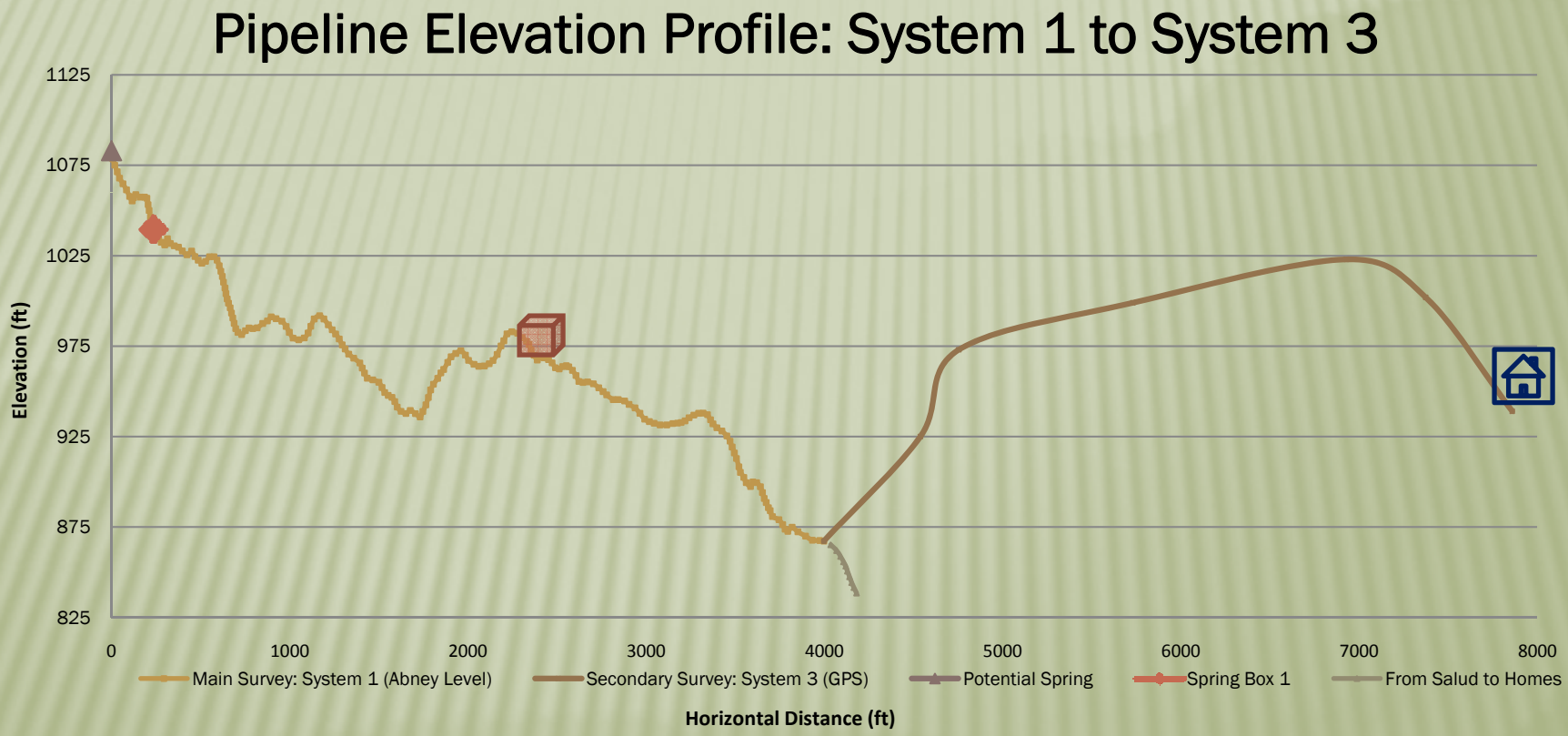
GPS MAPPING

- GPS points recorded throughout community
- Google Earth map generated
- Pipeline profile elevation created (combined with survey points)



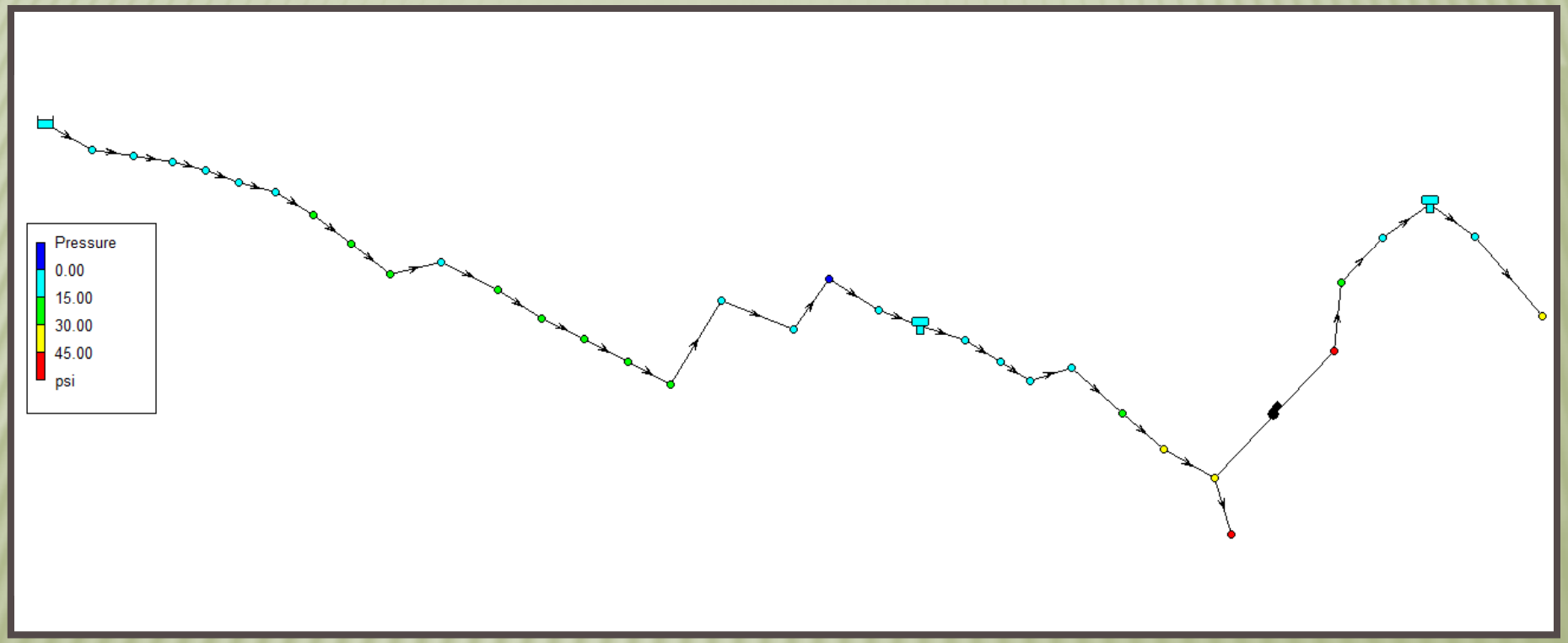
LAND ELEVATION PROFILE:



