

International Senior Design

Santa Cruz, Bolivia



2007



Integrated Stormwater Solutions

Ryan Biehl • Travis Ostrom • Cindy Schafer

- International Senior Design
- Santa Cruz, Bolivia
- Stormwater Drainage
- Los Bosques Project
- Methods
- Design Decisions
- Recommended Design



International Senior Design

- Pre-trip preparation
- 2 weeks in Santa Cruz
 - Constructing school
 - Gathering information for design
- 3 months on campus
 - Designing solution
 - Writing report
 - Creating construction drawings
- Submit design to Santa Cruz engineers



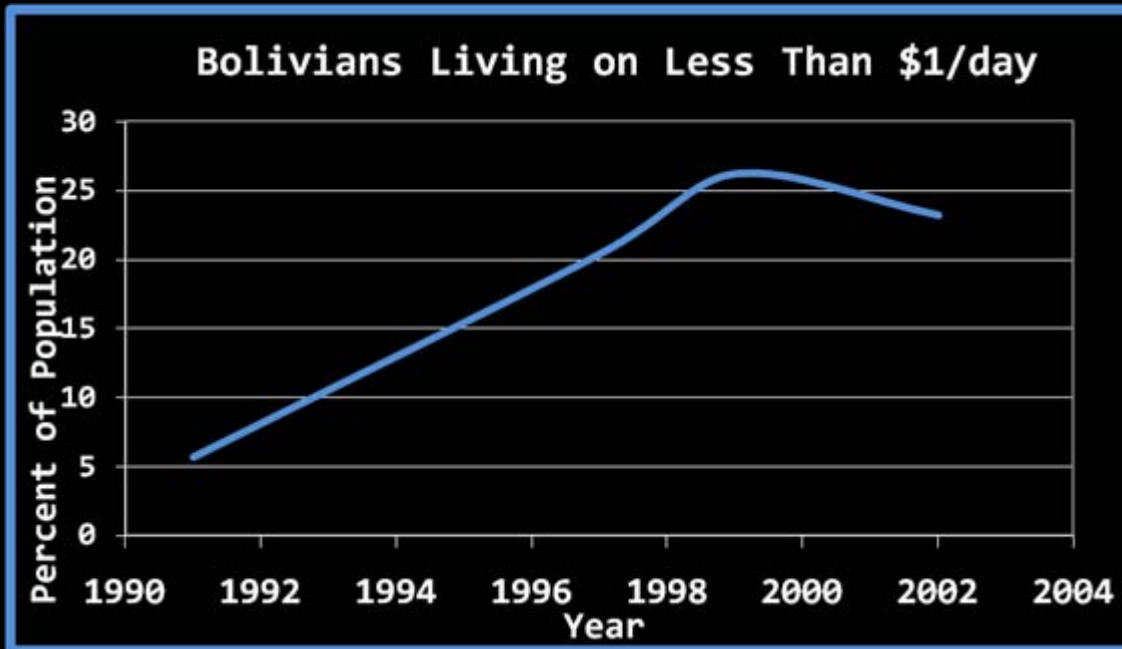
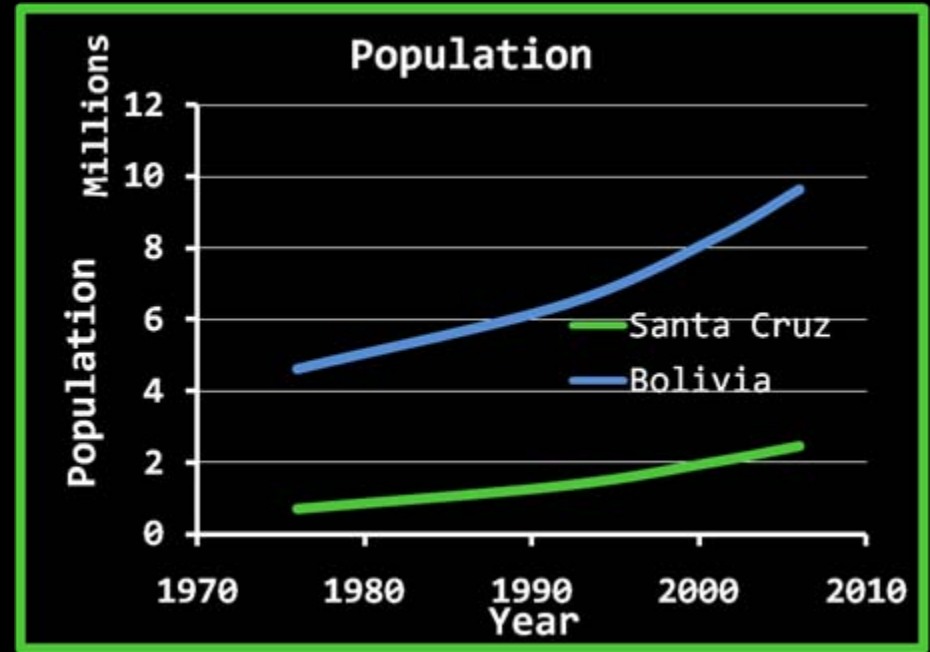
Bolivia



