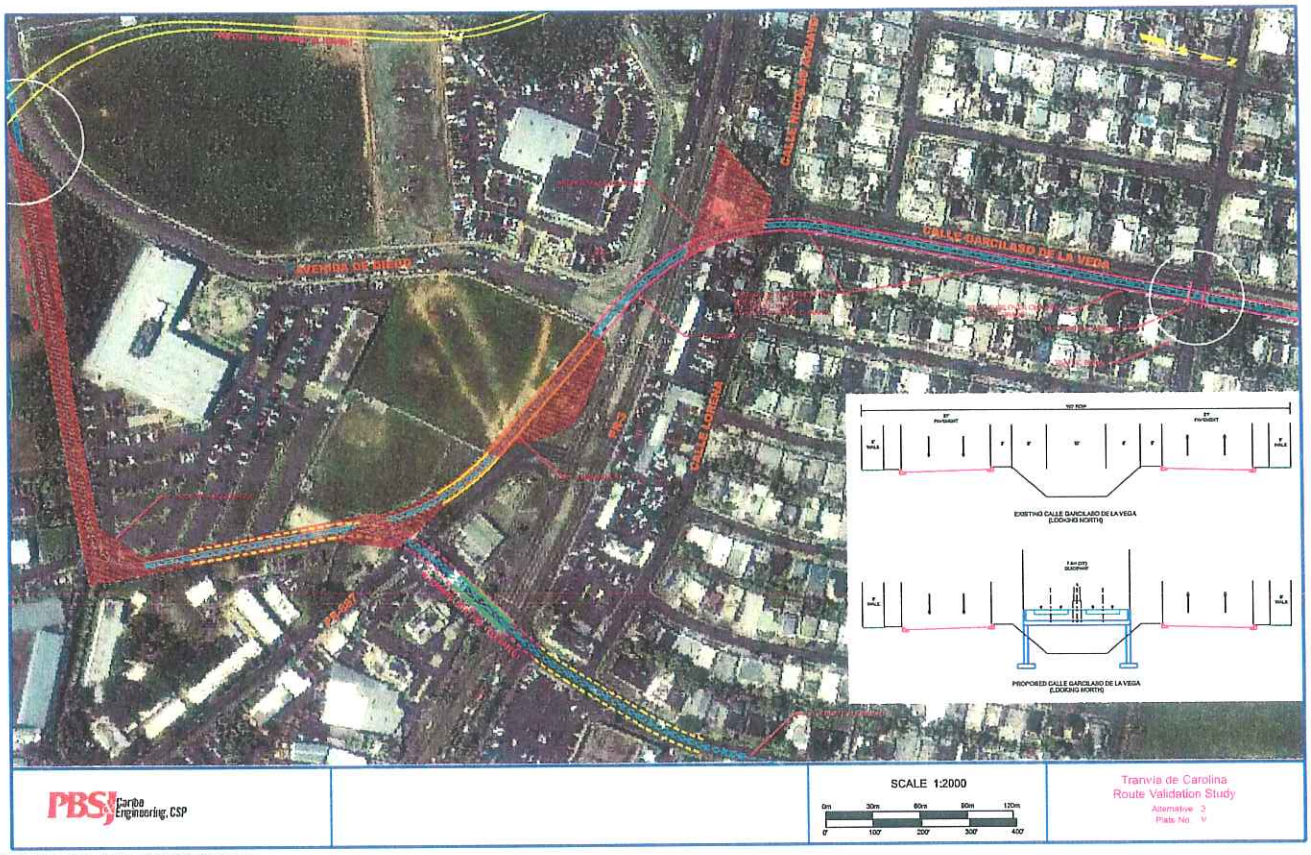

PBSJ Caribe Engineering, CSP

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Tranvia de Carolina
Route Validation Study
Alternative 3
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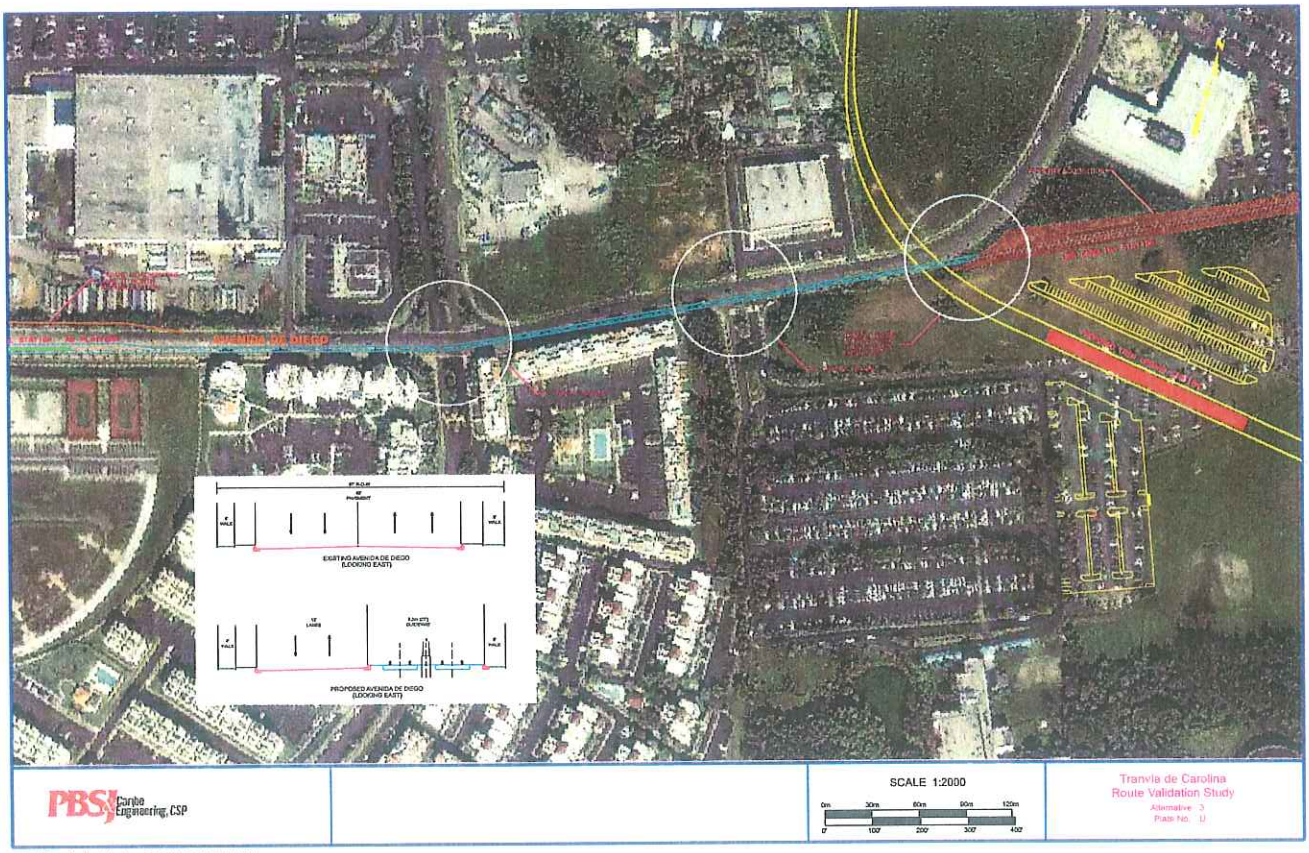

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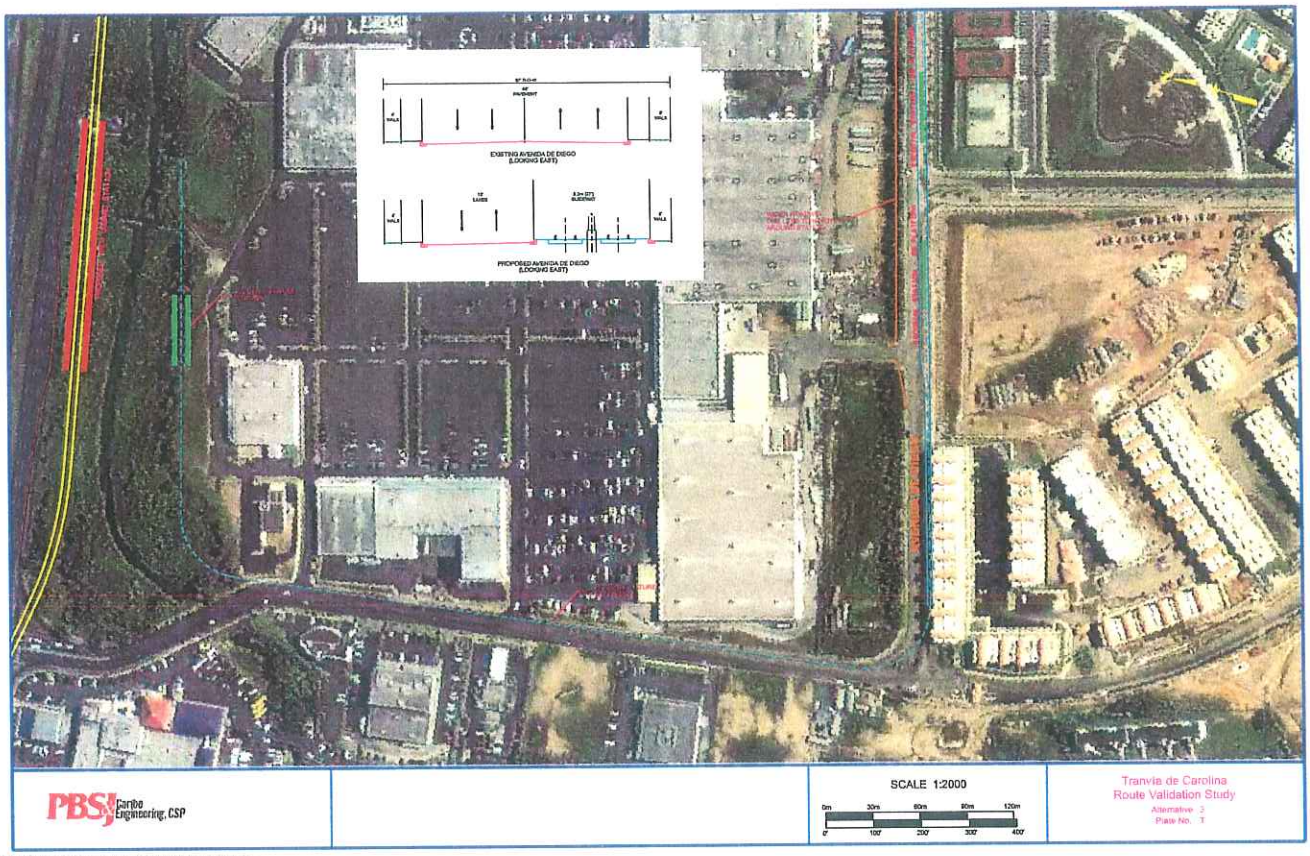