WATER FLOW RATES

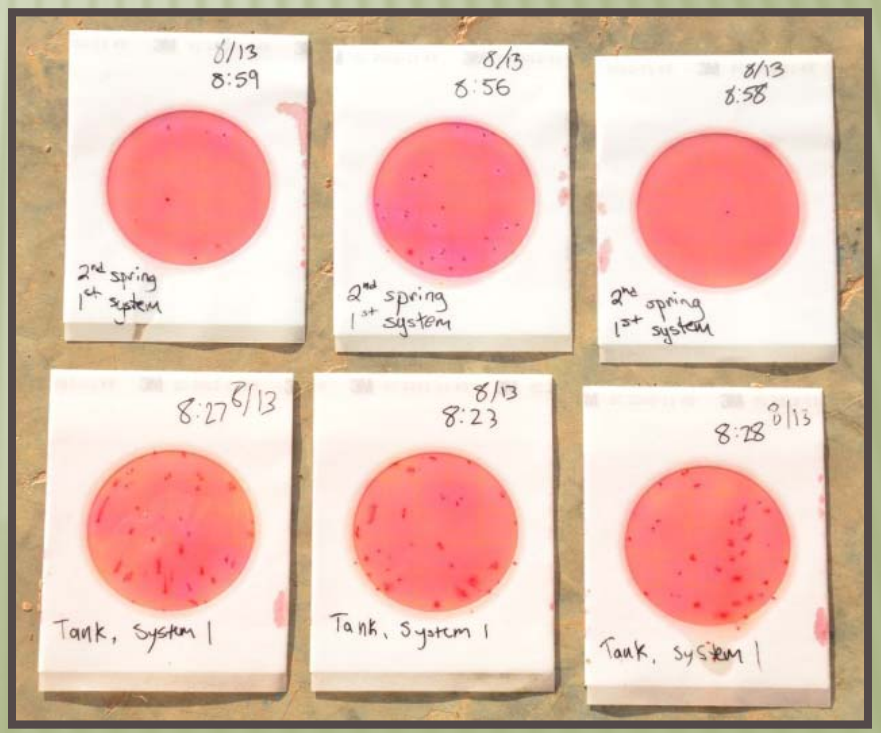
- Volume time method
- System 1:
  - Original spring: 1.81L/sec
  - Potential spring: 1.05 L/sec
- System 2
  - Spring: 1.05L/sec
- System 3:
  - Total: 0.82L/sec

EPANET MODEL



WATER QUALITY TESTS

- 3M Petrifilm E.coli/Coliform Count Plates
- 1ml samples (multiple samples taken)
- No E. coli present in samples
- Significant coliform



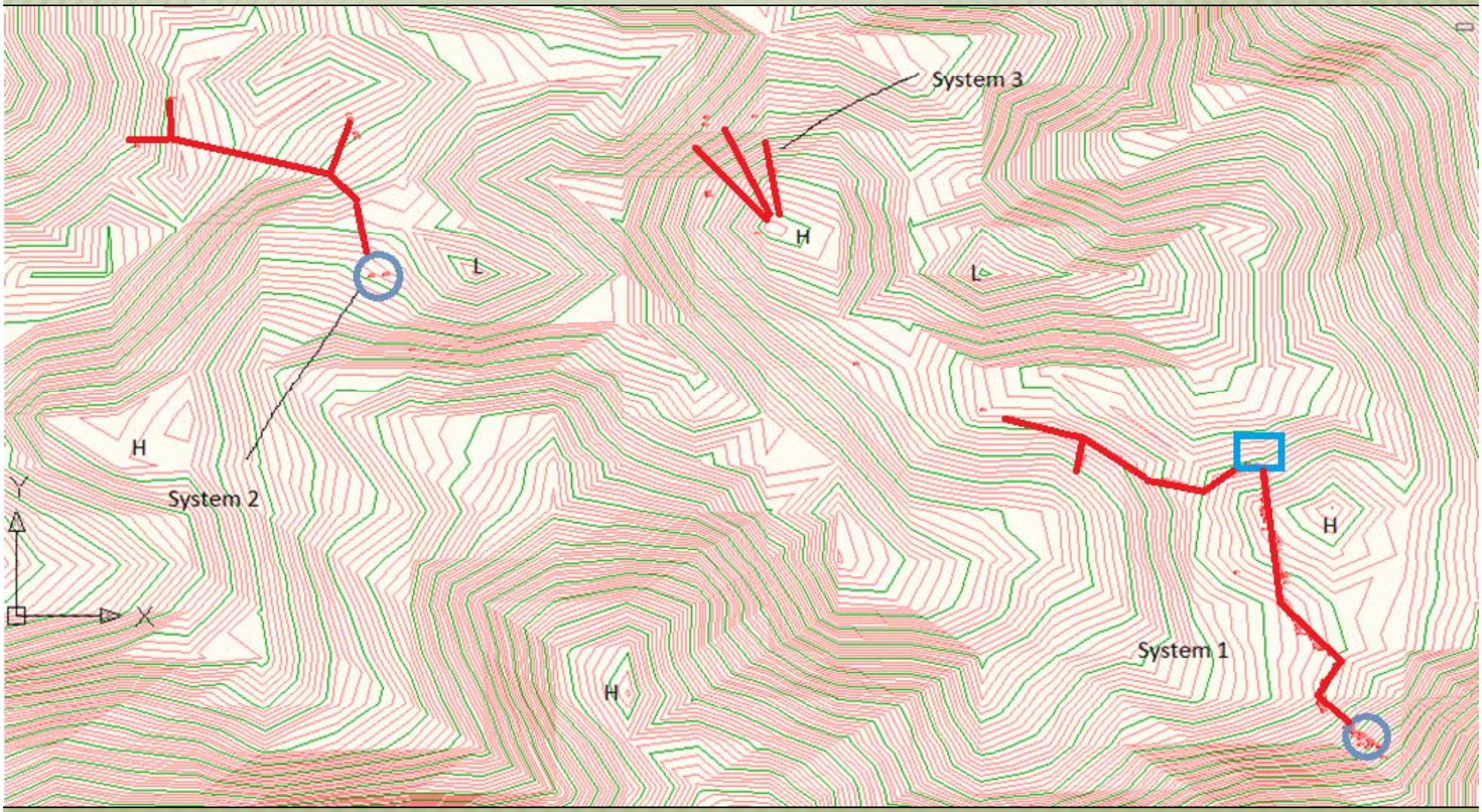
COMMUNITY SURVEYING

- Topics queried:
  - Health
  - sanitation
  - water usage (demand)
- Helped develop overall community goals
- Illness around beginning of the wet season
  - Community connects illnesses to their water

