Traffic Calming: A Study of It's Application to the Tren Urbano

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Abstract

This study investigates the implementation of traffic calming measures in Jardines de Caparra station. Its goal is to explain the concept, its advantages and disadvantages, and to demonstrate why it should be used in this project. The benefit of traffic calming is based on the experience of its use in many locations around the world. A suggested implementation, with a description of the devices used, will be included. Within the observations, it is found that the purpose of traffic calming in Jardines de Caparra is to reduce speed, not traffic. Traffic calming is a good option for the station, because it assesses the need for pedestrians' safety, and create a more comfortable environment in the station's neighborhood.

Introduction

The construction of the TU is causing several changes along the alignment that can affect the quality of life of people in the surrounding areas. The expected increase in vehicular traffic will have adverse effects on the environment, the peacefulness of the neighborhoods, and on pedestrian's safety. Therefore, it is necessary to maintain a control of the traffic around the stations. Traffic calming can be an option to address the possible problems on stations located in a residential area.

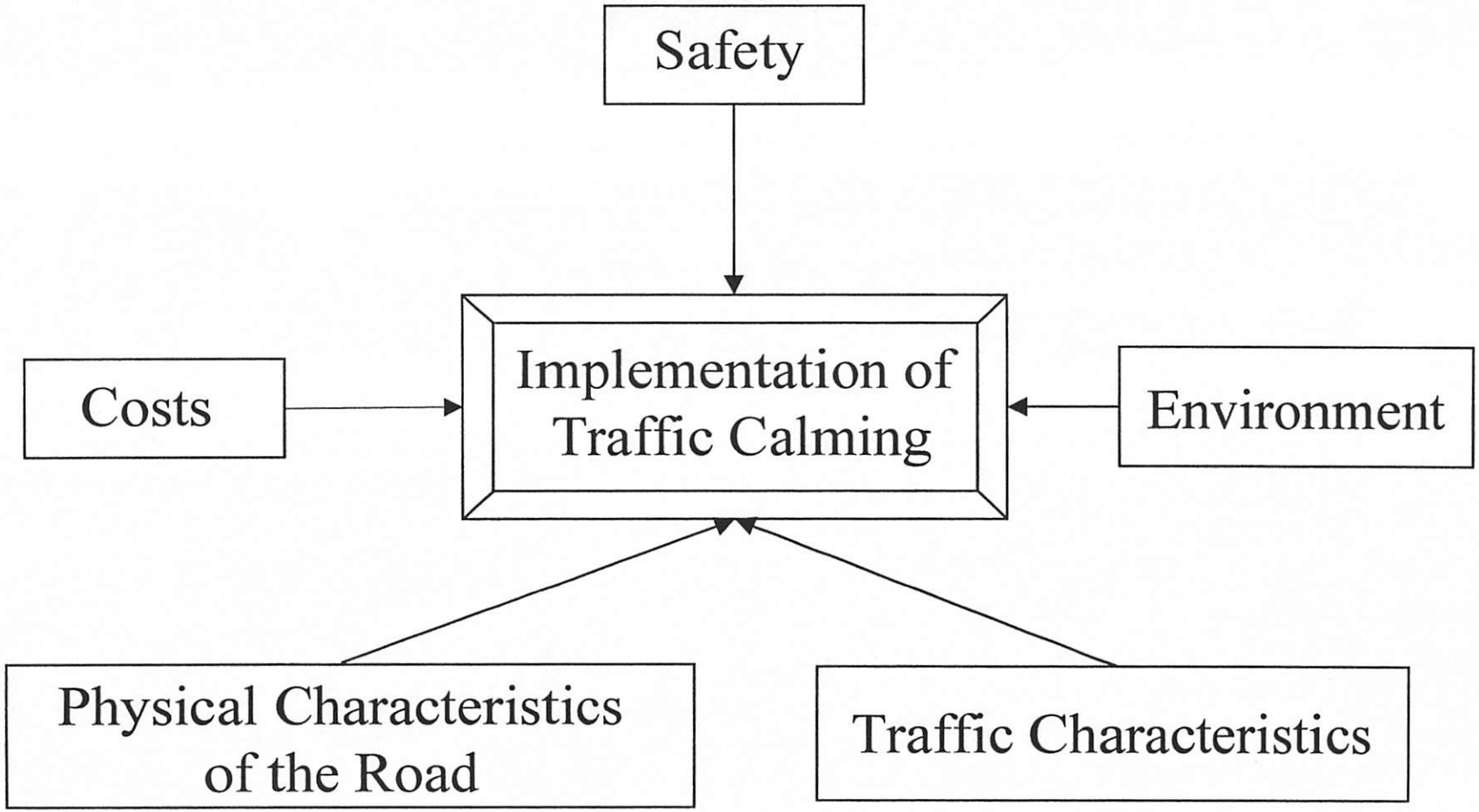
Research Objectives

- Explain the concept of traffic calming and evaluate its possible application in the Tren Urbano Project.
- Study the advantages and disadvantages of the several techniques suggested.
- Demonstrate the use of traffic calming on one station located in a residential area.
- Recommend a design criteria for the use of traffic calming in future phases of the Tren Urbano Project.

Traffic Calming

Urban planning concept used to manage traffic by geometric restrictions, diminishing its speed and volume. The purpose is to improve safety and mobility for pedestrians and vehicles, especially in residential neighborhoods. The techniques applied control the behavior of drivers, making them conscious that roads are not just for cars but for social interaction between vehicles, pedestrians, and cyclists.

