#GPC V-29

Bus Lanes in Downtown Miami

Final Report

submitted to:

Miami-Dade Metropolitan Planning Organization

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DOWNTOWN MIAMI BUS LANES STUDY

FINAL REPORT

Work Order GPC #V-29

Prepared for

MPO

Prepared by

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1.0 INTRODUCTION

This study provides an assessment of existing transportation conditions in the study area for the Miami Downtown Bus Lanes Study. The data provided is intended to provide the framework for the identification and evaluation of potential transit priority treatments in the downtown Miami area. This includes both roadway segment treatments such as exclusive or semi-exclusive bus lanes and stop consolidation, and intersection treatments such as transit signal priority (TSP), queue jumps/bus bypass lanes, and curb extensions.

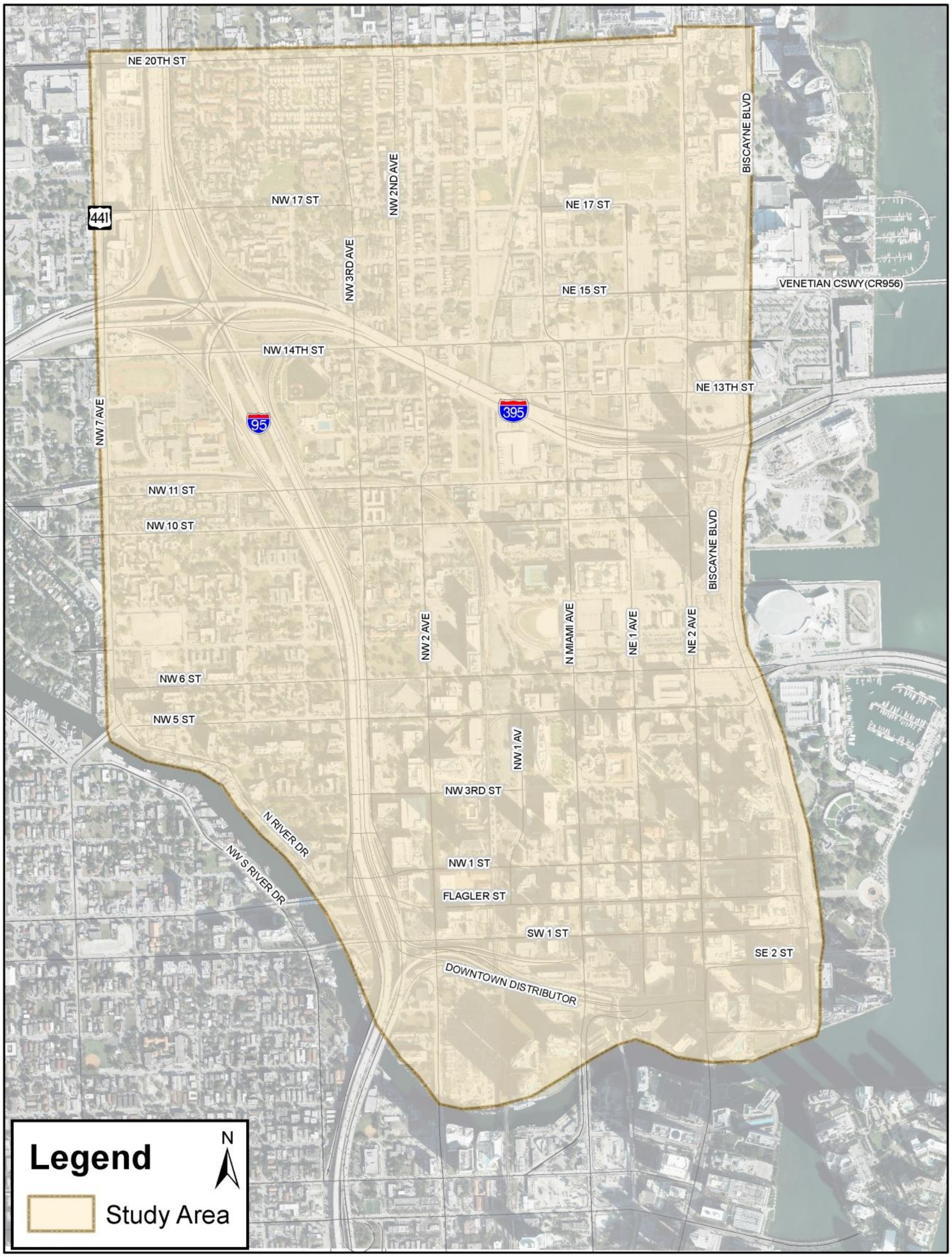
Traffic data collected include existing roadway segment traffic volumes and intersection turning movements, intersection level of service, and crash experience. Transit data collected or calculated include bus volumes, passenger on-board volumes, and bus operating speeds. The transit data was collected for both Miami-Dade Transit (MDT) and Miami Trolley routes in the study area. Parking data was also obtained, including an inventory and occupancy survey for on-street spaces for all streets in the study area.

Input received from a meeting with selected MDT Street Supervisors on bus operations difficulties in the study area is also presented. Studies and plans undertaken by the Miami Downtown Development Authority (DDA) were reviewed to identify any streets where transit is envisioned to be enhanced or restricted could be noted.

1.1 Study Area

The study area for the Miami Downtown Bus Lanes Study is bounded by Biscayne Boulevard on the east, NW 7th Avenue on the west, NW/NE 20th Street on the north, and the Miami River on the south. Figure 1-1 illustrates this area.

Figure 1-1: Study Area



1.2 Agency Coordination

Agency involvement in the study was coordinated through the Miami-Dade Metropolitan Planning Organization (MPO) Transportation Planning Technical Advisory Committee, or TPTAC. Presentations by the study team to this committee were made at two points in the study: 1) in April 2015 at the outset of the study to present the study scope and to review critical issues, and 2) in September 2015 to review the results of the existing conditions analysis, deficiencies and needs analysis, and preliminary recommendations.

Specific agencies which participated in these coordination meetings include:

- Miami-Dade MPO
- Miami-Dade County Public Works and Waste Management
- City of Miami
- City of Miami Parking Authority
- Miami-Dade Transit
- Miami Downtown Development Authority (DDA)
- Florida Department of Transportation District 6

2.0 EXISTING CONDITIONS

Transit services that operate in downtown Miami are continuing to experience increasing travel delays, slower operating speeds and a reduction in on-time performance due to an increasingly congested roadway network.

The assessment of existing conditions involved the analysis of data collected from Miami-Dade Transit (MDT) and the City of Miami as well as the review of previous studies in the Miami downtown area. A field review of existing conditions during weekday AM peak and PM peak hours was completed to confirm the findings of the data analysis. The existing conditions assessment serves as the basis for the identification of areas of opportunity that can benefit from improvements in travel time reliability for local and regional bus service with the downtown area.

2.1 Data Collection Efforts

Table 2-1 and Table 2-2 summarize the data and insights that were obtained related to both roadways and bus service in the study area, from applicable agencies.

Table 2-1: Data/Insights Obtained Related to Study Area

Roadway	Transit
Traffic Volumes - ADT and Peak	Bus Volumes – Daily & Peak
Traffic Signals	Passenger Volumes – Daily
Intersection Level of Service (LOS) – AM and PM Peak	Bus Speeds – Daily & Peak
Crashes – 5 Year (2008-2012)	MDT Street Supervisor Input
Roadway Number of Lanes (Directional)	
Parking Availability (No. of spaces)	
Parking Occupancy – AM and PM Peak and Mid-day	

Table 2-2: Bus Service Data Obtained or Calculated by Agency

Agency	Available Data		
	Bus Volumes	Bus Passenger Volumes	Bus Speed
MDT	●	●	●
Miami Trolley	●	●	

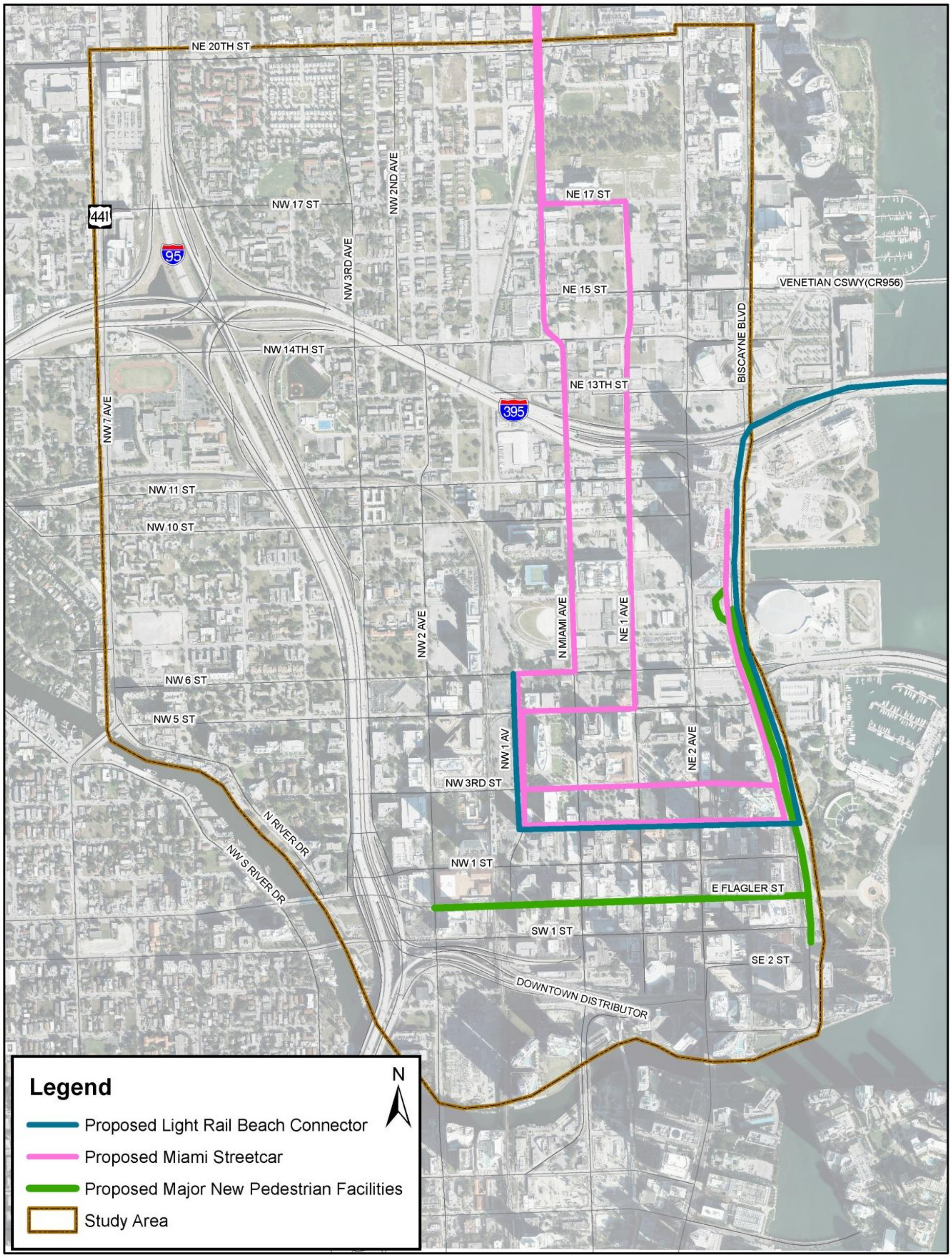
For bus volumes, data was obtained from individual route schedules for MDT and City of Miami Trolley services, and stratified by roadway segment by direction for the weekday peak (6:00 AM to 9:00 AM, and 3:00 PM to 6:00 PM) and off-peak periods. Passenger volumes were only available for MDT and Miami Trolley services, and only on a daily basis. This information was stratified by roadway segment and by direction.

Bus speeds were also only available for MDT routes, and calculated by roadway segment by direction based on travel time between bus stops, using Automatic Vehicle Location (AVL) data. The MDT vehicle speeds were stratified by morning (6:00 AM to 9:00 AM) and afternoon (3:00 PM to 6:00 PM) peak period and on a daily basis.

2.2 Programmed and Planned Improvements

There are a number of programmed and planned improvements to the transportation system in downtown Miami. These improvements provide both opportunities and constraints to the development of bus lanes on certain streets. The improvements include intersection channelization and signal improvements, new rail lines, and new pedestrian plazas and corridors. Figure 2-1 identifies the location of the new rail line and pedestrian facility improvements, which are further explained below.

Figure 2-1: Planned Improvements



2.2.1 Roadway Improvements

Improvements to the roadway system within the study area will be focused on realignment and widening of I-395 and local street improvements associated with major new development projects such as the World Center along NE 2nd Avenue. Signal upgrades will also be undertaken over time, including enhanced coordination and upgrading of controllers which could accommodate added and flexible phasing to accommodate special bus signal phases and transit signal priority where it would not have an adverse impact on general traffic operations.

2.2.2 Transit Improvements

The primary transit improvements planned in the future are the Miami Streetcar, light rail transit (LRT) from Miami Beach (Beach Connector), and a new multi-modal transportation center in the vicinity of Government Center. The current proposed route for the streetcar would run primarily on NE 1st Avenue and NE Miami Avenue, with segments along Biscayne Boulevard, NE/NW 3rd Street, NE 5th and 6th Streets, NE 14th Street, and NW 1st Avenue. The LRT line would run primarily on Biscayne Boulevard, NE/NW 2nd Street, and NW 1st Avenue.

Site selection for a new multi-modal transportation center is still underway, but the intent is to develop a major transfer point between downtown bus routes, Metrorail and Metromover, extended Tri-Rail service, the new All Aboard Florida intercity rail service, and the Miami Streetcar and Miami Beach LRT. The primary location being considered is along NW 1st Avenue north of Government Center.

2.2.3 Non-motorized Improvements

The 2025 Downtown Miami Master Plan developed by the Miami DDA identifies several major pedestrian facility improvements in the downtown area. This includes development of Flagler Street as a pedestrian-oriented main street downtown, a pedestrian promenade along Biscayne Boulevard from the Miami River north to the American Airlines Arena (the designated Biscayne Green project), and the Freedom Plaza in front of the arena.

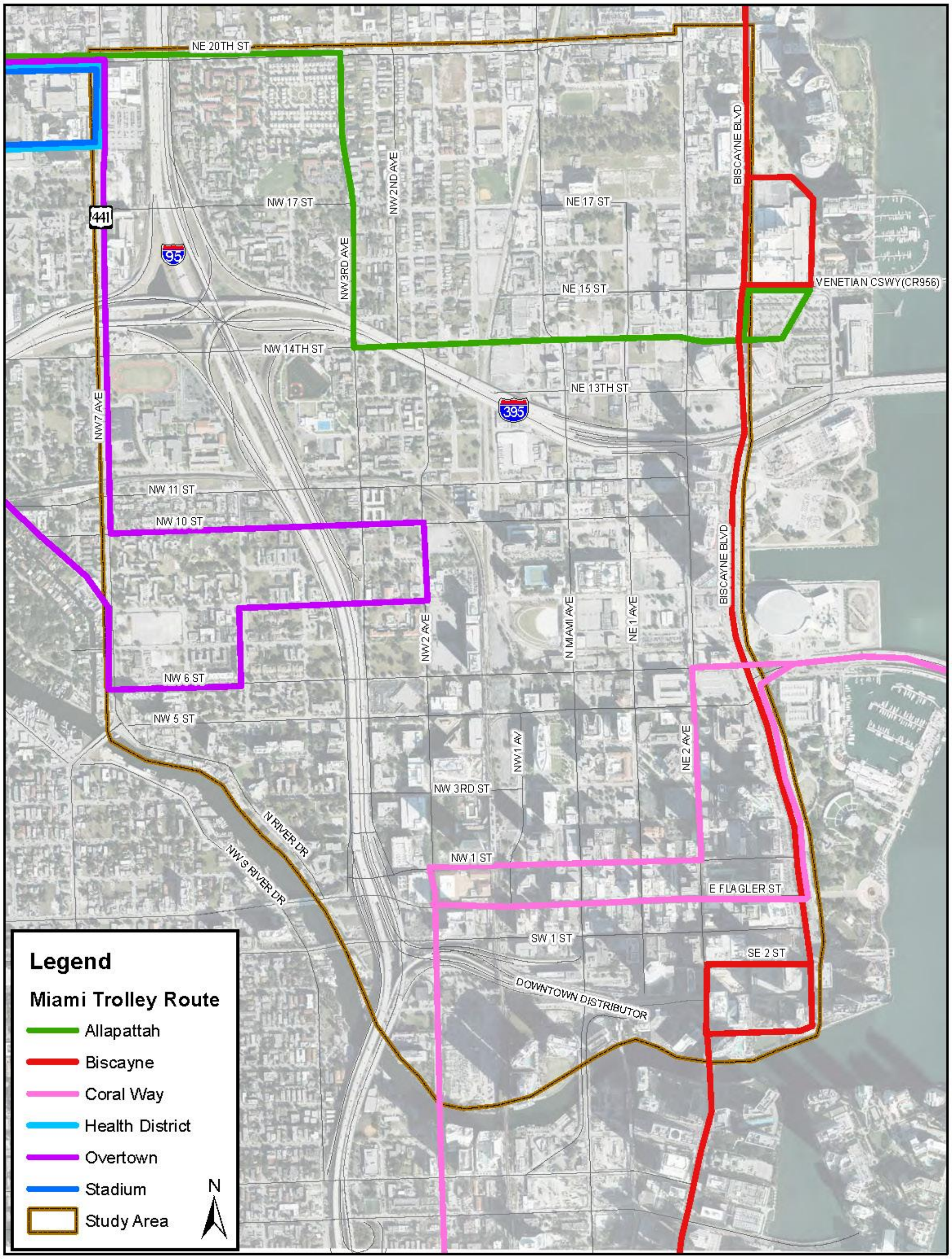
2.3 Existing Transit Services

This study encompasses an area that is bounded by Biscayne Boulevard on the east, NW 7th Avenue on the west, NW/NE 20th Street on the north, and the Miami River on the south. The transit services within this area are some of the most comprehensive within Miami-Dade County. In total, 27 MDT Metrobus routes, the Metromover system and Metrorail station stops, six (6) City of Miami Trolley routes, and three (3) BCT routes all operate within the study area.

The maps in Figure 2-2 and Figure 2-3 depict the MDT and Miami Trolley transit services that serve the study area. The high concentration of transit routes within the study area, particularly rubber-tire service, indicates that exclusive bus lanes can potentially be implemented to improve the County’s overall transportation network. Reductions in travel times for buses within the downtown can have a positive effect on the on-time performance of the same routes once they leave the City’s core.

Figure 2-2: Miami-Dade Transit Routes Serving Downtown Miami

Figure 2-3: Miami Trolley Routes Serving Downtown Miami

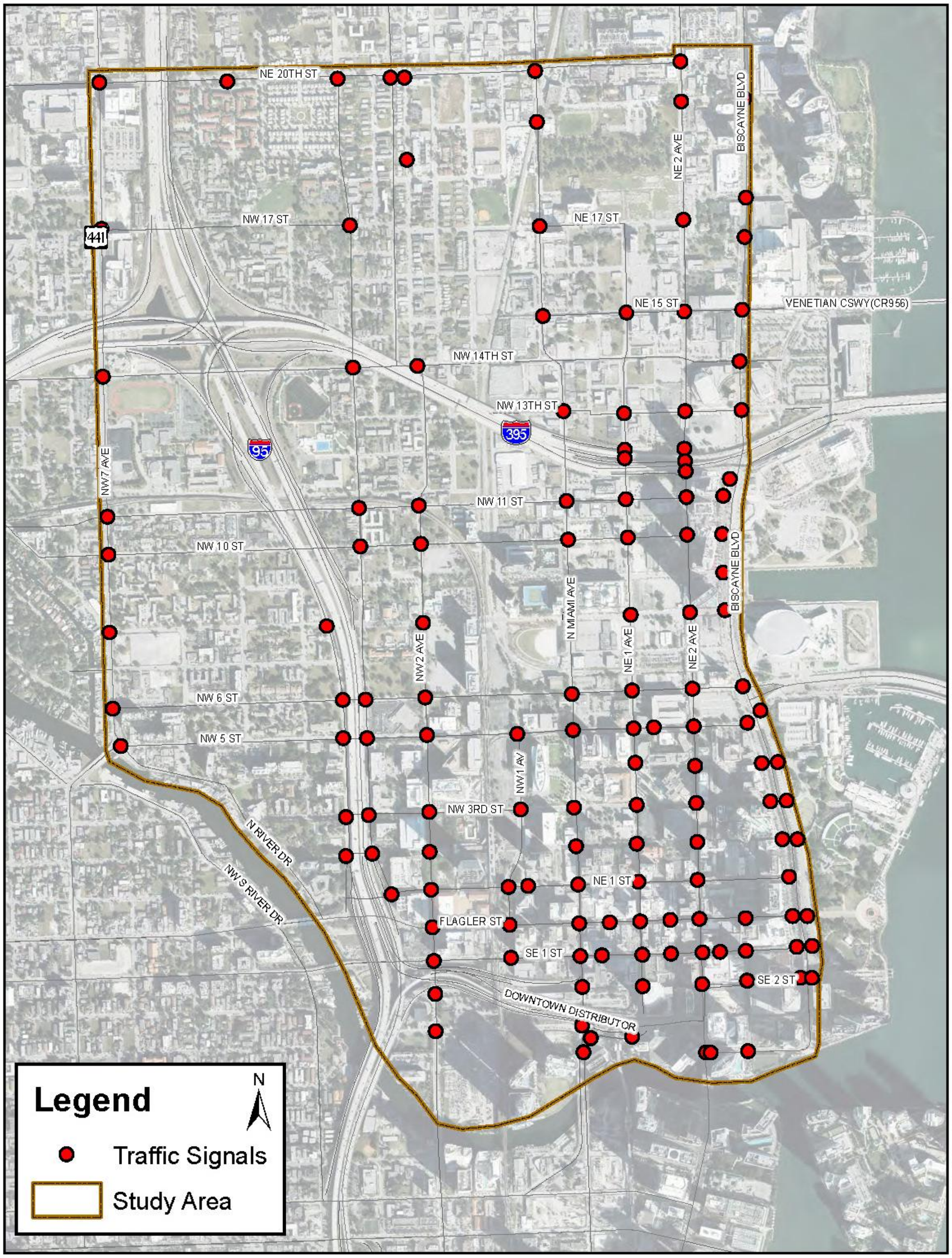


2.4 Traffic Signals and Intersection Lane Configuration

Traffic signal data for the study area was collected from Miami-Dade County's publically accessible Geographic Information Systems (GIS) layer. The map in Figure 2-4 depicts all of the traffic signals within the study area.

The highest concentration of traffic signals occurs in the southeast corner of the study area, in the area designated as the Central Business District (CBD). The northwest corner of the study area, which is primarily comprised of the Overtown neighborhood, is predominantly residential with a lower concentration of signalized intersections.

Figure 2-4: Traffic Signals



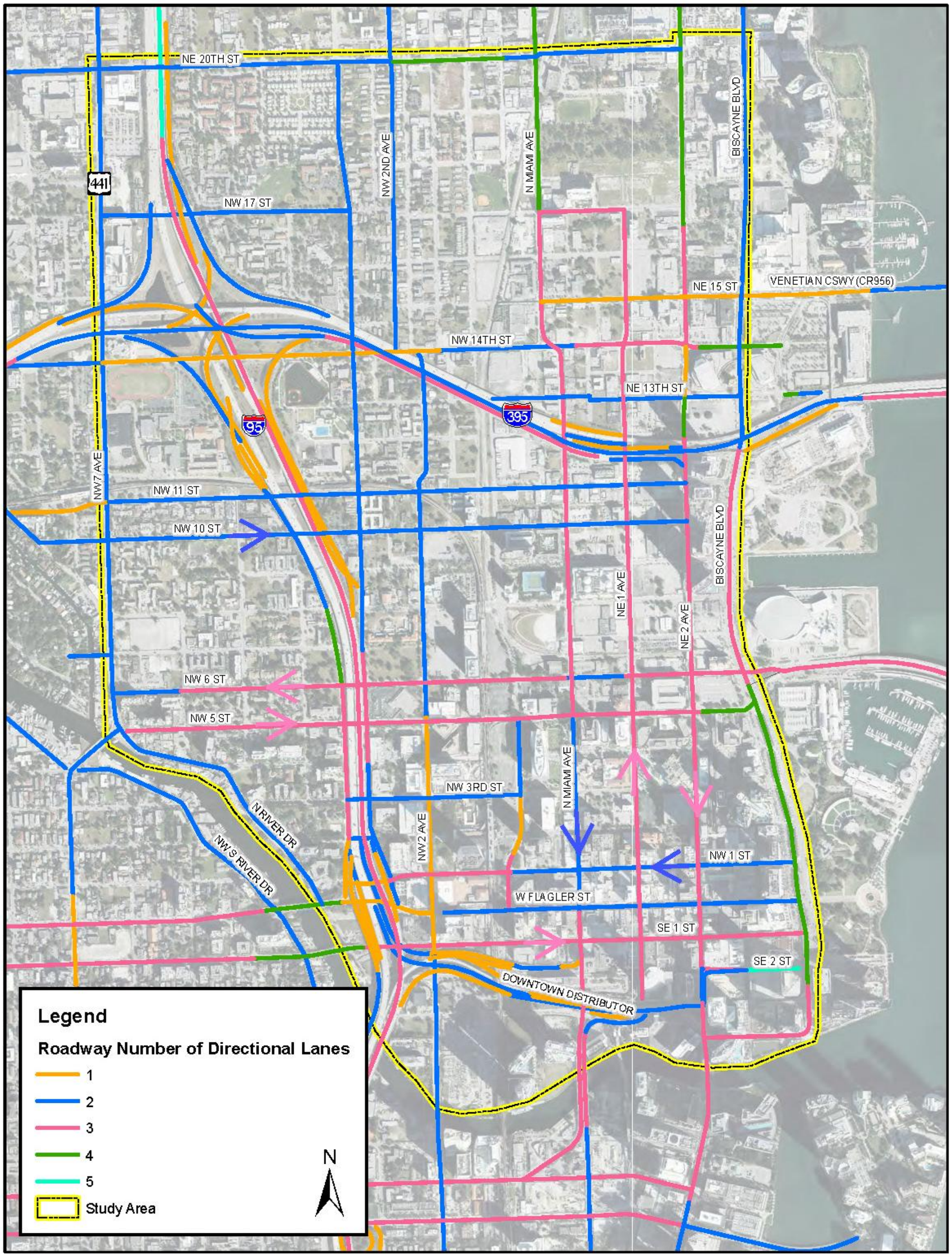
2.5 Number of Traffic Lanes

Figure 2-5 depicts the number of directional travel lanes within the study area. Several of the main arterials, including SE/NE 1st Avenue and NE/SE 2nd Avenue and SW/SE 1st Street are three-lane roads. NW/NE 5th and NE/NW Streets are one-way paired streets that have served as a key arterials linking PortMiami to I-95. These connectors are three-lane streets for most of their length within the study area.