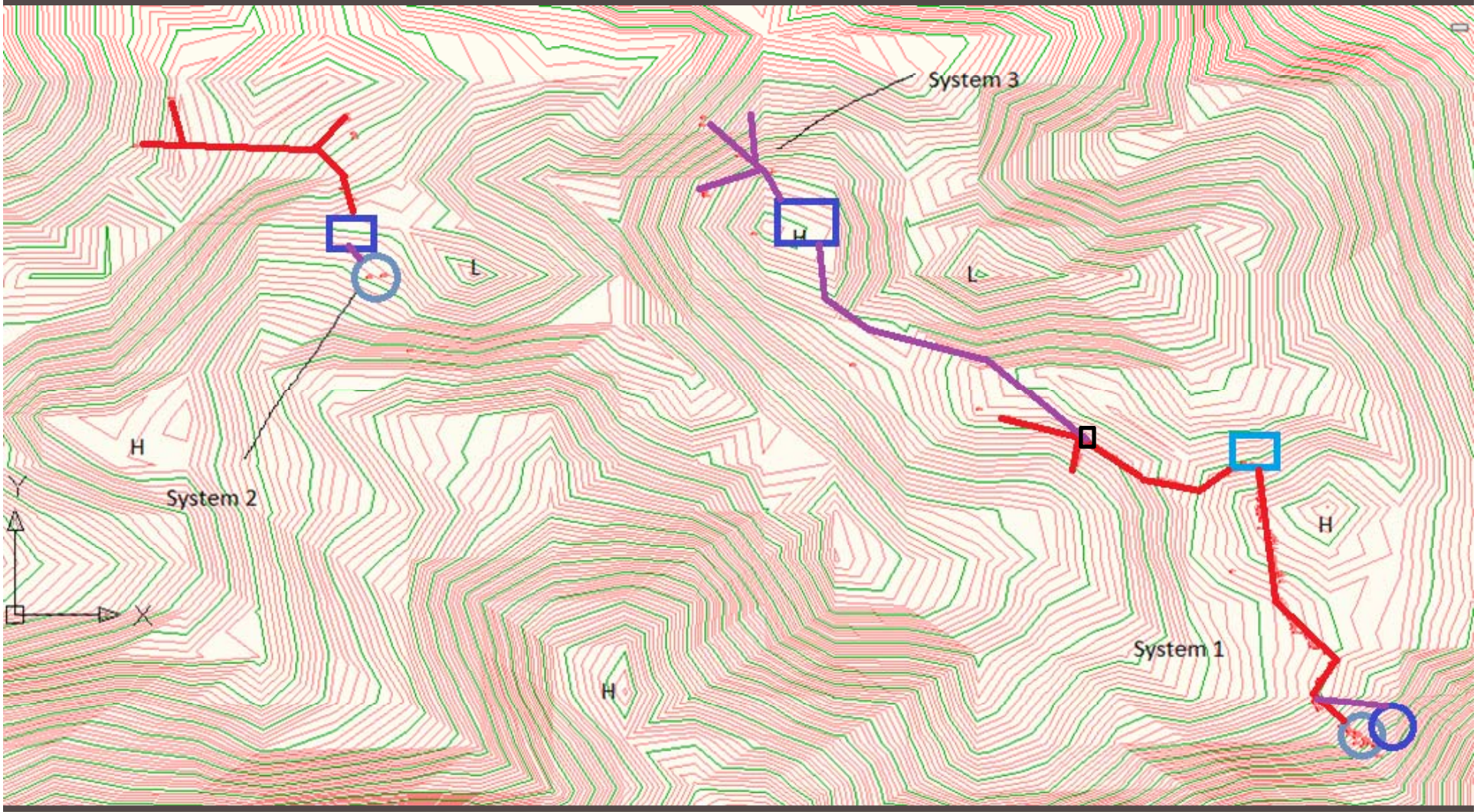
RECOMMENDATIONS

- Immediate
- Long term

CURRENT SYSTEM

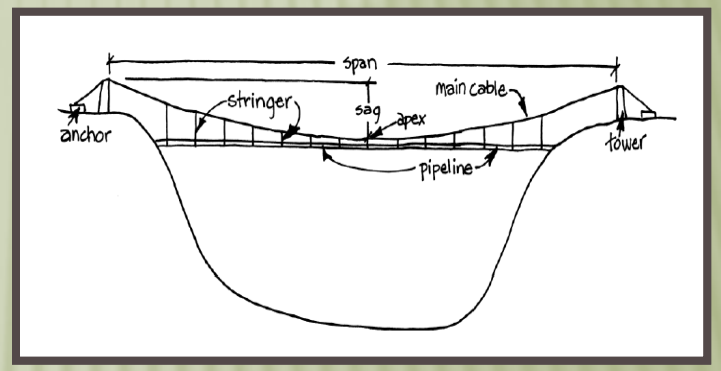


PROPOSED SYSTEM



IMMEDIATE RECOMMENDATIONS

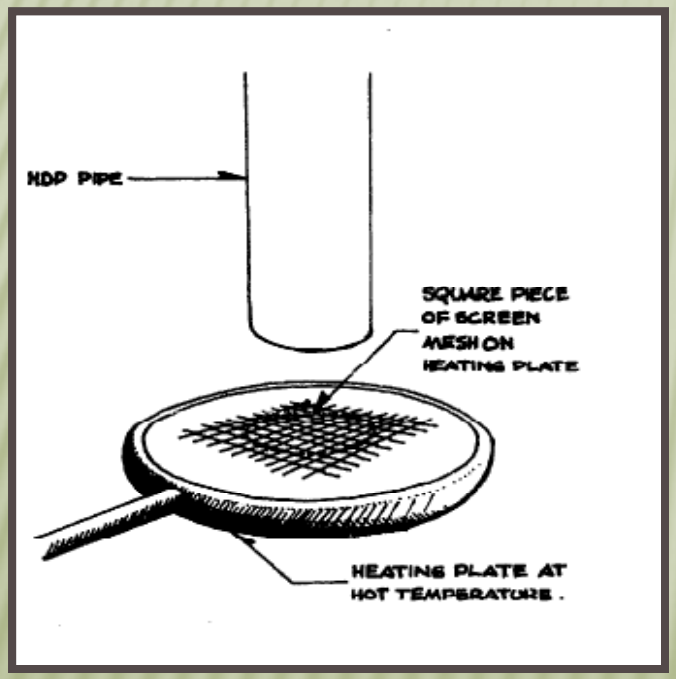
- Bury PVC pipeline/paint or cover the rest
- Support all pipeline crossing ravines
- Fix leaking pipe sections and joints