Bolivia

Santa Cruz

Population and Economics



Urbanization
and expansion

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



Road and Drainage Project in the Los Bosques Neighborhood



Ryan Biehl • Travis Ostrom • Cindy Schafer

City Layout

- City Layout
 - Districts
 - Ring and Radial Roads
- Drainage System
 - Canals
 - Storm Sewers



Problem: Flooding



Los Bosques Neighborhood and 5th Ring Road



17.5
Radial
road
and
canal

5th
Ring
road

Doble Via
Radial
road
and storm
sewer

Los Bosques Neighborhood



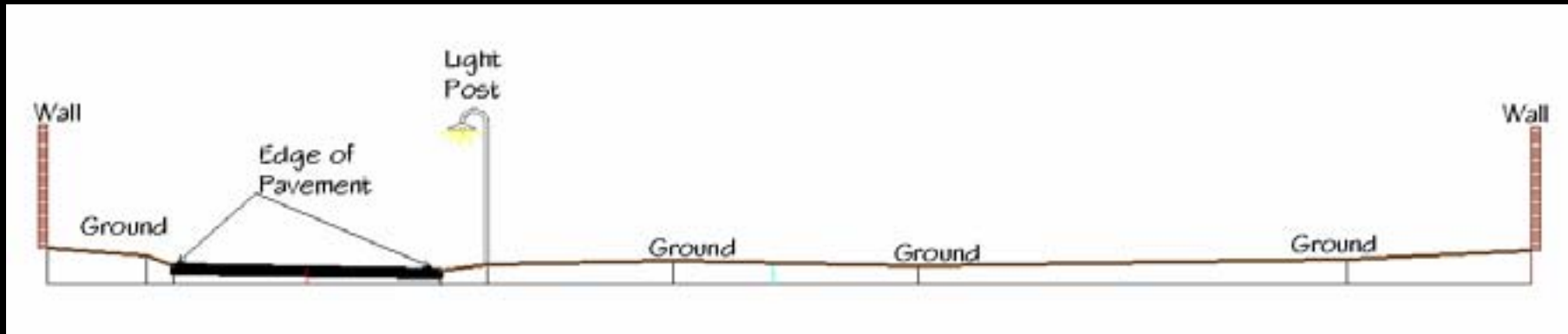
- Flat topography
- Irregular terrain
- Half of road paved
- Graywater and sanitary sewer

Los Bosques Neighborhood



- Flat topography
- **Irregular terrain**
- Half of road paved
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Los Bosques Neighborhood