Unlike its eastbound pair, westbound NE/NW 1st Street is a two lane roadway from Biscayne Boulevard until NW 1st Avenue, which presents a physical constraint for implementing potential bus lane improvements within the corridor.

Other key corridors in the study area, such as Biscayne Boulevard have up to four travel lanes in a single direction. With few exceptions, these major roadways have considerable excess capacity during the majority of travel periods. However, the Miami DDA has plans to remove two travel lanes from Biscayne Boulevard, which limits the ability to place exclusive bus lanes on the facility.

Figure 2-5: Number of Directional Travel Lanes



2.6 Bus Volumes

The weekday daily bus traffic within the study area is concentrated along Biscayne Boulevard and the commercial area in downtown along NE 1st Street and SE 1st Street. High concentrations of daily bus volumes were also identified along NE 2nd Avenue and NE 1st Avenue. Figure 2-6 illustrates the daily bus traffic in the Study Area.

During morning commute hours, an increased concentration of bus traffic was identified along Biscayne Boulevard in both directions, as well as on I-95 southbound and NW 2nd Avenue between NW 6th Street and SW 1st Street. During evening commute hours increased bus traffic was observed in both directions of Biscayne Boulevard and NW 2nd Avenue. Figure 2-7 and Figure 2-8 illustrate the weekday AM peak period (6 to 9 AM) and weekday PM peak period (3 to 6 PM) bus traffic in the Study Area, respectively.

Figure 2-6: Weekday Daily Bus Volumes

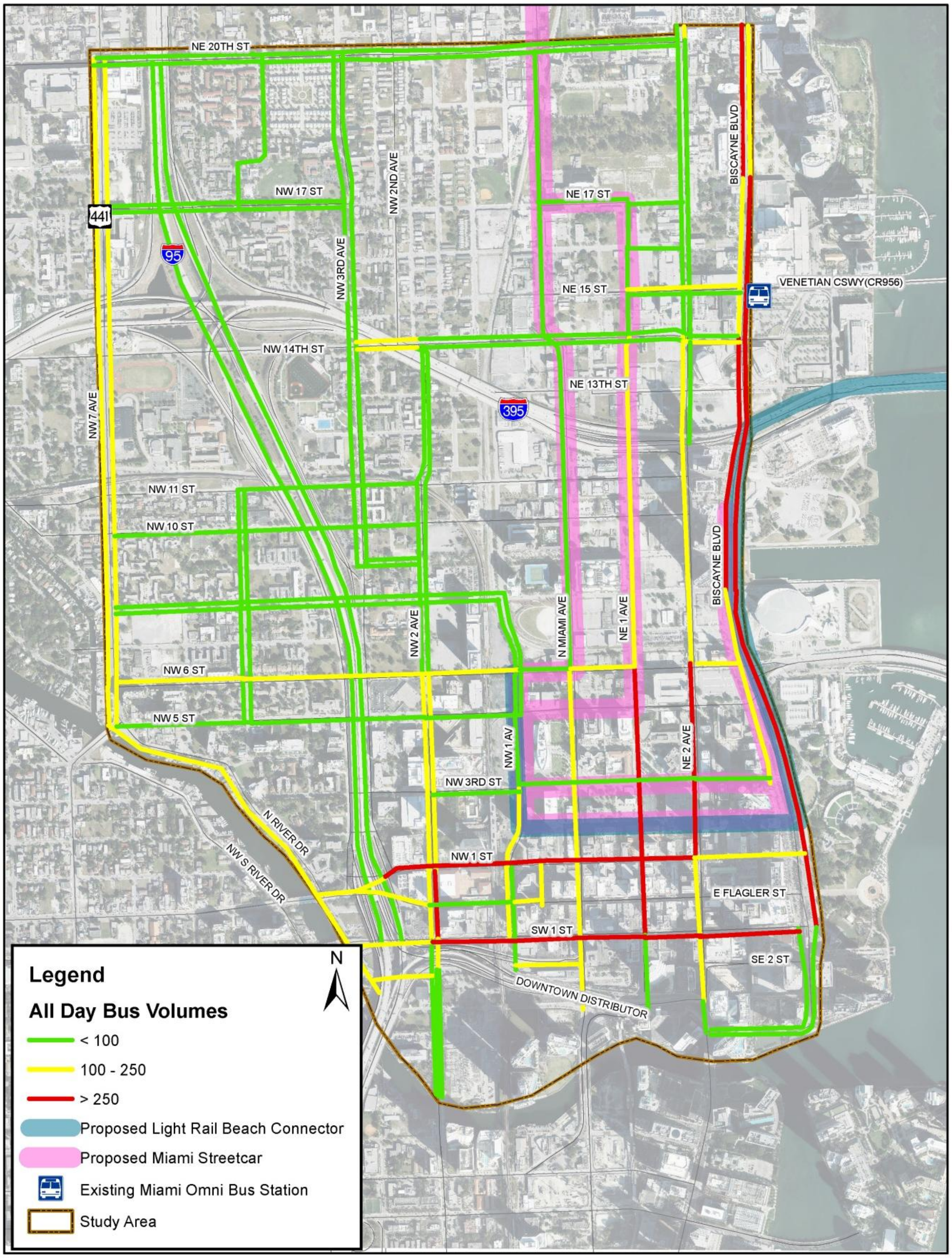


Figure 2-7: Weekday AM Peak Period Bus Volumes

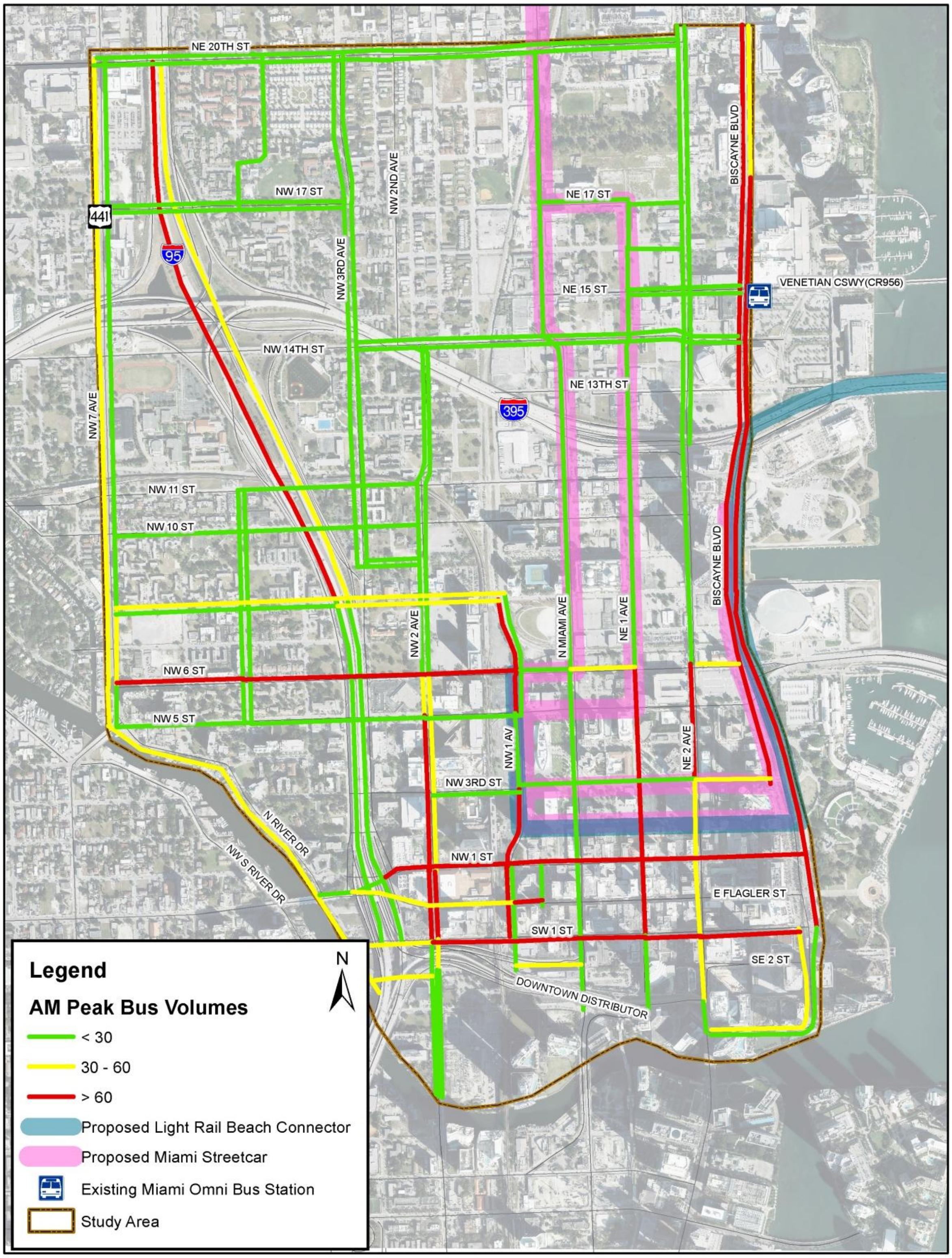


Figure 2-8: Weekday PM Peak Period Bus Volumes

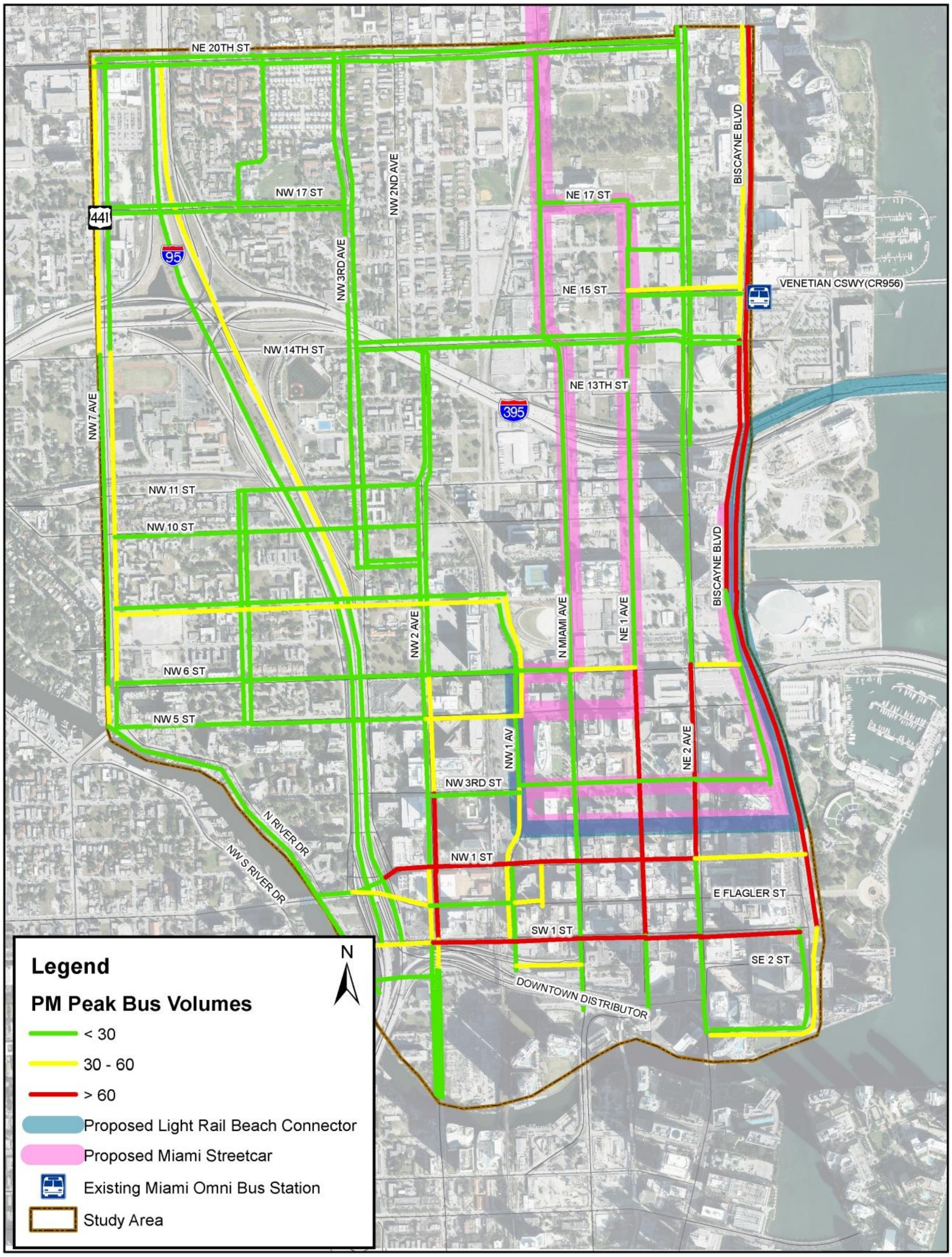
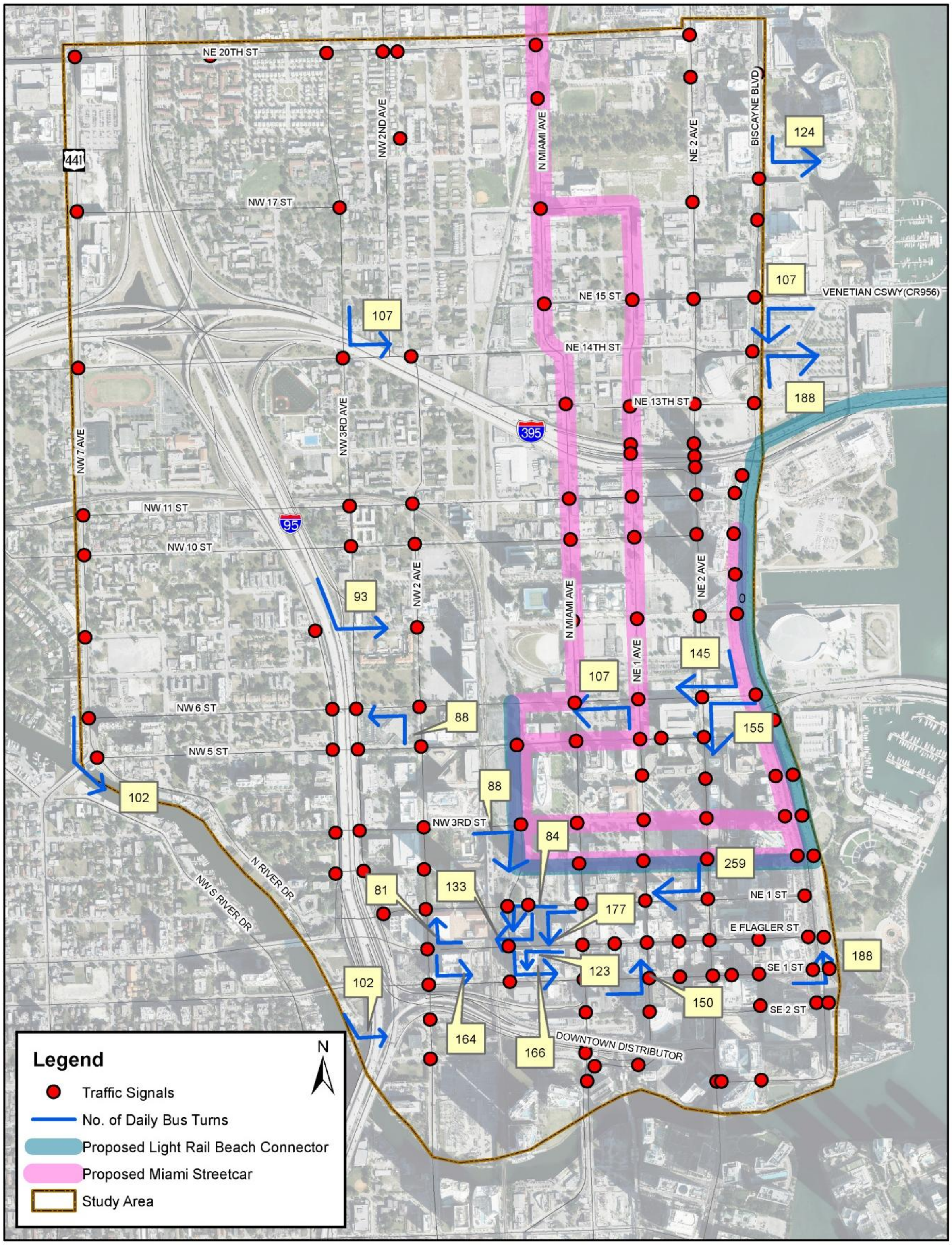


Figure 2-9 depicts the number of bus turning movements overlaid with the network of existing traffic signals within the study area. These movements are highlighted as it relates to potential warrants for special signal phases for bus turning movements in the study area. Turning movements are generally concentrated at the two bus terminals within the study area – the Downtown Bus Terminal and the Omni Bus terminal. Each of these represents major transit hubs for bus routes serving the urban core.

Significant bus turning movements occur at the intersection of Biscayne Boulevard and NE 14th Street for access to the Omni Bus Terminal. At the intersection of NW 1st Street and NW 1st Avenue, 177 southbound left turns occur on a daily basis. On a daily basis, 259 buses make the westbound right at the intersection of NE 1st Avenue and NE 1st Street and 188 buses turn from SE 1st Street to Biscayne Boulevard. These observations were also confirmed with the MDT Street Supervisors who identified this intersection which presents an operational challenge in maintaining on-time performance in downtown Miami.

Figure 2-9: Weekday Daily Bus Turning Movements



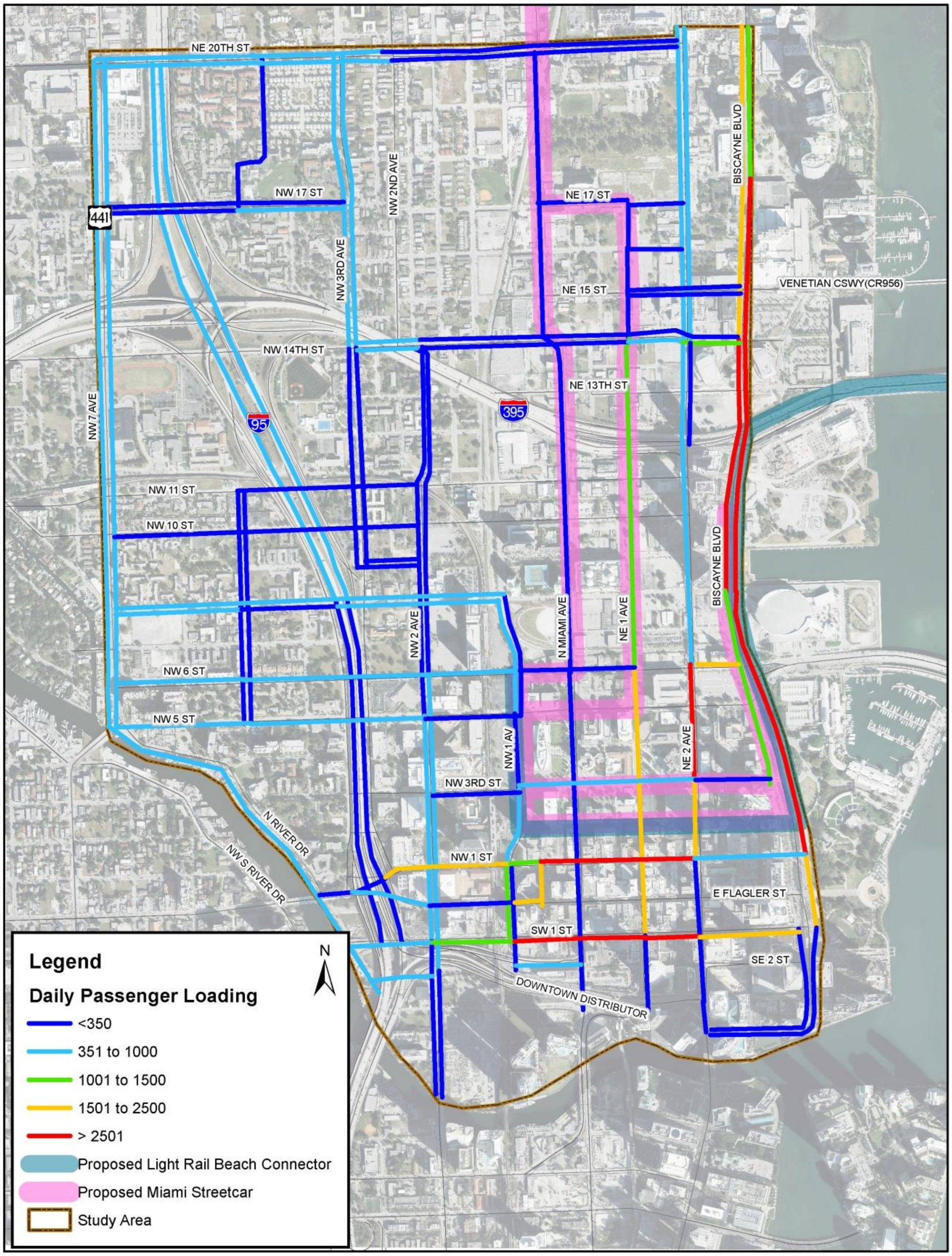
2.7 Passenger Loadings

The largest concentrations of weekday passenger loadings occur along the Biscayne Boulevard corridor, predominantly between the Omni Terminal and NE 1st Street. Similarly high concentrations of loadings, of more than 2,500, occur on the NE/NW 1st and SE/SW 1st Street corridors. NE 2nd Avenue has between 1,000 and 1,500 boardings north of NE 6th Street and between 1,500 and 2,000 boardings south of NE 6th Street.

Other key corridors within the study area experience considerably fewer passenger boardings. For instance, the Miami Avenue corridor has relatively few boardings, with fewer than 350 passengers per day. Likewise, the NW/NE 7th and NW/NE 3rd Avenue corridors have between 351 and 1,000 daily boardings. In addition, NW 5th and NW 6th Streets, a one way pairing, also have fewer than 1,000 daily boardings each.

Figure 2-10 illustrates the concentration of passenger boardings throughout the study area in Downtown Miami.

Figure 2-10: Weekday Bus Passenger Loadings



2.8 Bus Speeds

Bus speeds in the study area are generally reflective of the existing travel conditions within downtown Miami. The bus speeds were identified through an analysis of MDT's Computer Aided Dispatch/Automatic Vehicle Location (CAD/AVL) data that tracks bus movements. Overall, the speeds in the weekday AM and PM peak periods were observed to be similar.

Generally, bus speeds are observed to be lower on streets with greater traffic, signal density, higher passenger loadings and bus frequencies. From the data, the NE/NW 1st Street corridor was observed to have bus travel speeds less than 10 miles per hour during both the weekday AM and PM peak periods.

The southern end of the E 2nd Ave corridor also experiences reduced bus speeds under 10 miles per hour. Based upon field observations, this is in part due to regular Brickell Avenue Bridge openings that occur throughout the day resulting in traffic delays.

Figure 2-11 and Figure 2-12 illustrate weekday AM and PM peak period bus speeds within the downtown Miami study area.