http://engineersinaction.org

IMMEDIATE RECOMMENDATIONS

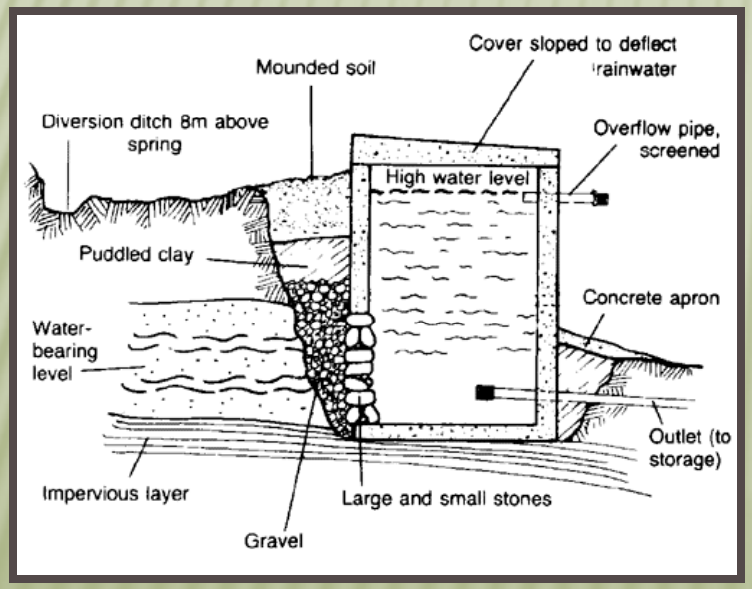
- Outlet screens

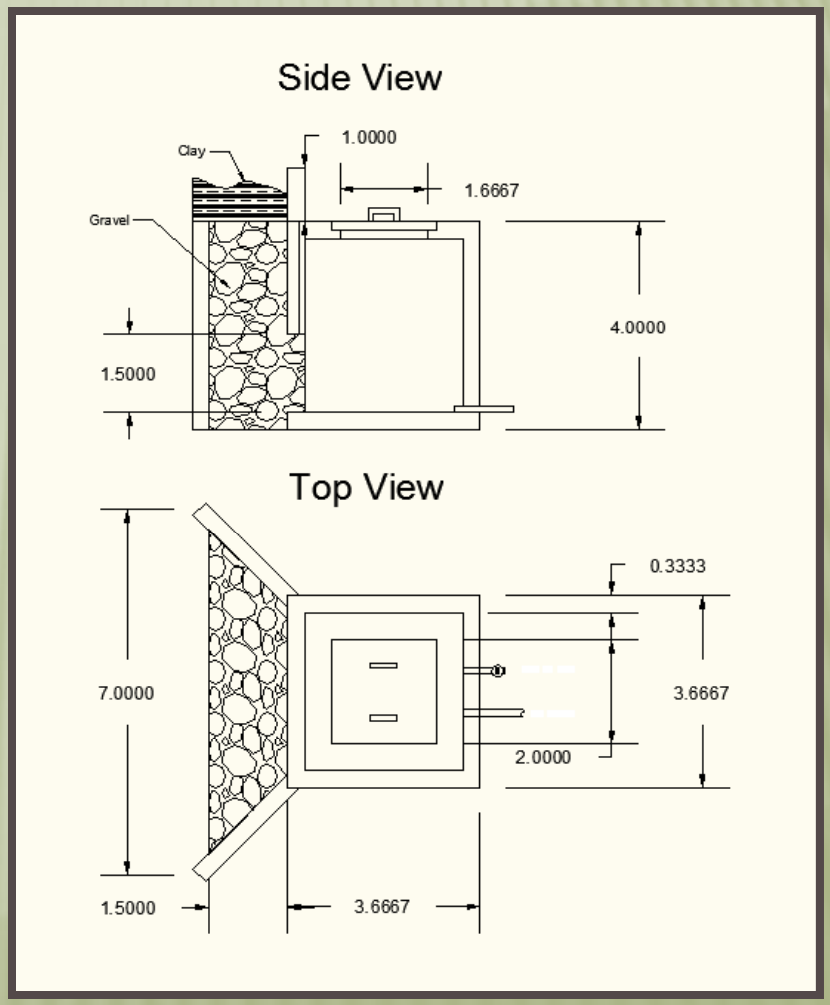


- Boiling water

LONG TERM RECOMMENDATIONS

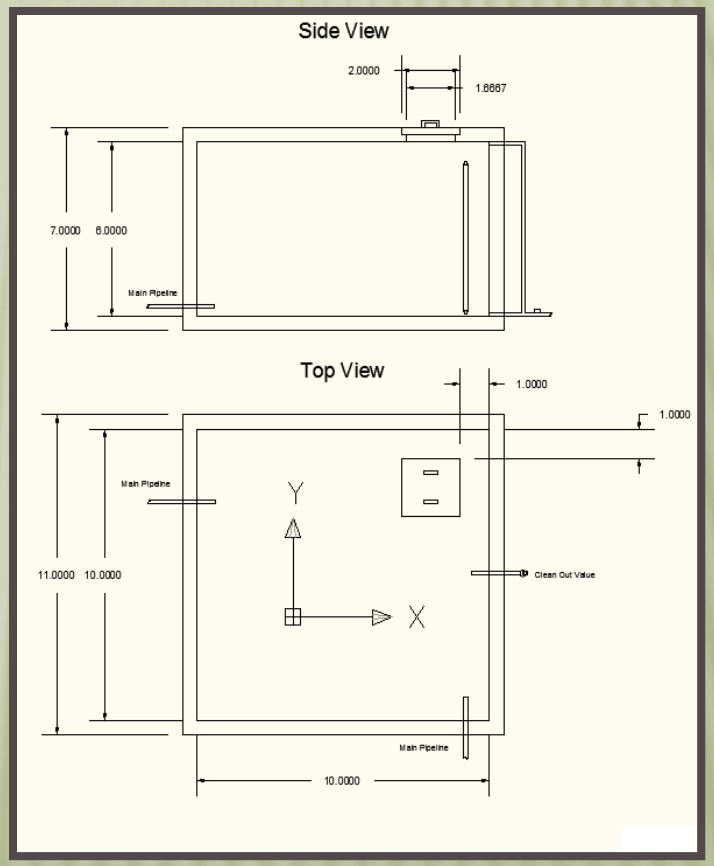
- Renovation and construction of spring boxes





