Embera Puru Water Supply

To improve quality of life: one community, one design, and one drop of water at a time.

GLOBAL Brigades

Michigan Tech
Team Introductions

Victoria Quinde
ME Student
Project Manager

Ross Hogan
ME Student
Applications Engineer

Kelsey Fournier
CEE Student
Technical Writer
Outline

- Project Introduction
- Site Assessment Phase
- Design Phase
- Planning Phase
- Challenges
- Looking Forward
- Questions
Introduction - Community Background

- Darien Province, Panama
- Located along Pan-American Highway
- Indigenous Community
  - Reservation Area: ~ 32 mi² of land
  - Population: 318 people

Cultural Event at Embera Puru

Photograph by Author

Photograph from Google Maps
Introduction - Problem Definition

- 81% of Indigenous Territories are Extreme Poverty Level
- End of Functioning System
  - Wet Season: Water 1-2 days/week
  - Dry Season: No water!
- Population Growth
- Increase in Demand

Spring defined as potential source: “Source 1”
Introduction - Project Background

- **Goal:** Provide potable water to meet water demand of 20-year projected population

- **Project Stakeholders:**
  - Community Members
  - Footprint Possibilities Panama
  - Global Brigades Panama

- **Access to water:** 74 faucets
  - 3 community buildings
  - 1 school (5 taps)
  - 63 homes (Average 4 people per house)
Introduction - Site Overview

Aerial from Bing Maps

- Spring Source
- Tank Location
- Outlying Community Households
Site Assessment Phase
Existing Conditions

- Fundacion San Jose de las Canasas (Foundation) System
  - Supplied by Rio Sabana (~ 50 km away)
  - Well-built and Established System (1994)
  - Supplies 13 communities
  - Embera Puru is at the end
  - Problem: System has been outgrown

- TRUNZ Ultrafiltration System
  - Supplied by remote spring source
  - Vandalized and abandoned 7 years ago
  - Problem: Inappropriate Technology
Data Collection - Topographic Data

Data Collection

- GPS Points
- Nikon RangeFinder
- Compass Bearing
Data Collection - Soil Classification

Tests:
- Settlement test on level surface: 1 minute, 1 hour and 24 hours
- Turbidity Test: Additional 4 days undisturbed
- Knife Test

Results:
- High Silt and Clay Content

Table 1: Soil Sampling Results

<table>
<thead>
<tr>
<th>Location</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sand</td>
</tr>
<tr>
<td>Spring Source</td>
<td>17%</td>
</tr>
<tr>
<td>Tank Option #1</td>
<td>Inconclusive</td>
</tr>
</tbody>
</table>

Photographs by Author
Data Collection - Water Quality

**Test:** Incubation on 3M Petrifilm Plates Coliform

**Results:**
- *Tap (existing Foundation system):* 0 coliform count, no settled solids
- *Spring Source:* coliform count of 12 per square or 240 total count, minimal settled solids

**Verification:**
- Consistent with Laboratory Observations

*Photograph by Author*
Design Phase
Design Parameters - Criteria

- Appropriate Technology
- Mitigate Safety and Environmental Hazards
- Capacity Requirements
  - Current Design Population: 305 people (central community)
  - 15.85 gallons (60 liters)/person/day
  - 4% Population Growth Factor
  - 20 year projection
- Metered Distribution System
- Protective Barriers (i.e. fences, locks, etc.)
Design Parameters - Constraints

- Viability of Spring Source
  - Spring Flow Rate

- Electrical Power Supply
  - Pumps
  - Control System
Design Parameters - Assumptions

- **Spring Source**
  - Enough water to meet design criteria
  - Flow Rate: Minimum 7.9 GPM
  - Minimum Water Output: 10,600 gallons per day

- **Household Height**
  - 7-ft above ground elevation

*Example of Elevated Houses*

*Photograph by Author*
System Analysis - Water Balance

- **Projected Population**: 670 people in 20 years (4% growth from current)
  - 7.9 gpm needed to maintain storage tank level
  - 10,600 gallons total usage
System Analysis - EPANet Model

- **Design:**
  - Tank Capacity
  - Pipe Sizing
  - Pump Locations

- **Analyses:**
  - Head
  - Pressure
Design Overview: Emberá Puru

- **Design Components:**
  - Water Collection Structure
  - Pump Stations
  - Electrical Supply
  - River Crossing
  - Water Storage Tank
  - Water Treatment
  - Supply and Distribution Pipelines
**Water Collection Structure**

- **Catchment:** Collect water from Spring
- **Wet Well:** Provide buffer for Pumping
- **Feeder Pipe with Roughing Filter**
Water Collection Structure