Figure 2-11: Weekday AM Peak Period Bus Speeds

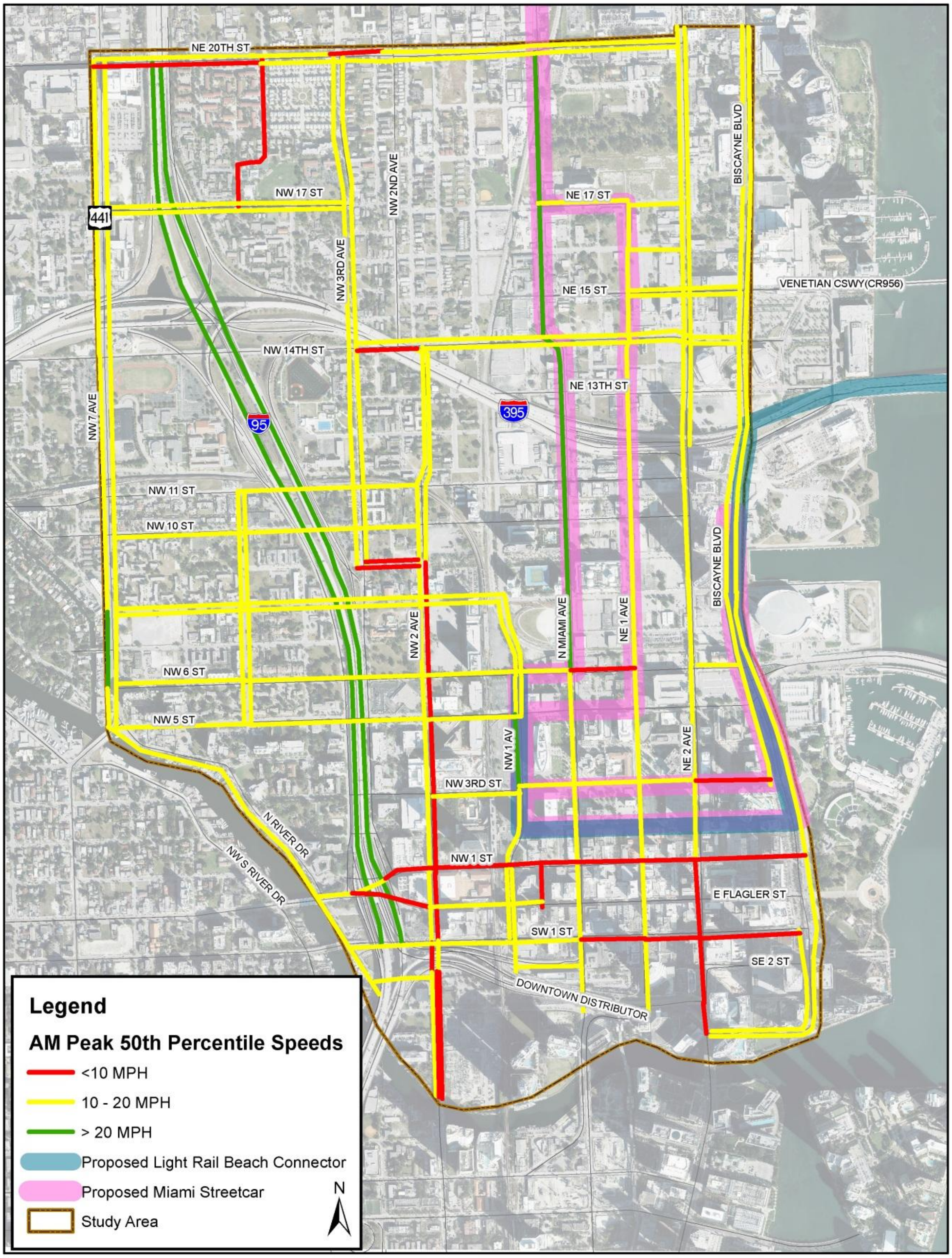
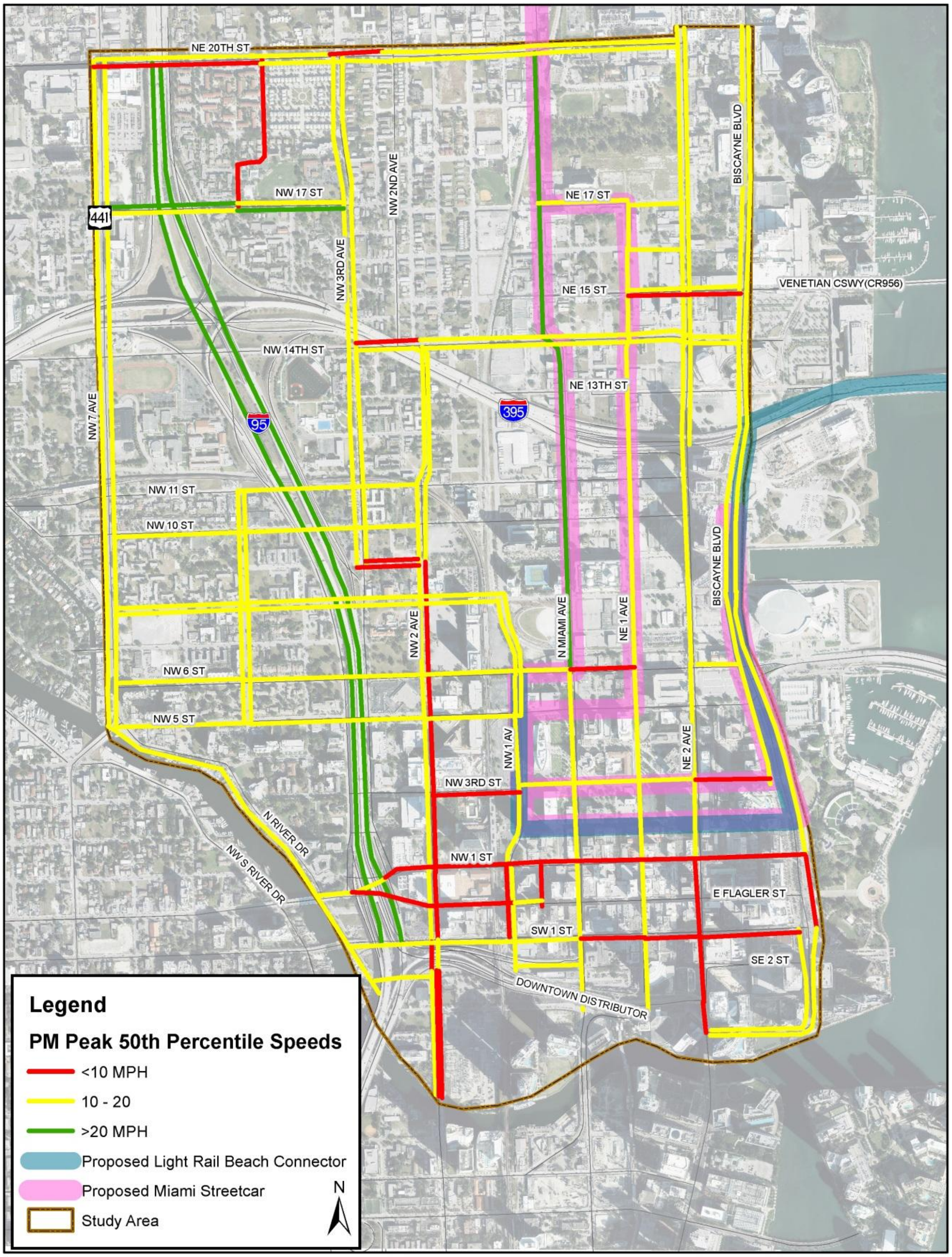


Figure 2-12: Weekday PM Peak Period Bus Speeds



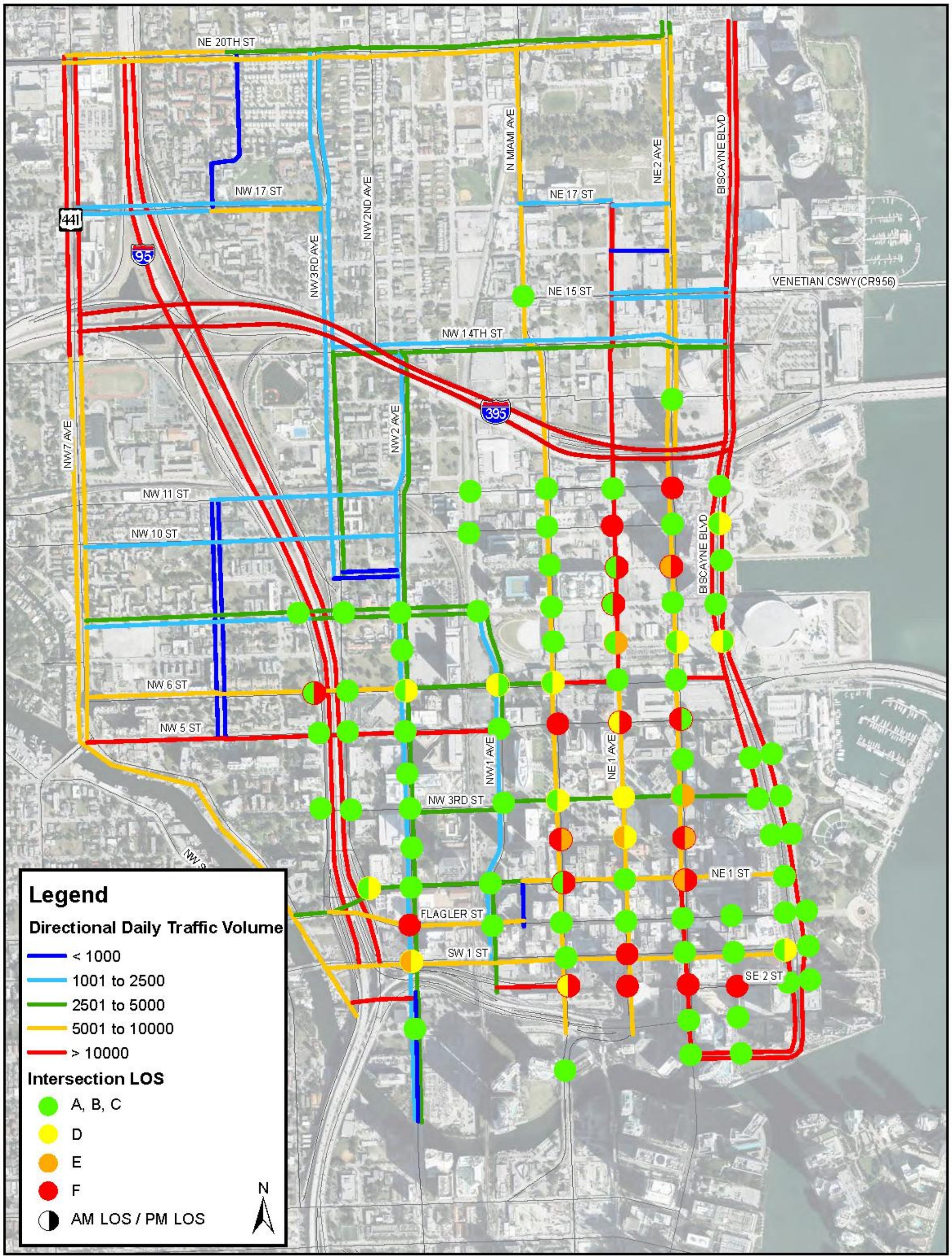
2.9 Traffic Volume and Level of Service

Figure 2-13 illustrates existing weekday peak period intersection Level of Service (LOS) for signalized intersections within the study area. This information came from the Kimley-Horn report: *Impact of PortMiami Tunnel on Downtown Traffic Congestion – Technical memorandum #1, March 2015.* Many of the intersections on the periphery of the study area have a LOS of A, B or C, particularly along Biscayne Boulevard and NW 2nd Avenue. However, key bus corridors in downtown Miami have traffic signals that are performing at or below LOS D.

The intersections of NE 2nd Avenue at NE 9th and NE 5th Streets are operating with an AM peak period LOS of E and F, respectively. As a key route for southbound buses in the AM peak, the low LOS at these intersections can have a detrimental impact on transit on-time performance.

Figure 2-13 also depicts weekday directional daily traffic volume numbers for streets within the study area. The orange and red lines indicate traffic volumes in excess of 5,000 and 10,000 vehicles, respectively. Streets with high traffic volumes include Biscayne Boulevard, NE/SE 2nd Avenue, SW/SE 1st Street and NE/NW1st Street.

Figure 2-13: Existing Traffic Operations



2.10 Parking Inventory and Occupancy

This study evaluated parking data throughout downtown Miami which was derived from two sources; direct field observations as conducted over the course of two days in May and June 2015; this information was supplemented with on-street parking inventory as obtained from the Miami Parking Authority (MPA) .

The field observations were conducted to identify the number of parking spaces and their occupancy rates on a weekday at midday, AM and PM peak periods. The AM peak period is defined as 7:00 AM to 9:00 AM, the PM peak period is defined as 5:00 PM to 7:00 PM, and the midday period was defined as 12:00 PM to 2:00 PM.

Figure 2-14 depicts the parking inventory for the study area. High concentrations of on-street parking were identified on North Miami Avenue, NE 1st Avenue, NW 6th Street and on NW 2nd Avenue. Additionally, NE 2nd Avenue and NW 3rd Avenue had significant concentrations of on-street parking.

North 1st Street and SE 1st Street also had on-street parking. The former’s on-street parking is limited for re-adaptation by the presence of curb extensions that would limit a peak-period bus lane. The latter could be converted for peak-period bus exclusive service if necessary.

Figure 2-15, Figure 2-16, and Figure 2-17 depict the occupancy rates of the on-street parking by weekday AM Peak, PM Peak and Mid-Day, respectively. Overall, the highest usage of on-street parking was concentrated in the southern portion of the study area during the AM peak. A lower occupancy rate was observed in the PM Peak, which is indicative of the Central Business District’s reduced activity after regular business hours. The mid-day period occupancy rates are mapped in Figure 2-17, illustrating a high demand for parking on NE 1st Avenue, NE 3rd Street, and NW 20th Street.

Figure 2-14: Parking Inventory

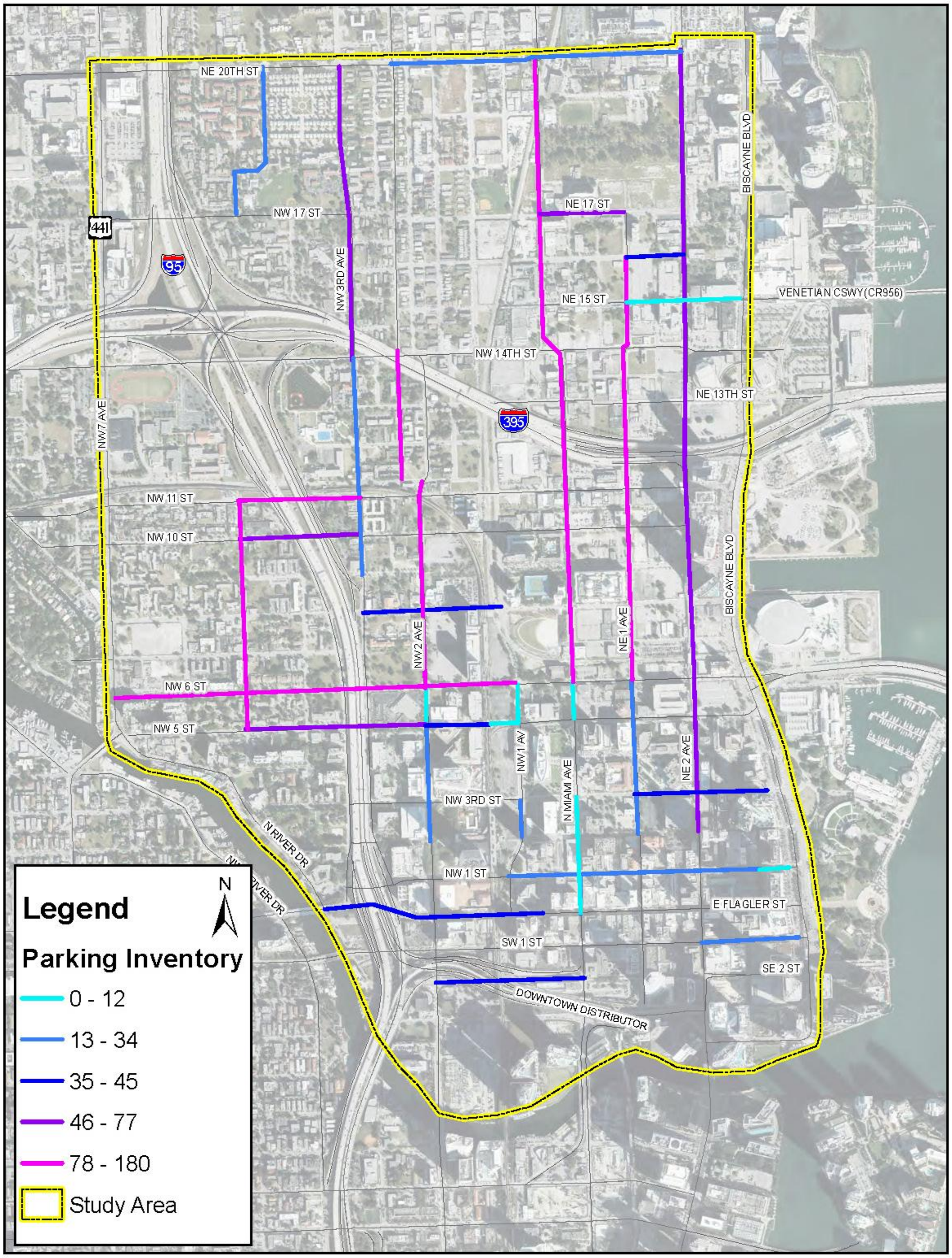


Figure 2-15: Weekday AM Peak Period Parking Occupancy

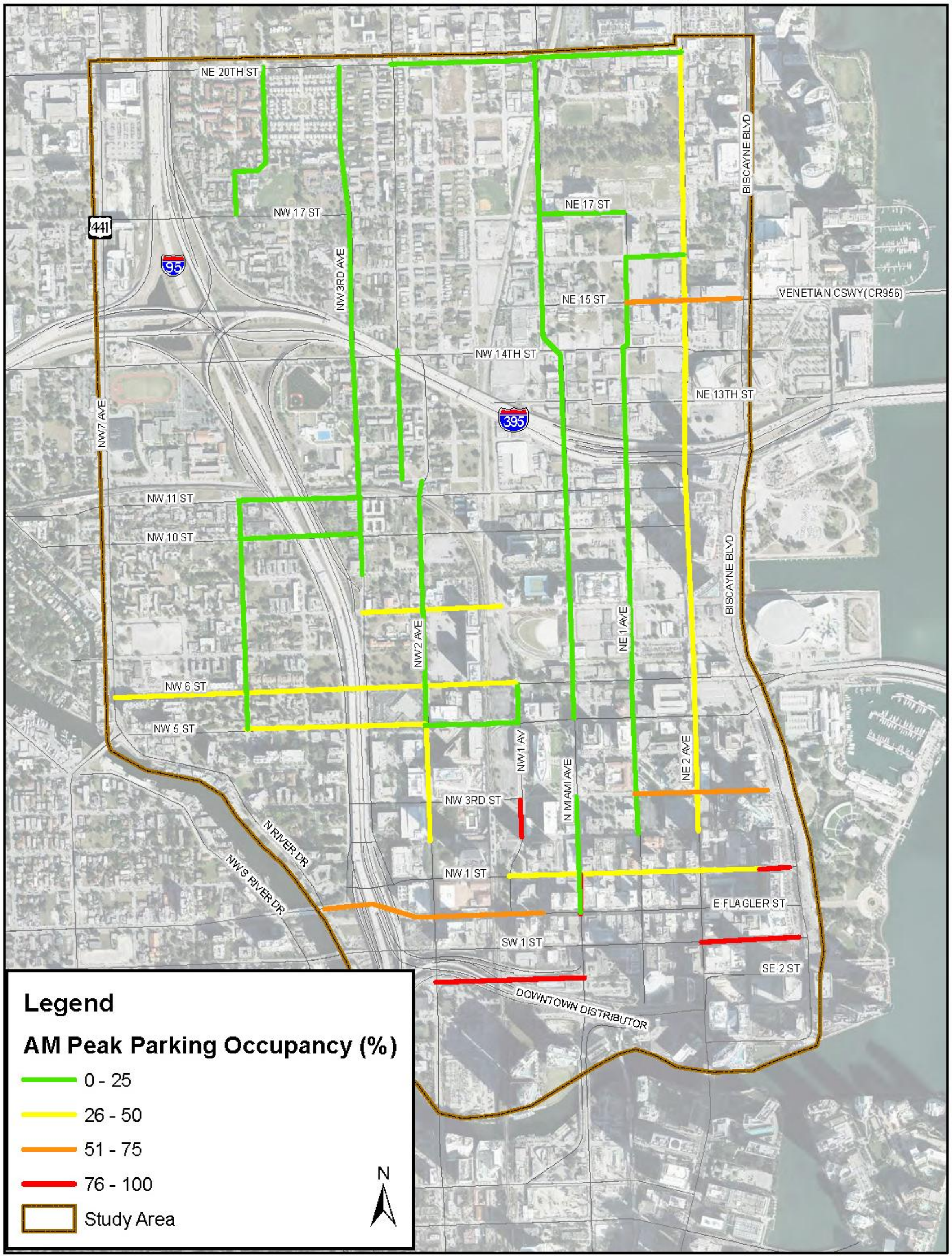


Figure 2-16: Weekday PM Peak Period Parking Occupancy

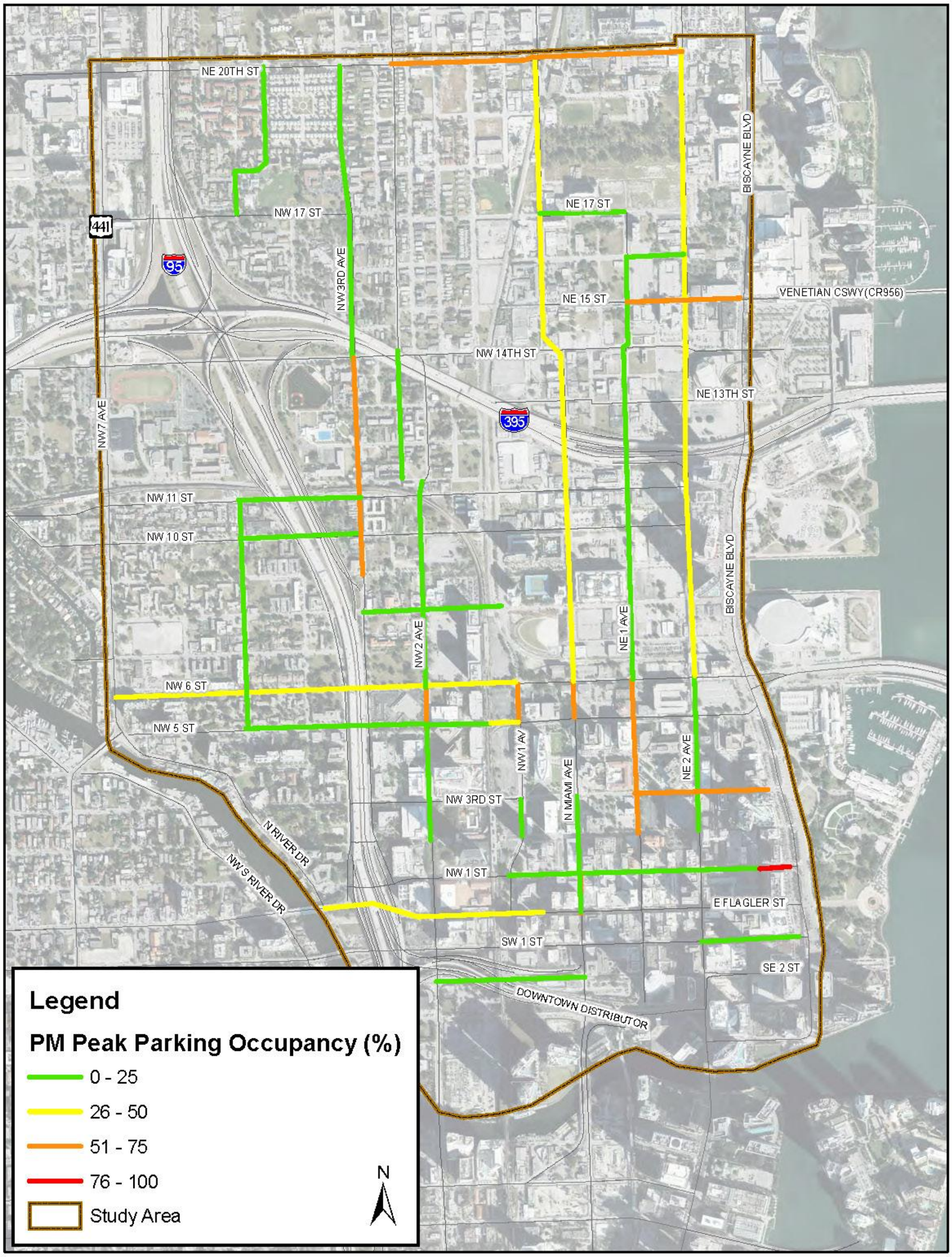
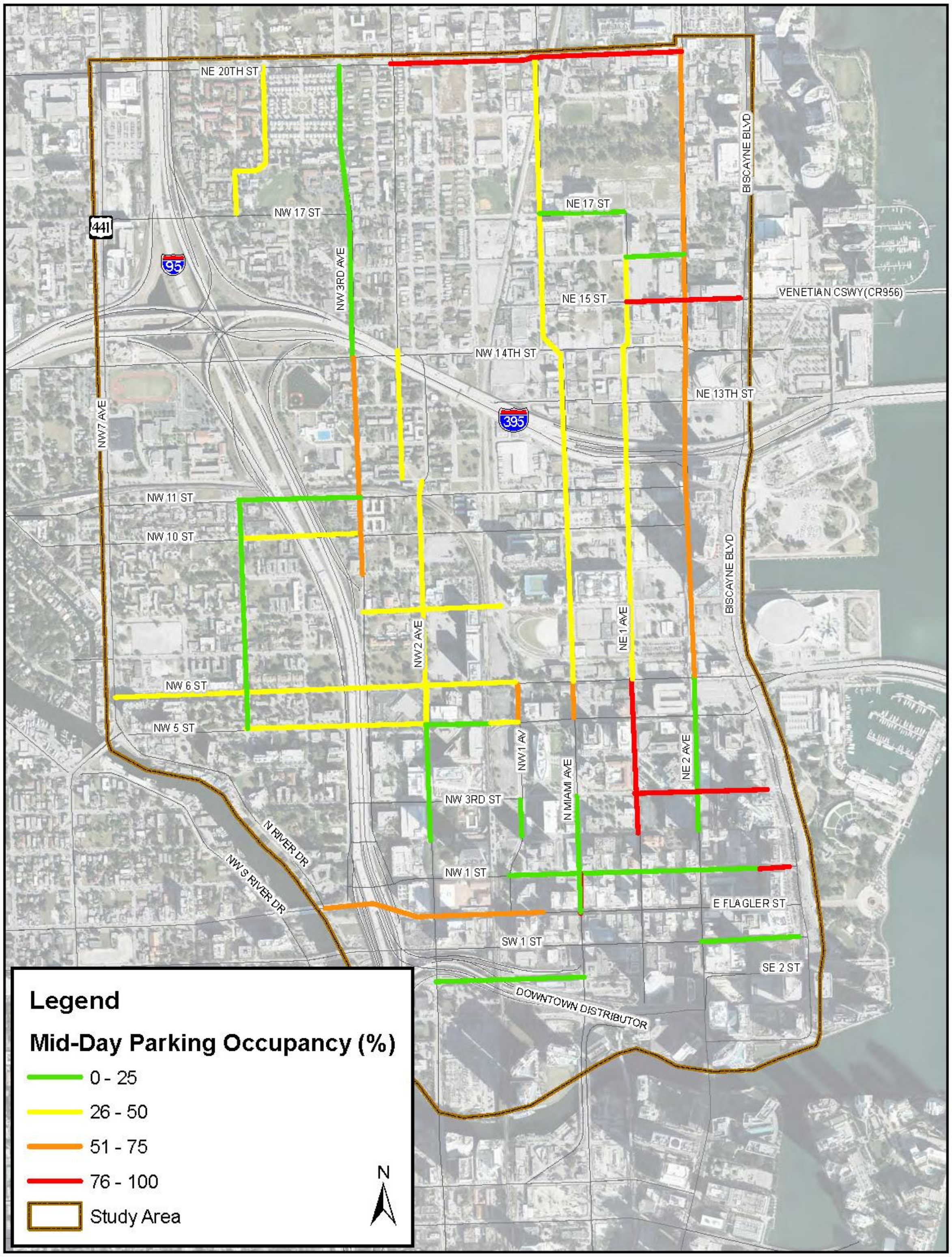