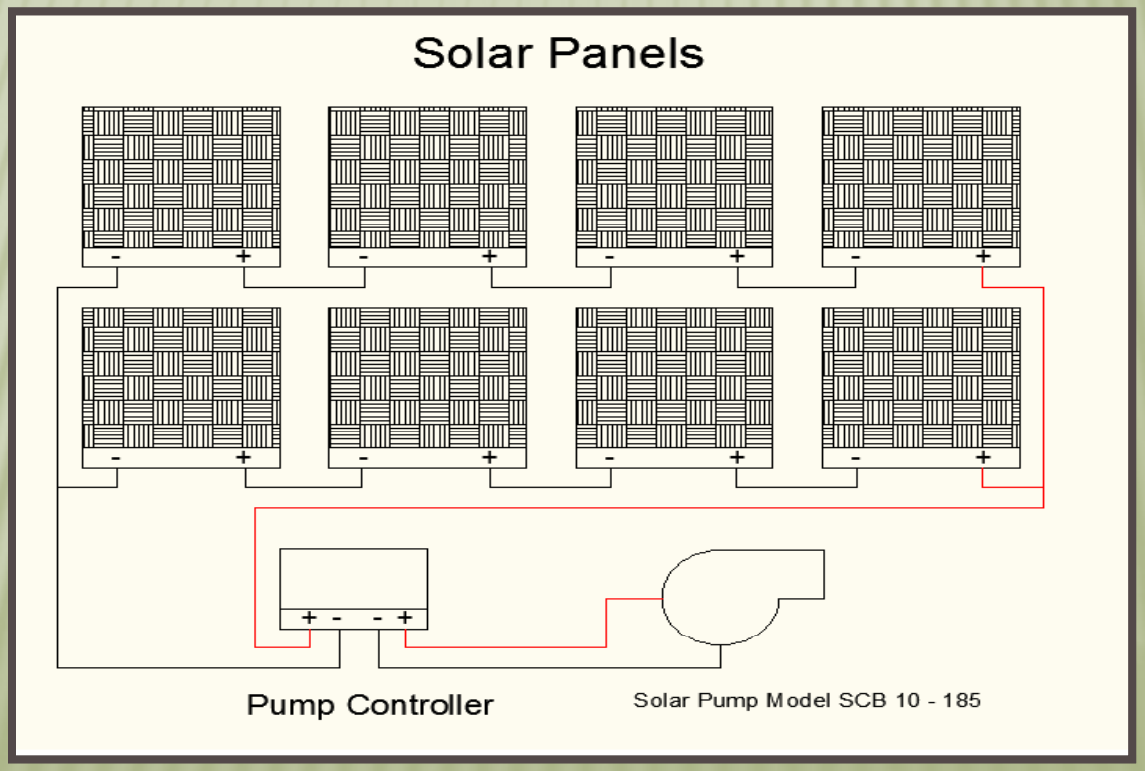
LONG TERM RECOMMENDATIONS

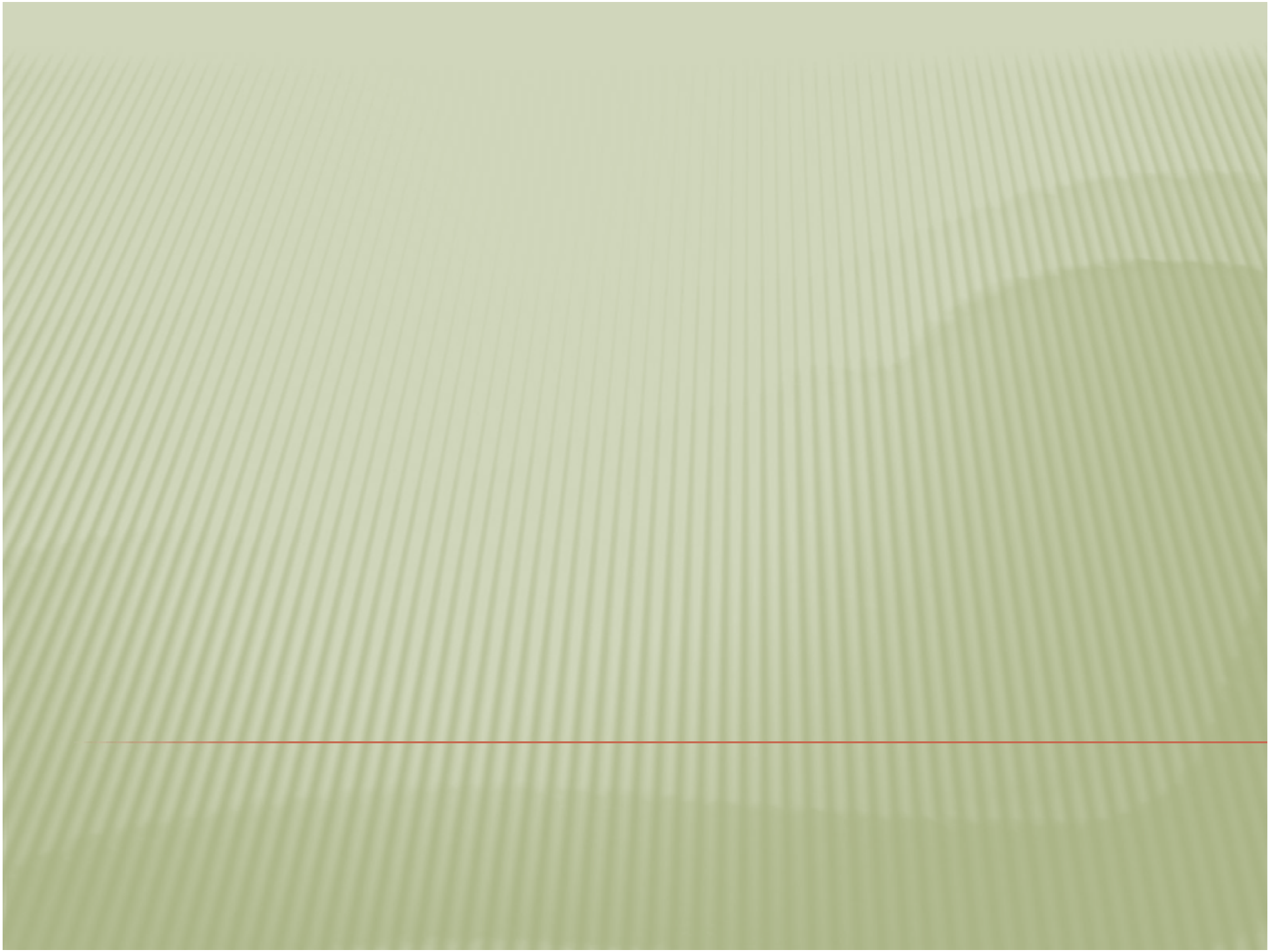
- Construction of 2 Water Storage Tanks
- Tank Design:
  - 4500 gallons
  - 10x10x6ft