Factors Considered in the Implementation of Traffic Calming

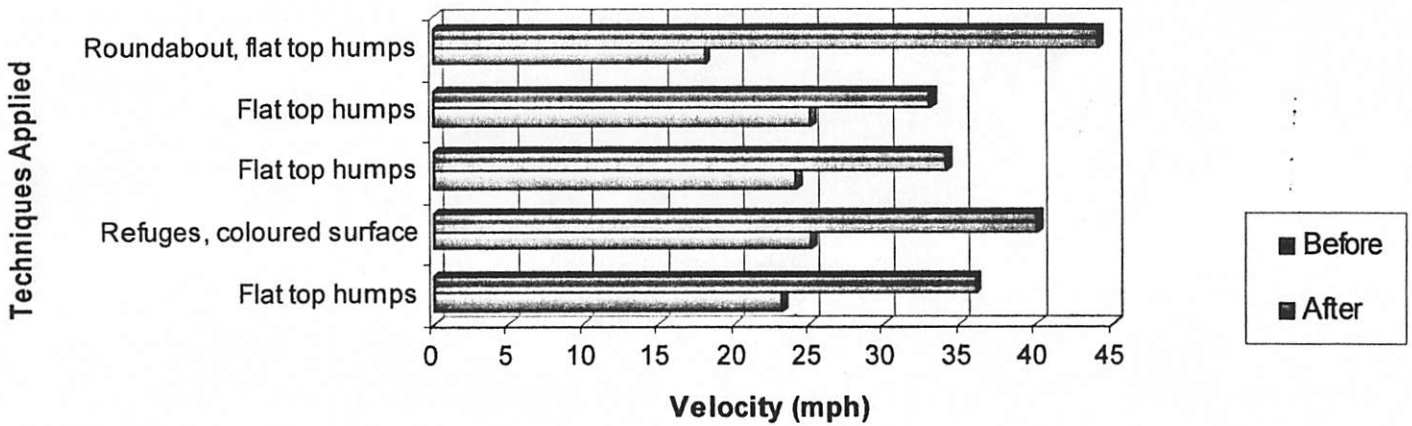


Advantages of Traffic Calming

- Reduce speeds
  - Less noise
  - Less environmental harm by less emissions
  - Less accidents
  - Better road capacity
- Pedestrians' and cyclists' safety
- Neighborhood security
- Aesthetics
- Alerts drivers that they are entering in a residential zone

Results of Traffic Calming Case Studies

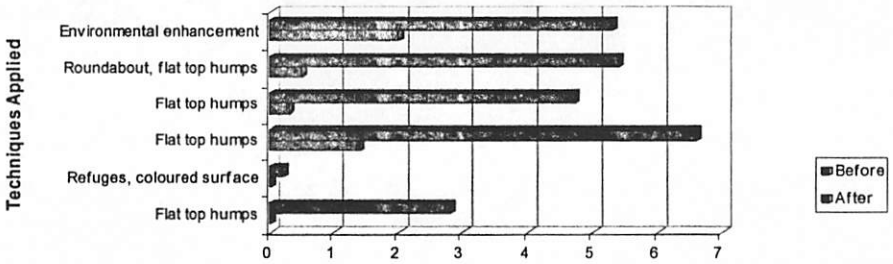
Speed Reductions With Traffic Calming



	Flat top humps	Refuges, coloured surface	Flat top humps	Flat top humps	Roundabout, flat top humps
Before	36	40	34	33	44
After	23	25	24	25	18

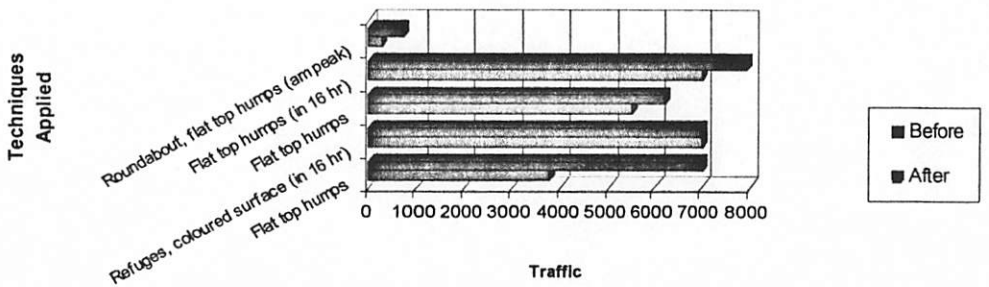
Results of Traffic Calming Case Studies

Accident Reduction Using Traffic Calming Measures



	Flat top humps	Refuges, coloured surface	Flat top humps	Flat top humps	Roundabout, flat top humps	Environmental enhancement
Before	2.8	0.2	6.6	4.7	5.4	5.3
After	0	0	1.4	0.3	0.5	2