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Los Bosques Neighborhood



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Los Bosques Neighborhood



- Market
- Petrobras
- Trucks and tires
- Existing canals and culverts

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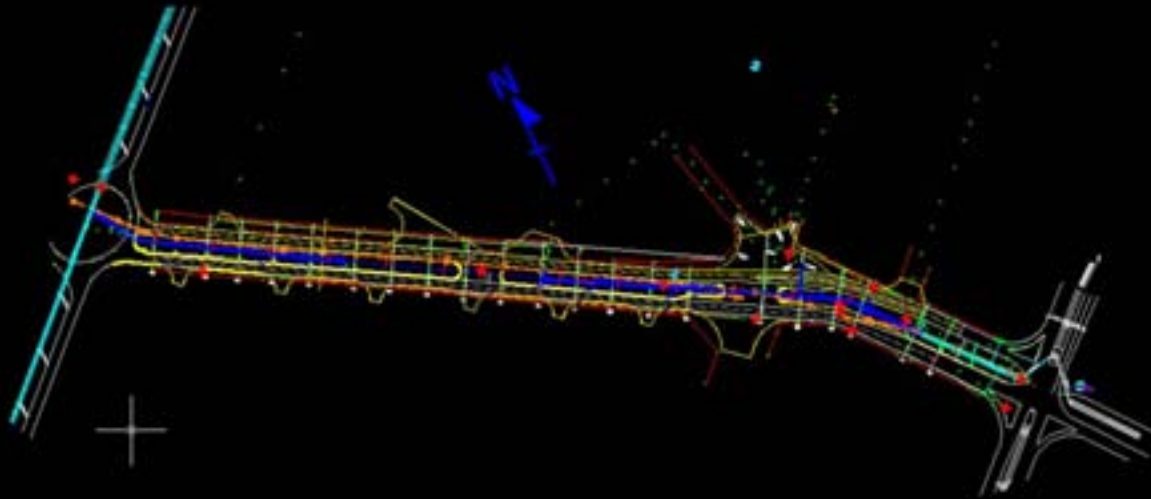
Methods