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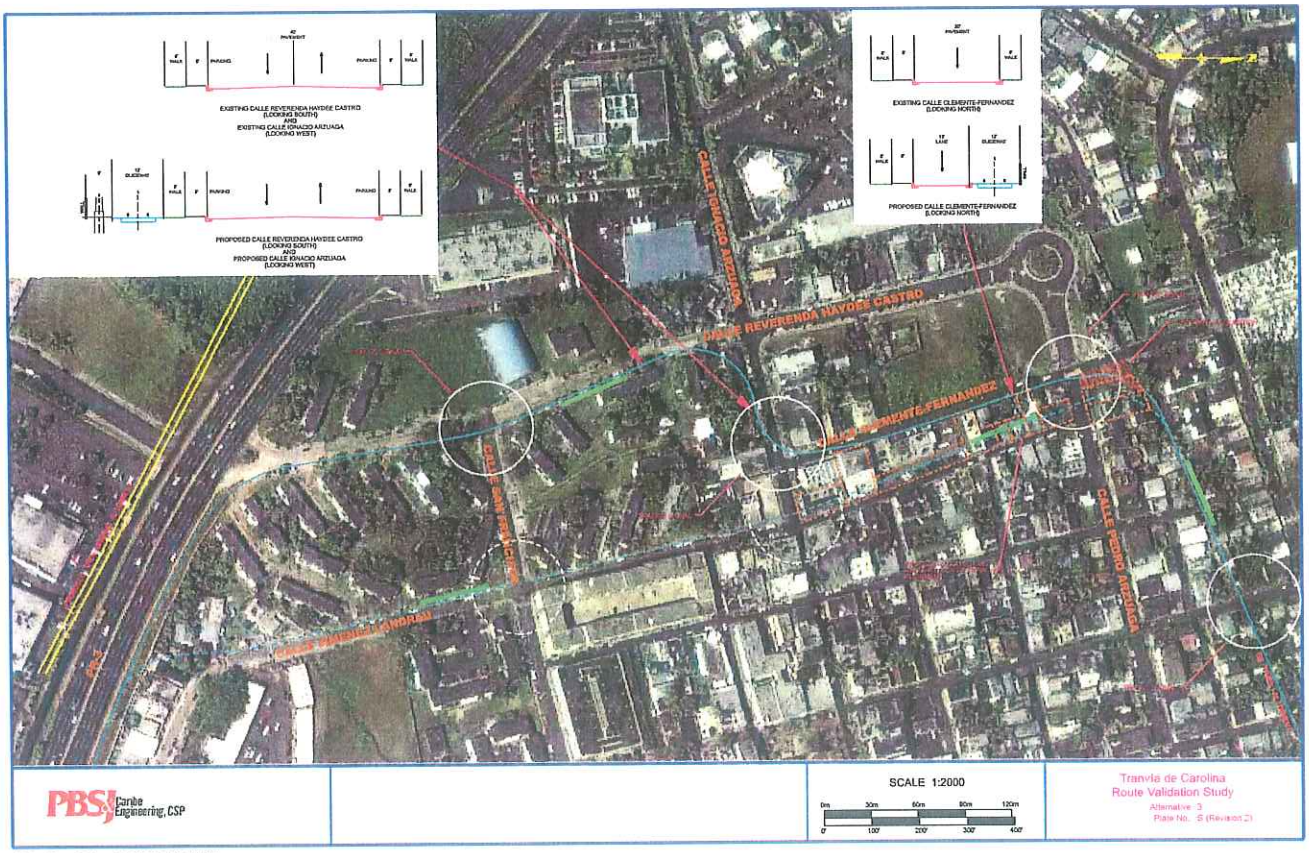

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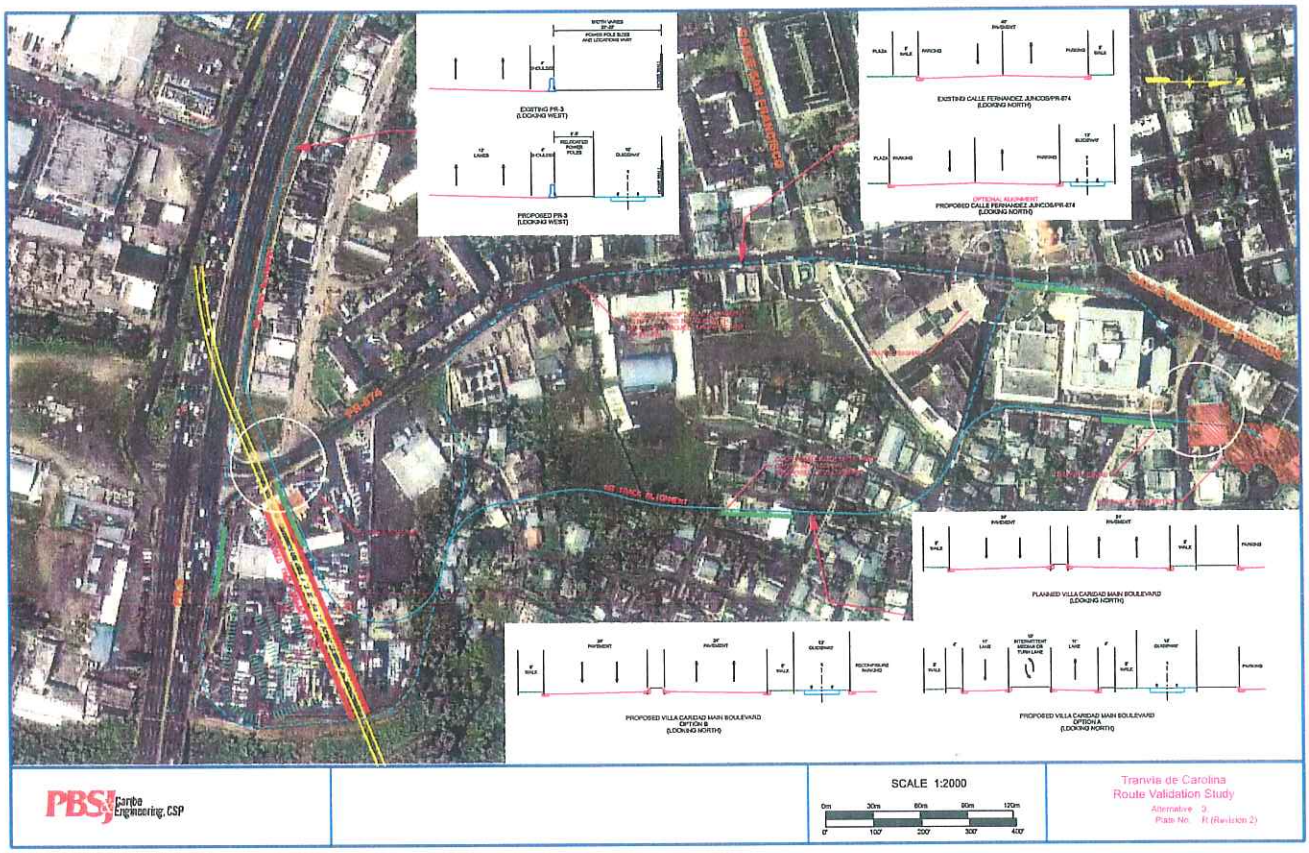

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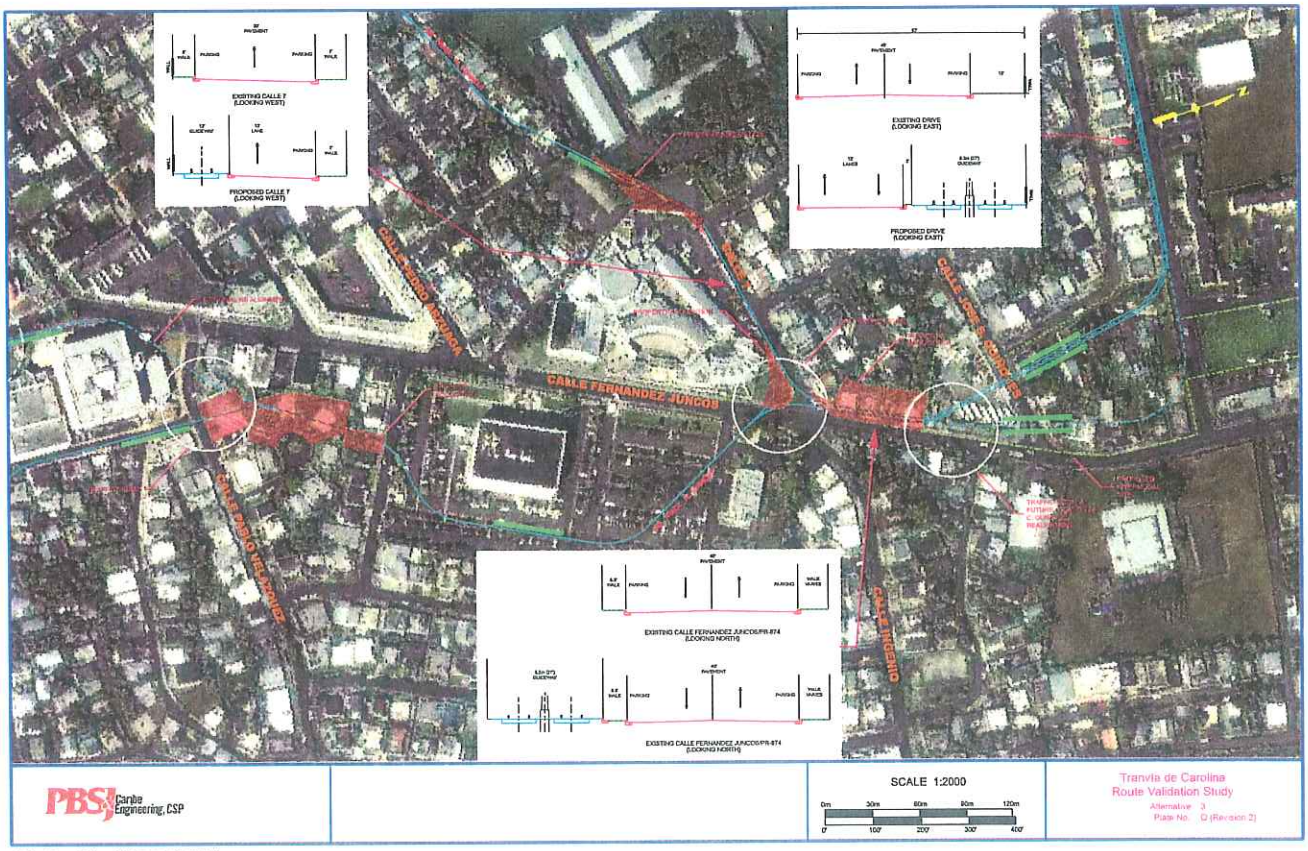