Figure 2-17: Weekday Mid-Day Parking Occupancy



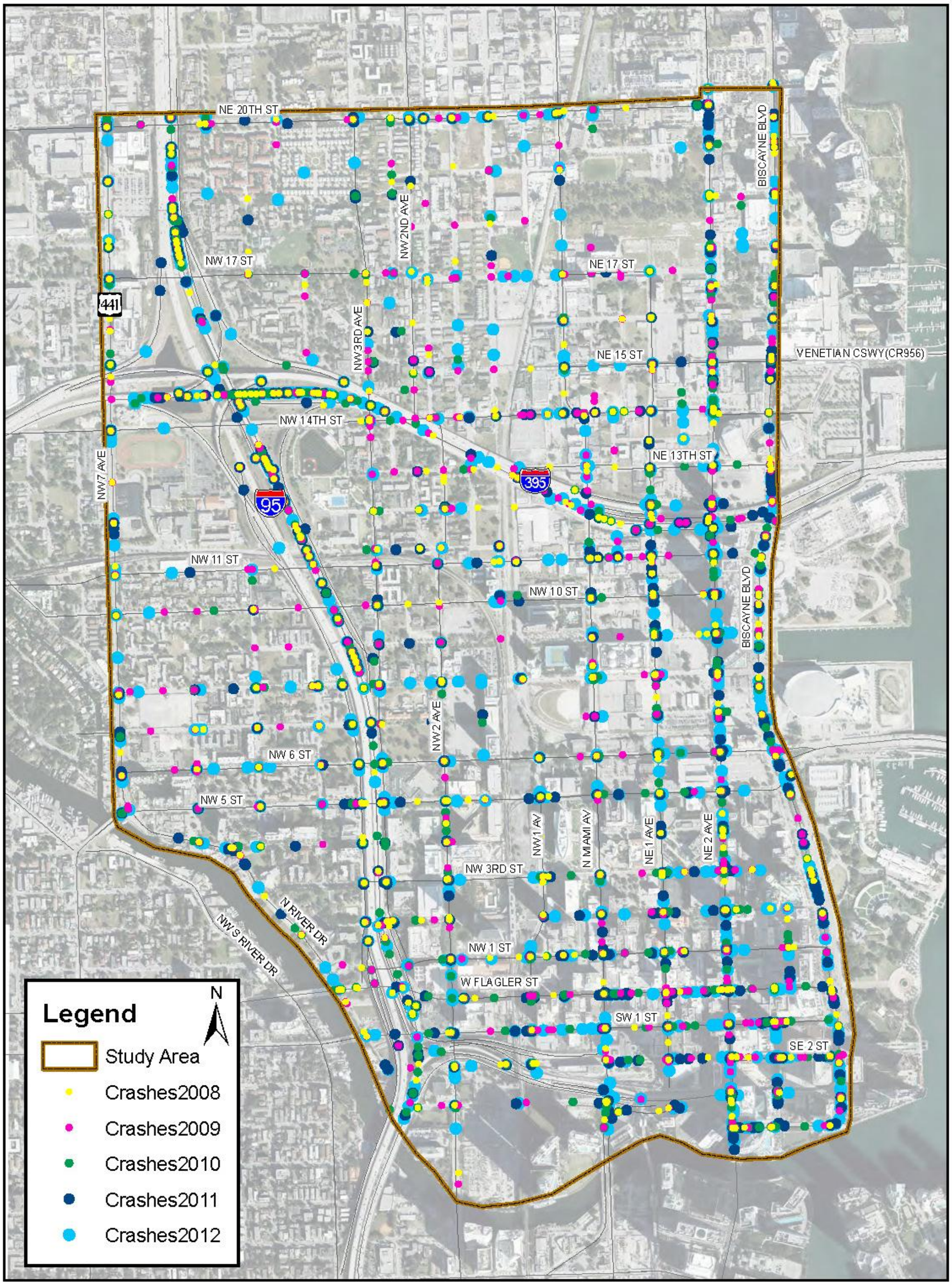
2.11 Crash Locations

Crash locations within the study area were obtained from FDOT's State Safety Office for the 2008 to 2012 time period. Mapped, the crashes are generally concentrated on corridors with greater traffic volumes; I-95 and I-395 both experience high rates of crashes.

Biscayne Boulevard, NE 2nd Avenue and Flagler Street also emerge as corridors with high concentrations of crashes. Street design treatments, more concentrated traffic enforcement, and other safety measures could be implemented to reduce these occurrences, thereby improving traffic flows within the study area.

Figure 2-18 identifies these crash locations throughout the study area.

Figure 2-18: Study Area Crashes



2.12 Insights from Miami-Dade Transit Street Supervisors

A coordination meeting with MDT street supervisors, planning and operations staff was held to identify the issues bus operators confront when providing transit service within the study area. A number of conflicts and congestion points were identified and discussed at length. A summary of this input is described below. The locations of the items described in this section are noted in Figure 2-19.

1. Bus routes turning at NE 14th Street and Biscayne Boulevard conflict with traffic exiting the Macarthur Causeway.

2. Biscayne Boulevard closings during special events result in detours to NE 1st and 2nd Avenues, triggering delays.

3. The limited amount of activity on Miami Avenue and its distance from Biscayne Boulevard limits its use as an alternate route for Biscayne Boulevard closures.

4. Intersection at NE 1st Avenue and NE 5th Street is regularly blocked.

5. Buses see significant delays on NE 2nd Avenue due to Brickell Avenue Bridge openings.

6. On-street parking on both sides of NE 2nd Avenue results in damage to buses.

7. Queue of cars accessing I-95 ramps at Miami Avenue and SE 1st Street causes delays and conflicts with bus stop at this location.

8. Pedestrian / car / transit conflicts at SW 1st Street between SW 2nd Avenue and SW 1st Avenue.

9. Evaluate possibility of extending NW 1st Avenue south of NW 10th Street to provide access to Overtown Metrorail Station.

10. Access to new Downtown Terminal from Biscayne Blvd will potentially require transit only designation to an east-west street (NE 6th Street, NE 5th Street, NE 3rd Street, NE 2nd Street, NE 1st Street, SE 1st Street).

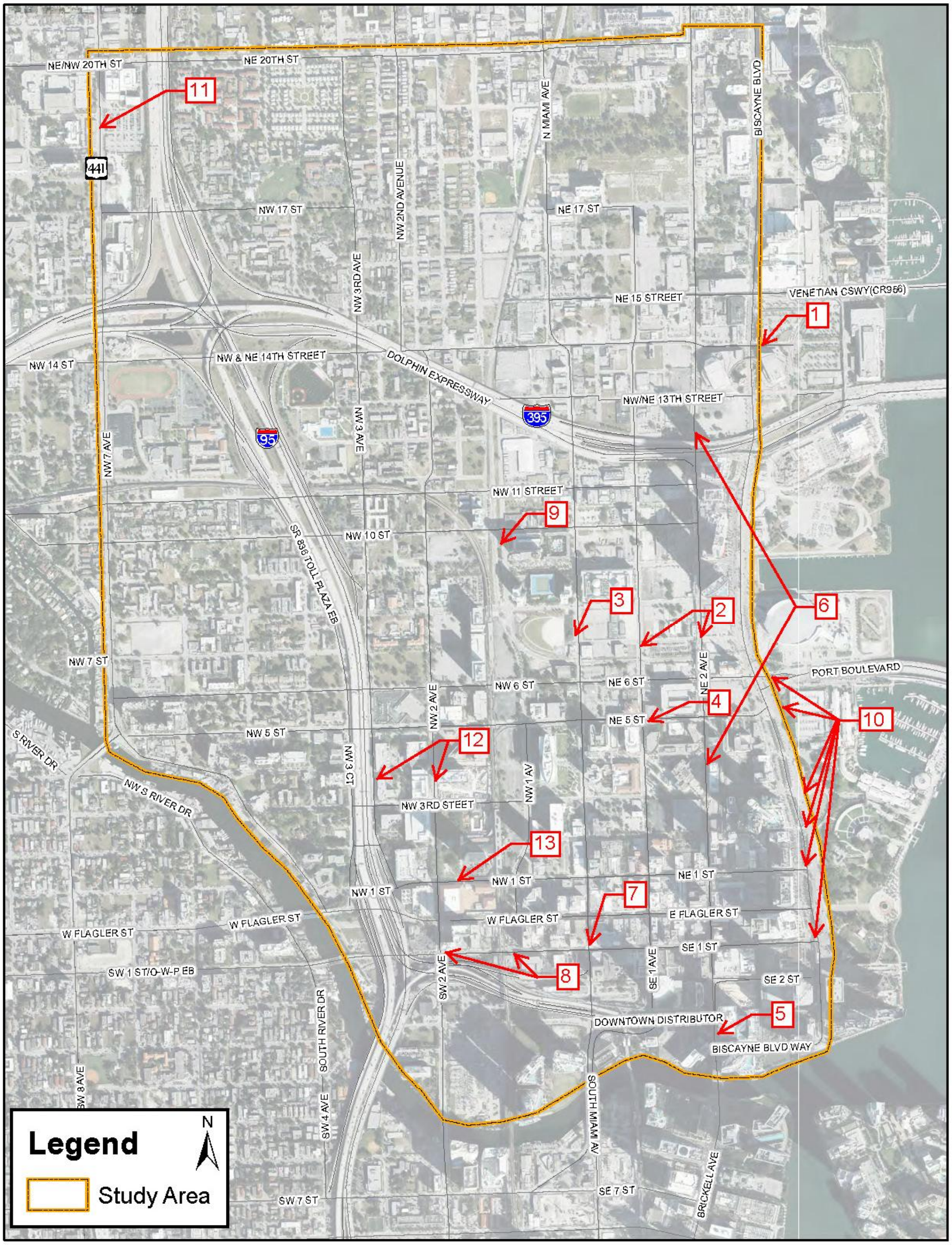
11. On-street parking on NW 7th Avenue is restricted to off-peak hours. However, these spaces are frequently not vacated on time, causing conflicts with peak hour traffic.

12. NW 2nd Avenue and NW 3rd Avenue present a significant conflict for bus drivers during peak travel periods. Peak traffic coming from I-95 and presence of Law Enforcement Officers Memorial High School present challenges for bus operations.

13. Critical Mass (bike event – last Friday every month) causes significant delays at NW 1st Street at Government Center.

14. More enforcement is needed downtown to prevent passenger and commercial vehicles from blocking bus stops.

Figure 2-19: MDT Supervisor Input



2.13 Insights from Miami-Dade Traffic Operations

A discussion with Miami-Dade County Traffic Operations was held to obtain their insights on the ability to implement special bus turn signals and transit signal priority (TSP) in the study area. This included a review of the signal system configuration in downtown Miami, signal system hardware and software programmed/planned improvements, and the County's philosophy towards TSP, particularly in downtown Miami. The meeting identified the following opportunities and constraints:

- The downtown Miami area signal system is currently a grid system. There are 190 signals located in the study area. The County is planning to implement a coordinated system. Existing controllers are 170, with Econolite software.
- Miami-Dade County has started the implementation of TSP along Kendall Drive. The TSP system will be expandable to other areas in Miami-Dade County. TSP will be implemented to about 10 signals in this corridor for testing. This system will operate in a centralized architecture.
- The implementation of TSP in the downtown Miami area will be limited, because of the reduced cycle length to facilitate pedestrian movement and the level of overall traffic congestion. Bus operations will be facilitated with improved signal coordination, with some bus stops potentially needing to be relocated to facilitate bus movements.
- Roadways that provide access to downtown Miami such as I-95 and Brickell Avenue are highly congested and TSP implementation at selected signalized intersections on the fringe of downtown could benefit traffic flow and hence bus operations.
- County Traffic Operations suggested coordination with the Downtown Development Authority in relation to its Vision Plan for streets in the downtown area and their desire for certain streets to become more multimodal in nature and hence greater opportunity for provision of transit lanes.

2.14 Summary

The existing conditions analysis revealed that most of the bus operational issues are focused in the southeast portion of the study area, in the downtown core. Streets with major bus volumes include Biscayne Boulevard, SE/NE 1st Avenue and NE/SE 2nd Avenue, and NE/NW and SW/SEW 1st Streets.

These streets also have the highest number of on-board passengers, given the multiple bus routes on these streets. Bus speeds also are lowest on NE/NW SW/SE 1st Streets, SE 1st Avenue, and NW/SW 2nd Avenue.

Several site-specific bus operational problem locations were identified by the MDT street supervisors, again concentrated in the downtown core. Discussion with Miami-Dade Traffic

Operations revealed no applicability of transit signal priority in the study area today, and limited opportunity in the downtown core due to the close signal spacing and shorter cycle lengths.

3.0 DEFICIENCIES AND NEEDS

3.1 Analysis Methodology

To identify the roadway segments where buses are today experiencing operational problems in downtown Miami, a "hot spot" analysis was conducted. This analysis applied three measures reflective of the magnitude of bus service versus the speed of bus operations within the identified study area. The measures applied include:

- Number of daily bus trips by direction by segment
- Number of daily boardings by direction by segment
- Average peak period speed by direction by segment

Bus trips and boardings were available for both MDT and Miami Trolley service, with bus speeds available only for MDT service. The number of bus trips was identified according route schedules. Miami Trolley boardings were provided by spreadsheet, while MDT boardings and travel times (translated to speeds) were obtained through interpretation of Automatic Passenger Counter (APC) data collected from MDT.

The average bus speed represented roadway segments with hot spots were determined on the basis of high bus runs, high passenger loads, and low speeds. Scores were assigned on a 1, 3, 5 point scale for low, medium and high bus runs and passenger loads. Speeds were given a stronger emphasis in the analysis and therefore were assigned scores of and 0.5, 1.5, and 2.5 low, medium and high speeds respectively. Figure 3-1 summarizes the analysis process. Table 3-1 shows the ranges of values for each measure rating in the scoring process.

The scores for each measure were totaled to arrive at a total score per roadway segment. If the total score was less than 10 for a roadway segment, it was identified as a hot spot.

3.2 Results

Figure 3-2 and Table 3-2 highlight the location of those roadway segments by direction that received an overall hot spot score of under 10 and thus are a designated hot spot. The hot spot roadway segments, as would be expected, are concentrated in the downtown core, or the southeast portion of the study area. North-south hot spot roadway segments include:

- Biscayne Boulevard
- NE/SE 2nd Avenue south of NE 6th Street
- SE/NE 1st Avenue from SE 1st Avenue to NE 14th Street
- NW/SW 1st Avenue from NW 6th Street to SW 1st Street

- NW/SW 2nd Avenue from NW 6th Street to SW 1st Street to NW 6th Street
- NW/SW 7th Avenue from NW 20th Street to NW 14th Street, and south of NW 6th Street

Figure 3-1: Hot Spot Analysis Process

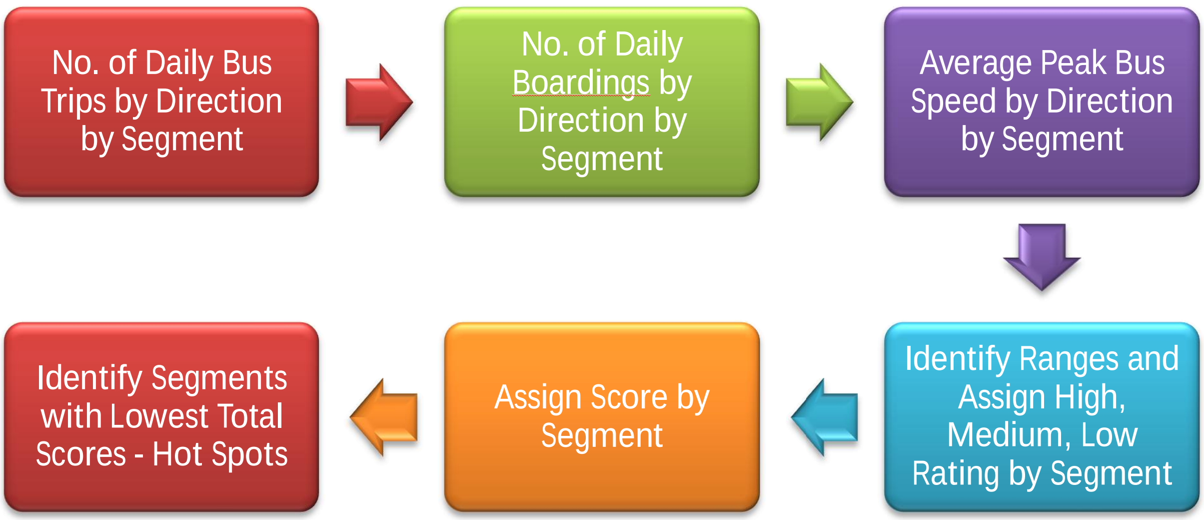


Table 3-1: Measure Ratings for Roadway Segments

Criteria	No. of Daily Bus Trips		No. of Daily Boardings		Peak Bus Speed (mph)	
	Range	Score	Range	Score	Range	Score
High Impact	>220	1	>1500	1	10 or less	0.5
Medium Impact	101 to 220	3	1500 to 701	3	11 to 20	1.5
Low Impact	100 or less	5	700	5	>20	2.5

Figure 3-2: Roadway Segment Bus Hot Spots

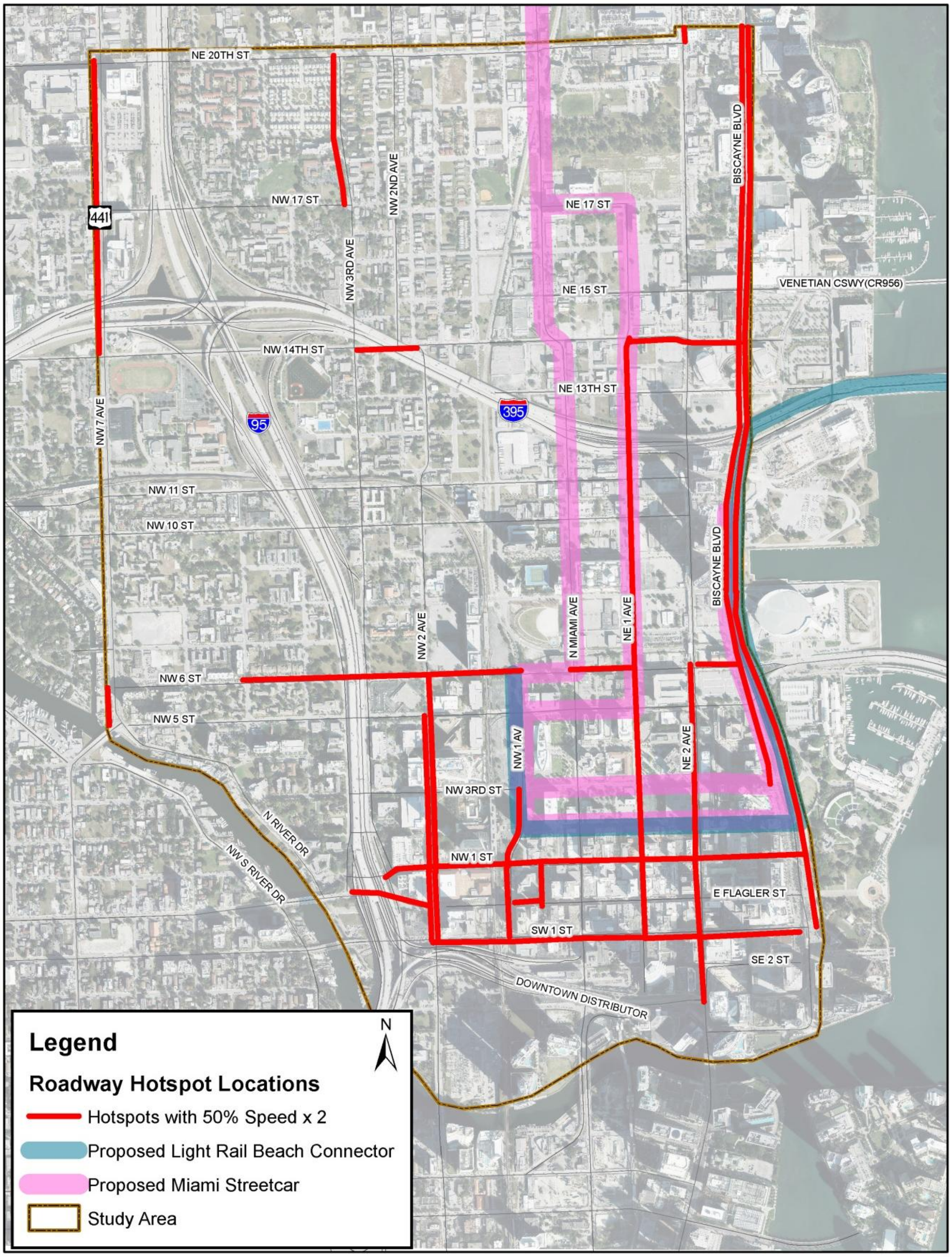


Table 3-2: Roadway Segment Bus Hot Spot Rankings

Ranking	Roadway	Segment	Score SB / WB	Score NB / EB
1	Miami Ct	NW 1st St to W Flagler St	3	
	NE/NW 1st St	to NE 2nd Ave to NW Miami Ct	3	
	SE 1st St	SE 2nd Ave to Biscayne Blvd		3
2	NW 1st Ave	NW 1st to NW 3rd St	5	
	SW/NW 1st Ave	SW 1st St to NW 1st St	5	
	Biscayne Blvd	NE 17th St to NE 14th St	5	5
	Biscayne Blvd	NE 14th St to NE 6th St	5	5
	SE/NE 1st Ave	SE 1st St to NE 6th St		5
	NE 2nd Ave	NE 6th St to NE 3rd St	5	
	NE 2nd Ave	NE 3rd St to NE 1st St	5	
	Biscayne Blvd	NE 6th St to NE 1st St		5
	Biscayne Blvd	NE 1st St to SE 1st St		5
	NE 6th St	Biscayne Blvd to NE 2nd Ave	5	
	NW 1st St	NW 2nd Ave to NW 3rd Ave	5	
	NW 1st St	NW 1st Ave to NW 2nd Ave	5	
	NW 1st St	NW to NW Miami Ct to NW 1st Ave	5	
	Flagler St	SW 1st Ave to NW Miami Ct	5	
	SW 1st St	SW 1st Ave to Miami Ave		5
	SE 1st St	Miami Ave to SE 1st Ave		5
	SE 1st St	SE 1st Ave to SE 2nd Ave		5
3	NW 3rd Ave	NW 20th St to NW 17th St	7	
	NW 2nd Ave	NW 5th St to NW 3rd St	7	7
	NE 1st Ave	NE 6th St to NE 14th St		7
	Biscayne Blvd	NE 20th Ter to NE 17th Ter	7	7
	Biscayne Blvd	NE 6th St to NE 3rd St	7	
	SW 1st St	SW 2nd Ave to SW 1st Ave		7
	NW 14th St	NW 3rd Ave to NW 2nd Ave	7	
4	NW 2nd Ave	NW 6th St to NW 5th St	9	7
	NW 2nd Ave	NW 3rd St to NW 1st St	7	9
	NW/SW 2nd Ave	NW 1ST St to SW 1st St	7	9
5	NW 7th Ave	NW 6th St to NW 5th St	9	
	NW 3rd Ave	NW 17th St to NW 14th St	9	
	NW 2nd Ave	NW 9th St to NW 6th St		9
	SW 2nd Ave	SW 1st St to SW 2nd St		9
	NW 1st Ave	NW 6th St to NW 8th St		9
	NW 1st Ave	NW 5th St to NW 6th St		9
	Miami Ave	NW 6th St to SE 4th St	9	
	NE 2th St	NW 4th Ct to NW 3rd Ave	9	
	NE 14th St	NE 2nd Ave to Biscayne Blvd	9	
	NW 6th St	NW 2nd Ave to NW 5th Ave	9	

Table 3-2: Roadway Segment Bus Hot Spot Rankings (Continued)

Ranking	Roadway	Segment	Score SB / WB	Score NB / EB
5	NW 6th St	NW 1st Ave to NW 2nd Ave	9	
	NW 6th St	Miami Ave to NE 1st Ave	9	
	Flagler St	NW North River Dr to NW 3rd Ave	9	
	Flagler St	NW 2nd Ave to SW 1st Ave	9	

East-west hot spot roadway segments include:

- SW/SE 1st Street east of I-95
- Flagler Street across I-95
- NE/NW 1st Street west of Biscayne Boulevard.• NW 6th Street from Biscayne Boulevard to N Miami Avenue, and from NW 1st Avenue to NW 5th Avenue.
- NW/NE 14th Street from NW 3rd Avenue to Biscayne Boulevard

Looking more closely at the ranking table, NE/NWE 1st Street, SW/SE1st Street, SE/NE 1st Avenue, NE/SE 2nd Avenue, and Biscayne Boulevard appear to be the more significant hot spot roadway segments.