Reductions in Traffic

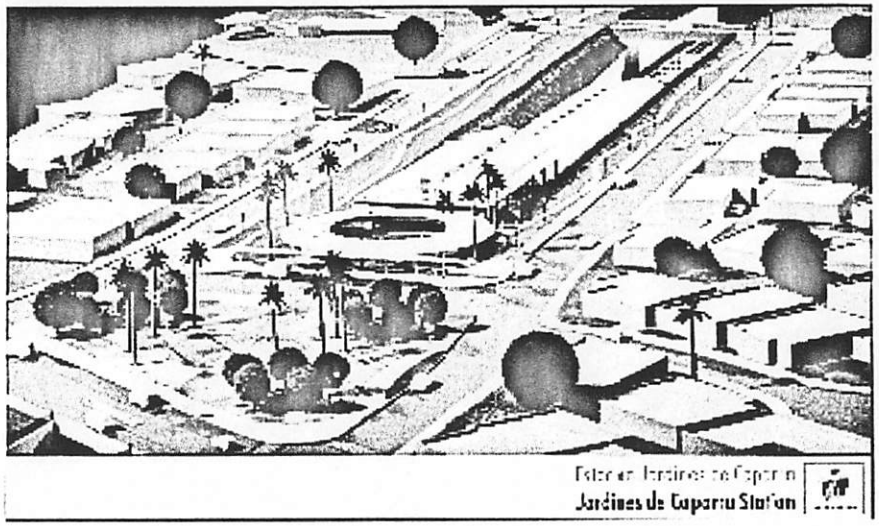


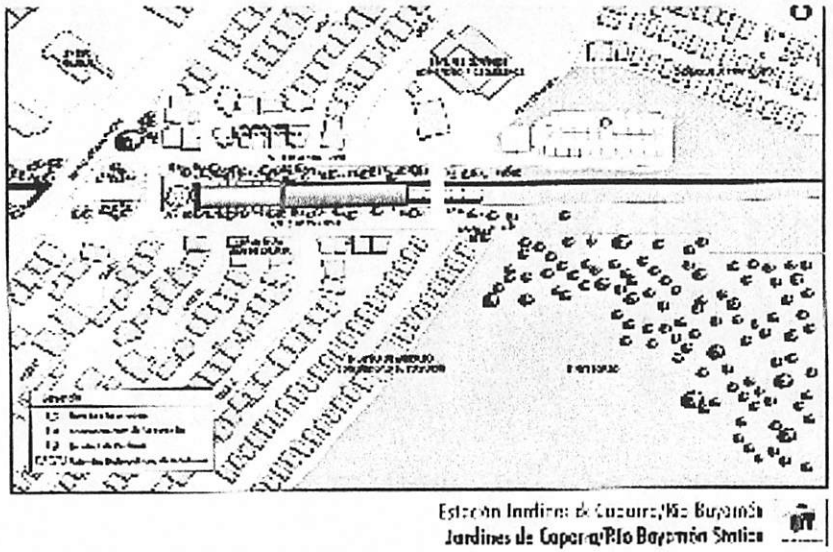
	Flat top humps	Refuges, coloured surface (in 16 hr)	Flat top humps	Flat top humps (in 16 hr)	Roundabout, flat top humps (am peak)
Before	7000	7000	6200	7900	723
After	3750	7000	5500	7000	265

Disadvantages of Traffic Calming

- Delays to emergency services
- Discomfort of patients
- Increased travel times for cars and buses
- "Público" efficiency can be affected
- Some techniques are expensive or confusing