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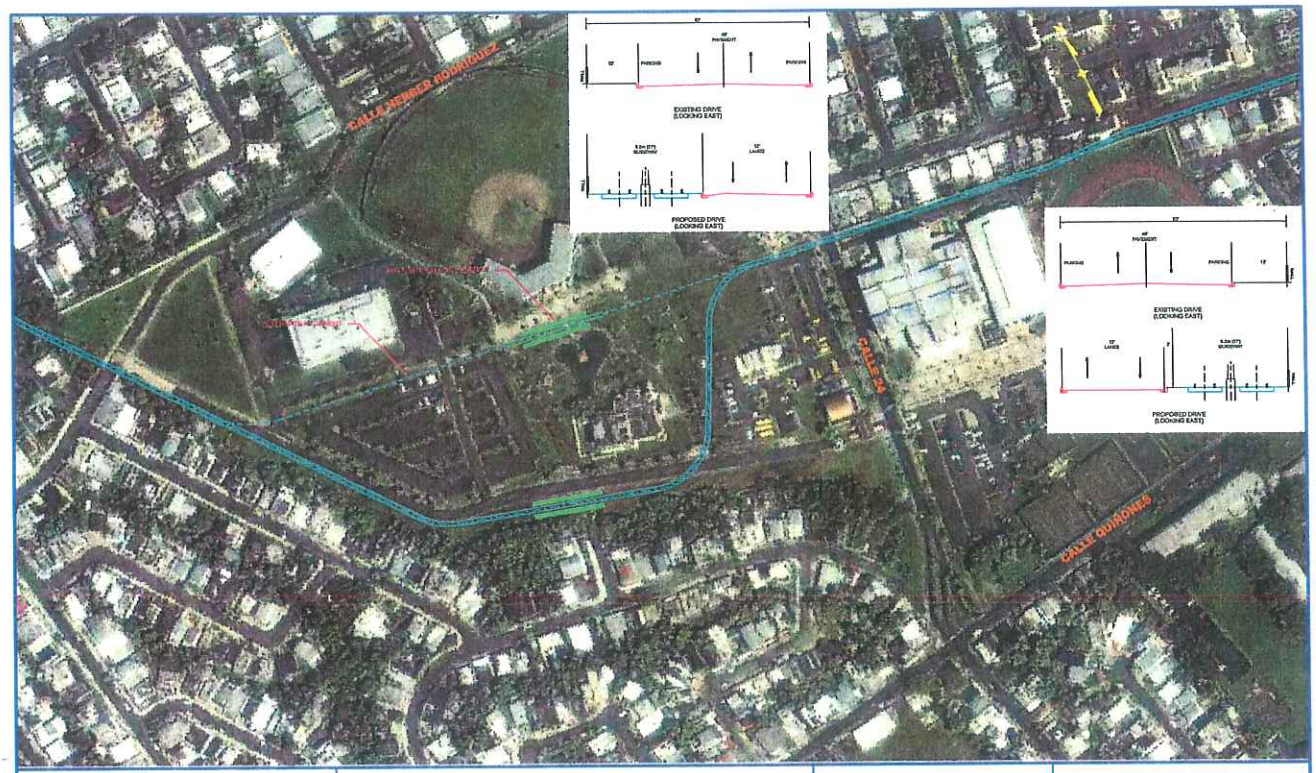

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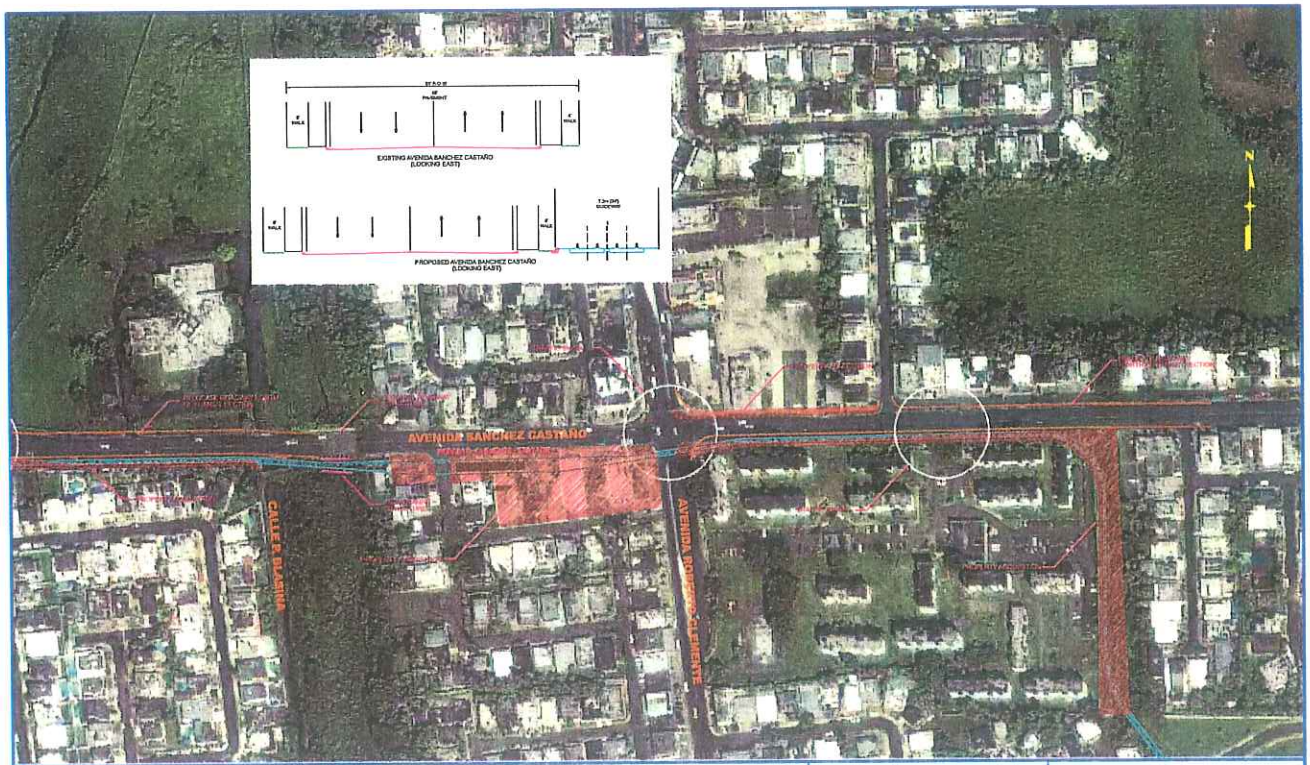

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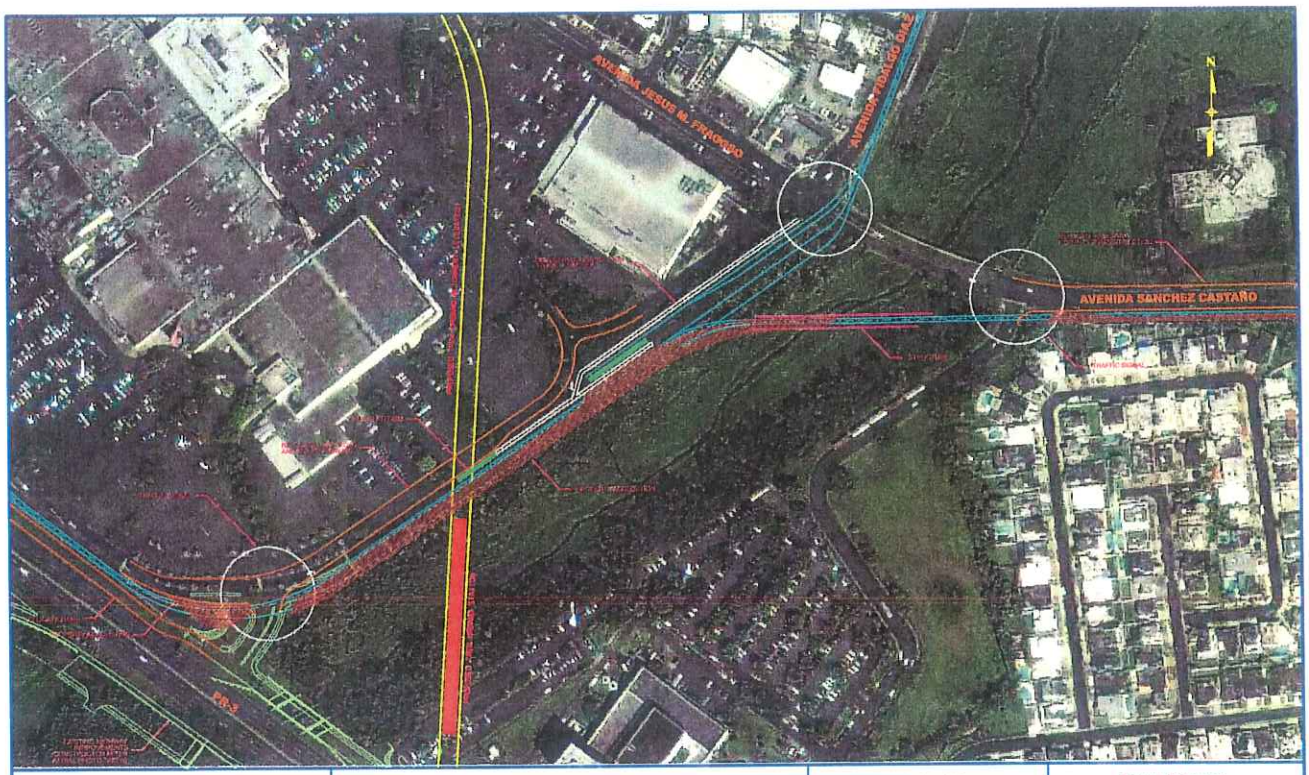

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Tranvia de Carolina
Route Validation Study
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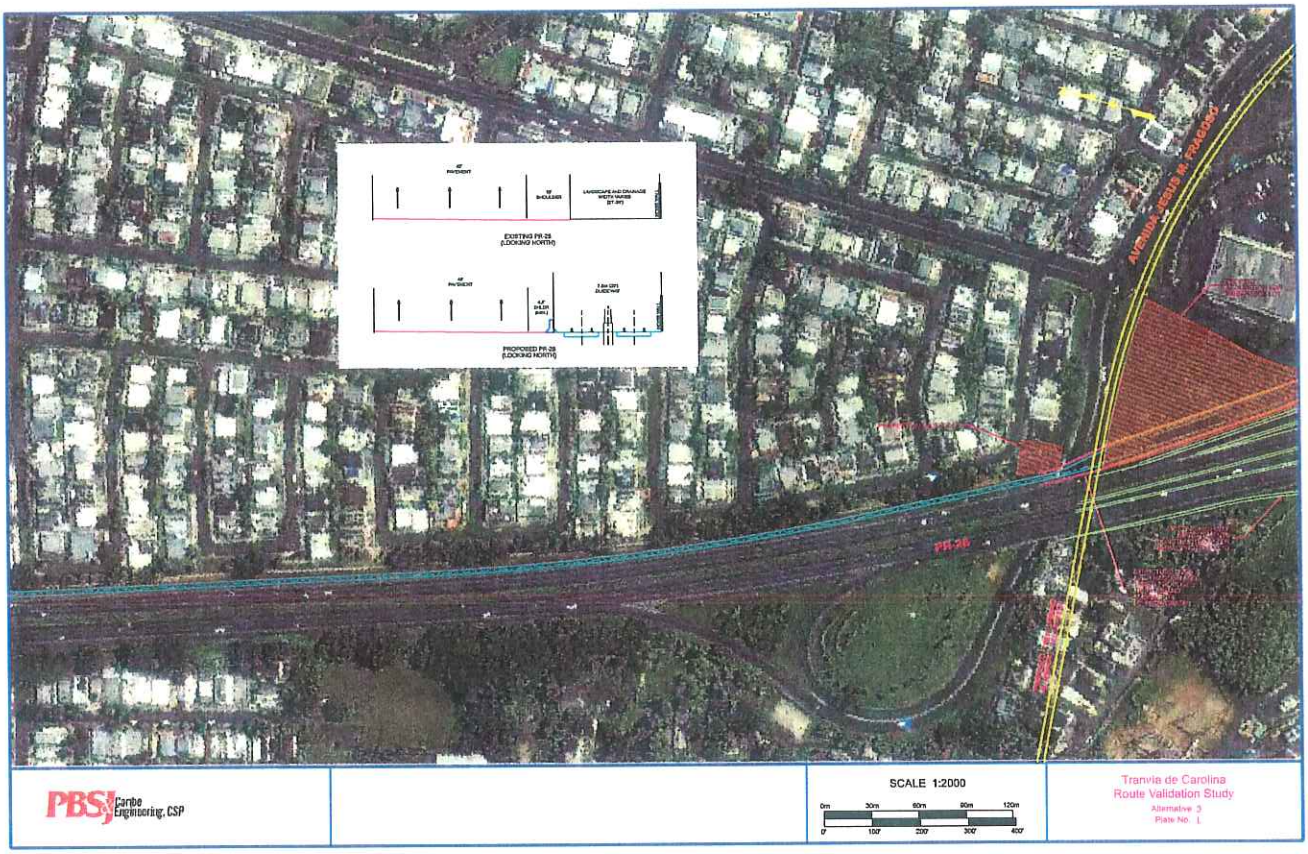