4.0 PRELIMINARY RECOMMENDATIONS

This section identifies the constraints and selection criteria identified in addressing the feasibility of development of bus lanes on the key north-south and east-west streets in downtown Miami where congested bus operations exist today.

These downtown streets include:

- NE/SE 2nd Avenue
- SE/NE 1st Avenue
- N/S Miami Avenue
- NW/SW 1st Street
- SW/SE 1st Street
- NW/NE 5th Street
- NE/NW 6th Street

Given these insights, a preliminary set of recommendations were made on the location and configuration of bus lanes on certain streets, potential bus priority treatments at certain intersections, potential enforcement mechanisms, an estimate of what the construction costs would be to retrofit streets to accommodate bus lanes, and policy changes related to on-street parking and signal system development to allow for application of bus priority treatments in the downtown Miami area.

4.1 Constraints and Selection Criteria

4.1.1 NE/SE 2nd Avenue

Description: NE/SE 2nd Avenue is a three-lane north/south corridor that runs continuously through the entire study area. The avenue is the main southbound corridor within the downtown area and is used as a detour route during special event and other lane closures on Biscayne Boulevard.

On the north end of the study area, NE 2nd Avenue provides access to I-395 ramps, bisects Miami-Dade College's Wolfson Campus, and runs parallel to a section of the Metromover Omni Loop. On the south end, SE 2nd Avenue connects to the I-95 ramps, the Brickell Avenue Bridge and the CBD.

The corridor is a three-lane road with on-street parking, including both sides of the street on several blocks, principally in front of Miami-Dade College. MDT street supervisors reported that the on-street parking poses a conflict, sometimes resulting in damage to parked vehicles and buses.

Opportunities: The corridor runs continuously throughout the entire study area and provides direct access to I-95 and I-395 ramps.

The urban density on the corridor, particularly south of NE 5th Street provides good opportunities for maximizing transit usage on this corridor.

Constraints: The opportunities to redesign NE 2nd Avenue are limited north of NE 5th Street by the presence of the Metromover OMNI Loop. In addition, the current road configuration narrows from three lanes to two (with a left turn lane leading to PortMiami) at NE 5th Street. The street returns to a three-lane road south of NE 5th Street with two on-street parking lanes, one on each side of the road.

SE 2nd Avenue's southern terminus is at the Brickell Avenue Bridge over the Miami River. Frequent bridge openings, which at times coincide with peak period traffic, can trigger gridlock conditions.

NE 2nd Avenue serves as an alternate route during Biscayne Boulevard closures. The diverted traffic results in heavy congestion during special events.

Figure 4-1: NE 2nd Avenue at NE 5th St. 2nd Avenue drops one lane at this intersection for eastbound left turns.

4.1.2 SE/NE 1st Avenue

Description: SE/NE 1st Avenue is a northbound three-lane corridor that operates as a pair to NE/SEt 2nd Avenue. The corridor connects the Knight Center and I-95 ramps in the Central Business District on the south side of the study area to the I-395 ramps on the north side of the study area. The Avenue borders the western side of Miami-Dade College and the east side of the United States District Court facilities.

Opportunities: Federal courthouse facilities between NE 3rd and NE 5th Streets have resulted in lane closure on west side of NE 1st Ave between NE 3rd and NE 5th Streets. Local and Federal governments should collaborate to redesign the avenue in a way that can maintain the Federal facility's security and enhance Downtown's transportation network.

Constraints: The proposed northbound alignment for the Miami Streetcar would be on NE 1st Avenue. A bus lane configuration paired with the streetcar corridor would potentially conflict.

SE 1st Avenue does not connect across the Miami River to Brickell Avenue.

More enforcement is needed to prevent commercial and passenger loading in travel lanes, particularly during peak travel periods. It is not uncommon to see both outside lanes blocked by commercial and passenger vehicles with hazard lights on. This practice has a negative effect on traffic flows by bottlenecking vehicular flow to one or two lanes. See Figure 4-2 illustrating this behavior.

Attempts to reconfigure NE 1st Avenue may be superseded by Federal government security requirements for the facilities they own on the west side of NE 1st Avenue.

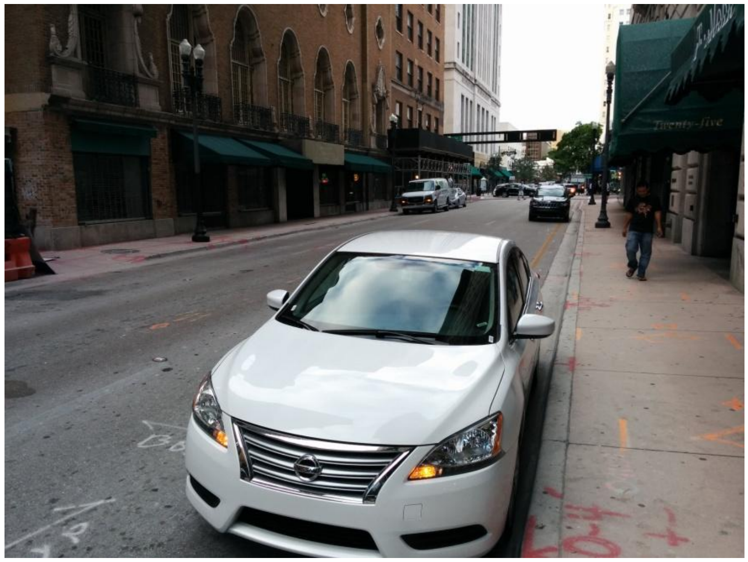


Figure 4-2: Passenger and commercial vehicles blocking traffic in both outside travel lanes during the PM peak period on SE 2nd Avenue. This practice is common throughout the study area.

Figure 4-3: NE 2nd Ave from College North Metromover Station southbound view. Note the barricade in right lane, which was installed as a security measure.

4.1.3 Miami Avenue

Description: Miami Avenue runs continuously north-south through the study area predominantly as a three-lane southbound only corridor. The road becomes a two-way facility north of N 17th Street. Miami Avenue is the County's meridian road, dividing the street grid into east and west avenues.

Opportunities: Relative to current traffic volumes on Miami Avenue, the roadway has excess capacity. The avenue is one of just three north-south connections across the Miami River linking Downtown to the Brickell neighborhood.

Reconfiguration of lanes by Federal Courthouse and removal of on street parking from North 3rd Street to Flagler Street would add a third travel lane that could serve as an exclusive bus lane.

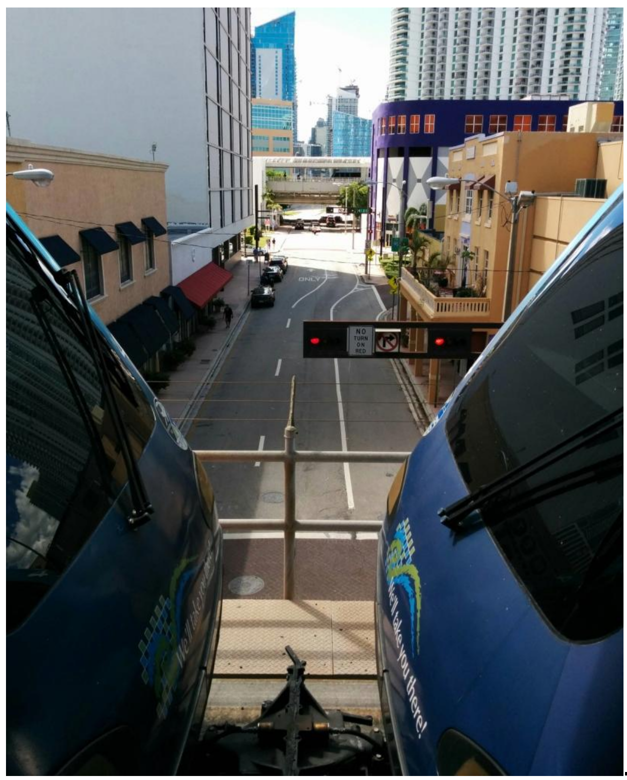


Figure 4-4: South Miami Avenue southbound view from the Miami Avenue Metromover station at the intersection with S 1st Street. The three lane road becomes two lanes at the I-95 ramp just before S 2nd Street.

Constraints: Proposed Miami Streetcar project projects southbound alignment on North Miami Avenue. A bus lane configuration paired with the streetcar would potentially be an incompatible combination.

Limited residential and commercial activity along the Miami Avenue Corridor limits the viability for high-intensity usage. More development along the corridor could be stimulated by the development of a bus only lane within the corridor.

Miami Avenue separates the new Federal District Court facility from older Federal facilities to the east. Barricades prevent the existing right of way to be fully utilized. Furthermore, underutilized commercial space on Miami Avenue between North 5th and North 3rd Streets are considered surplus real estate by the Federal Government. Questions regarding the cost of needed improvements to the facilities have delayed the transfer of title of the facilities to a second party.

Figure 4-5: North Miami Avenue southbound view at N 4th Street. The Federal Courthouse on the east side of Miami Avenue is protected by a barrier in the easternmost lane that narrows the road from three to two travel lanes.

Figure 4-6: The barricaded parking on North Miami Avenue south of N 5th Street in front of the Federal Courthouse.

4.1.4 NW/NE 1st Street

Description: NW/NE 1st Street is a one-way westbound street that runs continuously from Biscayne Boulevard on the east to NW 2nd Avenue on the west, whereupon it feeds directly on to the Flagler Street one way westbound bridge to Little Havana.

NW/NE 1st Street is the street is the only westbound street that crosses the Miami River within the study area and therefore is a critical transit link from the CBD to nearby residential neighborhoods.

Opportunities: NW/NE 1st Street is a candidate for a conversion to include a bus lane, given its significant bus traffic. Segments of the street see over 450 bus runs per day. Relatively little vehicular traffic on block between NW 1st and 2nd Avenues (see figure on next page).

NW 1st Street provides bus traffic with a direct connection to the Government Center Metrorail Station, making it a significant hub in the County's transit network.

Constraints: Curb extensions west of NE 1st Avenue restrict ability to convert parking lane in to additional travel lane.

Travel lanes are frequently blocked by vehicles stopped for passenger and freight loading which can trigger bus route delays.

Quality of bus stop facilities at Government Center are not commensurate with passenger volumes and should be improved– comparably little shelter is available to shield commuters from the elements.

Figure 4-7: N 1st Street at N Miami Ave westbound view. Note cars changing lanes to pass stopped bus.

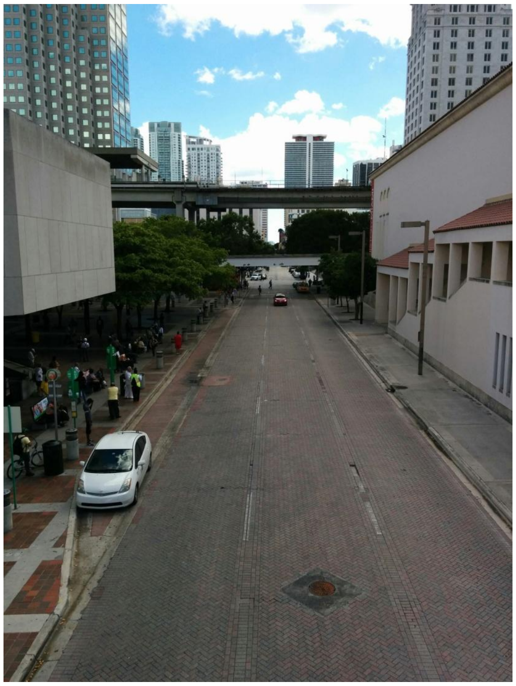


Figure 4-8: NW 1st Street at Government Center serves as a significant transfer point for Metrobus and Metrorail services.

4.1.5 SW/SE 1st Street

Description: SW/SE 1st Street is a one-way eastbound street that runs continuously from the Miami River on the west to Biscayne Boulevard on the east. The street operates as a pair with NE/NW 1st Street. The corridor is one of the busiest transit corridors in downtown Miami.

Opportunities: SW/SE 1st Street has an ideal setup for bus operations. The road has three continuous travel lanes from the Miami River to Biscayne Boulevard and provides direct access to Metromover Stations, Flagler Street, the CBD and Biscayne Boulevard.

Constraints: Near free-flow conditions of SW 1st Street at SW 2nd Avenue trigger conflicts with pedestrians at SW 1st Court and SW 1st Street. Despite signage urging pedestrians to use a nearby crosswalk, a combination of jaywalking and vehicular traffic that does not yield to pedestrians in the crosswalk creates a set of dangerous conditions.

A similar pedestrian/vehicular conflict occurs immediately to the east, at the intersection of SW 1st Avenue and SW 1st Street, where buses exit the Downtown Miami Bus Terminal.

Southbound bus and passenger vehicle turning movements conflict at the intersection of South 1st Street and Miami Avenue. A ramp to I-95 is located directly south of this intersection and experiences heavy usage during peak travel periods. Passenger vehicles entering the right lane conflict with buses attempting to use the bus stop. A reconfiguration of the travel lanes at this juncture could be beneficial for all of the facility's users.

Figure 4-9: SW 1st Street bus stop between SW 1st and SW 2nd Avenues. A combination of jaywalking and vehicles failing to yield to pedestrians in a nearby crosswalk create unsafe conditions.

Figure 4-10: SW 1st Street queuing at S Miami Avenue intersection. Right turning traffic sometimes compels buses to use the middle lane despite the presence of a bus stop on the far side of the intersection.

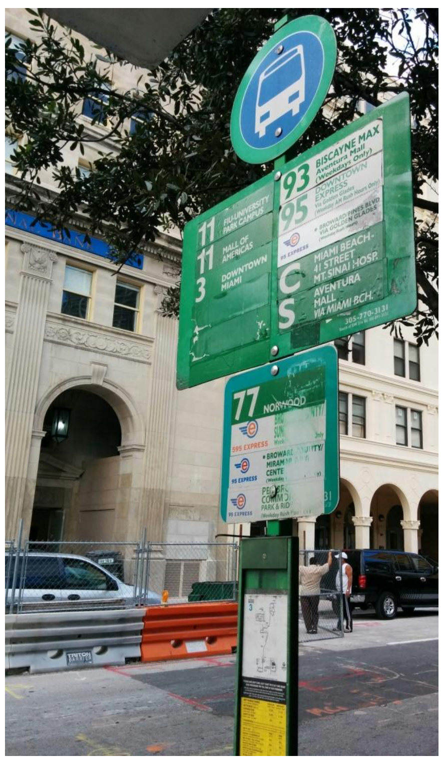


Figure 4-11: SW 1st Street bus stop between S Miami Ave and SE 1st Street. 16 routes operate on SW 1st Street within the study area.

4.1.6 NW/NE 5th Street

Description: NW/NE 5th Street is a one way eastbound street that runs continuously through the study area. It operates as a pair with westbound NE/NW 6th Street. At its eastern limit, NE 5th Street becomes Port Boulevard, and forms a direct link to PortMiami. To the west, NE 5th Street connects to the NW 8th Street I-95 ramps, and terminates at NW 7th Avenue.

NW/NE 5th Street is a principal arterial for truck traffic going to the port. The opening of the tunnel has reduced truck volumes, but since the opening of the PortMiami tunnel, the volumes have decreased. The Metromover Inner Loop runs parallel to NW 5th Street between NW 1st Avenue and NE 2nd Avenue, providing a multimodal link to bus routes using the street.

Opportunities: Since the opening of the PortMiami Tunnel, fewer trucks utilize NW/NE 5th Street, resulting in excess capacity that could be used for the implementation of a bus-only lane.

NW/NE 5th Street will bisect the new All Aboard Florida Miami Station. Despite being one of the lowest ridership stations in the Metromover System, the Wilkie D. Ferguson stop at NW 1st Avenue and NW 5th Street will be at the center of the new All Aboard Florida Miami Station.

Figure 4-12: Construction of All Aboard Florida Miami Station straddles NW 5th Street at NW 1st Avenue. The station will place greater transportation demands on the corridor.

Constraints: The N. 5th Street corridor is underdeveloped, bordered by several surface parking lots that limit the ridership potential of a bus lane on the corridor.

The Metromover piers between NW 1st Avenue and NE 2nd Avenue eliminate the potential for widening the roadway.

Security perimeter considerations for the Federal Government facilities on south side of street between NW 1st Avenue and NE 1st Avenue limit potential improvements to corridor.

The proposed City of Miami Streetcar alignment will conflict with a potential bus lane between NW 1st Avenue and NE 1st Avenue.

Figure 4-13: NE 5th Street between NE 1st and NE 2nd Avenues. The Metromover piers on the right are visible, which restrict potential capacity expansions of the roadway.

Figure 4-14: NE 5th Street between NE 1st Avenue and N Miami Avenue as seen from the Metromover Inner Loop. At most times of the day, NE 5th Street has excess capacity.

4.1.7 NE/NW 6th Street

Description: NE/NW 6th Street is a three lane one-way westbound street that runs from Biscayne Boulevard to NW 7th Avenue. Until the PortMiami Tunnel opened in 2014, this was a significant freight corridor.

Opportunities: Since the opening of the tunnel, there is less freight demand on the NE/NW 6th Street Corridor. Consequently, there is more capacity for the implementation of a bus lane in this corridor.

New economic activity at the new All Aboard Florida Miami Station makes the NE/NW 6th Street corridor a good candidate for exclusive transit service.

Constraints: Similar to the North 5th Street corridor, currently there is little commercial activity on the NW/NE 6th Street corridor, which limits the ridership potential of a bus lane.

The proposed City of Miami Streetcar alignment will conflict with a potential bus lane between NW 1st Avenue and North Miami Avenue.

West of I-95, where NW 6th Street runs through Overtown, the street is narrowed to two travel lanes with on-street parking on both sides of the street. Curb extensions were built between NW 5th and NW 6th Avenues, further limiting dedicated bus lane options.

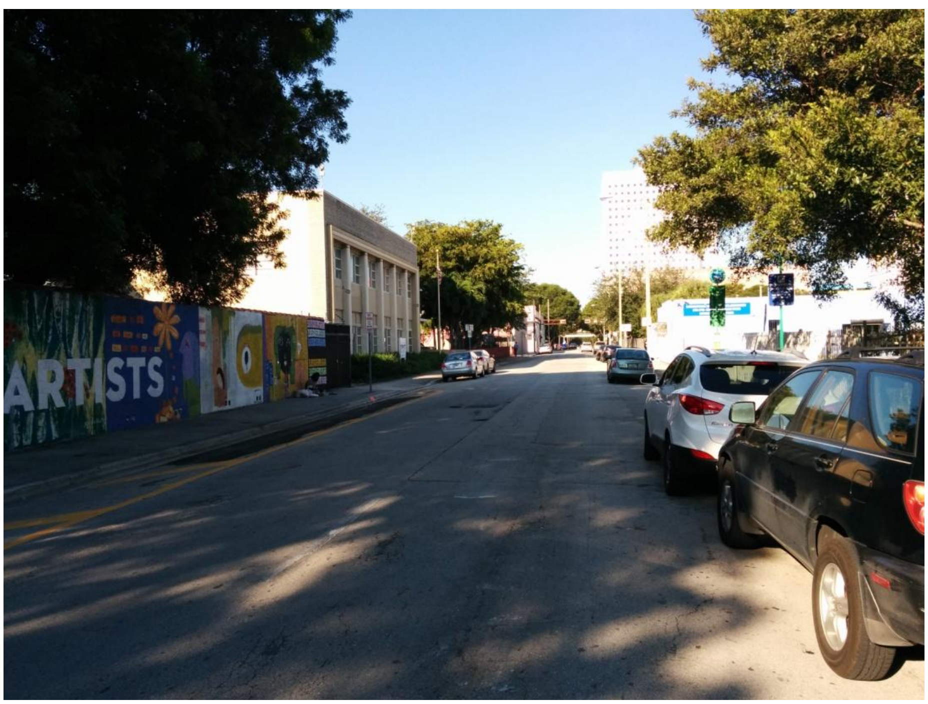


Figure 4-15: NE 6th Street west of NE 1st Avenue. On-street parking narrows the road to two travel lanes on this block.

Figure 4-16: NW 6th Street west of I-95 is a two-lane road with on-street parking on both north and south sides of the road.

4.2 Recommended Bus Lane Locations and Configuration

4.2.1 Assumptions

Based on the analysis conducted, and opportunities and constraints identified, some preliminary recommendations can be made with respect to a potential bus lane development strategy for the downtown Miami area. This would consist of one or more bus lanes on north-south and east-west streets, ideally connected to one another. In identifying streets for possible bus lane application, four major assumptions were made:

- Street was identified as a hot spot over a significant distance (not only for a 1-2 block stretch).
- Street would appear to have either sufficient capacity to convert a general traffic lane or ability to remove on-street parking to develop a bus lane.
- Street would not have a portion of the proposed streetcar or LRT line operating on the same street, unless the street were converted into a transit-oriented street with accommodations for both rail and bus modes (with at least two lanes converted to exclusive or semi-exclusive transit use). It was assume that if both streetcar or LRT and bus would have to share an exclusive lane, buses would have difficulty getting around the slower moving rail vehicles.
- Street should serve major trip generators in the study area, with particular emphasis of serving the new multimodal transportation center by the Government Center.

Given that all of the potential streets in the study area have adjacent residences and businesses, and several side street intersections, the bus lanes would have to operate as Business Access and Transit (BAT) lanes, where buses would share the lane with right turn traffic.

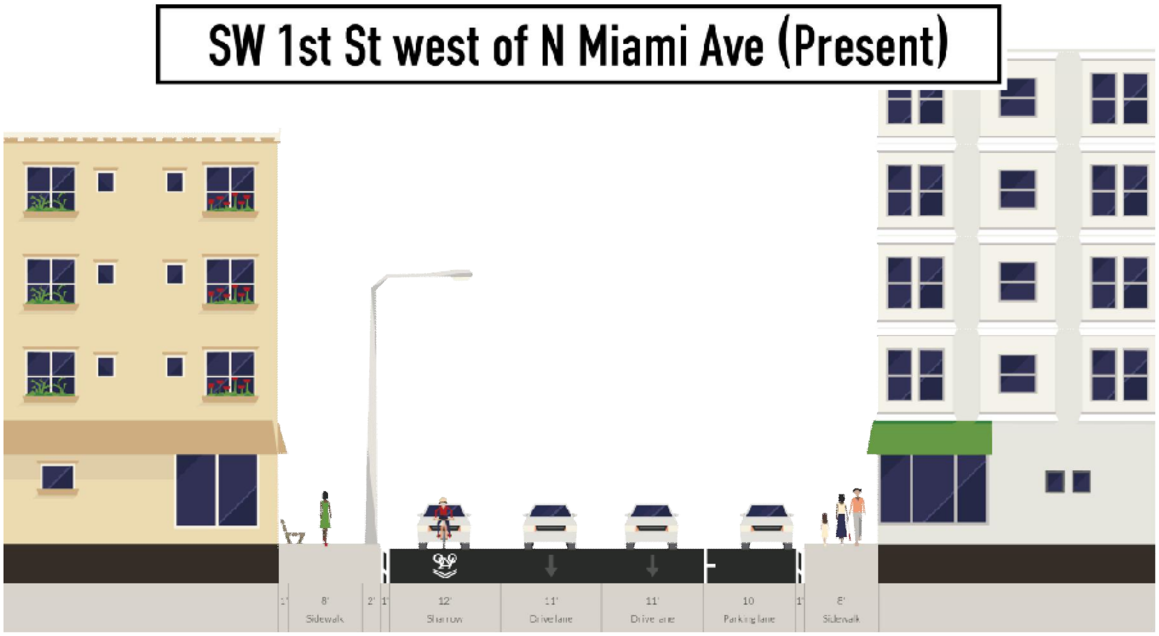
4.2.2 Recommended East-West Bus Lanes

The greatest congestion experienced by buses in the east-west direction in downtown is along NE/NW SW/SE 1st Streets. The south curb lane on SW/SE 1st Street is already acting as a de facto bus lane with the amount of bus traffic in the eastbound direction during both weekday peak periods. It is proposed that this lane from SW 2nd Avenue to SE 1st Avenue be designated as a BAT lane for buses and right turn vehicles during at least weekday peak periods if not all-day. Figure 4-17 illustrates a typical section of SW/SE 1st Street before and after the BAT lane conversion.

On NE/NW 1st Street, providing a westbound BAT lane from NE 1st Avenue to I-95 that would mirror an eastbound BAT lane on SW/SE 1st Street is very desirable yet more challenging. The ability of converting the parking lane on the south side of the street to a moving lane is restricted by the existing curb extensions, which would have to be removed. If these extensions could not be removed, then an alternate scenario would be to leave the parking on the south side of the street, and convert NE/NWE 1st Street to have a BAT lane on the north side of the street, with just one through lane.

Figure 4-18 shows the before and after options for a bus lane on this street.

Figure 4-17: Before and After Typical Sections with a BAT lane on SW/SE 1st Street.