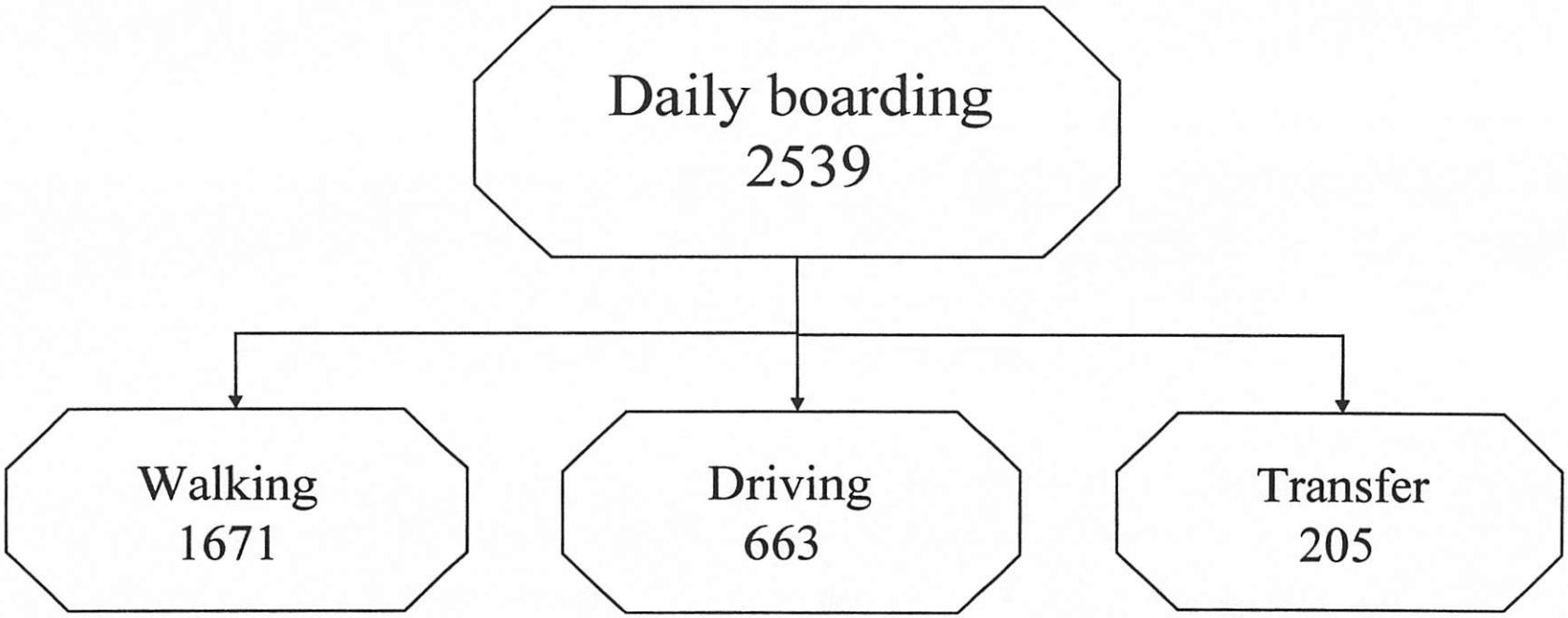
Study Area
Jardines de Caparra Station



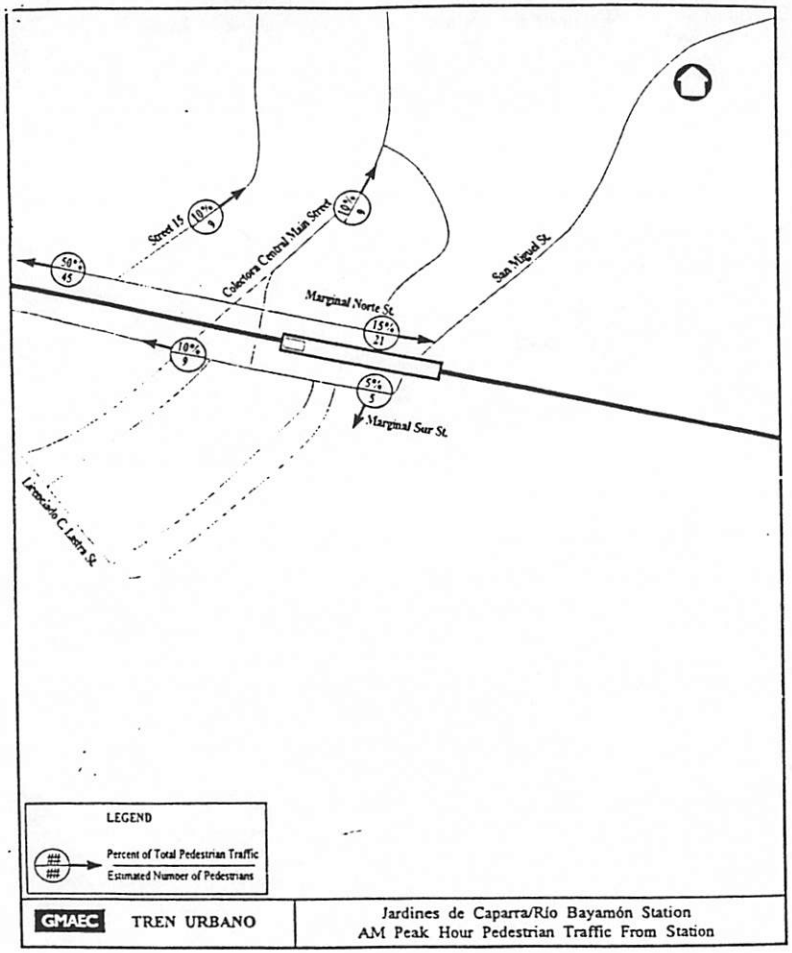


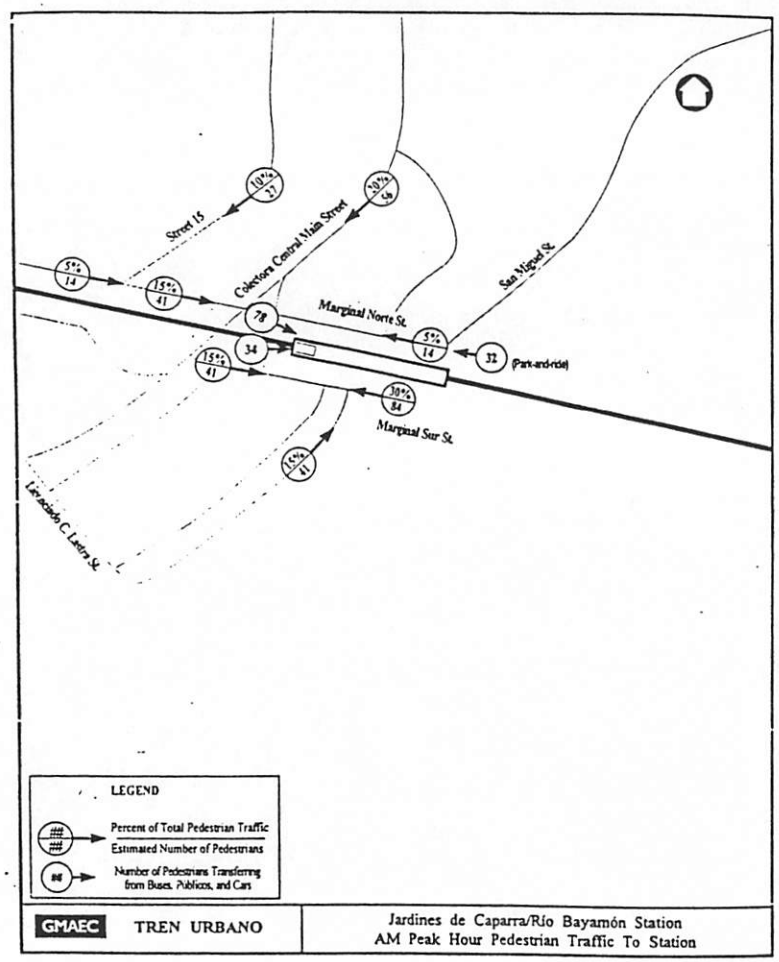
- Redondo Entrecanales Contractor
- Retained Cut Center Platform
- Low to medium income residential zone
- Expected to have high pedestrian activity
- Isolated parking lot

Jardines de Caparra Station (Cont.)



Pedestrian Flow





Why Traffic Calming on Jardines de Caparra Station?

- Residential area
- High pedestrian's incidence
- High school near the station
- Future residential developments
  - 2500 residences
  - densification
  - higher traffic flow
  - higher velocities
- Long distance between the station and the park & ride will expose pedestrians to danger.