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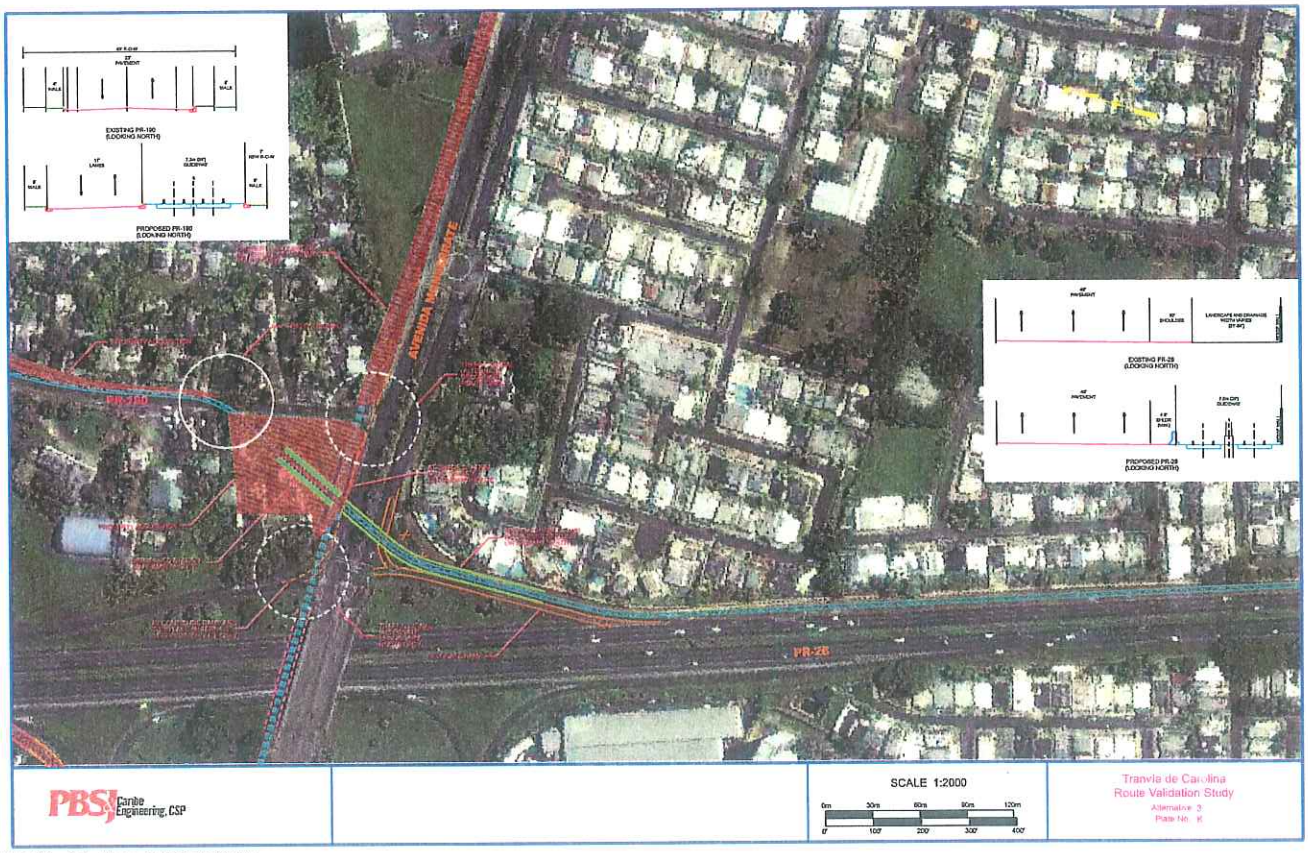

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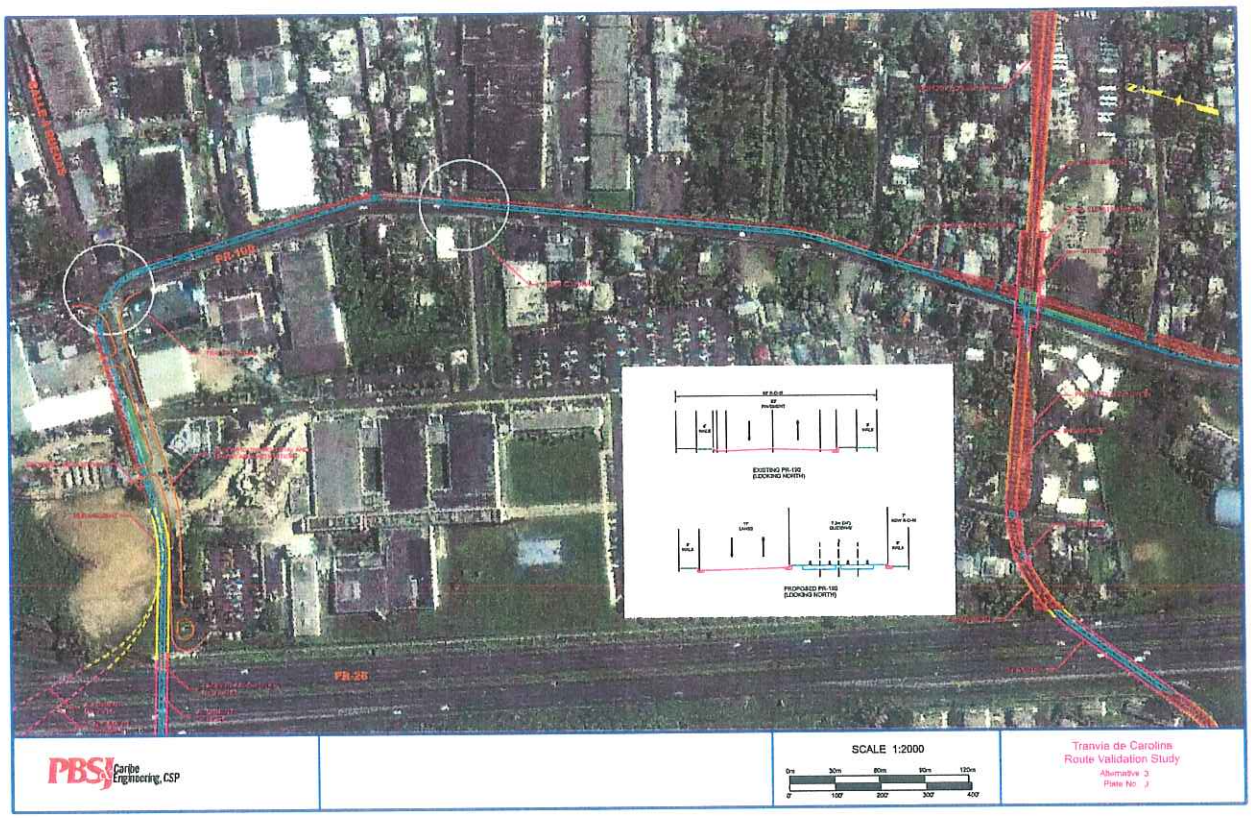

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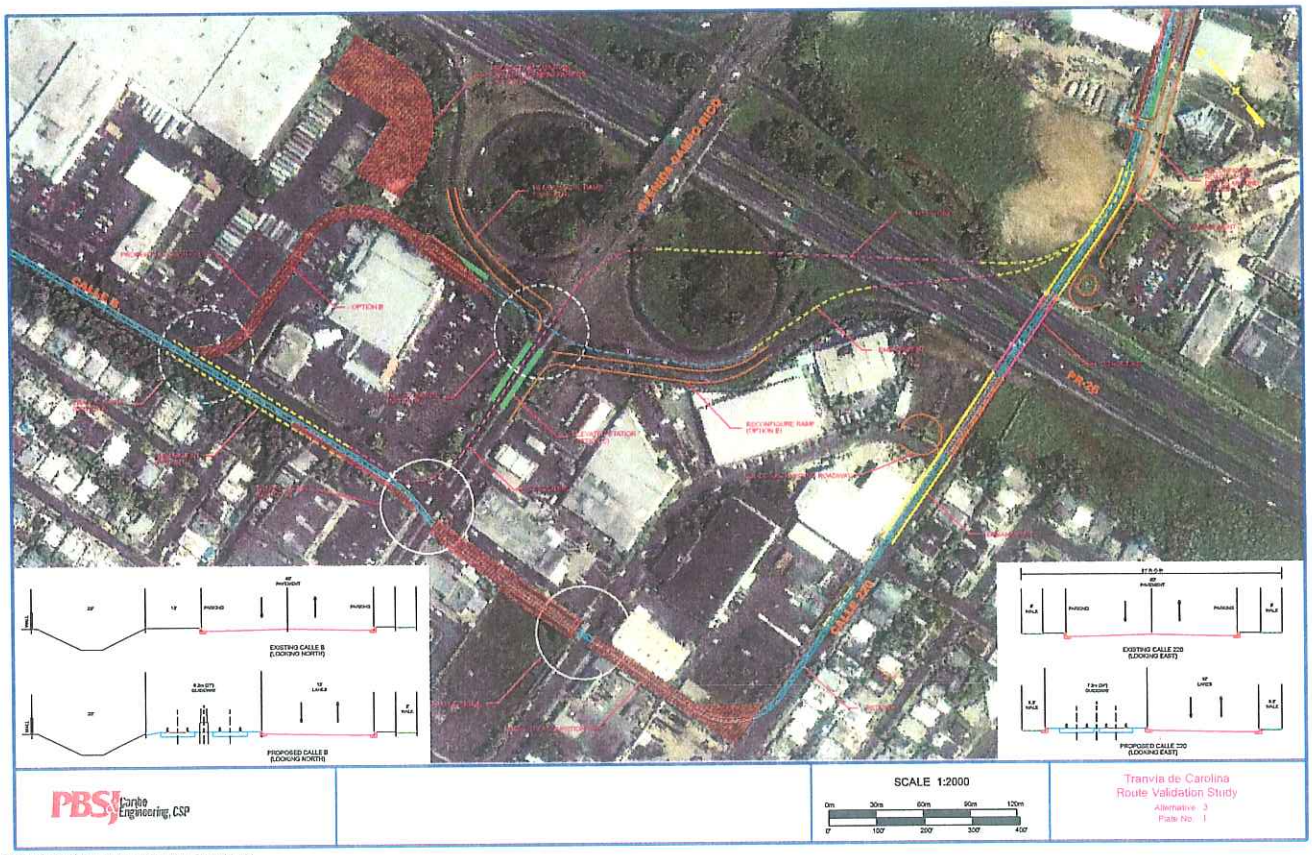