- District 10 and Downtown Meetings
- Survey
- Soil Samples



Design Methods

AutoCad



Watershed
Delineation
and Peak
Flow Rate

Los Bosques Neighborhood and 5th Ring Road

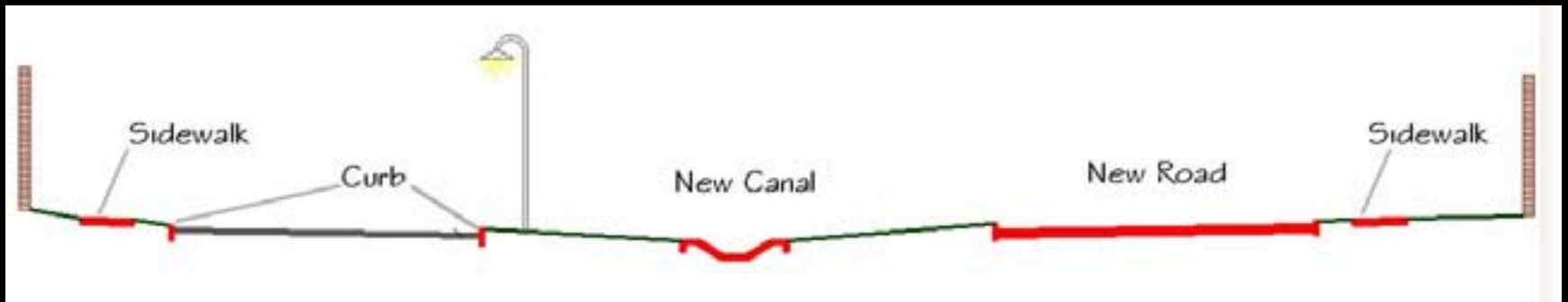
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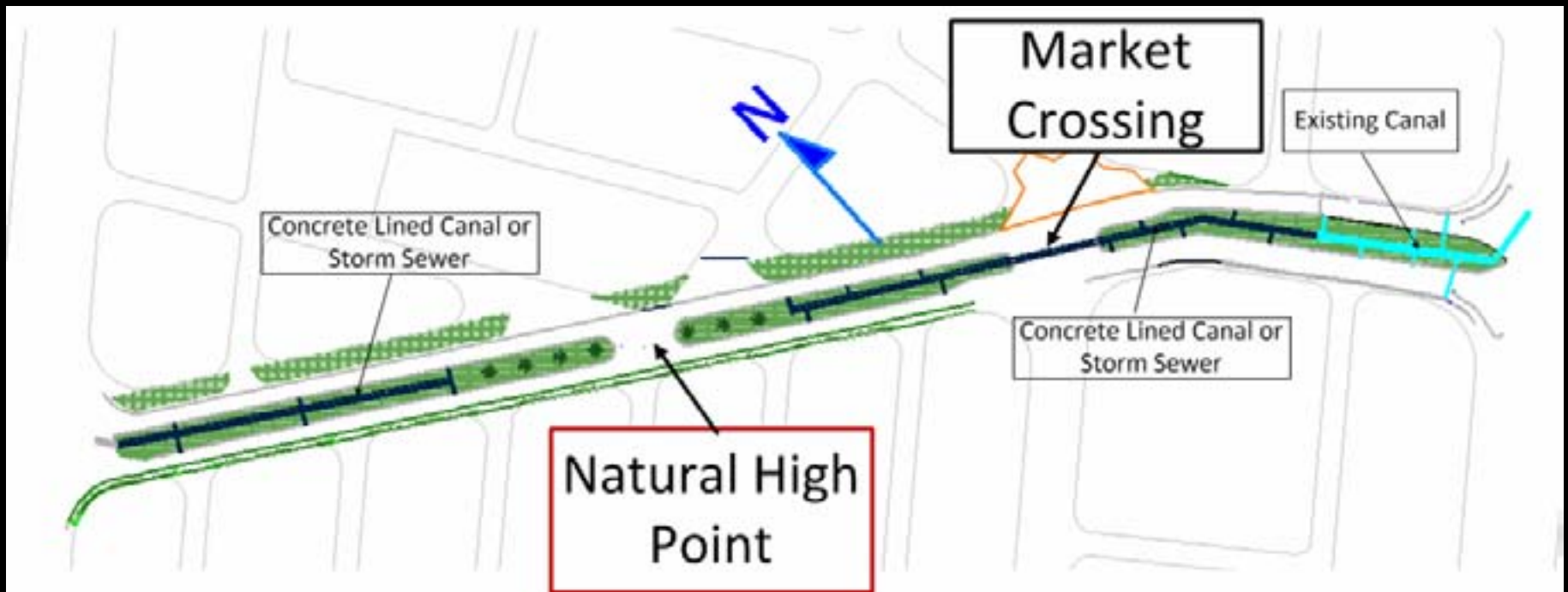


Doble Via
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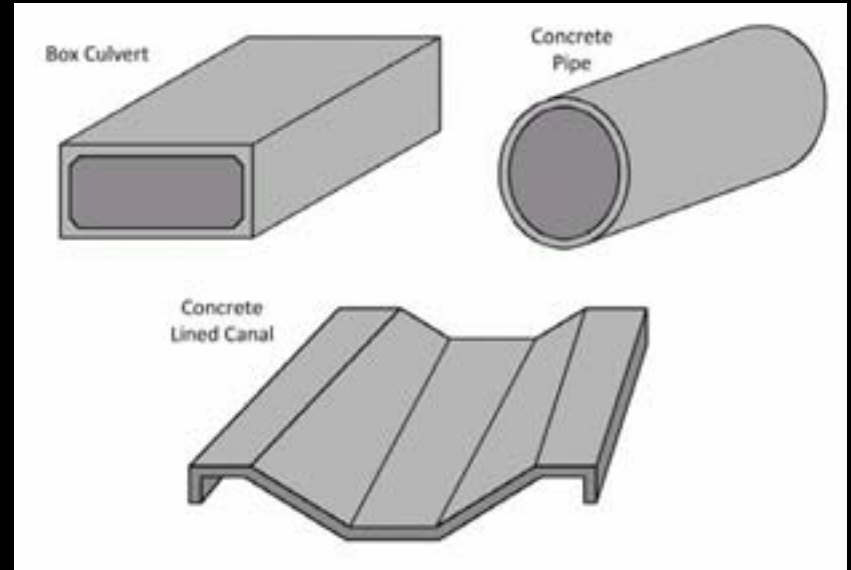
Design Options