Goals in the Implementation of Traffic Calming in Jardines de Caparra Station

- Increase pedestrian's and driver's safety
- Reduce noise
- Increase accessibility
- Protect the environment

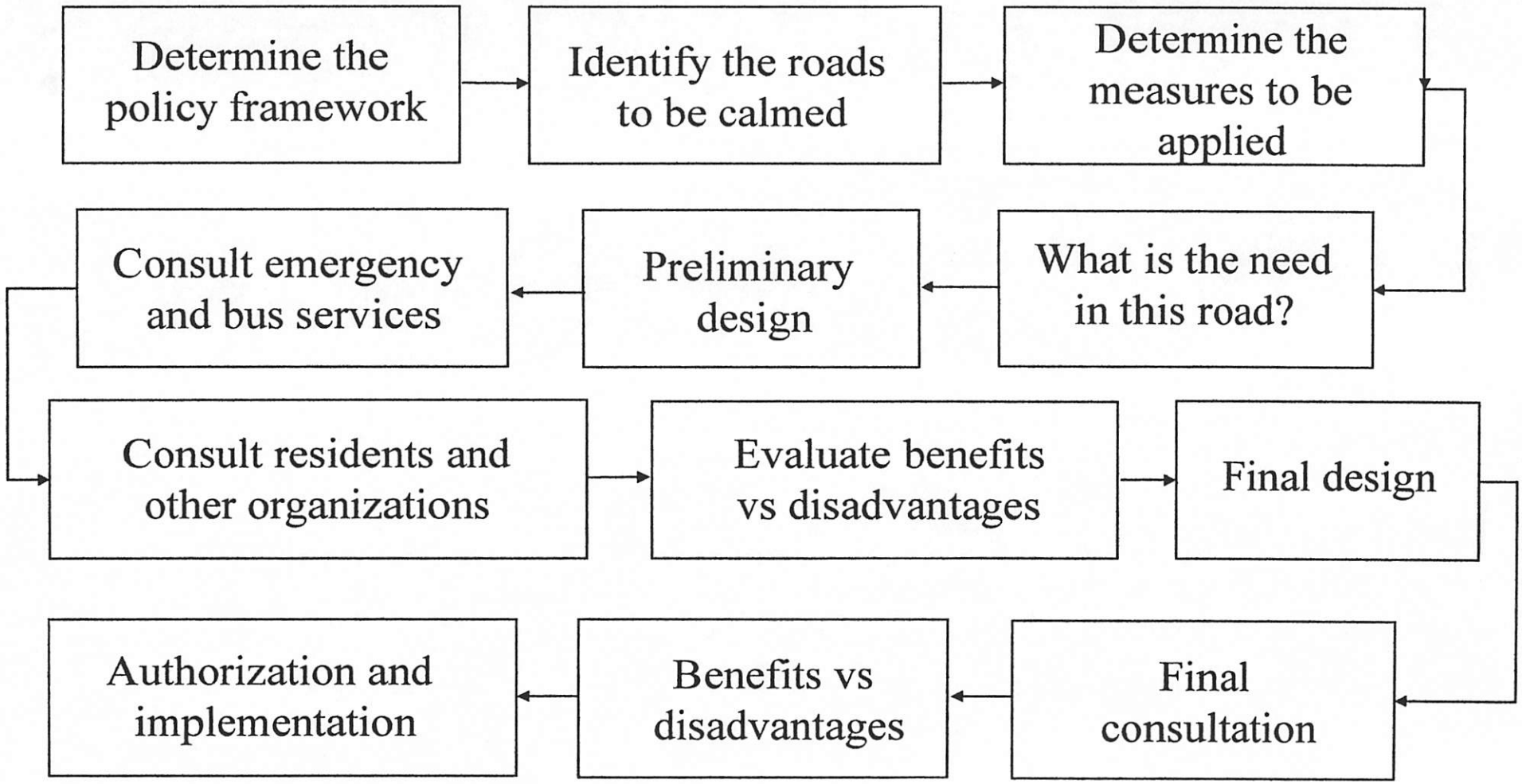
Contractor Design Criteria

- Pick-up/drop-off zones
  - Should be in front of the station far from the residences.
  - Have different pavement
  - Landscaping to diminish visibility from the residences
  - Located at the forecourt and oriented towards Colectora Central
- Entrance control that permit its closing at night
- Landscaped areas between residences and the station
  - Reduce noise
  - Limit visibility from the residences to the station
- The design should take into account future densification

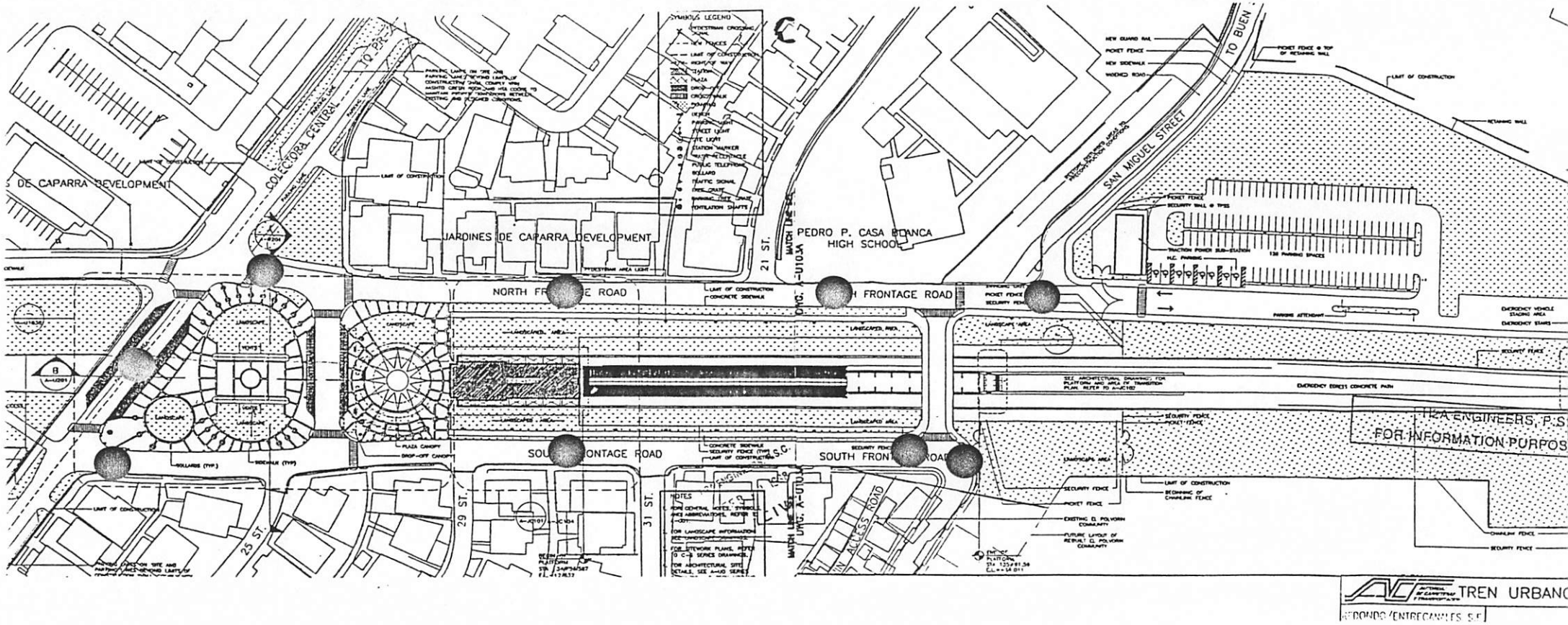
Additional Suggestions to the Design Criteria