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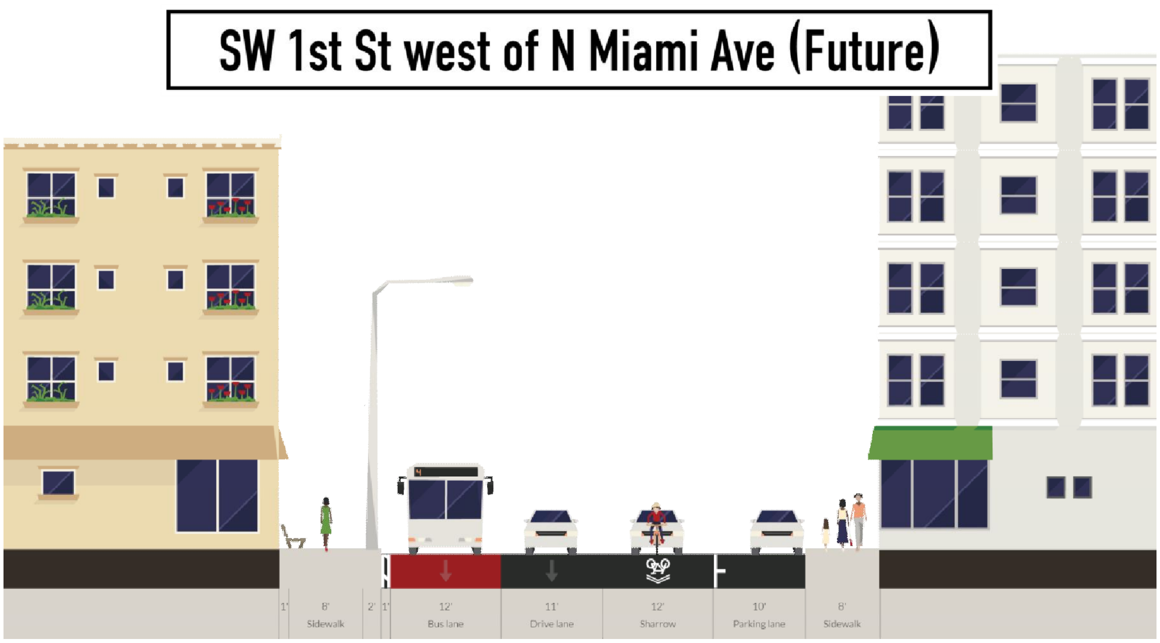
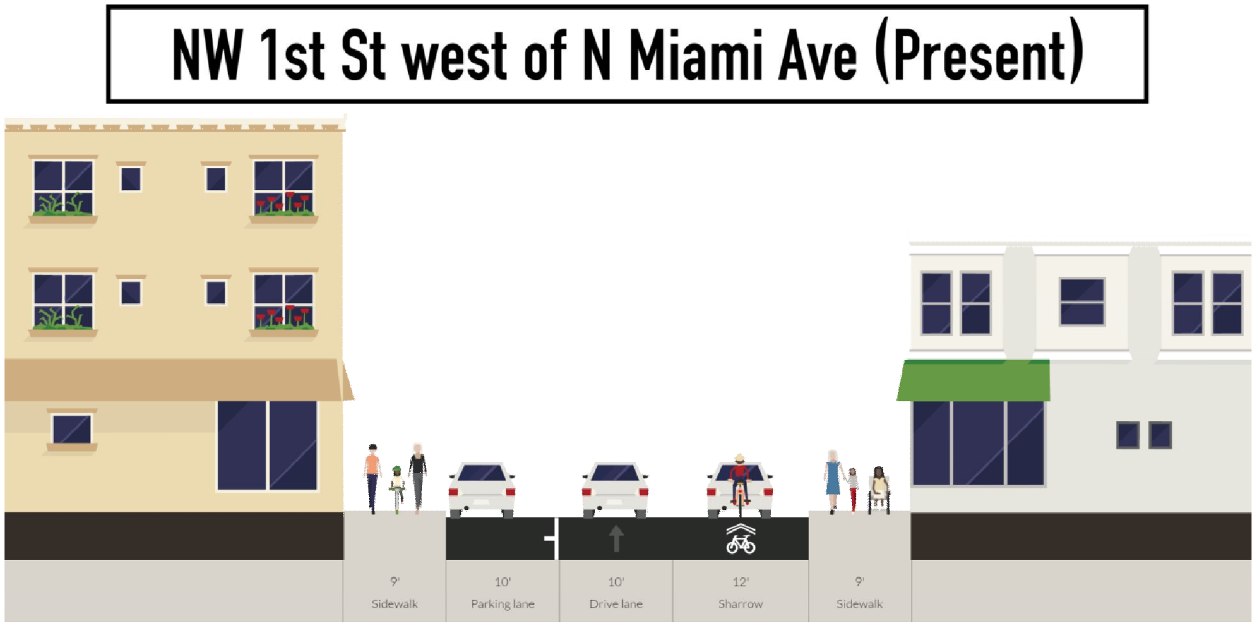


Source: Created with streetmix.net

Figure 4-18: Before and After Typical Sections with a BAT lane on NE/NW 1st Street.



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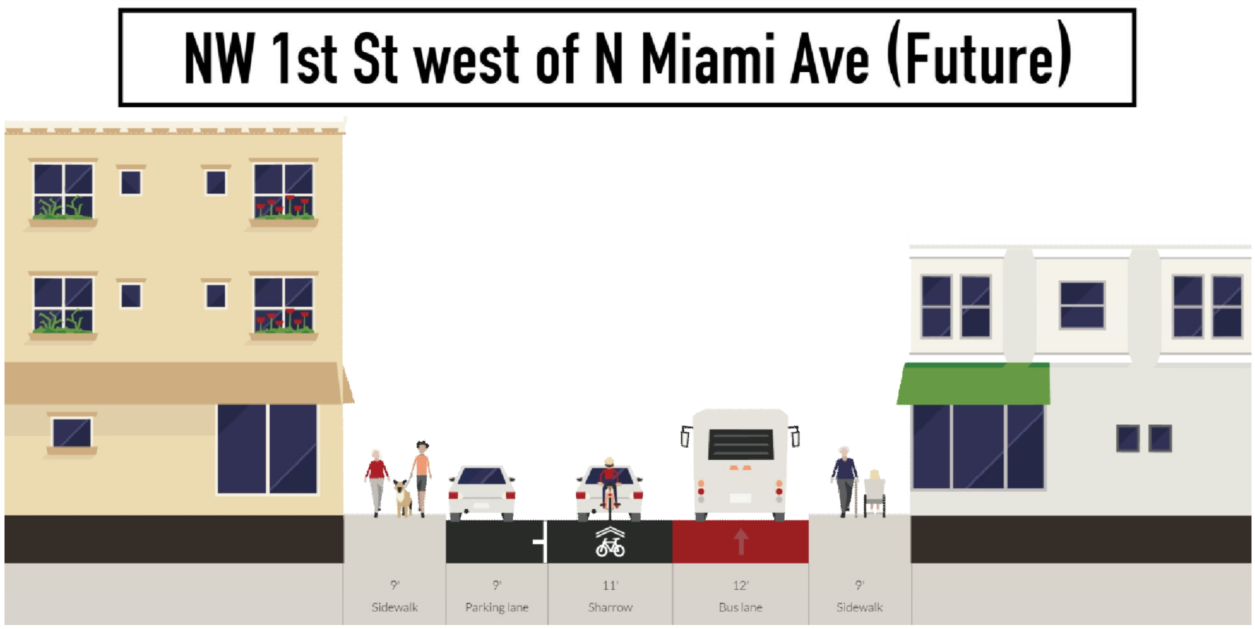


Source: Created with streetmix.net

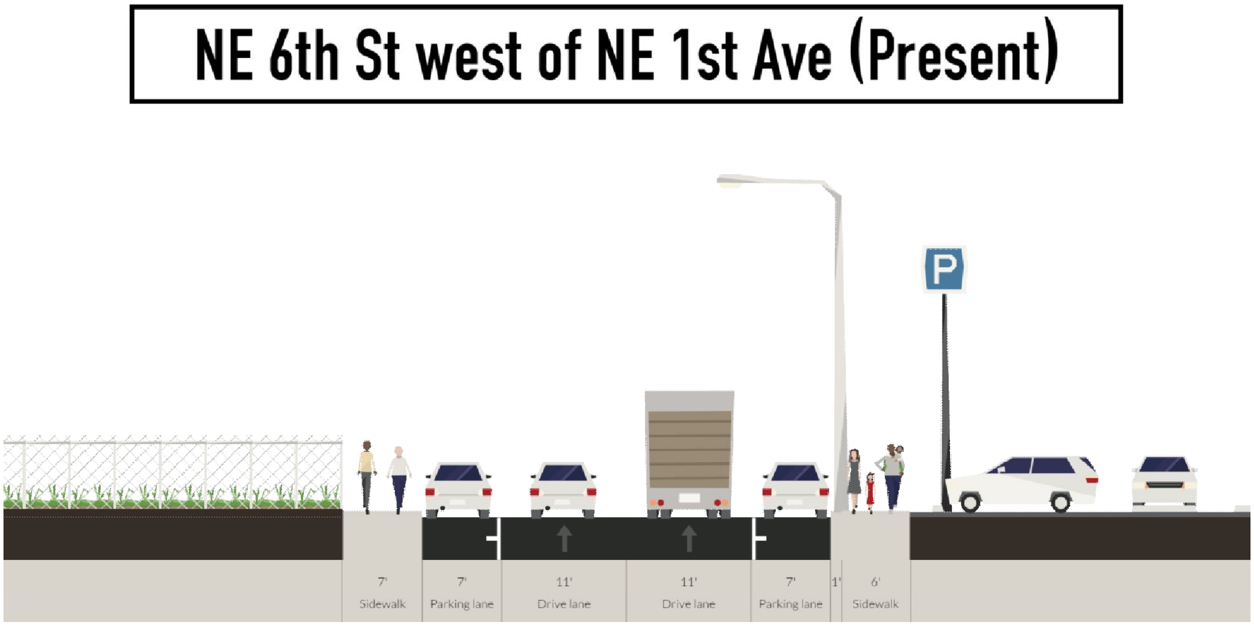
Having BAT lanes on both SW/SE NE/NW 1st Streets would facilitate new BRT operations planned to the west of downtown in the Flagler Street corridor, which would tie into this couplet downtown.

A BAT lane should also be considered for westbound NE/NW 6th Street, from Biscayne Boulevard to west of I-95. With the construction of the PortMiami Tunnel, and the diversion of truck traffic off of this street, NE/NW 6th Street has excess capacity to convert the right curb lane to a BAT lane, still providing two travel lanes. This street would also provide direct access to the new multimodal transportation center by the Government Center.

Ideally an eastbound BAT lane on NW/NE 5th Street would be desirable to mirror the westbound lane on NE/NW 6th Street, but encroachment of the Metromover guideway into the south curb lane of NW/NE 5th Street east of NW 2nd Avenue precludes any opportunity for use of that space as a BAT lane further to the east. A very limited two-block bus lane could be developed between I-95 and NW 2nd Street to facilitate inbound access off I-95 for buses into the new multimodal transportation center. East of NW 2nd Avenue, buses would need to merge back into the general traffic lanes due to Metromover pier encroachment into the roadway cross section. This movement would be facilitated with a queue jump signal.

Figure 4-19 and Figure 4-20 show the before and after typical sections with BAT lanes on NE/NW 6th Street and NW 5th Street (west of NW 2nd Avenue).

Figure 4-19: Before and After Typical Sections with a BAT lane on N. 6th Street



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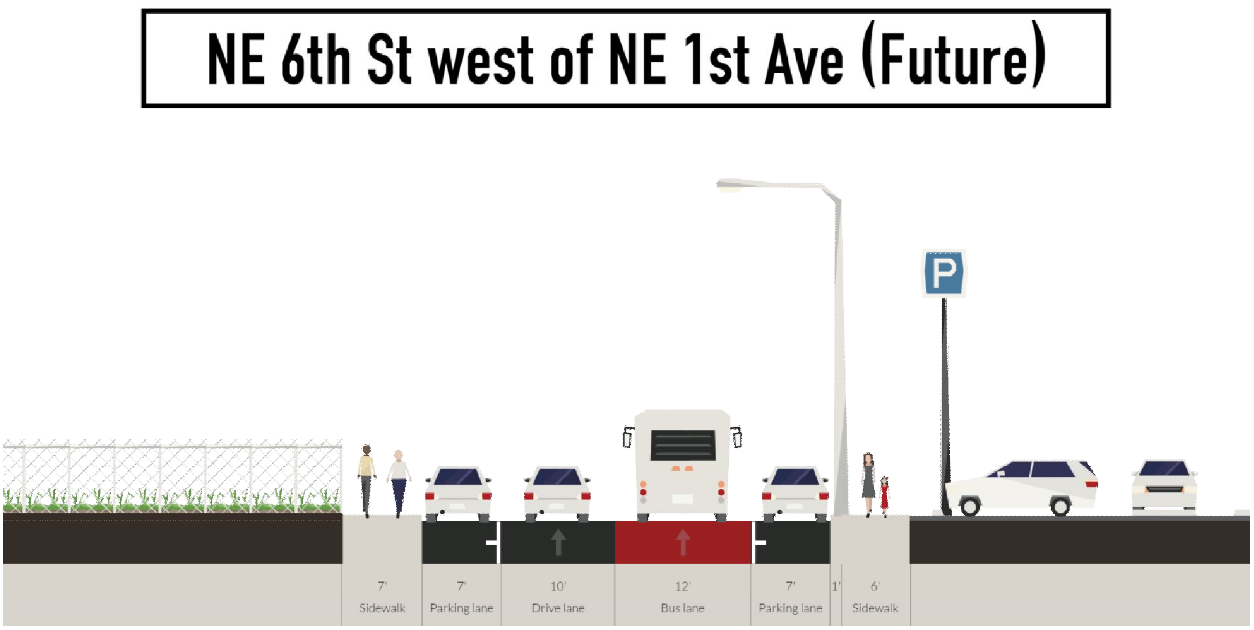
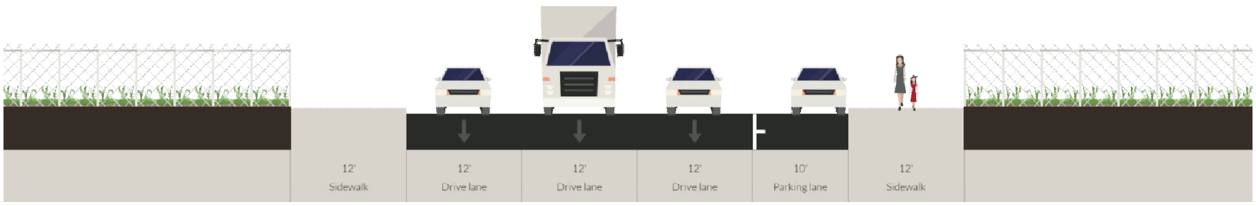


Source: Created with streetmix.net

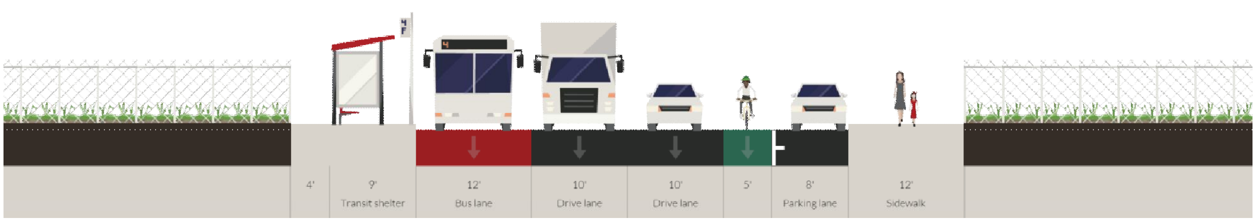
Figure 4-20: Before and After Typical Sections with a BAT lane on NW 5th Street west of NW 2nd Avenue

NW 5th St west of NW 2nd Ave (Present)



Source: Created with streetmix.net

NW 5th St west of NW 2nd Ave (Future)



Source: Created with streetmix.net

4.2.3 Recommended North-South Bus Lanes

Development of bus lanes on the north-south street system is more challenging if a streetcar line is to be accommodated in the future with its north-south orientation in the downtown area. With the reduction of Biscayne Boulevard to four lanes with the Biscayne Green project in the future, and the magnitude of traffic on that street, it would appear that street would be adversely impacted if a lane in one or both directions were converted to a BAT lane. Thus this leaves the through north-south streets west of Biscayne Boulevard as potential BAT lane candidates. These include NE/SE 2nd Avenue (southbound), SE/NE 1st Avenue (northbound), and Miami Avenue (southbound). Of these, the streetcar is currently identified to operate in the future on NE 1st Avenue north of NE 5th Street and Miami Avenue north of North 6th Street.

As indicated previously, unless they were to both operate in separate lanes on a street (creating a de facto transit street), buses should not operate in the same lane as a streetcar line, if only one lane could be devoted to both modes. It is recognized that the streetcar construction is still some years away, and thus there could be the potential to make a streetcar route adjustment that would allow a longer section of NE 2nd Avenue to be used for a southbound BAT lane, and a longer section of NE 1st Avenue to be used for a northbound BAT lane.

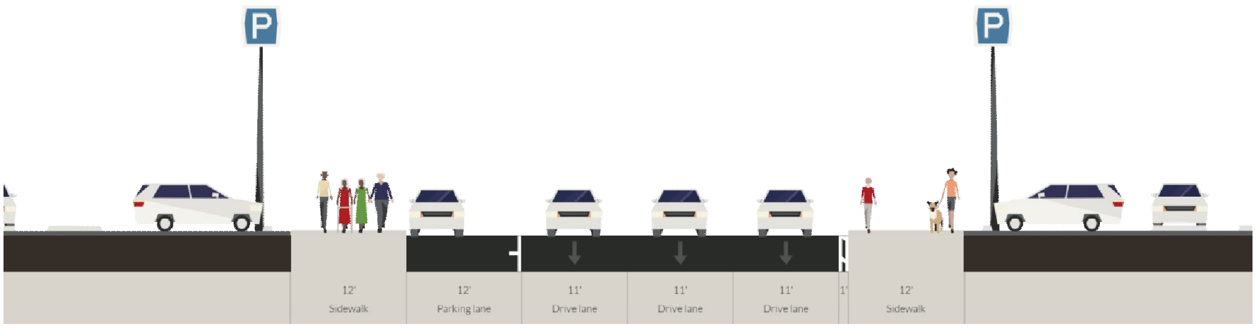
The sections of NE/SE 2nd Avenue and SE/NE 1st Avenue which are experiencing the greatest congestion today for buses is south of NW 6th Street. Thus, a reasonable scenario would be to initially develop right side BAT lanes by either using the parking lane during peak periods or converting a right side general traffic lane to a BAT lane from SE 1st Street to NW 6th Avenue (an eight block stretch). In the longer term, the lanes could be developed north of NW 6th Street pending resolution of the streetcar project preceding its specific alignment, and the ability of providing a separate lane for buses in one or both directions.

Figures Figure 4-21 through and 4-23 show the before and after typical sections developing BAT lanes on NE/SE 2nd Avenue and SE/NE 1st Avenue both north and south of NE 6th Street.

Miami Avenue could serve as an alternate alignment for a northbound BAT lane if such a lane could not be developed on NE 2nd Avenue, and the streetcar alignment were moved off Miami Avenue.

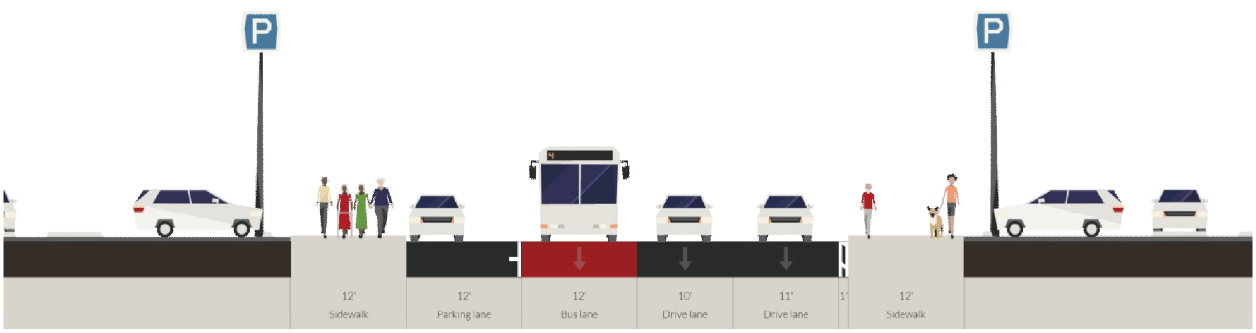
Figure 4-21: Before and After Typical Sections with a BAT lane on E 2nd Avenue

NE 2nd Ave north of NE 7th St (Present)



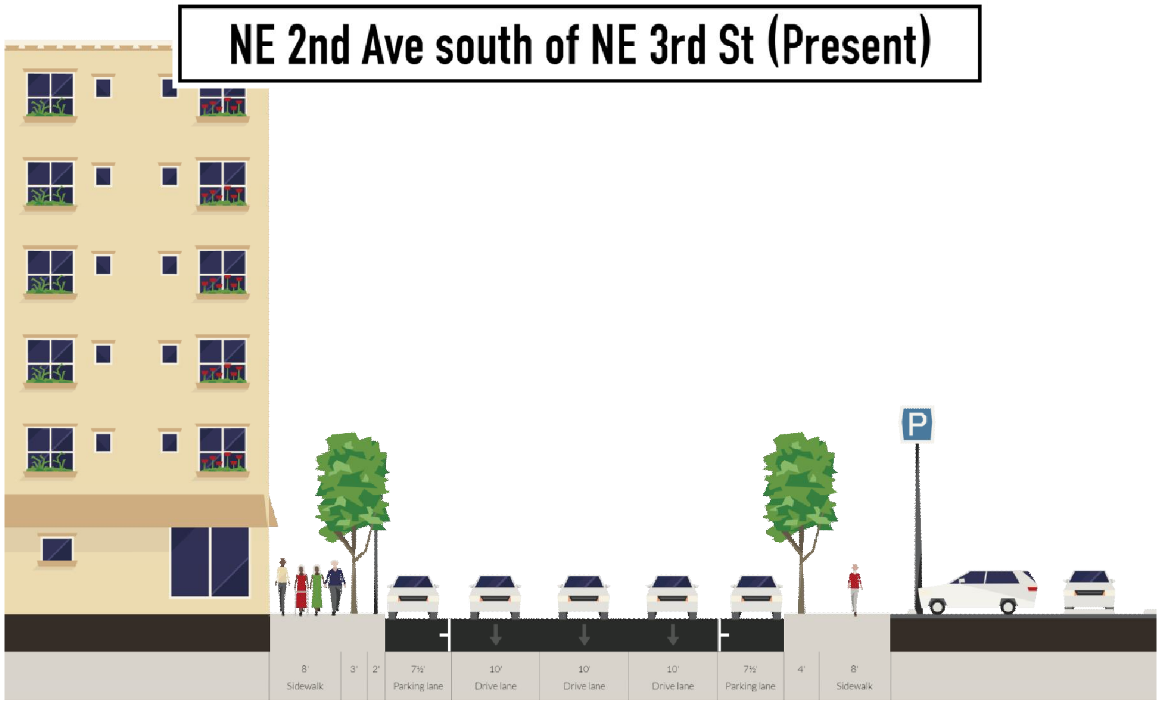
Source: Created with streetmix.net

NE 2nd Ave north of NE 7th St (Future)