Dividing Watershed

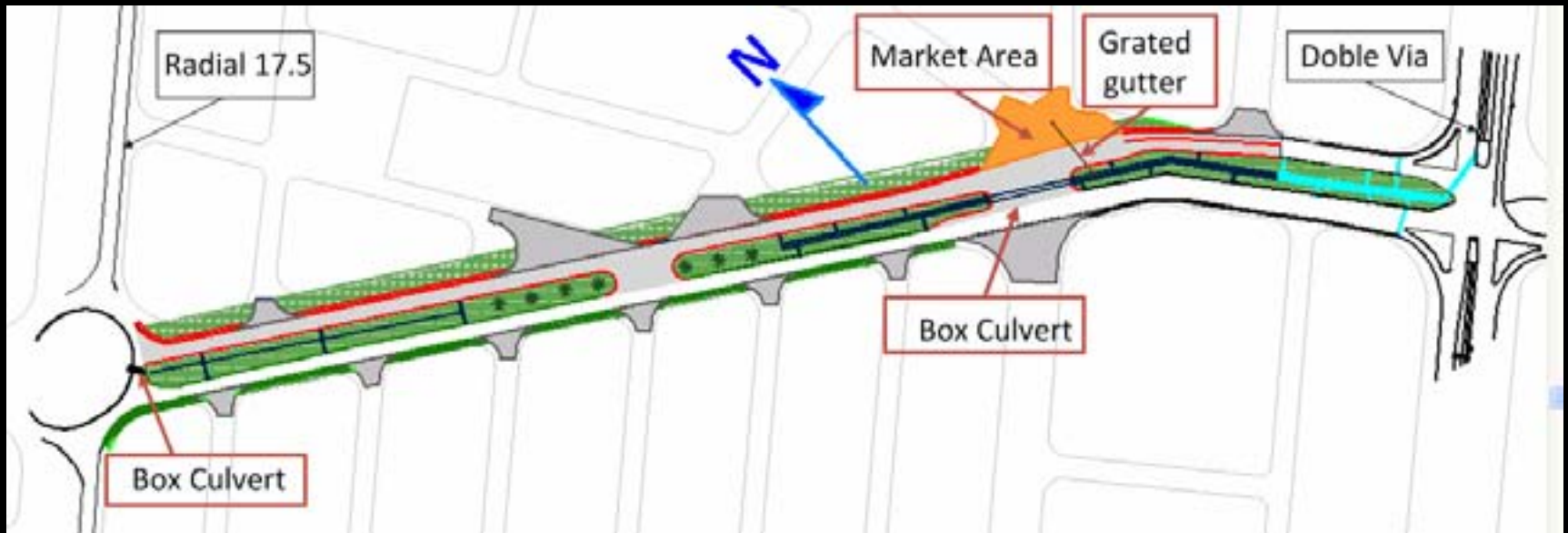
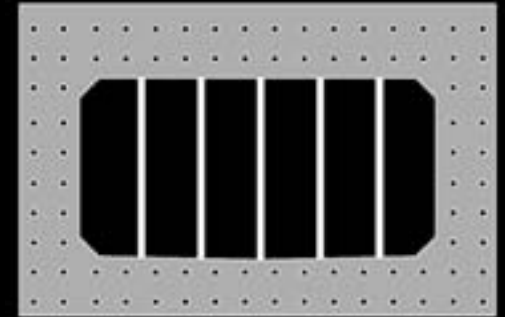
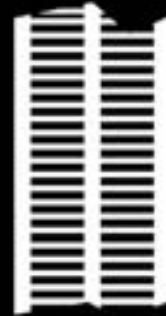
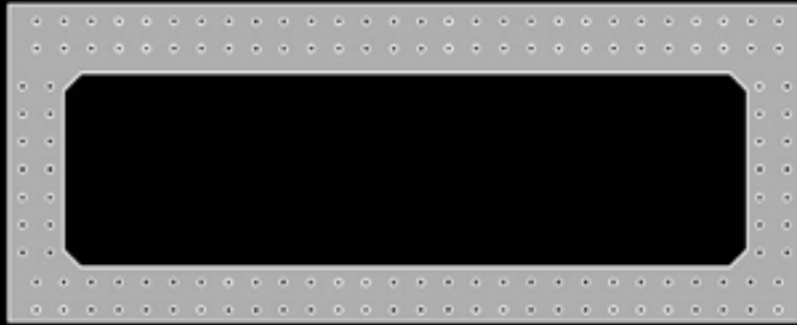