- Sidewalks shall provide:
  - Safety
  - Accessibility (also for handicapped people)
  - Direct routes
  - Visibility
  - Good illumination
  - Comfort
- Traffic Calming measures
  - Must not create a considerable increase of noise in the area
    - Avoid acceleration and deceleration
    - Consider the material
  - Sufficient and good signs

Implementation of Traffic Calming



Location of Traffic Calming Devices

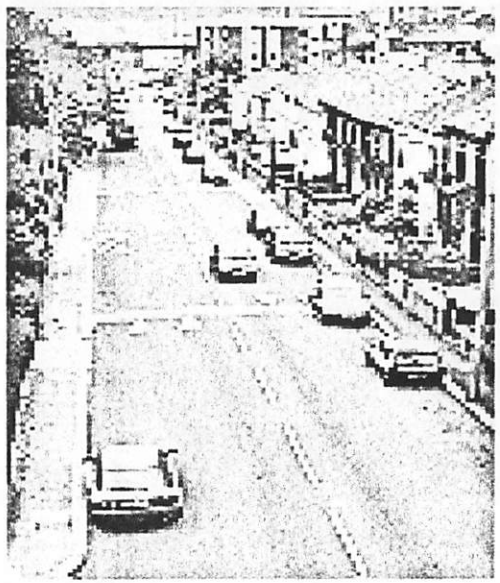


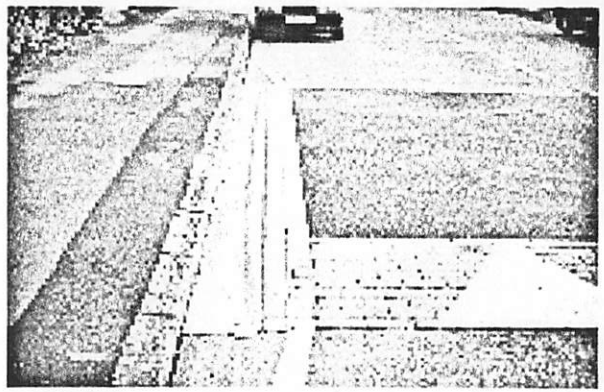
V Encuentro UPR/MIT sobre el Tren Urbano **January 7 - 15, 1999**

Suggested Implementation
Colectora Central

- Signs
  - Speed limit
  - Proximity of the station
  - Pedestrians presence
  - Thermoplastic paint ahead of the median
- Pedestrian Refuge or a median
  - Can cause a speed reduction
  - Pedestrian's safety
    - People cross one direction at a time
- Paved zone

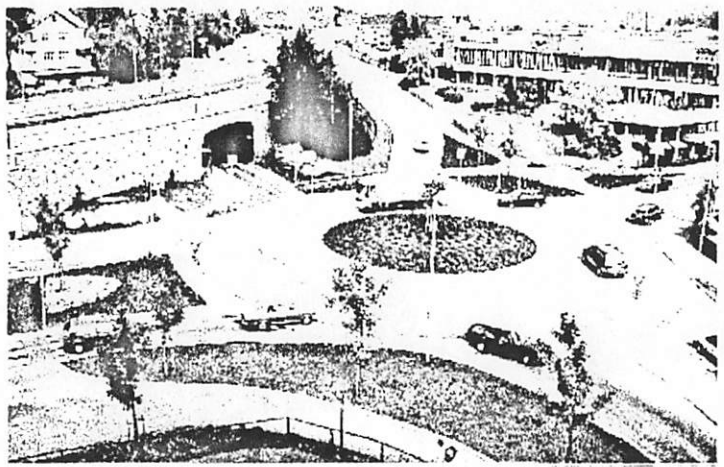
Suggested Implementation
Marginal Norte and Marginal Sur

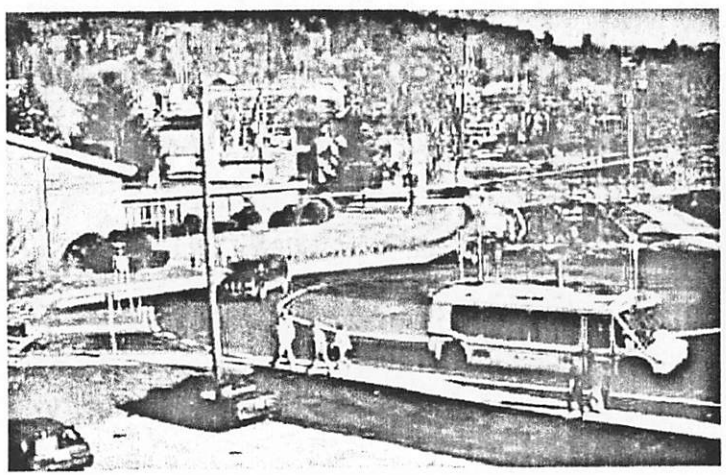




- Signs
- 3 Flat-top humps on each marginal
  - 50 mm high and ramps marked with arrows
  - Reduce speed
  - Used as crosswalks