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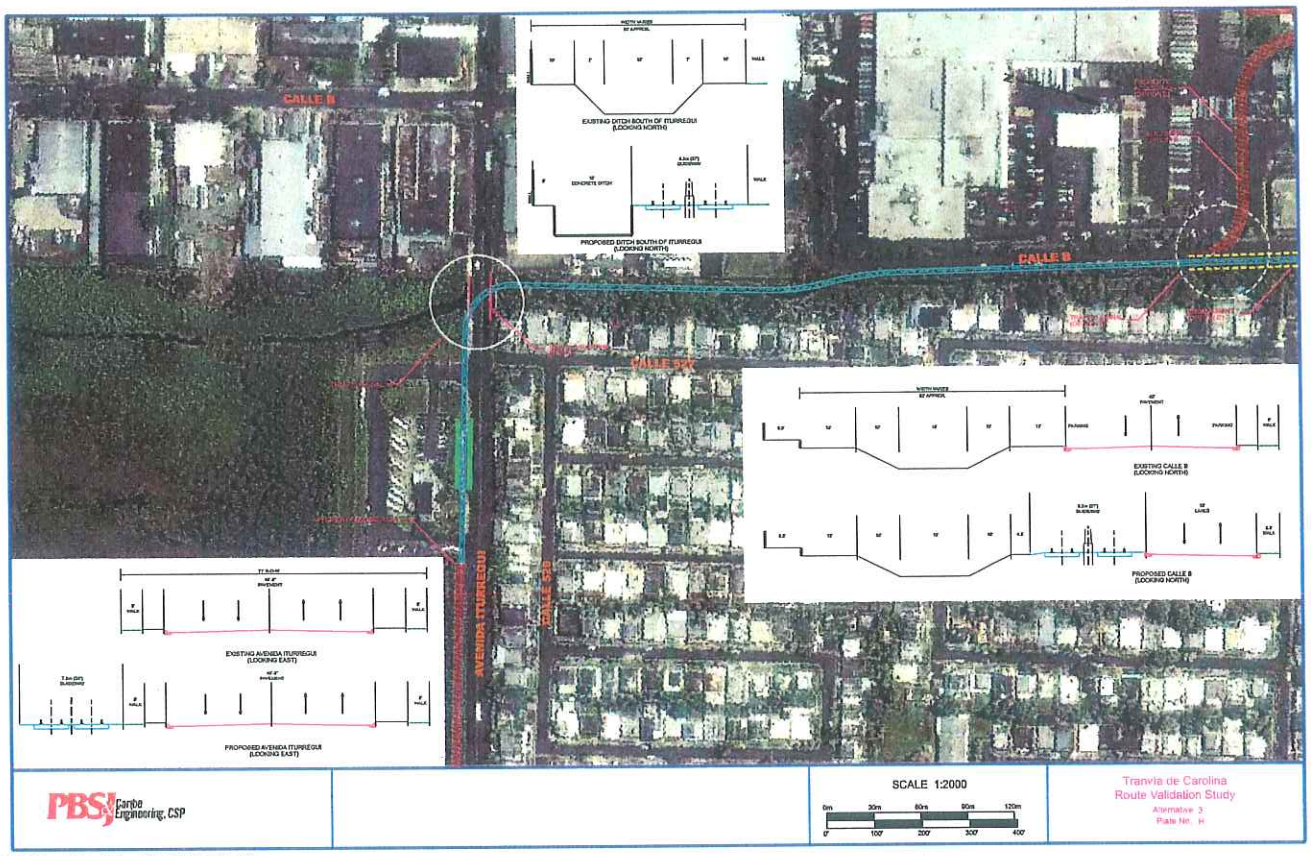

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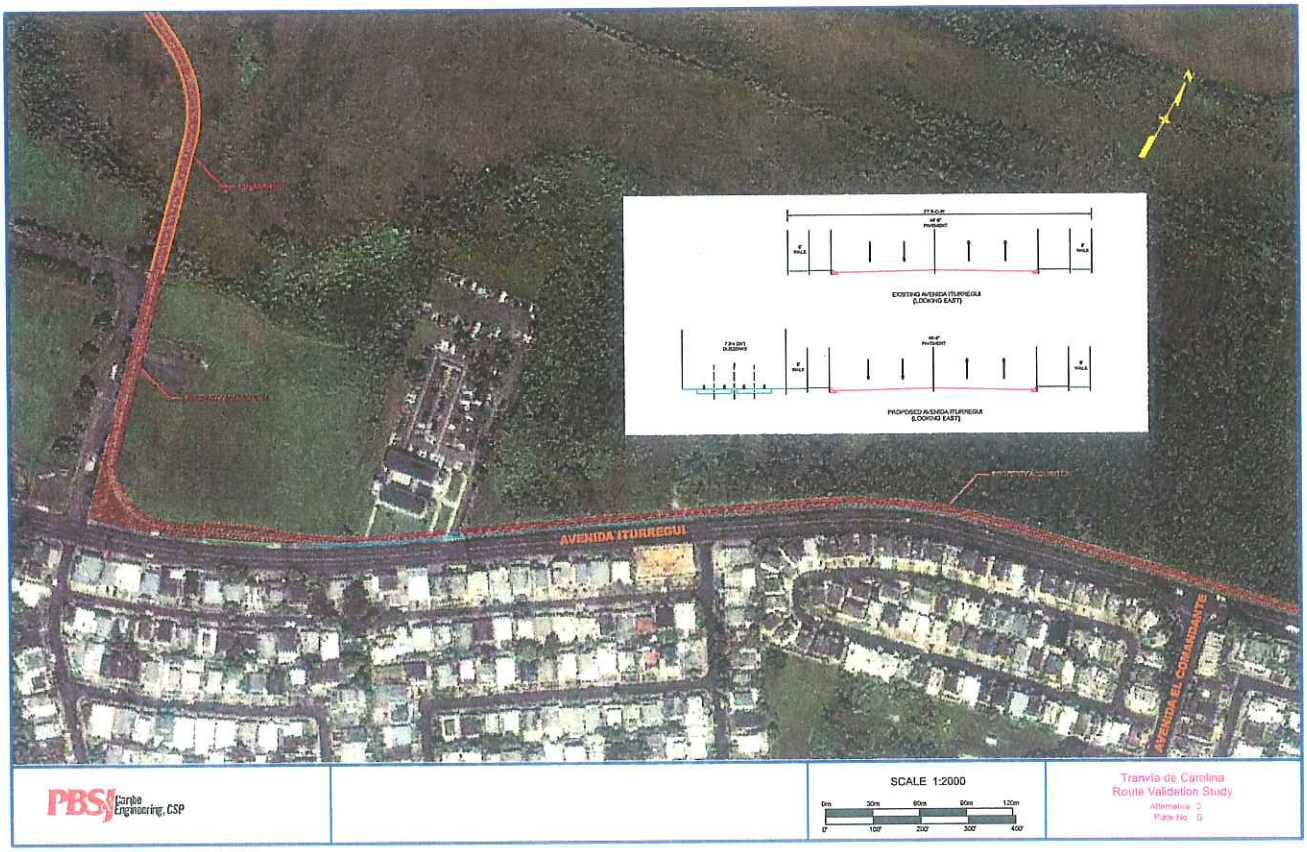

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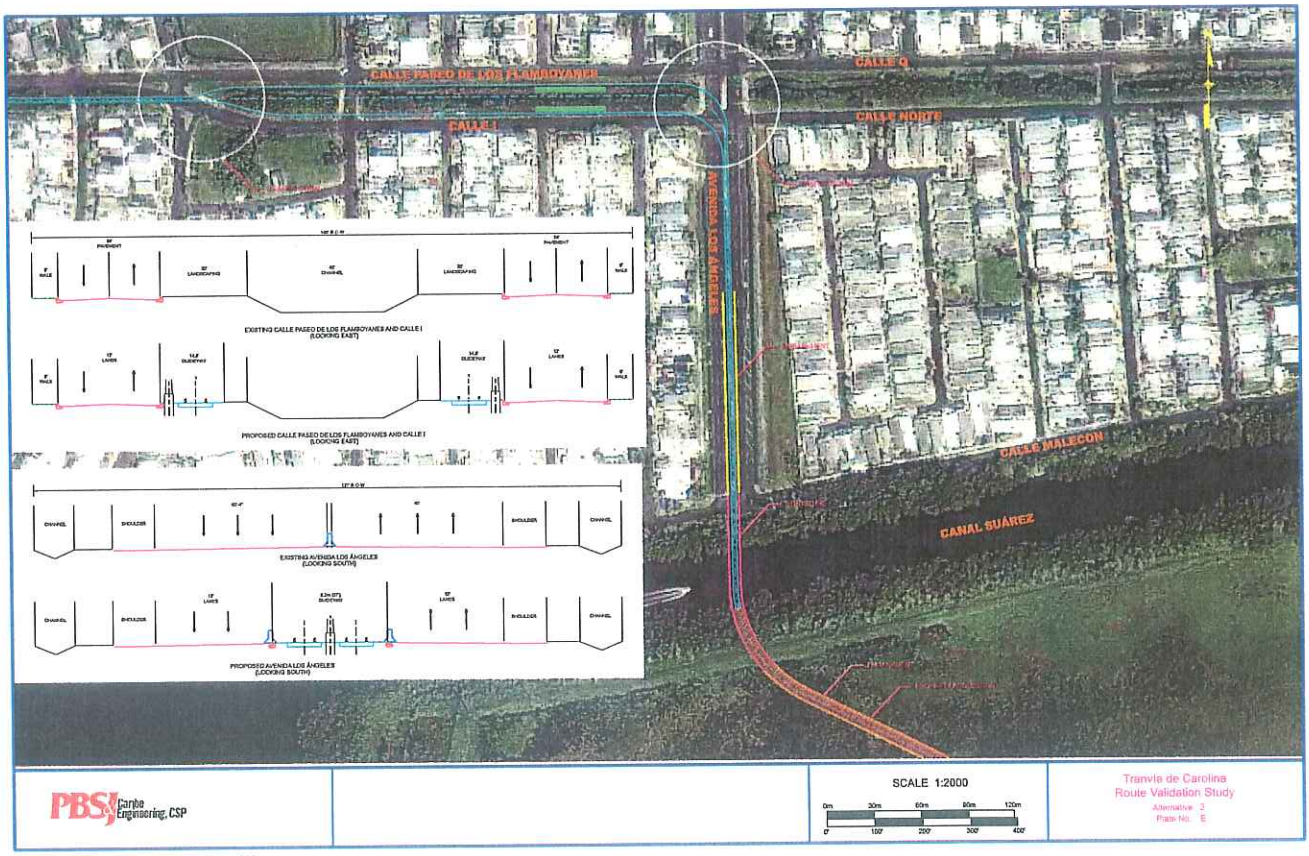

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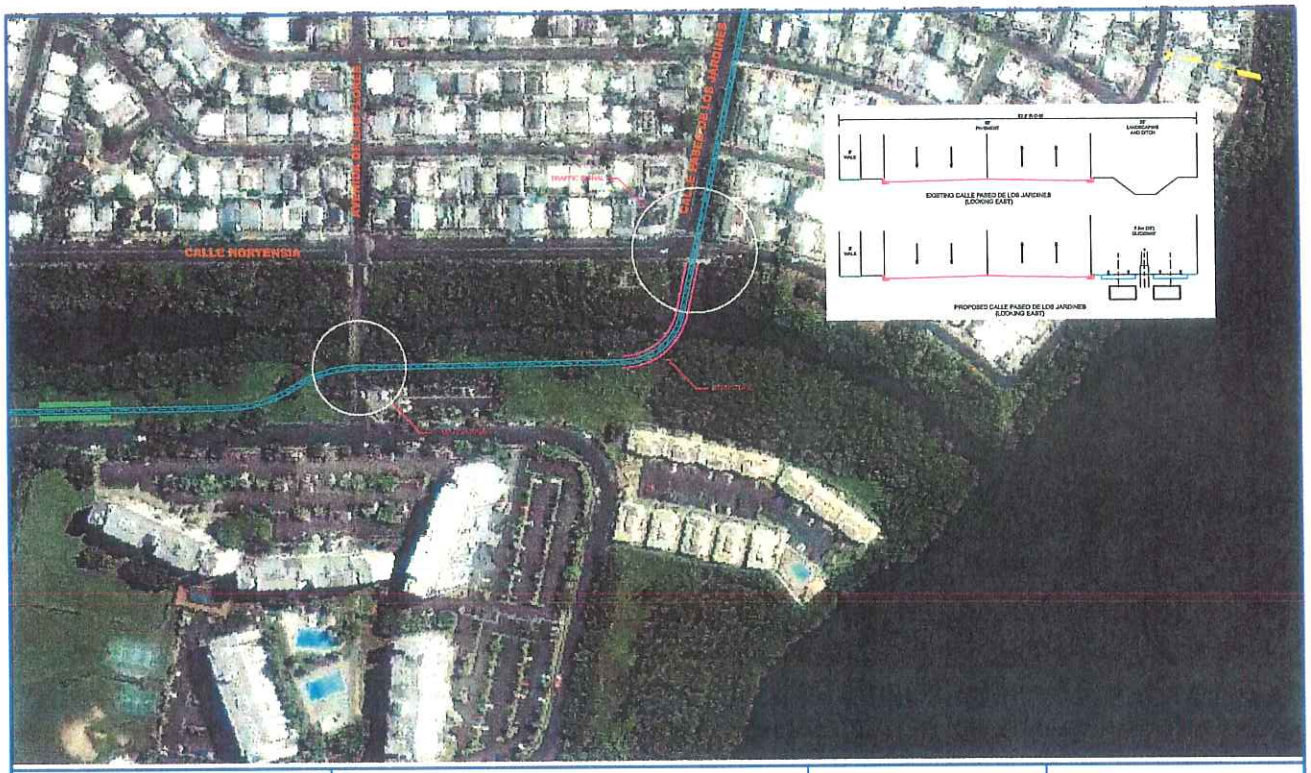