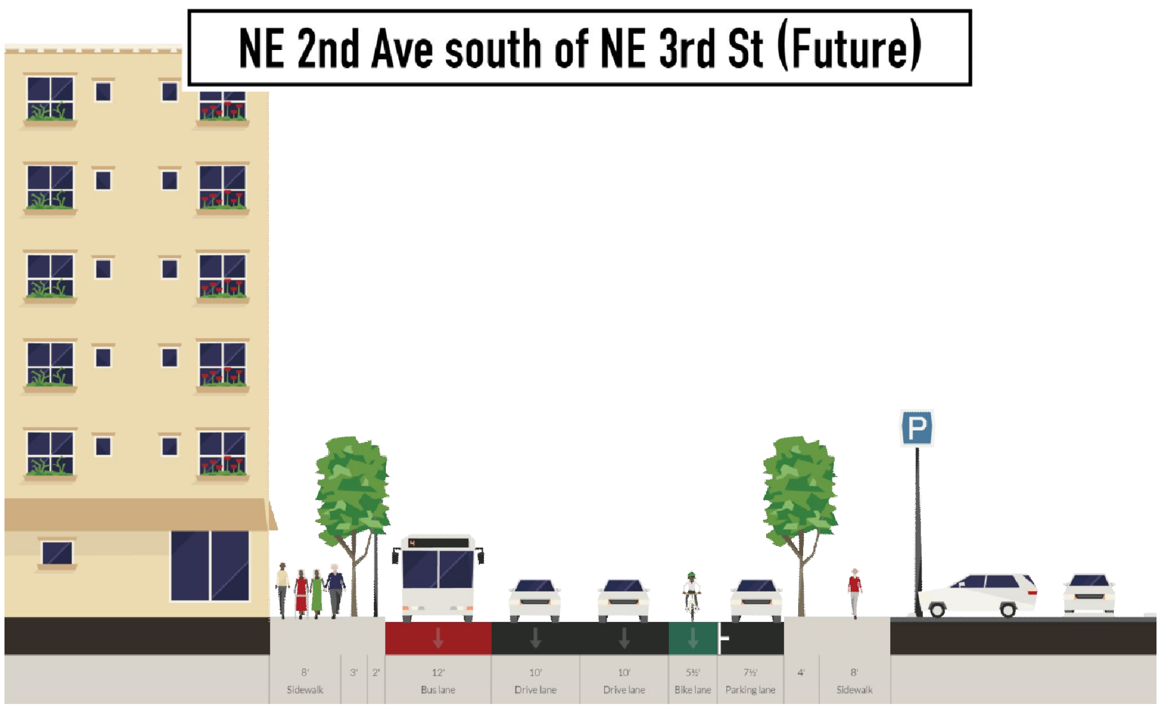


Source: Created with streetmix.net

Figure 4-22: Before and After Typical Sections with a BAT lane on NE 2nd Avenue

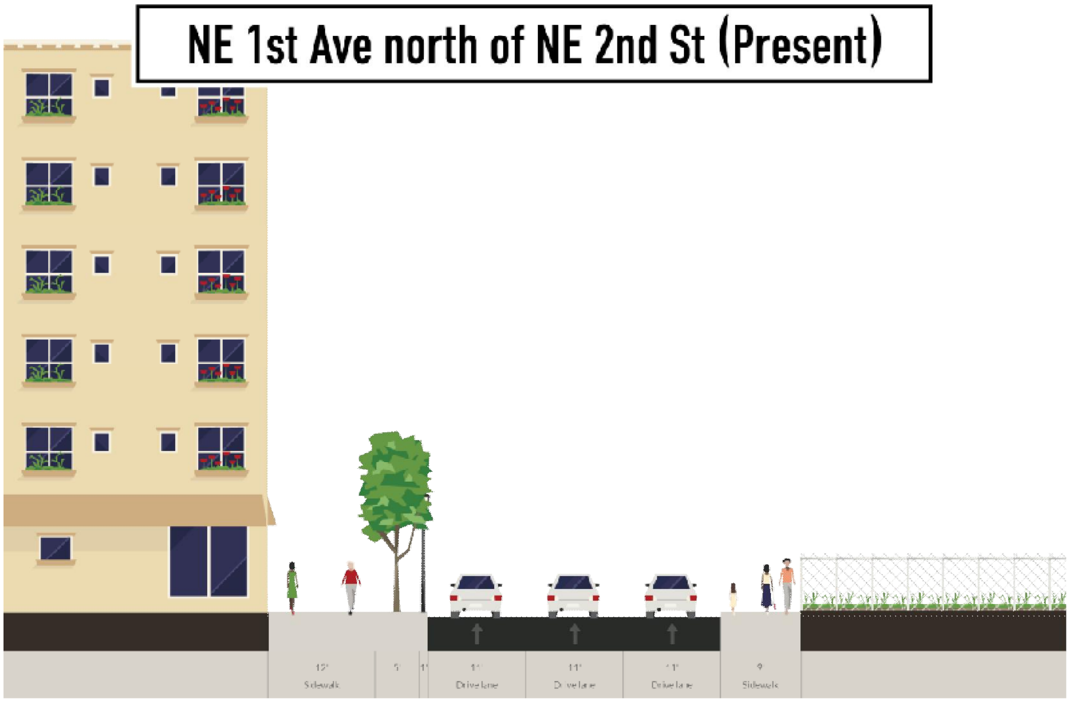


Source: Created with streetmix.net



Source: Created with streetmix.net

Figure 4-23: Before and After Typical Sections with a BAT lane on NE 1st Avenue



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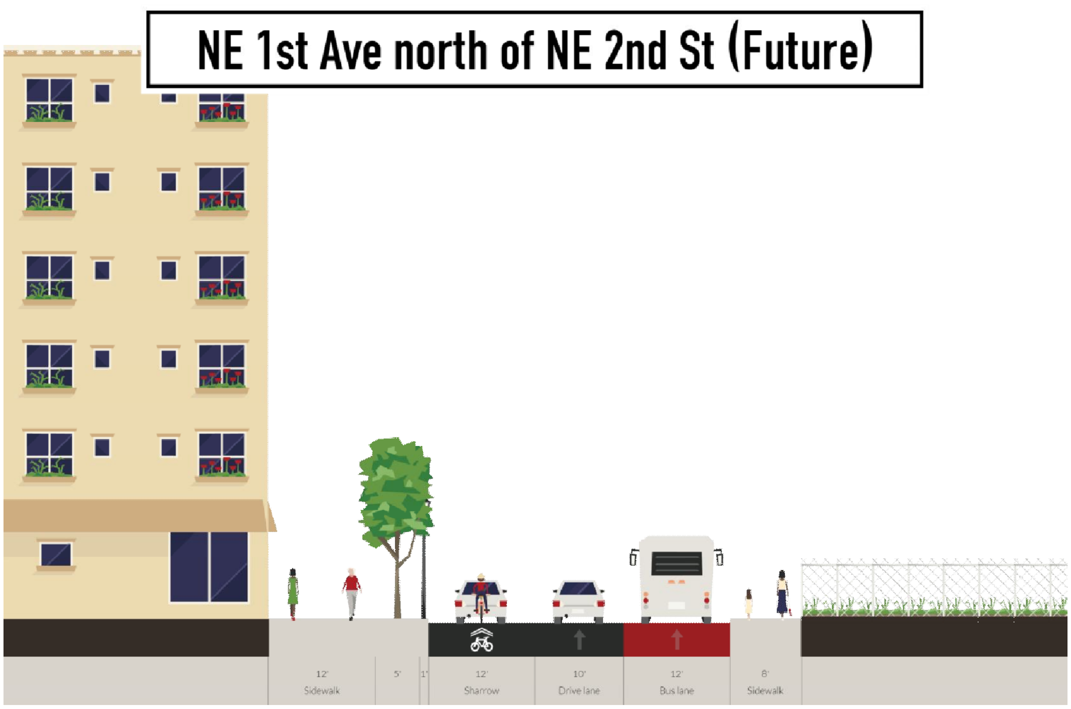
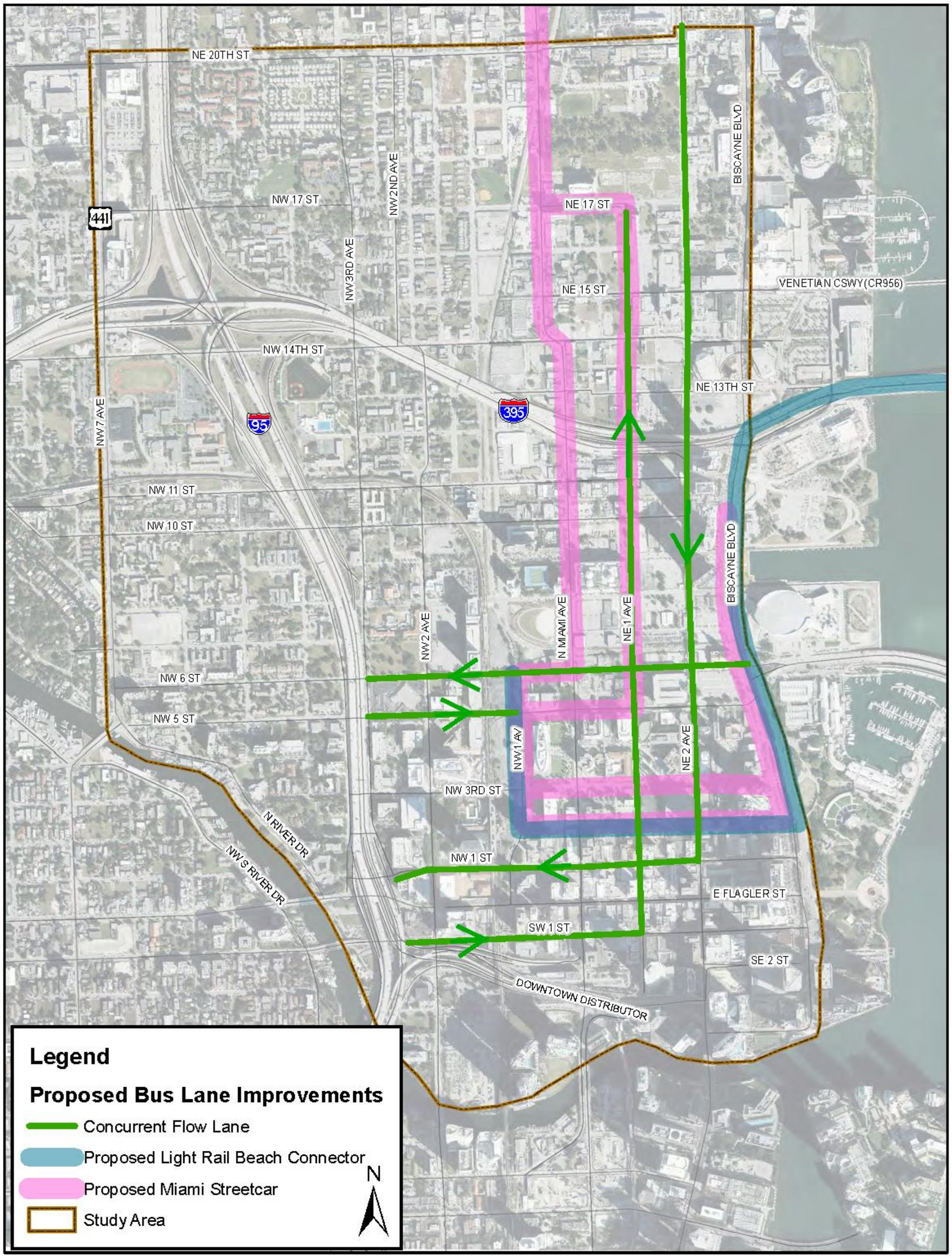


Source: Created with streetmix.net

4.2.4 Bus Lane System Continuity

Figure 4-24 shows the overall routing of potential BAT lanes in the downtown Miami area. With a system of bus lanes on both north-south and east-west streets, bus lane priority could be provided through downtown between the west and north directions. A bus lane on southbound NE 2nd Avenue could be tied to a bus lane on westbound NE/NW 1st Street, while a bus lane on eastbound SW/SE 1st Street could be tied to a northbound bus lane on SE/NE 1st Avenue.

Figure 4-24: Potential Bus Lane Improvements

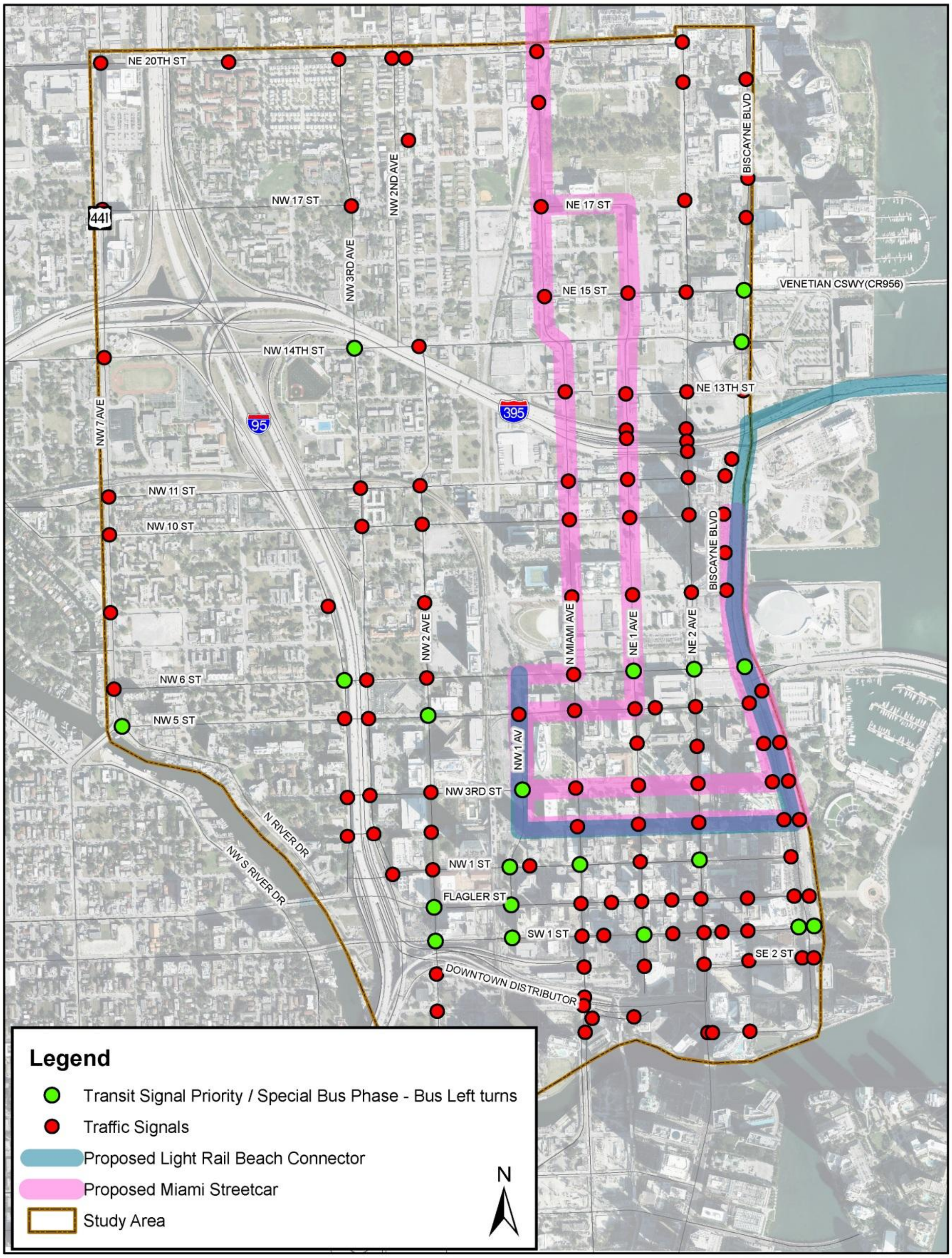


4.3 Recommended Intersection Improvements

Given the apparent limitations of implementing transit signal priority in the study area, the focus on intersection improvements was on identifying signal timing adjustments to increase green time for major bus movements on streets, and to provide a special signal phase to facilitate high bus turning movements at certain intersections.

Figure 4-25 identifies those intersections where special bus turning phases or extended green time would be beneficial. In addition, at the following intersections, a bus bypass lane or queue jump signal could be developed given the presence of a right turn lane today:

Figure 4-25: Potential Intersection Priority Treatments



4.4 Recommended Enforcement Mechanisms

For bus lanes to be successful in the study area, proper enforcement of use of the lanes will be required. The only general traffic which should use the lane would be right turning vehicles into adjoining driveways or side street intersections. The most successful enforcement technique applied to date is the use of overhead mounted cameras that would observe and record license plate numbers of vehicles that would use the BAT lane as an extended through lane. This treatment has been applied successfully in New York City associated with their BAT lane treatments on its BRT system, and in London, England, associated with their system of bus lanes in general. In downtown Miami, cameras could be placed systematically along the full length of the BAT lane, or just in selected locations where a greater number of violators are possible. Cameras could be mounted to existing light poles or signal poles along the corridor. Figure 4-26 illustrates a typical camera placement.

Figure 4-26: Typical Camera Placement and Signage

New York City

London

An alternative to overhead camera enforcement would be to mount cameras at the front of buses to note violators in the lane, particularly related to parked vehicles. This treatment has been instituted in San Francisco.

Another treatment critical to apply is the provision of regulatory signing clarifying the exclusive use of a BAT lane by buses, right turn vehicles, and other special vehicles.. In an area such as downtown Miami, such signs should be mounted overhead as opposed to being mounted side of road to increase visibility to both bus operators and motorists. Like for cameras, these signs can be .mounted to existing light poles and signal poles to reduce cost.

Figure 4-27 shows a typical overhead signing treatment for a BAT lane in Denver.

Figure 4-27: Typical Overhead Signing Treatment in Denver, Colorado.

Finally, the pavement section that includes the BAT lane could be colored in texture to provide more definition of the lane. This pavement coloring is increasing in popularity. Figure 4-28 illustrates such a treatment in London, United Kingdom.

Figure 4-28 : Pavement Coloring of Bus Lane in London, UK.

4.5 Potential Policy Changes

If bus lanes are implemented in downtown Miami, there will be the need to identify an access policy for such lanes, in particular when the lanes would operate in a BAT lane mode, and also if other vehicles such as charter buses, taxis, Uber, and emergency vehicles could use the lane while in active BAT lane operation. The enforcement policy will also need to be specified, identifying the extent of camera vs. patrol enforcement, and identifying what constitutes acceptable use of the lane by right turning vehicles.

In addition, some modifications to the City of Miami Municipal Code would probably be required, in particular related to fines for parked or stopped vehicles in the lane, and also specific provisions for overall use of the lane.

4.6 Preliminary Cost Estimates

Preliminary capital cost estimates have been developed for the identified BAT lane treatments for South and North 1st Streets, North 5th and 6th Streets, and North 2nd and 1st Avenues. These cost estimates reflect conversion of lane designation using pavement markings and overhead signing.

For the cost estimate, overhead signs were assumed to be mounted on existing light and signal poles about every 800 feet, which would reduce cost. It was assumed that no pavement reconstruction would be required if a general traffic lane were converted to a bus lane. If a parking lane were used, reconstruction of the lane to better accommodate buses could be undertaken. If roadway reconstruction were undertaken, there is the option of introducing a colored pigment to the pavement to provide added recognition for a dedicated bus lane.

Table 4-1 presents the identified potential capital costs to develop BAT lanes on the six streets. An assumed cost of $200,000 per mile (cost focused on signing and pavement marking modifications) was used in developing the estimates. Costs for SE/NE 1st Avenues are divided south vs. north of NE 6th Street, given the potential short-term development of a BAT lane initially at the south end of this corridor which would not conflict with the identified streetcar routing north of NE 6th Street.

Table 4-1: Preliminary Conceptual Bus Lane Construction Cost Estimate

Roadway	Limits	Length (miles)	Construction Cost
SW/SE 1st St	I-95 to SE 1st Ave	0.41	$82,000
NE/NW 1st St	NE 2nd Ave to I-95	0.53	$106,000
NE/NW 6th St	Biscayne Blvd to I-95	0.66	$132,000
NW 5th St	I-95 to NW 1st Ave	0.26	$52,000
NE 2nd Ave	NE 20th St to NE 1st St	1.45	$290,000
SE/NE 1st Ave (south of NE 6th St)	SE 1st St to NE 6th St	0.45	$90,000
NE 1st Ave (north of NE 6th St)	NE 6th St to NE 17th St	0.79	$158,000
Total		**4.55**	**$910,000**

The total cost of developing bus lanes on all seven street segments – assuming no pavement reconstruction or right-of-way acquisition – would be estimated around $910,000 million in existing dollars. Including camera enforcement and any street reconstruction would increase this cost estimate. In New York City, each camera installation (including central system monitoring) has cost $80,000, and $4,500 per month to operate. In San Francisco, the on-bus camera enforcement (again including central system monitoring) has cost about $10,000 per vehicle. Street reconstruction could range from $2 to $3 million per mile, pending whether concrete pavement is installed and the extent of drainage and curb modifications.

4.7 Estimated Benefits

Benefits from BAT lane implementation have been associated with the resultant bus travel time savings. Using information from Exhibit 6-73 of the *Transit Capacity and Quality of Service Manual, 3rd Edition*, presented in Table 4-2, the estimated travel time savings associated with the BAT lanes within a Central Business District has been estimated to be 1 minute per mile (time difference between buses operating in mixed traffic vs. a bus lane with right turn delays – a BAT lane). Given this the total bus travel time savings for the weekday AM and PM peak periods on an annual basis with BAT lane operation under existing conditions is shown in Table 4-3. This includes the savings for all bus runs which would operate in the BAT lanes during the peak periods. Total annual travel time savings from all six BAT lanes would be 235,624 minutes, or 3,928 hours.

Table 4-2: Exhibit 6-73 from Transit Capacity and Quality of Service Manual, 3rd Edition

Condition	Bus Lane	Bus Lane, No Right Turns	Bus Lane With Right Turn Delays	Bus Lanes Blocked by Traffic	Mixed Traffic Flow
CENTRAL BUSINESS DISTRICT					
Typical		1.2	2.0	2.5–3.0	3.0
Signals set for buses		0.6	1.4		
Signals more frequent than bus stops		1.5–2.0	2.5–3.0	3.0–3.5	3.5–4.0
ARTERIAL ROADWAYS OUTSIDE THE CBD					
Typical	0.7				1.0
Range	0.5–1.0				0.7–1.5

Source: *TCRP Research Results Digest 38* (*37*).
Notes: Traffic delays reflect peak conditions.
A metric version of this exhibit appears in Appendix A.

Table 4-3: Bus Travel Time and Operating Cost Savings with Identified BAT Lanes

BAT Lane	Segment	No. of Bus Miles		Weekday Travel Time Savings (min)		Annual Travel Time Savings (min)			Annual O&M Cost Savings
		AM Peak	PM Peak	AM Peak	PM Peak	AM Peak	PM Peak	Total	
SW/ SE 1st St	I-95 to SE 1st Ave	59	57	59	57	15,369	14,911	30,280	$26,520
NE/NW 1st St	NE 2nd Ave to I-95	63	52	63	52	16,385	13,543	29,929	$26,212
NE/NW 6th St	Biscayne Blvd to I-95	29	21	29	21	7,628	5,333	12,961	$11,352
NW 5th St	I-95 to NW 1st Ave	5	8	5	8	1,222	2,124	3,346	$2,931
NE 2nd Ave	NE 20th St to NE 1st St	64	64	64	64	16,715	16,650	33,366	$29,223
SE/NE 1st Ave (south of N. 6th St)	SE 1st St to NE 6th St	24	24	24	24	6,185	6,287	12,472	$10,924
NE 1st Ave (north of NE 6th St)	NE 6th St to NE 17th St	20	21	20	21	5,164	5,450	10,613	$9,295
	Total	264	247	264	247	68,669	64,298	132,967	$116,457

Applying an operating cost of $52.55 per bus revenue hour for MDT bus service (from 2013) from the Flagler Enhanced Bus Study, the total annual operating cost savings for the six BAT lanes downtown would be $116,457. This does not include any added operating cost savings if a bus could be saved due to the overall travel time savings of a particular bus run.

Added benefits will accrue from greater ridership on certain bus routes with some diversion from auto traffic, with associated environmental benefits. To calculate these specific benefits was beyond the scope of this study.

4.8 Next Steps

This study was intended to provide an initial review of the need for and identify potential configuration of bus lane and other transit priority treatments in the downtown Miami area. Much more analysis and discussion among agencies will need to occur before any specific bus lane improvement is identified and programmed for implementation. The next steps in the planning process should include the following elements:

- Closer review of traffic operations on the preliminary designated bus lane streets, including specific impacts of converting a general traffic lane to a BAT lane, or use of a parking lane for a BAT lane during peak periods or all day. If conversion of a parking lane is considered, further parking space occupancy survey should be conducted, including an assessment of the extent and timing of truck deliveries to local businesses.

- Conduct further best practices assessment to identify a cost-effective enforcement strategy with bus lane implementation.

- Identify a preferred BAT lane treatment on different streets from a technical standpoint, including updated capital costs and estimate of operations and maintenance costs.

- Meet with local business owners and perhaps the general public to review the objectives of bus lanes on the designated streets, and obtain their input.

- Make a final decision on whether a bus lane on the designated street is possible, and proceed to work to have funds programmed for implementation.

- Enter into any intergovernmental agreements required related to agency responsibility for construction, operations and maintenance and monitoring of performance of bus lanes on designated streets.

In parallel with further assessment of bus lanes, added discussion with Miami-Dade County Traffic Operations should be pursued to further review the potential for implementing transit signal priority in the downtown area, at least at the major entrances/exits to downtown (knowing the challenges of implementing TSP within a closely spaced downtown signal grid). Added operations analysis at critical intersections should be conducted where needed to identify the ability to make signal timing adjustments to accommodate heavy bus movements as noted in this study. This analysis would also provide input into assessing overall bus lane operations along different streets.

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APPENDIX A

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Downtown Miami Bus Lanes Peer Review & Applicable Guidance

#GPC V-29

PARSONS BRINCKERHOFF

February 24, 2015

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1.0 INTRODUCTION

1.1 Scope of Review

As part of the Downtown Miami Bus Lanes Study for the Miami-Dade Metropolitan Planning Organization (MPO), a peer review of the application of bus lanes in other cities in North America was conducted. In addition, applicable guidance related to various aspects of planning, design, and implementation of bus lanes was identified. This guidance includes:

- Warrants
- Capital and Operating & Maintenance Costs
- Impact Assessment
- Policy Considerations
- Regulatory Restrictions/Enforcement Strategies
- Implementation Strategies
- Intergovernmental Agreements

The peer review of actual bus lane applications was conducted through a review of various studies and research efforts conducted, in particular three documents:

- Transit Cooperative Research Program (TCRP) Synthesis 83 – *Bus and Rail Preferential Treatments on Urban Streets*
- TCRP Report 165 – *Transit Capacity and Quality of Service Manual, 3rd Edition*
- Mineta Transportation Institute Report 11-10 - *Shared-Use Bus Priority Lanes on City Streets: Case Studies in Design and Management*

TCRP Synthesis 83 surveyed over 50 transit agencies on the application of overall transit priority treatments on urban streets, and provided a synopsis of the basic characteristics and impacts of bus lanes. TCRP Report 165 discussed the different types of bus lanes on urban streets, and their capacity and overall impact on transit and traffic operations. The Mineta report presents a peer review of the bus lane application (including overall network integration) in San Francisco, Los Angeles and New York in the U.S, as well as in the international cities of London, Paris and Sydney..

Applicable guidance was primarily derived from the two TCRP reports, with a focus on application of bus lanes on streets in downtown areas.

1.2 Conditions Requiring Priority Treatment and Potential Bus Lane Application

Bus lanes on urban streets provide semi- or fully segregated rights-of-way for buses. Such lanes offer buses significant advantages over mixed traffic operations. Table 1-1 identifies common sources of delays to buses operating in mixed traffic that bus lanes and site-specific priority treatments help to reduce. These delays reduce bus capacity, speed and reliability, resulting in reduced service quality for passengers and higher operating costs for transit agencies.

Table 1-1: **Delay Sources for Bus Operations on Urban Streets**

Roadway Element	Delay Sources
Signalized Intersection	Insufficient traffic signal green time for bus approach Poor signal progression for buses Inadequate vehicle detection at signals
All	Queued vehicles on intersection approach On-street parking maneuvers Inadequate lane width Off-line bus stop reentry delay Right-turning traffic blocking access to stop Left turning traffic blocking shared lane

Bus lanes can be created in one of four ways:

1. Redesignating an existing travel lane as a bus lane.
2. Narrowing existing lanes to provide an added lane.
3. Widening the street to add a new lane for buses.
4. Restricting on-street parking (full-time or part-time) to provide a bus lane.

