Meet the Team

Team Members

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Presentation Outline

- Project Site Background
- Team Experiences
- Community Layout
- Existing Water Infrastructure
- Project Site: Las Delicias
- Data Collection
- Design Alternatives 1 & 2
- Alternative Analysis
- QD’s Recommendation
- Conclusion
- Q & A
Background: Quebrada Pinzón
Province: Bocas del Toro

- Census Information:
  - 37 houses
  - 220 inhabitants
  - Monthly income average: 144 balboas
  - 36% is illiterate
  - 6th grade education on average

- 1 hour dirt road hike
- Main income source: Cacao and Banana farming
Historical and Cultural Dynamics

- Selected as a BioComunidad Project Site
  - Many recent improvements to community facilities and infrastructure
- Current Peace Corps Volunteer
  - Briana Arnold
- Family units are stronger than organized committees
Team Experiences
Project Site: Las Delicias

Objective

To provide Las Delicias with basic water infrastructure and an uninterrupted water supply for storage, drinking, and sanitation purposes.
Community Layout
Las Delicias: Data Collection

- Rain catchment area measurements
- Two sets of water quality tests
- Assessment of existing systems
- River slope and velocity measurements
- Surveyed elevations within Las Delicias
Las Delicias: Survey Line

A. Structure A (Church)
B. Structure B (Family Home)
C. Structure C (Family Home)
D. Proposed Tank Location
Design Alternatives

1. River Pump System
2. Individual Rainwater Harvesting Systems
Alternative One

River Pump System
Layout of River Pump System
Alternative One: River Pump System

Hydraulic Ram Pump system

- Harvesting the power and size of the rivers energy and general typography
- No external power necessary
- Environmentally friendly
System Modeling

- EPANET 2.0 was used to analyze pressures and flow rates within the system
- Two different water demand patterns were modeled for weekdays and weekends
Alternative Two

Rainwater Harvesting Systems
Alternative Two: Rainwater Harvesting Systems

- Rainfall Data for the nearby city of Changuinola (2000-2012)
- Long term variability analysis with historical data (1960-1972)
- Reliability and Storage analysis
Alternative Two: System Components

- Catchment area: Rooftops of Structures A, B, and C
- PVC (Polyvinyl Chloride) gutters
- Filtration: Mesh filters and first flush system
- Disinfection: In-line chlorinators
- Plastic storage tanks

MINSA’s In Line Chlorinator [1]
Mesh Filter
First Flush System

![Diagram of a first flush system](image)

- First flush of contaminated water is diverted into chamber.
- Once chamber is full, fresh water flows to tank.

[3]
3D Model: Catchment System
3D Model: Filtration and Disinfection

A. Mesh Filter
B. First Flush System
C. In line chlorinator
3D Model
Alternatives Analysis: Design Constraints

Technical
- Feasibility
- Constructability
- Cost

Social
- Responsibility within the community
- Routine maintenance
- Interest within the community
Failure Modes and Effects Analysis

- All possible failure modes are given a probability of occurrence and severity rating
- Risk Priority Number (RPN) is calculated as the product of the two ratings
- Alternative with lower RPN average is recommended

<table>
<thead>
<tr>
<th>Probability of Occurrence of a Failure Mode</th>
<th>Ranking</th>
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</thead>
<tbody>
<tr>
<td>Highly Unlikely</td>
<td>1-2</td>
</tr>
<tr>
<td>Unlikely</td>
<td>3-4</td>
</tr>
<tr>
<td>Neutral</td>
<td>5-6</td>
</tr>
<tr>
<td>Likely</td>
<td>7-8</td>
</tr>
<tr>
<td>Highly Likely</td>
<td>9-10</td>
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</table>

<table>
<thead>
<tr>
<th>Severity of a Failure Mode</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very less significant</td>
<td>1</td>
</tr>
<tr>
<td>Somewhat significant</td>
<td>2</td>
</tr>
<tr>
<td>Significant</td>
<td>3</td>
</tr>
<tr>
<td>Harms human health</td>
<td>4</td>
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</table>
Failure Modes and Effects Analysis

Alternative One: Ram Pump Design

- High risk failure modes
  - Check valve malfunction
  - Clogging of the pump
  - Loose pipes
  - Dislodging of the pipe network

- Risk Priority Number Average = 8
Failure Modes and Effects Analysis

Alternative Two: Rainwater Harvesting Systems

- High risk failure modes
  - Clogging of gutters
  - Leakage
  - Chlorination malfunction and improper mixing
  - First Flush malfunction
  - Particle build up in the bottom of storage tank

- Risk Priority Number Average = 6
QD’s Recommendation

- Alternative Two: Individual Rainwater Harvesting Systems for all structures in Las Delicias

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Alternative One</th>
<th>Alternative Two</th>
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<tbody>
<tr>
<td>Feasibility and Constructability</td>
<td>Feasible but harder to construct</td>
<td>Feasible and easy to construct</td>
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<tr>
<td>Cost</td>
<td>3300 USD</td>
<td>800 USD (Structure A) 600 USD (Structure B)</td>
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<tr>
<td>Ownership of the system</td>
<td>Joint</td>
<td>Individual</td>
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<tr>
<td>Probability of system failure</td>
<td>RPN average = 8</td>
<td>RPN average = 6</td>
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<tr>
<td>Ease of repair and maintenance</td>
<td>High technical skill required</td>
<td>Technical skill not required</td>
</tr>
<tr>
<td>Water Quality</td>
<td>Fit for non-potable uses only</td>
<td>Fit for potable and non potable uses</td>
</tr>
</tbody>
</table>
Summary

Project Site: Las Delicias in Quebrada Pinzón, Bocas del Toro, Panama

- Alternative I: River Pump Design
- Alternative II: Rainwater Harvesting Systems
- Selection Criteria: Design Constraints and failure modes analysis results
- Final Recommendation: Alternative Two
References

Thank you!

Questions?