PBSJ Caribe Engineering, CSP

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Tranvia de Carolina
Route Validation Study
Alternative 3
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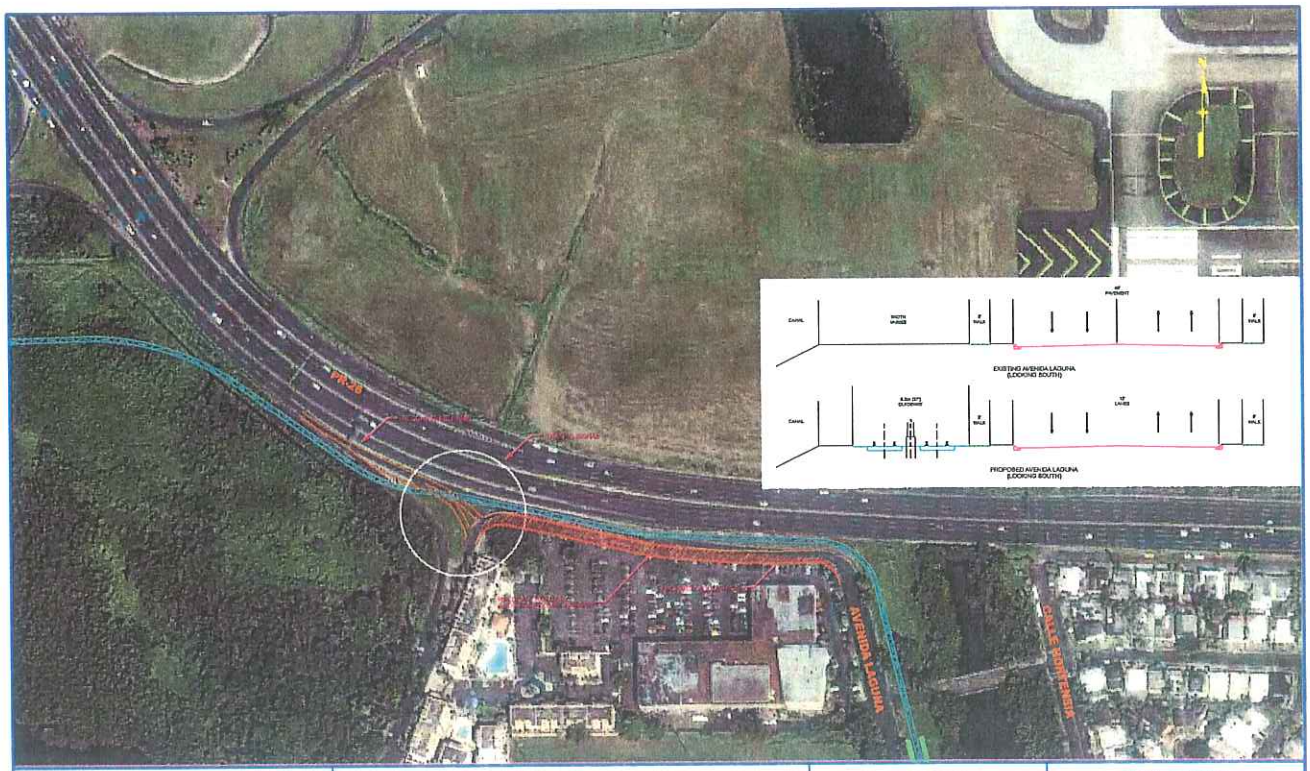

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Route Validation Study
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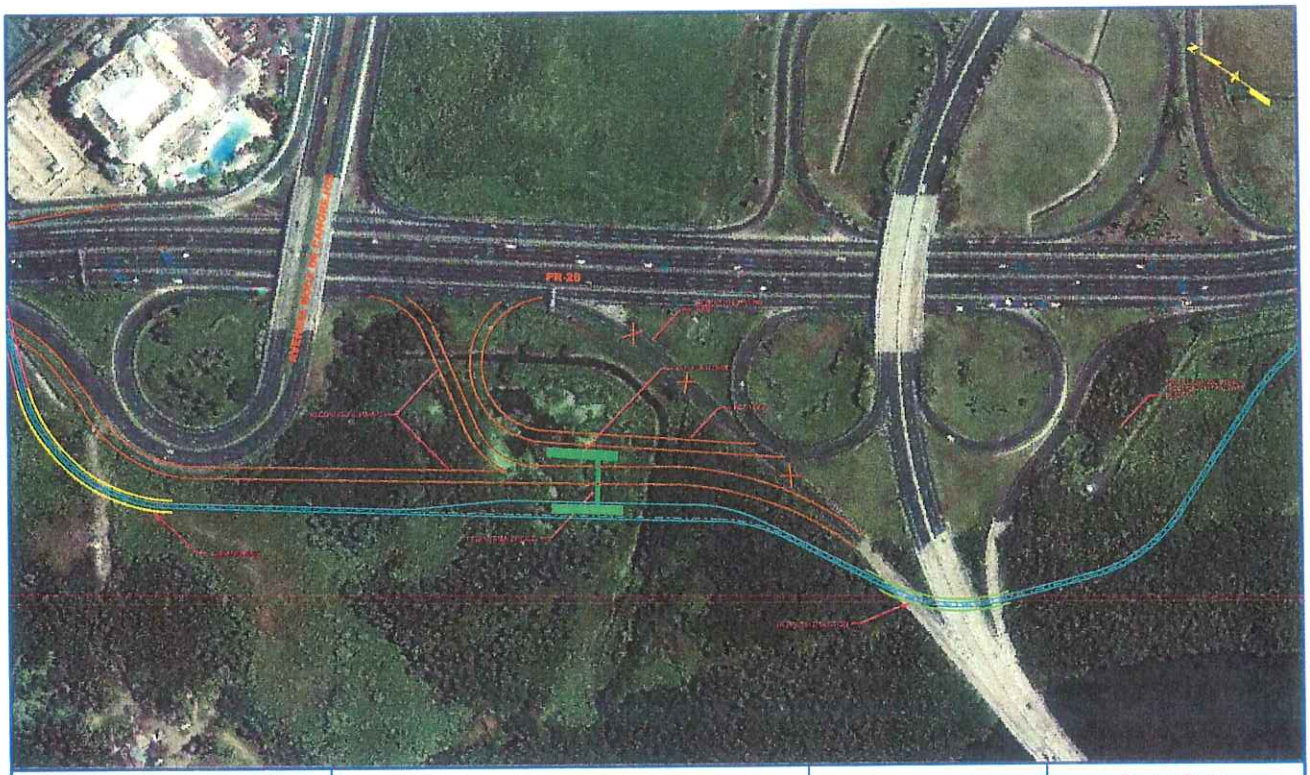

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Tranvia de Carolina
Route Validation Study
Alternative 3
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Tranvia de Carolina
Route Validation Study
Alternative 3
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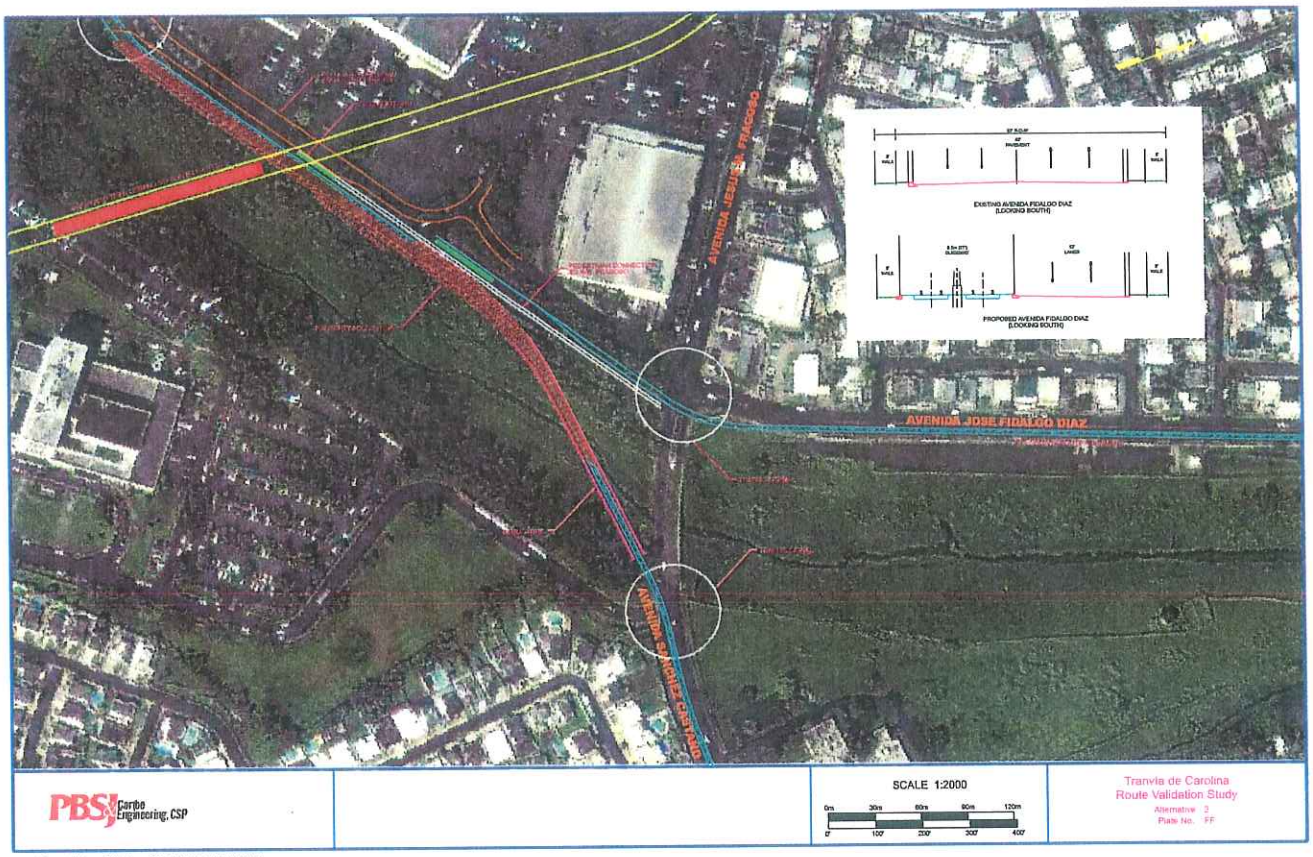

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Tranvia de Carolina
Route Validation Study
Alternative 3
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Appendix C: Tranvia General Description

The municipality of Carolina was founded in 1857 and has grown to a population approaching 200,000 persons, making it Puerto Rico's fourth largest city. Carolina enjoys a strategic location immediately east of San Juan, stretching from the Isla Verde tourist district on its north coast line at the Atlantic Ocean southward past the San Juan International Airport, through numerous residential districts, educational facilities, and industrial district to the PR-3 commercial/retail corridor and beyond to newer residential districts and rural areas in the rolling hills south of PR-3 and the proposed PR-66 corridor. The city has been called the "industrial capital" of Puerto Rico for its factory, warehouse and industrial districts, reflective of its proximity to the air freight facilities of the airport, the seaport facilities further west, and several major trunk highways, including PR-26 and PR-3.