Suggested Implementation
Bridge





- Localize the bridge toward the east
  - Align San Miguel Street with the principal street of the new development
  - 2 Roundabouts at the intersections with the Marginal Norte and Marginal Sur
    - Elevated
    - Landscaping
    - Signs
- Good illumination

Observations

- The purpose of traffic calming in Jardines de Caparra is to reduce speed, not traffic
- Traffic calming is a good option
  - to increase pedestrian's safety
  - to create a more comfortable environment around the station
- Many small measures around the station would be more effective than just controlling the velocity in the front

Recommendations

- Techniques applied in the Colectora Central or in the front of the station must not affect the bus and emergency services.
- There must be a good illumination
- Sidewalks shall be sufficiently separated from the road in order to provide safety to pedestrians
- Consider different designs and choose the one that fulfill the objectives of the project in a cost effective way.

Acknowledgements

- Dr. Nelson Irizarry
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- Ms. Lydia Mercado
- Mr. Kenneth Kruckemeyer

Future Work

- Complete the literature review of traffic calming around train and bus stations
- Complete the suggested design of traffic calming in Jardines de Caparra
- Feasibility analysis of the design suggested

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UPR

TREN URBANO

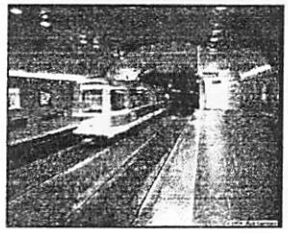
Techniques for Prediction of Ground-Borne Vibrations Caused by Subway Trains

By: Tomás Montalvo Torres
Academic Advisor: Dr. Luis E. Suárez

UPR

Objective

- Develop the required techniques and to carry out a rigorous analysis of the vibrations induced in neighboring structures by the propagation of waves caused by a train running through an underground tunnel.

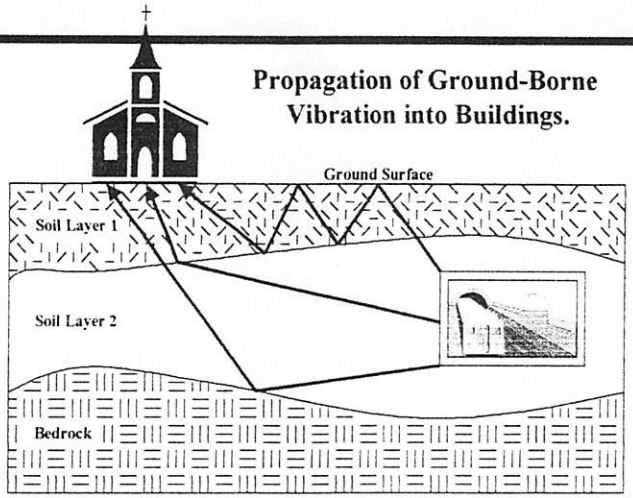


Analysis Procedure

- The commercial all-purpose FE program ANSYS will be used for discretization of the geometry and a numerical integration algorithm to calculate the displacements and velocities induced by the vibration waves.
- The soil deposit surrounded the tunnel, the tunnel itself, and the foundation of the structures in the vicinity will be modeled using a 2/D finite element model.

Vibration Impact Assessment

Propagation of Ground-Borne Vibration into Buildings.



Modified from Figure 7-1. FTA Manual.

Factors that Influence the Level of Ground-Borne Vibration

- Factors Related to the Vibration Source
  - Train Speed
  - Transit Structure (tunnel)
  - Depth of Vibration Source
  - Track Support System
  - Track/Roadway Surface

Factors that Influence the Level of Ground-Borne Vibration

- Factors Related to the Vibration Path
  - Soil Type
  - Distance to bedrock
  - Soil Layering
  - Depth to Water Table

Factors that Influence Level of Ground-Borne Vibration

- Factors Related to the Vibration Receiver
  - Foundation Type
  - Type of Building
  - Acoustical Absorption

Ground-Borne Vibration Impact Criteria

Land Use Category	Groud Borne Vibration
CAT.1 Building where low ambient vibration is essential for interior operations.	65 VdB
CAT. 2 Residences and buildings where people normally sleep.	72 VdB
CAT. 3 Institutional land uses with primarily daytime use.	75 VdB

• VdB re 1 micro inch/sec.

Soil Type Found in the Tren Urbano Corridor

Name	Symbol	Description
Artificial Fill	Af	Wet organic soil under mixed rock fill, depth 5 m.
Recent Alluvium	Qa	Organic soil, sand, clay creek deposits, depth 20 m., water 2-6 m.
Alluvial Fan Deposits	Qf	Silty and sandy clays, water 2-6 m.
Older Alluvium	Qtt	Stiff silty and sandy clays, water 2-6 m.
Mucarabones Sand	Tm	Coarse quartz sand
San Sebastian Formation	Ts	Sandy clay with small rocks , water 5-6 m.
Río Piedras Siltstone	Tr	Layers of claystone and sandstone

Vibration-Sensitive Locations Within 150 Meters of Tren Urbano Alignment (STA 219-232)

Station No. / Side	Vibration Sensitive Locations *	Vibration Cat. / Soil Type
219-220 / E	Residences along Ponce de León Avenue	2 / Qa
220-221 / E	Church, Plaza-Rio Piedras	3 / Qa
223-226 / E	University of Puerto Rico	3 / Qa
229-232 / W	Residences in Rio Piedras	2 / Qtt

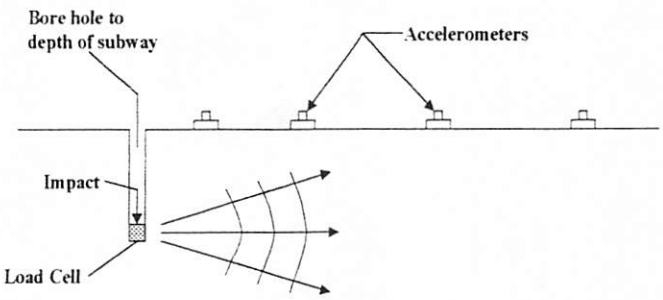
* Including Historic Buildings.