Type of Drainage System

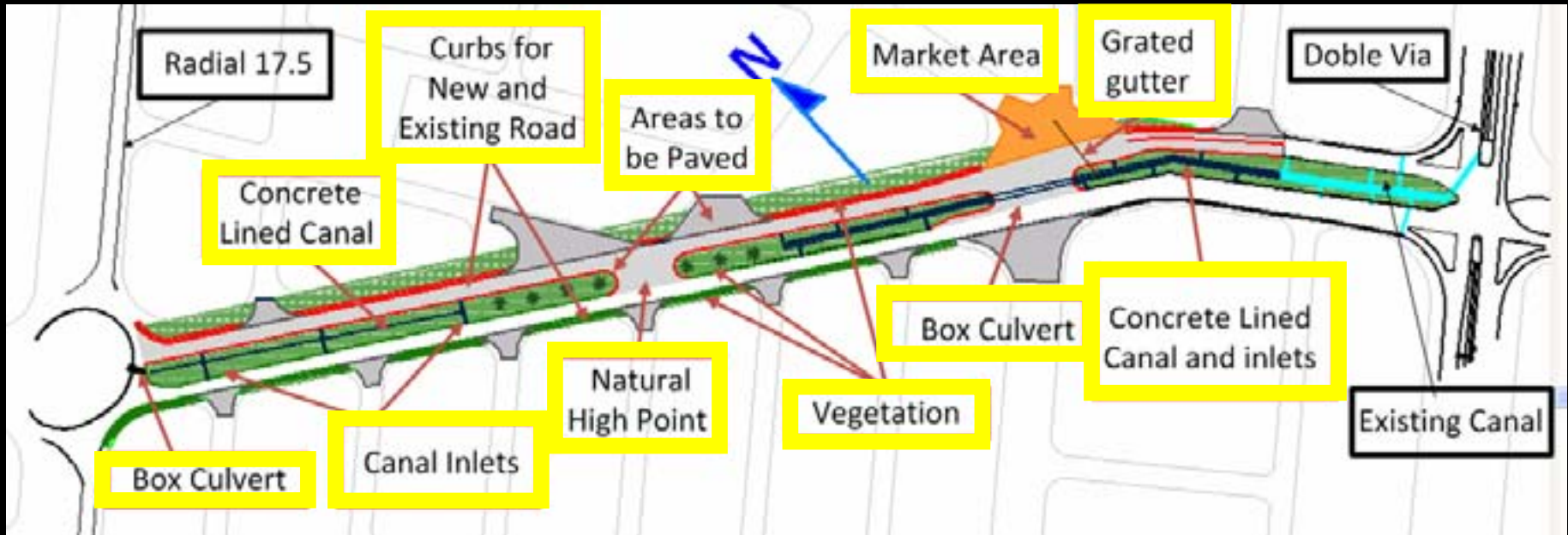


Crossing Canal

Design Decisions



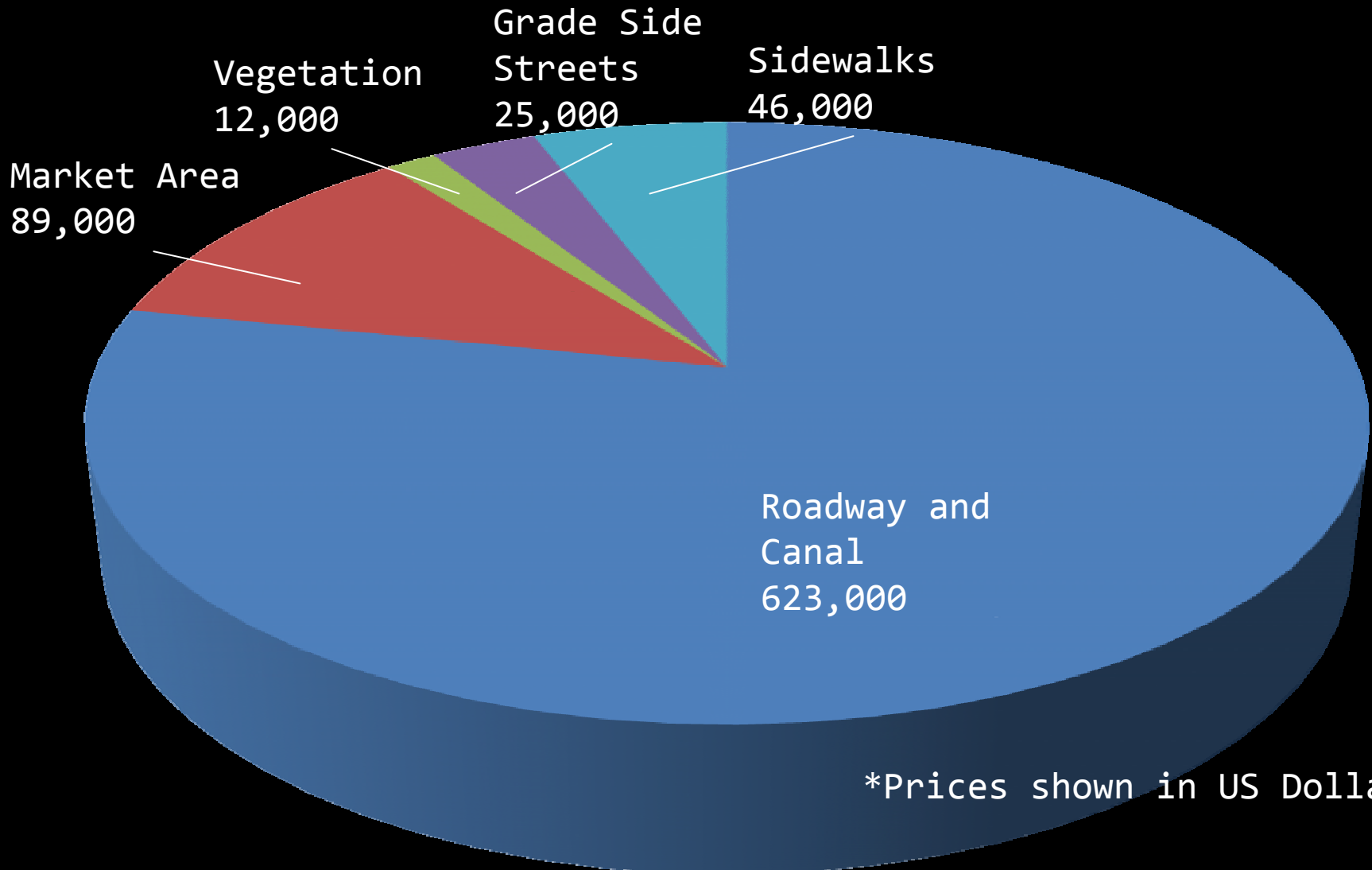
Recommended Design



Cost

6,042,000 Bolivianos

797,000 US Dollars



*Prices shown in US Dollars

Benefits

- Flooding Reduced
 - Reduces mosquito breeding grounds
 - Decreases work and school absences
 - Encourages commerce
 - Prevents traffic obstruction



Implications

- Infiltration Decreased
- Sediment and Garbage Transport
- Urban heat island effect
- Regular Maintenance required



Conclusion

- Best feasible option
- Integral to city drainage plan
- Valuable learning experience



Muchas Gracias

Linda Phillips

Dennis Magolan

Henry Santeford

Joe O'Neill

Marilyn Phillips

Other MTU professors

ISD alumni mentors

And fellow ISD students



¿Preguntas? Questions?



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