The municipality has a rich mix of land uses, and a generally dense pattern of development intensity outside of the environmentally sensitive habitats which comprise a significant part of the city. These land use patterns have led to relatively congested conditions on the major roadways, compounded by the fact that residential and commercial land uses lying to the east generate trips for work commuting, business, shopping and other types of trips that traverse the main road arteries of Carolina, compounding the municipality's congestion. Long-range projections anticipate a worsening situation for Carolina and the San Juan metropolitan area. This outlook was the impetus for the Tren Urbano urban rail project, Phase 1 of which was recently completed.

As a trunk heavy rail system for the metropolitan region, Tren Urbano can provide regional mobility to the area's primary activity and employment centers. A planned Tren Urbano extension would run along the PR-3 corridor from Trujillo Alto eastward to Roberto Clemente Stadium just east of the Rio Grande de Loiza. Carolina would be served by this eastward route of Tren Urbano, with five of the nine new stations on this extension lying within Carolina.

Strategically located around the north and east side of the Lagoon San José, Carolina experiences a significant proportion of linearly-oriented travel patterns that would be candidates for consideration of alternative travel modes. While Carolina is served by a number of AMA public transit routes as well as publicos, these services become trapped in the congestion of major intersections and corridors, reducing them in some respects to an alternative service of last resort. As a result of these conditions, and with a view to a better future, a study of future travel alternatives was conducted. That study was presented in a report entitled: Study for the Design of a Mass Transportation System in the Municipal Territory of Carolina (Second Final Report) - February 2005, Innovative Transport, Inc. with Semaly. The study evaluated various routings and transit technologies (Metro - heavy rail transit, light rail transit, bus rapid transit) and recommended the light rail transit technology along a specific proposed route alignment.

Appendix C: Tranvia General Description

Coordination

During the course of the project, there was ongoing coordination with AFI, with its coordinating consultant DEPLAN, and with the Municipality of Carolina. Through review meetings, presentations, teleconferences and project memoranda, dialogue on various technical issues was accomplished and progress information was disseminated. This coordination was useful in providing periodic updates on work progress, in resolving various issues, and in refining the results of the study. already developed, and of already developed working relationships with the involved agencies.

The primary guiding document for the planning and management of land use and transportation for the Carolina municipality is the Plan de Ordenacion Territorial (POT). The key aspects of this document which provide a framework for refining the Tranvía de Carolina project are summarized from the previous report, Need Study on Interurban and Intraurban Mass Transportation, DEPLAN with R&R, as follows::

Territorial Plan

The Territorial Ordering Plan ("*Plan de Ordenación Territorial*", POT) stipulates the public policy toward the municipality's development and land use, becoming a land use planning tool in the municipality.

Carolina obtained its autonomy in 1992, when the first Territorial Ordering Plan was approved. The municipality is actually formulating the integral revision of the POT, which will guide planning after its adoption.

The POT highlights as a premise that the municipality's areas or focal points (Airport, Isla Verde and the Urban Center) must be linked in a mass transportation network able to allow the maximum development of each focal point conserving or improving the physical surroundings, environment and natural resources of the municipality.

POT Public Policies

The POT stipulates important public policies that must be taken into consideration:

To turn the Traditional Urban Center (CUT) into one of the main spots of social, economic and cultural activities.

To improve the mass transportation system in the CUT (taxis, public transportation and AMA) making it more integral.

To improve physical accessibility conditions of public and private facilities.

To minimize environmental impacts associated with transportation.

To strengthen the tourism sector in the municipality.

To delimit the following areas: Urban Center, 65th Infantry Avenue (between Loíza Expressway and the Río Grande de Loíza) and Isla Verde, as first-class strategic centers and to establish a system of distinctive urban furniture for each area.

To recognize Campo Rico Avenue, Paseo de los Gigantes Avenue; Fragoso-Sánchez Castaño Avenue; Sánchez Osorio Avenue; Fidalgo Díaz Avenue; and Roberto Clemente Avenue as Commercial Avenues.

To group the governmental, commercial, institutional, recreational and sport facilities, among others, based on population distribution.

POT Proposal for Integrating Central Nuclei with a Mass Transportation System

The POT proposes and identifies several nuclei that must be integrated into a mass transportation system. Within the main reasons to identify these nuclei, is the fact that the Central Government approved the Tren Urbano extension to the Municipality of Carolina. This situation compels the municipality to refocus its spatial and physical development vision. In order to identify these nuclei, the population increase directly related with the increase of the automobiles in the municipality was considered.

The central nuclei identified by the municipality are:

Luis Muñoz Marín International Airport

The location of the airport within municipal territory distinguishes Carolina as a city with international character that allows a constant social, cultural and economic interchange in the country. These characteristics make the airport a nucleus of great importance; for this reason it must be connected to the proposed transportation system.

Isla Verde Area

Its particular characteristics differentiate the Isla Verde area from other sectors. Its nearness to the airport, its natural attractions, and proximity to the capital city have turned it into the main location for the establishment of hotels and residences as well as the tourist activities. It is necessary to provide transportation alternatives, to provide parking areas, and to establish intervention strategies for the creation of new economic activities.

Urban Center

The Traditional Urban Center (CUT) represented a role of vital importance in the municipality's social, economic and cultural development. Nevertheless, it has reported a decrease in commercial activity and loss of population in the last decades. In response to these needs, the municipality has been preparing an Area Plan for the Urban Center, which attempts to organize and equip the CUT with a rational and normative planning approach.

Appendix C: Tranvia General Description

A. Establish a *Mass Transportation System* that emphasizes:

1. Integration of mass transportation of the MAC residents and visitors.

2. Reduction of traffic congestion.

3. Prevention of congestion where it has not yet begun.

4. Reduction in environmental problems associated with traffic congestion.

B. Link the focal points stated in the Territorial Plan of the Autonomous Municipality of Carolina.

These are: Urban Center, Luis Muñoz Marín International Airport, the Isla Verde area that stands out for its hotels and tourist zones, the urbanized zone of *barrios* such as: Sabana Abajo, Hoyo Mulas, Martín González and San Antón, and the territories south of the 65th Infantry Avenue that have been considered for residential development.

The service configuration of the transit operations consists of several interrelated components. These are the route layout, station location and spacing, service frequency, demand levels (daily and peak), and the size and number of train cars to be used on each circuit of the transit route, which in turn defines the length of the station platform.

The selection of the prototype train car is the central assumption in defining the light rail system planning parameters. The selection of the train car is dependent upon other system operations assumptions, policies and strategies. At a maximum capacity per train car of 200 passengers (seatedand standing), the service would require 10 train cars per direction, or one train car per direction every six minutes of the peak hour. Station platform length depends on how many train cars in a consist (group of train cars), train car length and door location. If a train car 50% longer capable of serving 300 peak users were utilized, then the headways could be extended to 9 minutes, and 33% fewer train operators would be needed.

Other estimates in the prior reports ranged up to 34,800 daily passengers, a higher figure, but the final recommended headway was 5 minutes on the common section which compensates for the higher rider ship.

Design Criteria

Criteria utilized to date were presented in the report: Estudio para el Diseño de un Sistema de Transportación Masiva en el Territorio Municipal de Carolina - Segundo informe completo, Innovative Transport, Inc. February 2005. The criteria from this report assumed for the purposes of this work that the proposed technology is light rail transit, with propulsion to be provided by electricity conveyed to the vehicles by an overhead catenary system (or possibly some segments with power supplied from an underground rail), and that the alignment will operate within an exclusive guideway , with some segments within the right-of-way for existing streets and roads, except for at-grade crossings at street level.

Appendix C: Tranvia General Description

Based on further planning of stations under this study, the need for three station platform configurations was identified. The three types are:

Center Platform: a wide platform located between the two light rail tracks serving trains traveling in both directions. Passenger access is typically from one or both ends of the platform. One or both tracks are offset slightly from their basic spacing to accommodate the platform width.

Side Platforms: these are narrower platforms location on either side of the standard dual track cross section. Passenger access can be from one or both ends and at midpoints as well. The tracks maintain their standard spacing as the platforms are located outside of the tracks.

Staggered Center or Side Platforms: these are platforms the width of side platforms, but placed between the two tracks longitudinally along the alignment, or to opposite sides outside the track alignment. Passenger access is typically from one or both ends of each platform. One or both rail tracks are offset outward of their standard placement to accommodate the width of the platforms between the tracks. This configuration is used where right-of-way acquisition issues come into play because of the narrow footprint; however, the station area is much longer along the alignment. This configuration is often used at an intersecting street with the platforms located on either side of the intersecting street.

Stations must be configured to accommodate the following basic features, as applicable:

Adequate passenger waiting areas for anticipated peak loads, including space for discharging passengers.

Support poles for overhead canopies and lighting.

Support poles for the overhead catenary system if located in the center of the alignment.

Benches and trash receptacles.

Access ramps and steps for difference in elevation from the platform to adjacent sidewalks, and to accommodate wheelchair and mobility-impaired access.

Ticket dispensing machines and/or kiosks.

Railings and tactile warning strips.

Signing and information boards.

Telephones, emergency phones, security cameras, and/or panic buttons (depending upon final design features).

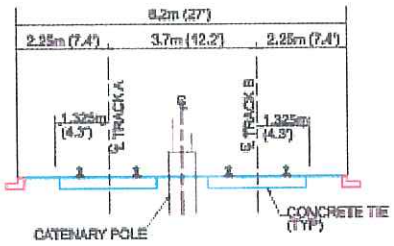
Two station types have been defined for Tranvía de Carolina: the local station and the hub station.

Appendix C: Tranvia General Description

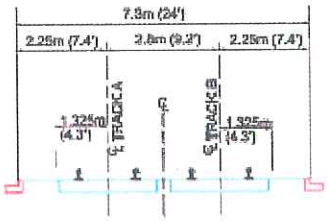
The study has presumed a platform length of 45 m. (150 feet) for conceptual planning purposes.

Figures 2.2 and 2.3 depict the proposed typical sections along the alignment and at station locations, and the plan configurations for the different station configurations.

