Don Jaguar Design

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• International Senior Design
• Santa Cruz, Bolivia
ISD involvement with Walter Henry since 2000
Santa Cruz Layout

- Inner city rings
- 16 Districts
- Districts into UVs
- Plan 4000 area
Funding

• Central Government in La Paz
• Funding to Santa Cruz
Santa Cruz: Flooding
Stormwater Drainage

“In the slums and shanty towns of the Third World, many residents feel that they need drainage more urgently than water supply or latrines ... Many neighborhoods are flooded several times a year, and people have to cope with water or other people’s sewage inside their dwellings.”

-Cairncross and Feachem

From Environmental Health Engineering in the Tropics, 2007
Plan 4000: Flooding

- Residential and septic flooding
- Transportation
- Diseases
Survey

- DJD worked with city of Santa Cruz surveyors
Survey

• City crew established a total of 27 benchmarks
Survey

• DJD conducted topographic survey of 5.5 km canal route
Soil Samples

• Soil samples were performed at 3 locations
• In country tests = sand-silt with clay underneath
Design Methods

• Watershed Delineation
• 500m sections
Design Methods

- Time of concentration based on watershed
- Rainfall intensity for Santa Cruz
- Rational Method
  \[ Q = C \times I \times A \]
- Manning Equation
  \[ V = \left( \frac{k}{n} \right) \times R_h^{2/3} \times S^{1/2} \]
Existing Conditions

• Plan 4000 area is in District 16
• Population of Plan 4000 = 30,000
Existing Conditions

- Elevation change over 5.5 km route is 20m
- Canal route follows existing gas lines
Design Options

• **Underground Pipe**

  • Required diameter
  • Pipe diameters < 1.2 m (Bolivian Standards)
Design Options

• Covered Rectangular Concrete Canal
  • Removal of cover
  • Inlets necessary
  • Excavation Depth
Design Options

- Open Trapezoidal Canal

  - Easy maintenance
  - Hydraulically efficient
  - Minimal Excavation
  - Construction methods
Canal Construction
Estimated Earthwork Cost: $10,200,000 or $700,500,000 US Dollars
Concrete Trapezoidal

- 50 year design life
- Easy Maintenance
- Concrete Required
Design Alternative

Magisterio Canal

Canal Route
Design Alternative

Canal Route

2k

400m
DJD Recommendation

- Further investigation for alternate route
- Open concrete lined trapezoidal canal
Cost vs. Benefit

- Transportation access
- Domestic life
- Improve Health
Questions?