LONG TERM RECOMMENDATIONS

- Pipe connection of System 1 to System 3
  - Solar pumping system included

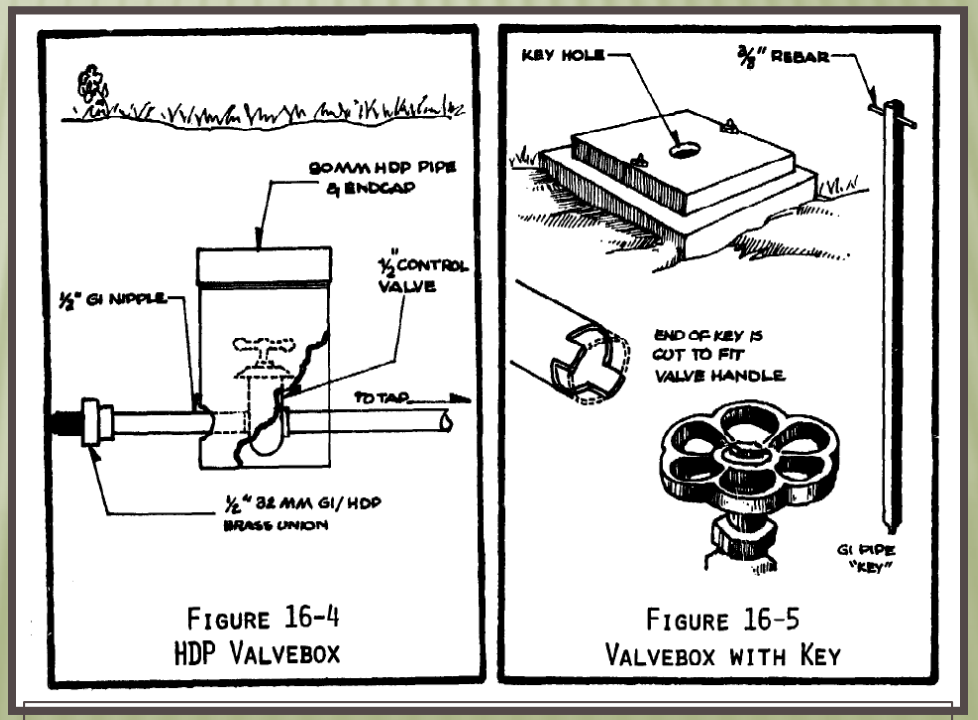




LONG TERM RECOMMENDATIONS, CONTINUED

- Inline Water Chlorinator

- Valve Locks



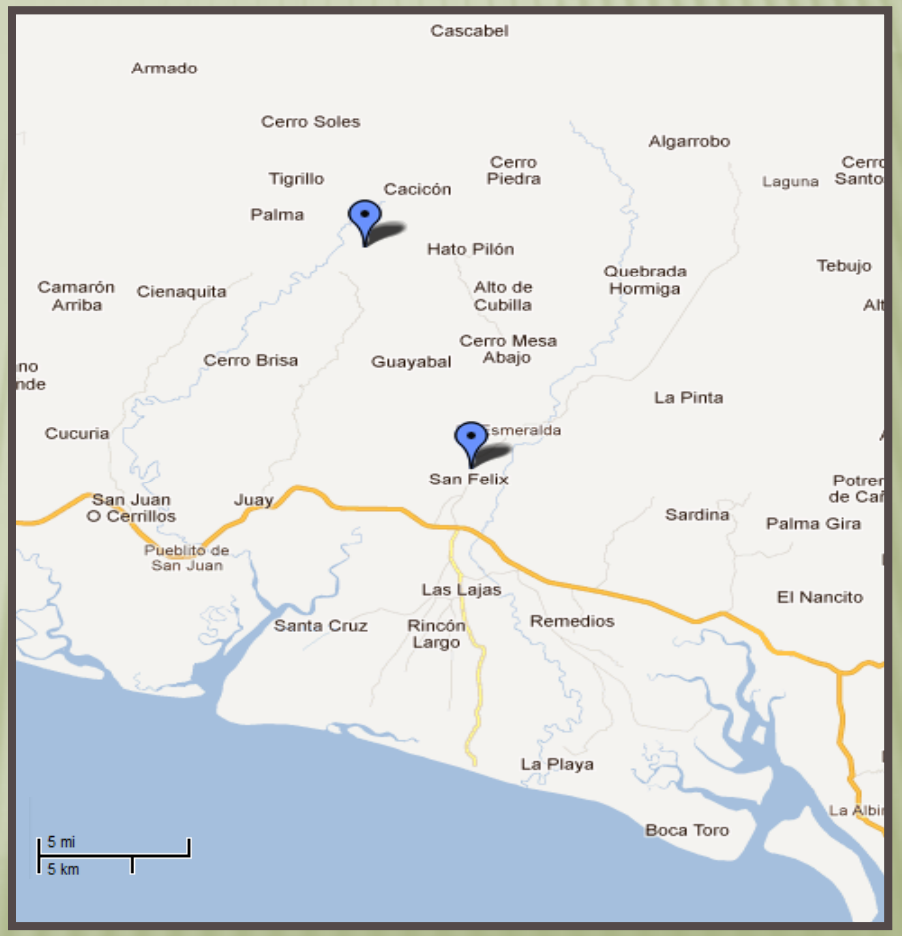
Handbook of Gravity Flow Water Systems P. 150

PROJECT CONSTRUCTION-LABOR

- Will rely heavily on volunteer labor and PCV supervision
  - Depends on if the site is given a full time PCV
  - Necessitates community investment
- Contractors:
  - Solar panels
  - Air release valves
  - Pumping system
  - Chlorinators

PROJECT CONSTRUCTION- MATERIALS

- Utilized local materials as much as possible
  - Locally collected sand and aggregate
  - Locally purchased rebar, pipe, lumber
- Some items may need to be ordered
  - Prices and possible manufacturers are included in our report