Figure 2.2
TYPICAL SECTIONS

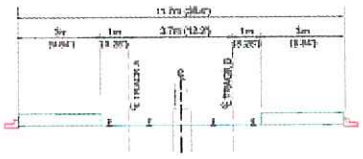


TYPICAL SECTION
WITH CENTER CATENARY POLES

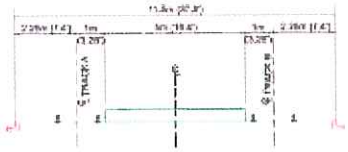


TYPICAL SECTION
WITHOUT CENTER CATENARY POLES

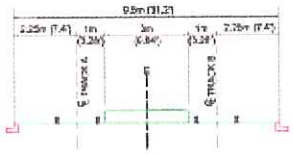
Figure 2.2 (continued)
TYPICAL SECTIONS



TYPICAL STATION SECTION
SIDE PLATFORMS



TYPICAL STATION SECTION
CENTER PLATFORM



TYPICAL STATION SECTION
STAGGERED CENTER PLATFORMS

The urbanized and developed areas of the municipality are characterized by relatively efficient use of land areas, with relatively modest street rights-of-way, usually limited building setbacks, and intensive use of public and private space between buildings and the street by commercial properties. There are relatively few open corridors that could accommodate a facility such as the light rail transit without some disruption of the existing built urban environment. There are open spaces around the municipality, some developed as parks, and others which are undeveloped due to the presence of wetlands or low-lying lands subject to occasional flooding.

As a result of these conditions, initial alternatives for the light rail transit system had alignments largely located within existing street rights-of-way. While this configuration avoided property acquisition, it introduced dramatic changes to the traffic operations on the affected streets. Namely, there is a loss of traffic capacity along the affected segment, implied but not fully defined or recognized in the prior study, changes in property access and circulation patterns, impacts in some cases to truck delivery, and loss of onstreet parking. The presence of the light rail transit system in an "in-street" configuration also reduces the capacity of traffic signals at existing street intersections as the light rail transit will require a separate traffic phase for passage through the intersection, over and above the possible loss of traffic lanes at the intersection.

Appendix C: Tranvia General Description

Using existing streets for the light rail transit avoids right-of-way acquisition, but it creates other disadvantages to traffic operations and there is still an inherent cost of constructing the facility within the street pavement area, including installing the light rail section and adjustment of utilities, among other items. The "in-street" configuration usually dictates the acquisition of property for the placement of light rail transit stations as well, as the width of existing streets is relatively constrained.

The most likely situation is that in order to best accommodate the light rail within existing streets while minimizing adverse traffic operations impacts and property access conflicts to the extent possible, the placement of the alignment to reduce utility conflicts and relocations becomes a secondary consideration.

Certainly it is prudent to avoid major longitudinal utility conflicts along the length of a light rail segment and costly "point" conflicts with major trunk utilities. However, in this built-up urban environment, it is inevitable that there may be some trunk transmission utility conflicts, more distribution utility conflicts, and many service connection utility conflicts.

As Alternatives 1 and 2 as provided for this study both had substantial amounts of their alignments in existing street rights-of-way, Alternative 3 was devised to provide an alternate approach to inserting the light rail corridor into the compact and relatively dense urban environment. This approach attempted to minimize use of existing traffic lanes on arterial streets, and maximize use of open areas with fewer improvements and utilities, though involving some right-of-way acquisition.

The following sections describe the features of the proposed alignment alternatives, each subdivided into a number of short segments with profiles of the alignment, the typical section, stations, structures, traffic and circulation, utilities, and environmental and community factors. For each segment, the appropriate alignment plan sheets are identified for cross referencing.

Station Facilities

The proposed alternative has transit stations located at intervals based on spacing intervals, potential transit demand, and alignment limitations and design criteria. The plan sheets depict the location, configuration and vicinity land uses for each station site. The following sections discuss other aspects associated with station area planning and design.

Station Feature Program

The station design program would include the following elements at all stations:

Station platform: Preliminarily (subject to refinement after further studies are completed), 150 feet (45meters) in length; 10 feet (3 meters) for side platforms; 16.5 feet (5 meters) for center platforms.

Entry area: Accommodates ticket vending, system information signing, telephone, etc.

Station canopy: Overhead roof to shelter patrons from sun and rain; modular design could be more flexible and cost-effective.

Signing and graphics: Station identification, general/regulatory/security signing, system information signing, way finding information, variable message signs for transit information.

Bicycle facilities: Bicycle racks.

Station furnishings and amenities: railings, fences, benches, trash receptacles,

Lighting: Illumination of station entrances, platform and other major public areas.

Security: Closed circuit television cameras, patron assistance telephone, public address system.

System Facilities: Small communication and signal building.

Station Walkways: Concrete sidewalks, paver brick treatments, walls, fences.

Landscaping: Carefully selected, tolerant, drought resistant plantings.

Pedestrian and Bicycle Linkages: Enhancement of station approach corridors and connections to pedestrian and bicycle paths.

Other Features: At certain stations, bus stop areas, passenger car drop-off zones, circulation drives, and parking.

For the proposed alignment alternative there is a proposed aerial station on the Escorial route at the crossing of PR-3. Also there are additional elevated stations at Ave. Fragoso and at Ave. Monserrate . All of these locations will require vertical circulation to move patrons from the upper station level to the lower level. At the Ave. Monserrate location, the upper level is at the grade of Ave. Monserrate, and the lower level near the level of the area to the north approaching PR-190. For the center platform configurations on a bridge structure, in addition to patron movements, vertical circulation must meet life safety requirements. For stations on bridge structures, the vertical circulation is proposed to include a connecting stairway and an elevator at each end of the platform to access both sides of the roadway below. Escalators would not be included, unless subsequent study substantiates the need.

Intermodal Connections

Where light rail transit stations provide connections to other transit services by virtue of proximity, these intermodal linkages which would be made by walking, should be clearly defined and signed, attractively designed, and in the case of certain connections, be provided an overhead canopy.

All the alternatives have stations situated in proximity to at least three proposed Tren Urbano stations and to one or two AMA bus centers (on Ave. Iturregui west of PR-26, and on PR-874 at Ave. Quiñones). In addition, one of several AMA bus routes serving the area intersect with the alternatives at various points providing transfer opportunities. Also, the municipality operates a rubber-tired trolley service in the Centro Urbano district and is currently initiating a new municipal bus service. The preliminary design phase should identify facilities needed to support these intermodal transfers, as noted below:

Tranvía - Tren Urbano: The light rail stations for the alternatives are located as closely as possible to proposed Tren Urbano stations, to minimize walking distance and maximize convenience. Designs for both systems will need to be coordinated regarding a direct and attractive pedestrian pathway between the two adjacent stations.

Tranvía - AMA Bus Center: The bus center on Ave. Iturregui is not directly served by Alt. 1, but could be reached via a three-block walk along Ave. Iturregui. Alt. 2 and Alt. 3 pass directly in front of the bus center on the north side of the street, so a short pedestrian walkway is needed. All three alternatives pass by the AMA bus center on PR-874. This center is proposed to be replaced by the municipality with a new intermodal center just to the north. Alt. 1 and Alt. 2 pass by this site on the east side of the street, so a pedestrian crosswalk connection would be needed. Alt. 3 is conceived to pass directly through the proposed intermodal center, so with proper design development, suitable walkways can be incorporated into the site design.

Tranvía - AMA Bus Routes: The transfer between the light rail and intersecting AMA bus routes should be facilitated to the extent possible with attractive connecting walkways, and bus bays for the AMA buses if possible. Due to probable configurations of the light rail and the bus routes, some patrons will need to cross arterial streets to make the transfer, and designated pedestrian crossings should be provided as part of the overall station pedestrian access plan.

As plans for the Tren Urbano extension are in development, there is the potential to reconfigure some AMA bus routes in view of the new light rail service, and the municipality is still planning for its new municipal bus service, definition of specific intermodal physical linkages must be deferred to preliminary engineering.

Station Area Definitions

Transit station areas are typically subdivided into three rings from a planning standpoint. The **station site** is an area including the station and the surrounding area outward for a distance of 200 to 500 feet (60 to 150 meters), depending on the level of transit usage at the station and the character of the surrounding land uses. This area would include station entry points, key walkways, parking areas, dropoff areas and other integral features. This zone would receive the highest level of streetscape and landscape features.

Station entrances would have visible, direct access from adjacent streets and public spaces. The **station vicinity** extends outward from the station site boundary a distance of another 200-300 feet (60-100meters), and further near major activity centers. In this area, the major access corridors to and from the station would receive the same treatments as for the station site, but on a selective and less intense level, to extend the presence of the nearby station outward into the surrounding land uses. The **station influence area** is the area surrounding the station vicinity outward from the station site to a distance of one-quarter to one-half mile (400 to 800 m), depending upon surrounding land uses, demographics, and geographic barriers, from which transit ridership using the walking or bicycle modes will be drawn. In this zone, it is expected that only guide signs to the station might be posted at selected locations. Two types of stations are identified for use in the proposed project; these are:

Local Stations: These are located in neighborhoods and employment areas in the service corridor, and serve smaller volumes of transit passengers. The station design would be consistent but on a reduced scale of design treatment and amenities. Streetscaping and landscaping features would extend outward into a smaller station vicinity area on fewer approach corridors to the station. No significant redevelopment is anticipated around these stations due to the established, stable nature of the surrounding land uses.

Hub Stations: These are located near activity centers, districts of higher density, more land use diversity, and increased levels of transit usage. These stations would be consistent in design with the system, but would have a more robust design treatment, level of amenities, and level of streetscaping and landscaping. Access pathways may be enhanced for greater distances outward from the station.

These stations would have generally greater visibility and prominence within their setting, and should be integrated with surrounding land uses to the extent practical.

Certain of these stations may present opportunities for transit-oriented development and more intense land development, either as a catalyst for surrounding private lands or for adjacent land in the public domain. Some of these stations will be sited adjacent to other transit facilities and thus provide the opportunity for intermodal transfers between the Tranvía de Carolina system and the planned Tren Urbano - Carolina Extension, AMA bus routes, the new municipal SITRAC system, and publicos.

Signage and Graphics

The design of the system needs to include a integrated and coordinated family of system signing and graphic elements. This design component serves several functions:

Wayfinding and orientation information to guide system users to the transit stations

Basic information on system usage, travel destinations, station identification, nearby destinations and services, and intermodal connections.

As applicable, guide signing for passenger drop off or parking areas.

These elements will include standard signing, potentially lighted signs for nighttime visibility, and variable message signs to communicate systems information to passengers at the station and onboard. A comprehensive signing and graphics system will need to be developed in the preliminary design phase, featuring customized elements to give the system a highly recognizable identity and visibility within the community.

Pedestrian Linkages

These are designated access corridors to and from stations that would serve the dominant land uses and pedestrian travel paths. These linkages would include elements such as street trees, landscaping, streetscaping accents, sidewalk treatments, lighting, signing, and enhanced crosswalks.

Bicycle Facilities

Bicycle parking should be provided at every station. Initially, this should take the form of bicycle racks designed to permit locking bicycles in place. Desirably the bicycle parking would be sheltered by a roof.The bicycle racks should be positioned in a convenient, lighted and visible location in proximity to the platform.

Public Art

The project presents opportunities at hub stations and selected local stations for public art. Overall visual quality and identity is an essential facet of the light rail system to enhance attractiveness, usage, and enjoyment of the system by the public. Public art is also a way to reflect the character and history of the municipality into the system. At a minimum, public art could be accomplished by incorporating appropriate elements as part of the final station design, in designated areas or envelopes reserved for public art. At a maximum, public art could be incorporated into the design guidelines for the functional components of the system, including:

Station canopies, Station walls, Station furnishings (signing, benches, kiosks, lighting, etc.), Streetscaping elements, Sidewalk and paving areas, Freestanding art pieces, Bollards, Overhead catenary poles and arms, Alignment bridges and walls, Vandalism resistance.

Appendix D. Area Photos. Tranvia Carolina JD