Detailed Vibration Analysis

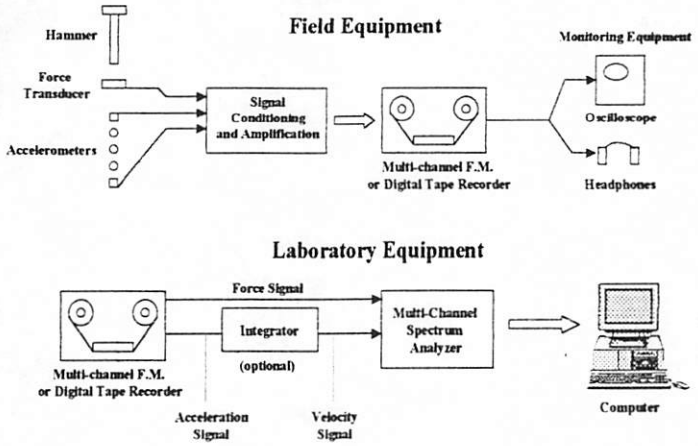
- Survey of Existing Vibration
- Predict Future Vibration and Vibration Impact
- Develop Mitigation Measures

Testing Procedure

Subway Testing



Equipment for Field Testing and Laboratory Analysis



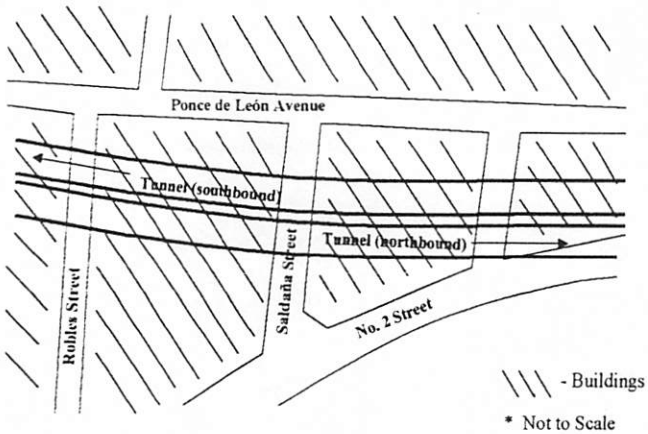
Predicted Vibration Levels in Subway

Area (Subway)	Nearest Sensitive Receiver	Type of Track	Speed (Km/hr)	Interior Vibration Level Without/ With Crossover (VdB)*	Impact Without/ With Crossover
Río Piedras / University of Puerto Rico	209+54 to 229+50 / 5 (est)	Subway	45	75 / 85	Yes / Yes

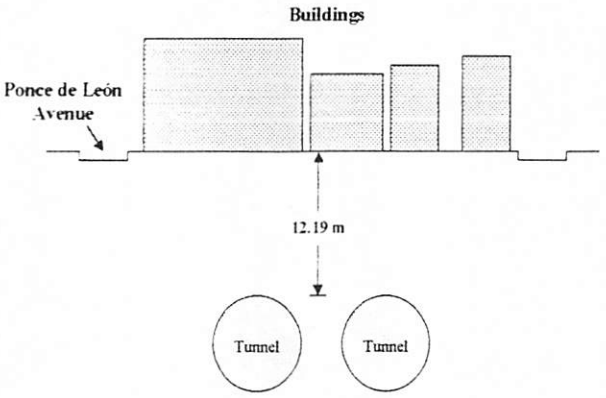
• VdB re 1 micro inch/sec.

Example of a Specific Area to be Studied - Sta. 222+02

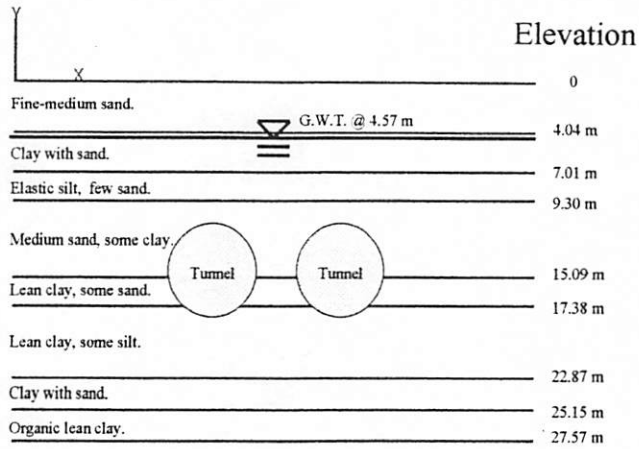
Center of Río Piedras



Cross Section of a Specific Area to be Studied - Sta. 222+02



Elevation of the Soil Layers
Sta. 222+02



Preliminary Conclusions

- A numerical simulation of the ground borne vibration induced in nearby structures by an Underground Rail Transit System is being implemented. It is expected that the methodology will be more rationale and accurate than current vibration prediction procedure.

Contribution of this Work

- The methodology and computational tools derived from the project will be useful to implement the detailed analysis required by the Federal Transit Administration when the results of preliminary screenings indicate that safe vibration thresholds are exceeded.

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