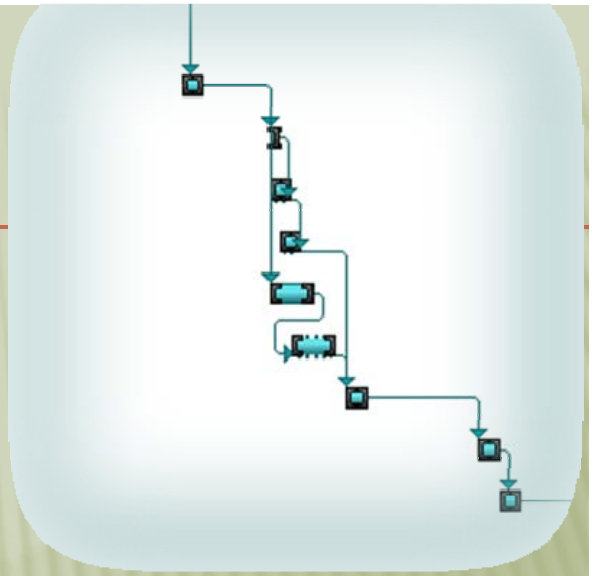
PROJECT CONSTRUCTION- TOOLS

- Designed to minimize tool use
- Certain tools will need to be purchased
  - Hydraulic bolt cutters for rebar
  - Wheelbarrows
  - Trowels for finishing concrete
- No electric tools required

PROJECT COSTS

- Total Project Cost Estimate: $12400
- Considerations made when calculating costs
  - Inflation
  - Waste factors for various materials
  - Local material prices
  - Prices do not include shipping costs

PROJECT TIMELINE

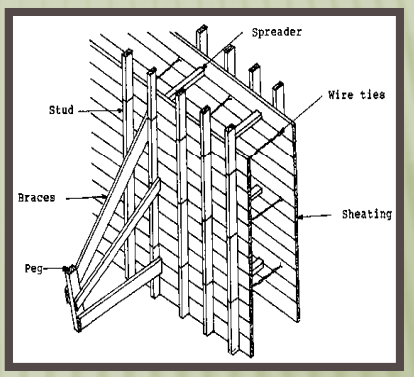


- Total Project Length: 6 months

- Factors influencing project scheduling
  - Remote site
  - Available labor
  - Weather considerations
  - Explanation and training

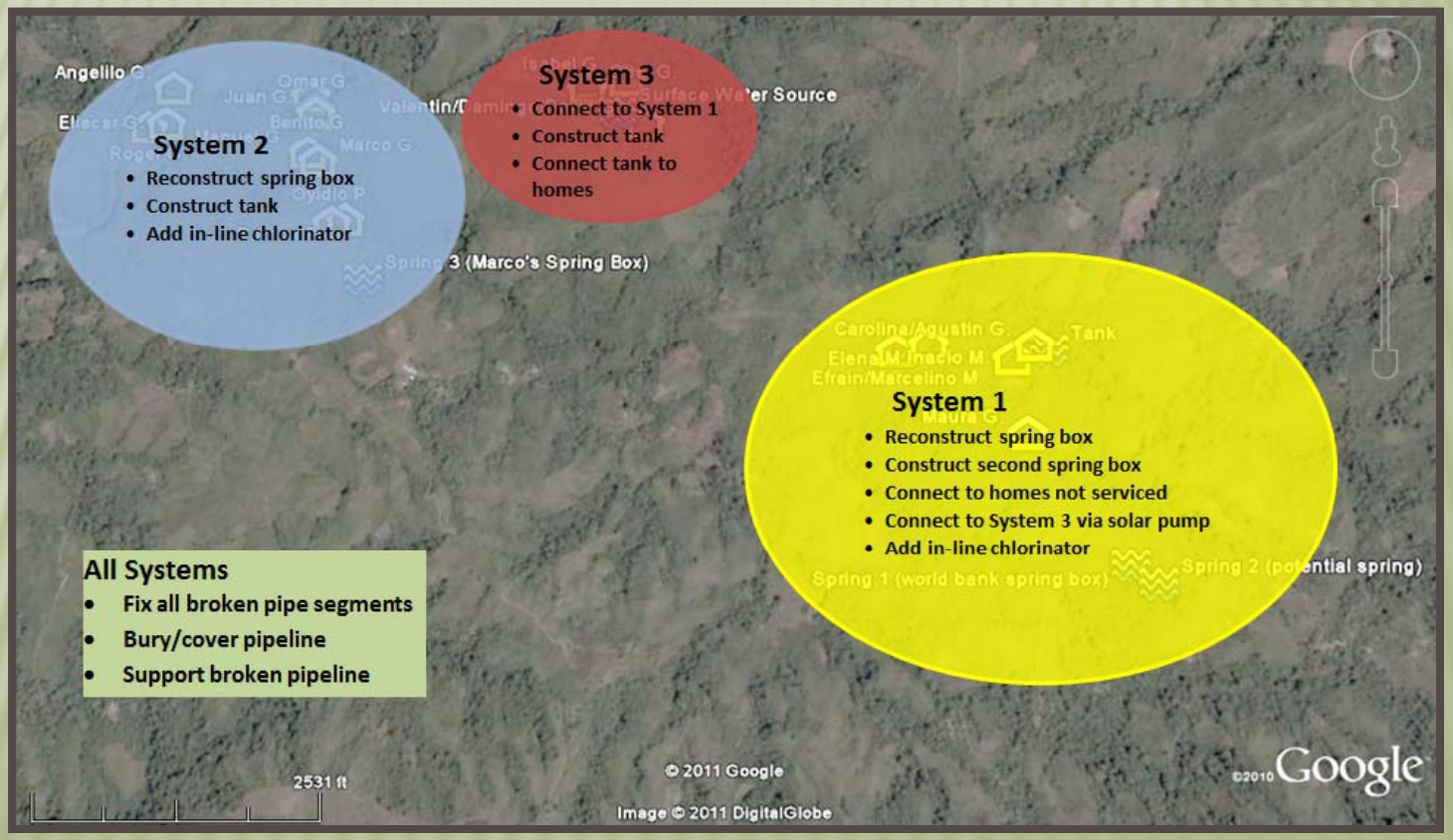
PROJECT TIMELINE

- Important scheduling benchmarks
  - Formwork set for the spring boxes and tank construction
  - Aggregate and sand collection for the concrete
  - Trench digging for the pipeline installation



PROJECT SUMMARY

- Total cost $12,400



ACKNOWLEDGEMENTS

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- Dr. Dave Watkins
- Mike Drewyor

Professor:

- Dr. Brian Barkdoll

QUESTIONS?