- **Control Accessories:**
  - Clean-out and Overflow Pipeline
  - Vent Pipes
  - Shut-off Valves

- **Hatch:** Lockable access for Maintenance
Pump & Pump Station

Pump at Source:
- **Purpose**: Deliver water to tank
- Centrifugal Pump
- One-stage Pumping
- Single-phase

Pump at Water Tank:
- **Purpose**: Deliver water to taps
- Booster Pump
- Maintains 20-30psi

Recommended Centrifugal Pump

Recommended Booster Pump
Electrical Supply & Controls

- **9-panel Solar Array**: Power Supply at Spring
- **Pad-mounted Control Box**: Electrical Controls
  - Required Voltage: 115 V
  - Minimum Required Amperage (Spring): 15 A
  - Minimum Required Amperage (Tank): 20 A

Recommended Solar Array with Battery Pack

Recommended Pump Control Box
Suspension Bridge Design:
Support Supply Line and Electrical Conduit
- Pipe Span: 36-ft

Fixtures - Tower and Anchor:
- Tower to Tower Span: 45-ft
- Tower Material: Steel Pipe Column
- Anchor Material: Reinforced Concrete
- Galvanized Vinyl Coated Steel Wire

Conceptual Design for Pipe Bridge Across a Small River
Water Storage Tank and Treatment

- **Capacity**: 5,400 gallons
- **Foundation**: Earth-build to supply 3’ head to pump
- **Hatch**: Lockable access for Maintenance
Water Storage Tank and Treatment

- **Treatment:** Chlorine Injection
- **Required Contact Time:** 11 min

Recommended Injection System
Supply Pipeline

SDR 26 PVC Pipe

- 3” Pipe
- *Length*: 1634-ft
- *Burial Depth*: 2-ft
SDR 26 PVC Pipe:

- **Trunk:** 2” Pipe
- **Branches:** 1” Pipe
- **Spigot:** ½”
**System Valves**

- **Shut off Valves**: Central and Critical Locations
- **Cleanout Valves**: Local Low Elevations
- **Air Release Valves**: Local High Elevations

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**Recommended Valve Box**

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**Legend**
- 
- Cleanout Valves
- Air Release Valves

*Two valves required in 3 locations where supply and distribution lines are together.*
Planning Phase
Cost Estimate

Estimated Required Budget

- Full Labor: $235,000
- Reduced Labor: $69,000

Cost Breakdown for Reduced Labor by Bid Package in US Dollars
## Schedule

**Duration:** 7 months

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Duration of Task</th>
</tr>
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<tbody>
<tr>
<td>Project Start</td>
<td>0 days</td>
</tr>
<tr>
<td>Order Materials</td>
<td>2.25 days</td>
</tr>
<tr>
<td>Remove Ultrafiltration</td>
<td>1 day</td>
</tr>
<tr>
<td>Pipe Installation</td>
<td>136.5 days</td>
</tr>
<tr>
<td>Piping Complete</td>
<td>0 days</td>
</tr>
<tr>
<td>Build Water Collection Structure</td>
<td>38 days</td>
</tr>
<tr>
<td>Build Water Storage Structure</td>
<td>126 days</td>
</tr>
<tr>
<td>Storage Tank Complete</td>
<td>0 days</td>
</tr>
<tr>
<td>Install Fencing</td>
<td>8.25 days</td>
</tr>
<tr>
<td>Install Pump and Solar Array</td>
<td>2.25 days</td>
</tr>
<tr>
<td>Install Chlorination System</td>
<td>1.25 days</td>
</tr>
<tr>
<td>Electrical Work</td>
<td>8 days</td>
</tr>
<tr>
<td>Pre-Start Tasks</td>
<td>6.75 days</td>
</tr>
<tr>
<td>Project Complete</td>
<td>0 days</td>
</tr>
</tbody>
</table>

*Construction Schedule extracted from Gantt Chart*
Challenges
Challenges

- Communication Barriers
  - Language Barrier with Community
  - Outstanding Action Items (4 months overdue)

- Unique Design and Conditions
  - Unknown Flow Rate
  - 2 Pumps

- Timeline & Alternatives
Looking Forward
Looking Forward

● Community Involvement

● Educating the Community
  ○ Rainwater vs. Treated Water
  ○ Importance of System Maintenance
  ○ Awareness of Water Scarcity
  ○ Disposal of Wastewater

● Operation and Maintenance

● Outstanding Action Items
Acknowledgements

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- Kiko de Melo e Silva

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Questions?

Thank You For Your Attention!

Photograph by Author