

Our Mission: To alleviate the flooding within the school, the park, and the surrounding neighborhood of El Recreo.

Background

Bolivia is a country in the middle of South America. Bolivia has a tropical climate that consists of two seasons, rainy and dry season. The rainy season occurs from November thru February. The city of Santa Cruz de La Sierra is located in low lands approaching the Amazon basin. Santa Cruz de la Sierra is the largest city in Bolivia. The population growth has been problematic for city planners because of industrialization. This has made flood control difficult for city officials to keep up with. Since the entire city is relatively flat, draining the storm water during the rainy season is a challenge.

The tax structure in Bolivia limits the amount of funds received by local neighborhoods. A limited amount of tax money gets back to the outer neighborhoods due to this hierarchy.



Ambassador Engineering

Project Manager
Nicholas Darga



Project Engineer
Erik Moore



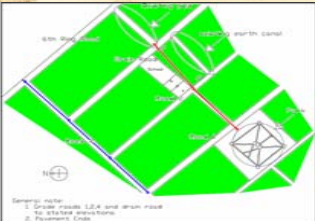
Project Engineer
Nicholas Link



Existing Conditions

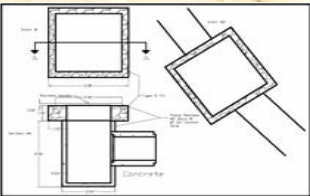
- An earthen canal east of the school.
- Concrete culvert from Drain Road to the 6th Ring Road Canal.
- The standing water hinders foot and vehicle traffic along Roads 1 and 4.
- During peak rainy season 700 students and 40 homes are impacted.
- Flooding may be a health hazard because most homes use the hole system burying fecal matter underground.
- E. Coli and coli forms were detected in onsite water. These bacteria pose a health threat to people wading through the flood waters. Malaria also exists in the area.
- Current earth canals are blocked with litter and other debris.

Underground Pipes



Advantages **Disadvantages**

- Not intrusive
- Low cost of maintenance
- Constructability
- Relocate school septic
- More expensive than earthen canals



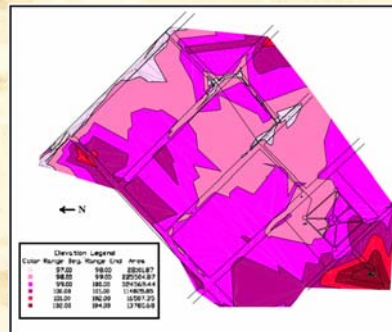
Inlet Structure & Sediment Trap

Gathering Data

Research of previous year's projects and engineering solutions was completed. Previous ISD storm water project reports were read while in Bolivia and information was organized for later use.

- A topographical survey was conducted.
- AutoCAD generated a model of the existing topography.
- Ambassador Engineering evaluated the soil in the barrio.
 - A soil auger was used to test material make up.
 - Three areas were tested to the depth of the water table.
 - Samples of the soils were taken and classified.
- Water testing was performed.
 - Water sample and brought it to Saugapac.
 - 3M E.coli and Fecal Chloroform Tests resulted positive.
- Interviews were conducted. Interviews were conducted in person with:
 - Public Works Officer of District 10, Sr. Horacio Cardenas
 - Barrio President, Sr. Domingo Cuasaca A.
 - Senior Engineer, Simon Murley EIT, SME
 - Owner and Senior Engineer, Richard E. Prince P.E., ABG Engineering
 - Principle and Owner, Thomas J. Darga, Interlake Associates, ABG Engineering
- Ambassador Engineering studied rainfall data.
 - Calculate watershed run off.
- Photographs of the barrio were taken documenting layout.

Topographic Map



El Recreo Park



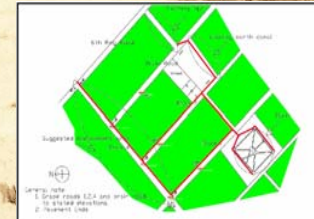
6th Ring Canal



Existing Outlet

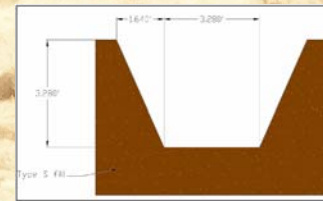
El Recreo Stormwater Drainage

Canals



Advantages **Disadvantages**

- Low initial cost
- Constructability
- High cost of maintenance
- Dangerous to children
- Canals aesthetic unappealing



Soil Boring

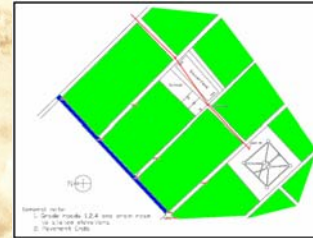


Meeting with Barrio President



Existing Earth Canal

Road and Pipes Combination

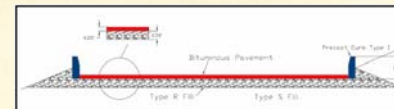


Advantages

- The neighborhood planned to pave Road 4 for traffic improvement.
- Material from Road 4 grading used as fill for the park flooding.
- Diverts flow under school.
- Roots all water directly towards 6th Ring Canal.

Disadvantages

- Using roads to convey storm water induces erosion.
- Driveway access must be designed to maintain curb depth.



Cost

Options	Total Cost Bolivianos	Total US \$
All Concrete canals	223000	27900
All Pipes	211000	26400
Road & Pipe Combination	238000	29700

Recommendation

Road and Pipe combination

- More cost effective in the long run because the road has two functions.
- Avoids health hazards
- Non intrusive
- Solves the Stormwater problems of Recreo