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los criadero
Llama hoy a
800-5500.
¡Elimina los criade
¡Organiza limpieza
Apoya los operativo
salud

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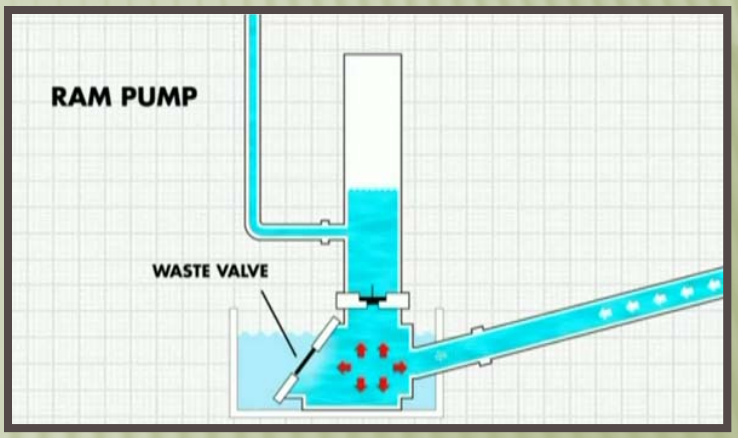
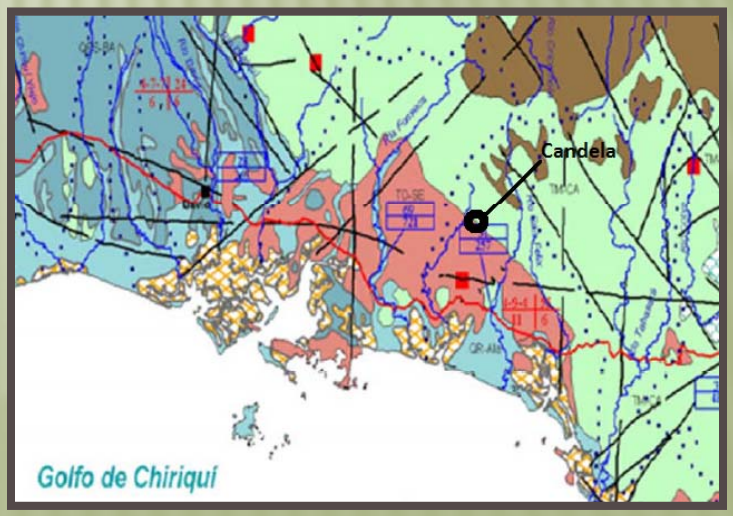
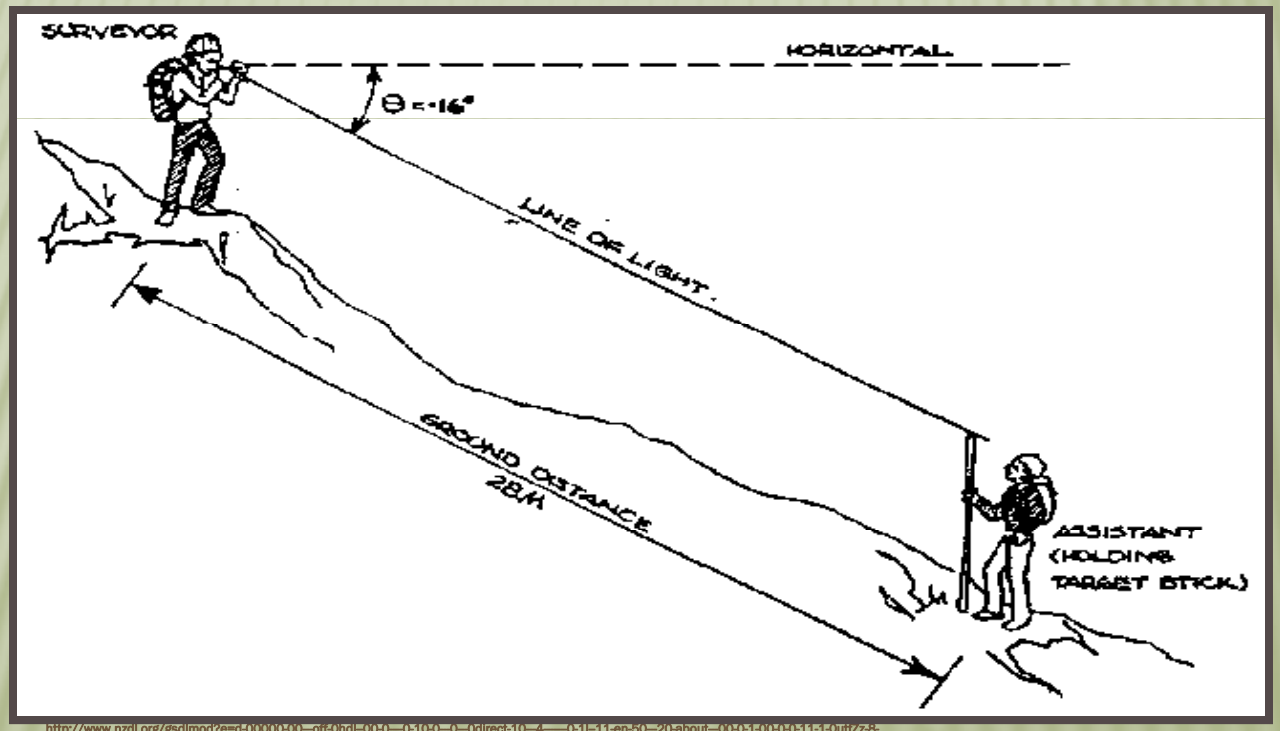
DESIGN ALTERNATIVES CONSIDERED

- The hydraulic ram
  - wastes 75% of the water
- 6 inch PVC piping
  - Not possible to serve System 3 by gravity.
- Well construction for System 3 past ridge
  - Poor soil conditions; likely not possible





- Abney level



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ELEVATION COMPARISON

	System 1			System 2	System 3
	Spring 1	Potential Spring	Tank	Spring 2	Top of Hill
Elevations (ft):	1010	1070	964	628	1023

	Difference in Elevation Beginning to End
Topographic map	110 Feet
Google Earth surface	105 Feet
GPS Points	101 Feet

MAJOR LOSSES WITH FLOWRATE

Darcy- Wiesbach Equation	
Pipe Length	7425 ft
Pipe Diameter	1.5 in
Design Flow Rate	0.0639 ft^3/s
Head Loss	**250 ft**