Figure 1-1 illustrates two of these examples, where on-street parking was removed and existing travel lanes narrowed to create a bus lane, and restricting parking during peak periods to provide a bus lane. The bus lane could either exclusively be used for buses, or more commonly, shared with local driveway and intersection turning movements. This shared lane concept is typically referred to as a Business Access and Transit Lane, or BAT lane for short.

1.3 Types of Bus Lanes

Urban street bus lanes can be distinguished by either being developed within the travel or parking sections of the street, or in a separated right-of-way in the middle of the street right-of-way (typically a median busway treatment). The basic characteristics of different bus lane types is presented as follows:

1.3.1 In-street Bus Lanes

In-street bus lanes are developed by dedicating one or more existing general traffic or parking lanes for transit use. There are four kinds of in-street bus lanes:

- Concurrent flow
- Contraflow
- Bi-directional
- Intermittent

SOURCE: TCRP Report 165 (TCQSM 3rd Edition)

Full-time Bus Lane (Portland, OR)

SOURCE: TCRP Report 165 (TCQSM 3rd Edition)

Part-time Bus Lane (Seattle)

Figure 1-1: Bus Lane Development in Former/Restricted Parking Lane

<u>Concurrent Flow</u>

A concurrent-flow lane is a lane designated for buses in the same direction as general traffic. In some cases, carpools and vanpools have been allowed to use such a lane, becoming a truly high-occupancy (HOV) lane. The lane can be located either 1) on the right side, adjacent to the curb or shoulder or 2) on an interior or offset bus lane that operates adjacent to the curb lane. The curb lane treatment requires either the full or part-time removal of on-street parking if present, with right turn and local driveway movements allowed to use the lane over short distances. With an interior or offset lane, this configuration leaves the curb lane available for other uses, including parking, loading and right turn movements.

Concurrent-flow lanes can be developed in a variety of configurations:

- One permanent lane in both or one directions of travel.
- One part-time lane operating in the peak direction during the peak period, with another part-time lane serving the opposite direction in the same period.
- One single lane operating in one direction during one time period, then reversed to operate in the opposite direction during another time period (a reversible lane).
- Two permanent or part-time lanes in each direction of travel, providing added capacity and capability of bypassing bus stops (skip stop operation) when bus volumes are high and multiple routes use the facility.

Figure 1-2 shows examples of different types of concurrent-flow lanes.

Contraflow Lanes

Contraflow lanes are bus lanes that operate in the opposite direction of general traffic. They are developed normally on one-way streets. Special signage, physical barriers and/or overhead lane use control signals are used to alert other roadway users of the direction and use of the lane. Figure 1-3 shows examples of contraflow lane operations.

SOURCE: TCRP Report 165 (TCQSM 3rd Edition)

Curbside Bus Lane with Right-Turn Lane (Copenhagen)

SOURCE: TCRP Synthesis 83

Interior Bus Lane (Boston)

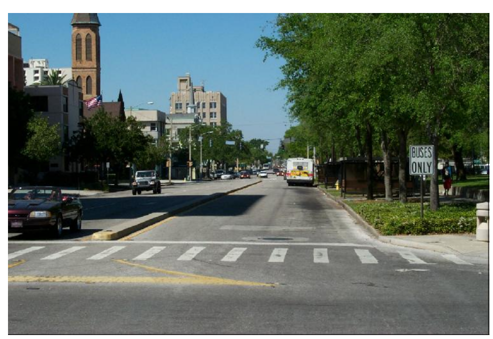
SOURCE: TCRP Synthesis 83

Dual Bus Lanes (New York)

Figure 1-2:   Examples of Concurrent Flow Bus Lanes

SOURCE: TCRP Report 165 (TCQSM r3rd Edition)

Orlando, FL



SOURCE: TCRP Synthesis 83

St. Petersburg, FL

Figure 1-3: Example of Contraflow Bus Lanes

A bi-directional lane is a two-way lane in the center of a street, where buses alternate directions in operating the lane. Figure 1-4 shows an example of a bi-directional bus lane. The longer the bi-directional section, the longer minimum headway required between buses to avoid conflicts. Bi-directional operation requires more sophisticated signal control to control bus movement through the section and special signing and pavement markings to alert other roadway users of the special lane operation. Buses will need to have doors on both sides if any a single station serving both directions is required. If buses only have right side doors, separate stations would be required for each direction or a joint station would require a lane for each direction (providing back-up passing capability).

Given the high bus volumes and traffic volumes in downtown Miami, a bi-directional lane treatment in general is probably not applicable.

(a) Eugene, OR

Figure 1-4: Example of Bi-Directional Bus Lane in Median of Street

Intermittent Lane

An intermittent, or moving, bus lane involves turning a segment of a general-purpose lane into a bus lane before a bus arrives and reverts back to general-purpose operation once a bus is passed. Any given section of the lane is restricted to bus-only use only for the short period of time when the bus is present. Figure 1-5 illustrates this treatment.

This treatment requires advanced technology and enforcement to be effective, including roadway sensors, an Automatic Vehicle location (AVL) system to monitor the bus location in real-time, and variable message signs and flashing lights installed in the pavement along the lane divider to communicate to motorists that a bus is approaching and that they must exist the lane. This lane concept is only applicable where bus service is infrequent but delays are high, and not really conducive to downtown Miami traffic conditions.

SOURCE: TCRP Synthesis 83

Vertical Signalization – VMS

SOURCE: TCRP Synthesis 83

Horizontal Signalization –Pavement LED's

Figure 1-5: Example of Intermittent Bus Lane (Lisbon, Portugal)

1.3.2 Median Busway

A median busway are exclusive bus lanes located in the median of an urban streets. These facilities required dedicated right-of-way for running-way and stations. Figure 1-6 illustrates a median transitway treatment. The busway interfaces with general traffic at signalized intersections where cross streets are allowed to cross the busway, and left turns on the street parallel to the busway cross the busway. Unsignalized intersections and local driveways along the busway are restricted to right-in, right-out movements. With stations in the median, all transit passengers need to cross half of the street to access a station platform.

SOURCE: TCRP Report 165 (TCQSM 3rd Edition)

Eugene, OR

Figure 1-6: Example of Median Transitway

2.0 LITERATURE/PEER REVIEW

2.1 Literature Review

Twenty-five (25) reports or articles have been identified that provide information on the characteristics, costs, impacts, and implementation strategies of the development of bus lanes on urban streets. Table 2-1 highlights the major features and conclusions of the documents.

2.2 National Survey Results from TCRP Synthesis 118

TCRP Synthesis 118, developed by Parsons Brinckerhoff, was a comprehensive review of the application of transit priority treatments on urban streets in North America. Transit priority treatments of interests included roadway segment treatments, such as in-street bus lanes, median transitways, and bus stop consolidation, and intersection treatments such as signal priority, queue jumps/bypass lanes and curb extensions. The synthesis was based on the results of a survey of transit agencies, along with roadway/traffic engineering jurisdictions in the same cities. This was supplemented by a literature review of 23 documents and case studies of priority treatments in four cities – San Francisco, Seattle, Portland (Oregon), and Denver . Eighty urban areas were contacted, and 52 transit agencies and 12 roadway/traffic engineering jurisdictions responded. Thirty-two of the areas had some form of priority treatment for buses in one or more locations, and ten (a third) identified bus lane or median transitway treatments. Transit signal priority was the most popular treatment applied (15 areas).

The synthesis also identified what criteria or warrants were applied in identifying bus lane treatments. Table 2-2 identifies the responses. Ridership, delay, and reliability were three key criteria identified in many cases. Most agencies did not have specific numerical warrants which triggered treatment investment.

The survey conducted for Synthesis 118 identified the extent to which the roadway/traffic engineering agency respondents viewed the impact of different transit priority treatments on general traffic operations. Figure 2-1 reveals that median transitways and in-street bus lanes which could reduce general traffic capacity were perceived to have more of a major impact than intersection-based treatments, no doubt reflective of bus lanes reducing the capacity or presence of general traffic and parking lanes.

Questions were also asked on the role of transit vs. roadway/traffic engineering jurisdictions in transit priority treatment implementation. Figures 2-2 and 2-3 summarize the responses. Transit agencies tend to be more involved in the early stages of implementation in identifying and locating treatments, and become less involved in the later stages, with the exception of monitoring performance. This is expected as local roadway/traffic engineering jurisdictions have control over the roadway and signal system and thus are typically more involved in construction and maintenance of treatments. Including bus lanes. The increase in transit agency involvement in monitoring performance is not surprising as these agencies.

Table 2-1: Summary Features and Conclusions from Documents in Literature Review

Document	Focus/Objectives	Major Findings/Conclusions
NCHRP Report 143 – Bus Use of Highways – State of the Art (1973)	First comprehensive documentation of bus operations and priority treatments in U.S. and internationally. 165 treatments evaluated. Identified bus travel time savings with different treatments.	Minimum 60 buses per peak hours to justify use of exclusive bus lane, and lane should carry at least 1.5 times the number of general traffic vehicle occupants.
NCHRP Report 155 – Bus Use of Highways: Planning and Design Guidelines (1975)	Extension of NCHRP Report 143. Presents planning and design guidelines for bus operations and priority treatments.	Suggested values for one-way peak hour volumes for priority treatments: curb bus lanes (within CBD) -20-30, curb bus lanes (outside of CBD) – 40-60, median bus lanes/transitway – 60-90, contraflow lanes (extended lane) – 40-60, short segment – 20-30, bus "preemption" – 10-15, special bus signal – 5-10
TCRP Report 165: Transit Capacity and Quality of Service Manual – 3rd ed. (2013)	Provides current research-based guidance on transit capacity and quality of service issues and the factors influencing both. It assembled a set of methods for evaluating the capacity of bus and rail transit services and facilities, and introduced a framework for evaluating the quality of transit service from the passenger point of view.	Presents methods of calculating fixed route bus capacity and speed for a variety of facility types, and provides a summary of current state of knowledge about factors influencing service reliability. Related land use and transportation factors: bus streets or malls/CBD curb bus lanes – commercially oriented frontage, curb bus lanes (normal flow) – at least 2 lanes available for traffic in same direction, median bus lanes – at least 2 lanes for traffic in same direction and ability to separate vehicular turn conflict for buses, contraflow bus lanes (short segment) – allow buses to proceed on normal route, turn around, or bypass congestion on a bridge approach, contraflow bus lanes (extended) – at least 2 lanes for other traffic in opposite direction and signal spacing greater than 500 ft intervals

Table 2-1: Summary Features and Conclusions from Documents in Literature Review

Document	Focus/Objectives	Major Findings/Conclusions
"Cost/Benefit Analysis of Converting a Lane for Bus Rapid Transit - Phase II Evaluation and Methodology.", Research Results Digest 332	Explores the trade-offs of converting a mixed flow arterial lane to exclusive BRT use. A demonstration of a cost/benefit analysis methodology that captures all the benefits across transit riders and auto drivers.	The best corridors for converting a lane for BRT are those with relatively high person throughput (at least 40,000 per day) and relatively high pre-project transit mode share (at least 15%). The new BRT service improves transit travel time by 40% or more, converting a lane for BRT is likely to product positive net benefits.
"Shared-Use Bus Priority Lanes on City Streets: Case Studies in Design and Management."	Examines the design and operations of bus lanes in major congested urban centers. It focuses on bus lanes that operate in mixed traffic conditions, and provides legal, institutional, engineering, and enforcement context for understanding the bus lane development and management strategies. Case studies for three cities in the U.S. – Los Angeles, New York, and San Francisco, as well as three international cities – London, Seoul and Sydney are presented.	Guidance related to agency coordination and implementation, physical design and signage, access policy, and enforcement for shared use bus lanes is provided. Major potential institutional reforms identified include merging transit agencies with street management agencies, establishing route planning committees, and handle bus lane violations like parking violations. Increased use of camera enforcement for bus lanes is also recommended. The most common physical arrangement for bus lanes on city streets is along the curbside; however, each city has to adapt bus lane designs and regulations to meet local conditions.
"Designing Bus Rapid Transit Facilities for Constrained Urban Arterials: A case study of the Webster Avenue BRT running way design selection process "	Describes the New York City Department of Transportation and MTA New York City Transit's selection of the most appropriate on-street BRT running way design for Webster Avenue, based on balanced, multi-modal set of criteria.	The offset bus lane alternative converts the right-most travel lane into a dedicated bus lane; local buses and right turning vehicles use the bus lane. Stations utilize bus bulbs giving more space to pedestrians. Minimal effect to on-street parking. The offset bus lane alternative most efficiently balanced the transit and traffic needs along Webster Avenue corridor while maintaining on-street parking and supporting pedestrian activity.

Table 2-1: Summary Features and Conclusions from Documents in Literature Review

Document	Focus/Objectives	Major Findings/Conclusions
"Bus Lane with Intermittent Priority (BLIMP) Concept Simulation Analysis."	Preliminary implementation study to determine the potential impacts of a new and innovative transit priority treatment along a BRT corridor in Eugene, Oregon. The bus lane with intermittent priority (BLIMP) utilizes dynamic lane assignment to designate an exclusive bus lane on a temporary, bus-actuated basis.	Travel time and travel time reliability would improve upon implementation of the BLIMP concept while having minimal impact on overall intersection delay. In addition, evaluation of movement delays indicated that concurrent movements would see improvements while conflicting movements would see minimal change.
"Red Bus Lane Treatment Evaluation."	Presents the methodologies and finding from a series of field and laboratory tests used to evaluate red bus lane treatments for NYCDOT.	Field evaluations included long-term observations of various products used on bus-only lanes, as well as durability and skid resistance testing. Parallel laboratory evaluations were undertaken to assess product durability and skid resistance on a controlled, indoor laboratory. The results indicate that a red epoxy-based street paint, an epoxy with red aggregate product, and a red asphalt concrete-based micro surface performed well across the field and laboratory tests.
"TCRP Synthesis 83: Bus and Rail Preferential Treatments on Urban Streets",	Review application of a number of different transit preferential treatments in mixed-traffic and offer insights into the decision-making process that can be applied in deciding which preferential treatment might be the most applicable in a particular location.	Presents information on the warrants, costs, and impacts of different transit preferential treatments. Reviews the applicability of different analytical tools to assess the impacts of different transit preferential treatments on transit and traffic operations.
"Assessing the Feasibility of Converting Two-Way Left Turn Lane into Bus Rapid Transit Lane."	Evaluates the performance of a median BRT lane and curb BRT lane considering varying traffic conditions and physical configurations. The pros and cons of each alternative are also specified according to simulation analysis.	Presents summary table derived from intersection simulation in VISSIM comparing average vehicle delay when different traffic volumes are considered for the application of BRT lanes.

Table 2-1: Summary Features and Conclusions from Documents in Literature Review

Document	Focus/Objectives	Major Findings/Conclusions
"Bus Lanes with Intermittent Priority: Screening Formulae and an Evaluation."	Evaluates strategies for operating buses on signal-controlled arterials using special lanes that are made intermittently available to general traffic.	Intermittent lanes, unlike dedicated bus lanes, do not significantly reduce street capacity. Intermittence, however, increases the average traffic density at which the demand is served, and as a result increases traffic delay. These delays are more than offset by the benefits to bus passengers as long as traffic demand does not exceed by much the maximum flow possible on the non-special lanes.
"Bus Lanes with Intermittent Priority: Assessment and Design."	Explore the design and institutional issues of Bus Lanes with Intermittent Priority (BLIP). Presents BLIP overview, design aspects, institutional issues surrounding BLIP implementation, and possible criteria for implementation feasibility.	Recommendations for BLIP implementation: near-side bus stops to maximize overlap between signal delay and passenger movement time; pair BLIP with TSP, include enforcement cameras; bus lane violations and policy statements in enabling legislation.
"A Summary of Design, Policies and Operational Characteristics for Shared Bicycle/Bus Lanes."	Contains the results of an investigation of the design and operation of shared bicycle/bus lanes (SBBL) in municipalities in the United States and other countries.	The minimum width of the SBBL that ensures safety and satisfactory level of service for all roadway users is estimated to be 16 feet, seven inches, where all of the following coexist: curb and gutter; posted speed limit 30 mph or less; lateral clearance of at least three feet between a bicyclist and passing motor vehicle; sufficient width for a public transit bus of standard width to pass the bicyclist while staying within the SBBL. The guidelines recommend that and SBBL not be considered where there are 20 or more buses per hour.

Table 2-1: Summary Features and Conclusions from Documents in Literature Review

Document	Focus/Objectives	Major Findings/Conclusions
"The Impacts of Bus Lanes on Urban Traffic Environment."	Proposes a general methodology for assessing the operational impacts caused by a bus lane scheme. The developed research was focused on the evaluation of bus lane schemes with special emphasis on the predicted operational changes for the "with" and "without" bus lane scenarios.	Suggests traffic microsimulation as a more suitable modeling tool for the evaluation of bus lanes because of its capacity for modeling highly detailed bus operational features. Traffic reassignment was found to be a key element in the evaluation of a bus lane scheme.
"Effective Bus Only Lanes." ITE Journal	Explores geometric design and institutional barriers to effective bus-only lanes in the United States. It highlights design features for effective bus lanes in those communities with bus-only lanes and discusses institutional barriers.	Recommendations to improve efficiency of bus-only lanes: standardize hours of operation; signage and markings; photo enforcements for bus-only lanes; the addition of bus bulbs along streets where bus-only lane is next to a parking lane; physical barriers to separate from traffic lanes.
"Bus Lanes/Bus Rapid Transit Systems on Highways: Review of the Literature."	Review of the literature illustrated by examples of bus rapid transit systems practice implemented on arterials, freeways, and busways.	Presents tables showing classification of bus running ways by extent of access control; running ways grouped by facility type; planning and implementation guidelines for arterial-related bus running ways.
MWCOG Bus Priority Treatment Guidelines.	Describes the range of improvements available in the operating environment and provides a general guide for the implementation of priority bus treatments within the Metropolitan Washington Region.	Where traffic is operating at level of service D, exclusive or restricted lanes must be decided on a case-by-case basis. Where traffic is operating at a level of service E or worse, it is unlikely exclusive lanes are acceptable. Parking should be removed from a street where an exclusive bus lane is being considered for the curb lane under the following conditions: traffic volumes are 500-600 vphpl, LOS E or F, and travel speeds fall below 20 mph.

Table 2-1: Summary Features and Conclusions from Documents in Literature Review

Document	Focus/Objectives	Major Findings/Conclusions
"Virtual Exclusive Busways: Improving Urban Transit While Relieving Congestion."	Addresses the benefits of implementing Virtual Exclusive Busways (VEBs) and the necessary changes in federal transit policy to facilitate its development.	FTA funds approval for HOV to HOT conversions is viable as long as transit service is maintained and suffers no degradation in service quality; managed lanes that increase the HOV occupancy level and use value pricing to maintain LOS C or better meet this requirement. Minor changes in operating hours and changing the occupancy requirements do not require federal approval. Value-priced lanes that guarantee a portion of their capacity for transit services should be defined in federal law as "fixed guideway" to facilitate the development of VEBs.
"Curb vs. Median Bus Lanes: The Yonge Street Case Study.",	Addresses the short –term needs within the Yonge Street corridor, recognizing the adopted long-term proposal to extend the Yonge Subway.	The preliminary impact assessment examined a broad range of assessment factors; each design concept was assessed under each criterion to determine the magnitude of the impact, the incidence of the impact and the significance of the impact. This screen process resulted in a comparison of only those factors that exhibited significant and varying impacts between design alternatives: transit system performance, traffic infiltration in adjacent residential neighborhoods, traffic delay/LOS, disruption of present land use development, road safety, access to adjacent business, emergency services access, and construction cost.

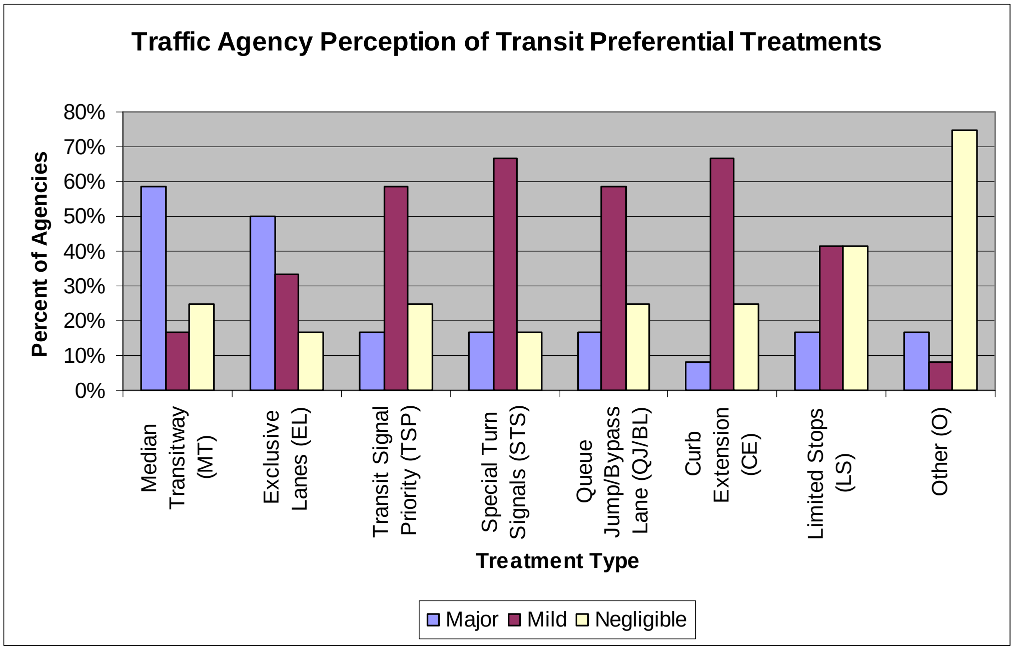
Table 2-1: Summary Features and Conclusions from Documents in Literature Review

Document	Focus/Objectives	Major Findings/Conclusions
. "Enhanced Transit Strategies: Bus Lanes with Intermittent Priority and ITS Technology Architectures for TOD Enhancement."	Addresses two enhanced strategies within the TOD framework: using Bus Lanes with Intermittent Priorities (BLIPs) to enhanced bus transit; and addressing how and what Intelligent Transportation System (ITS) technology can be used within the TOD system architectures.	Traffic disturbances caused by BLIP activation will not slow down subsequent buses, and roads with medium traffic demand can easily support a BLIP implementation. The evaluation of ITS strategies and architectures demonstrated the requirement for data management, data communication, and real-time data access.
"BRT: Bus Rapid Transit Service Design Guidelines."	Presents design guidelines and policies for BRT planning and implementation.	Summary tables with design guidelines for mixed-flow traffic lanes, converted bus-only lane, converted HOV lane, designated curbside bus-only lane, designated median bus-only lane, HOV lanes, at-grade transitway, and grade-separated transitway.
TCRP Report 26: Operational Analysis of Bus Lanes on Arterials (1997)	Guidelines for calculating the capacity and bus speeds for different bus lane configurations in urban areas.	Look-up tables and adjustment factors to account for different bus and adjacent traffic volumes, stop frequency, and dwell times, for single and dual bus lanes.

Table 2-2: Identified Criteria/Warrants for Bus Lanes and Median Transitways

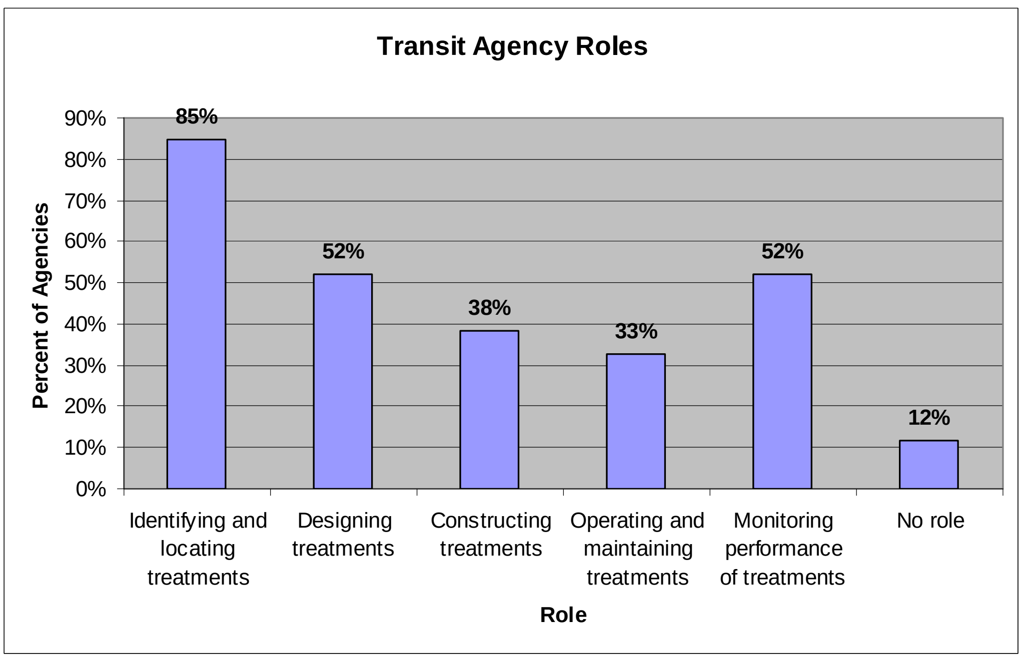
Agency	Criteria/Warrant
In-Street Bus Lanes	
Capital Metropolitan Transit Agency (Austin)	
LYNX (Orlando)	Traffic level of service (LOS), individual passenger trips
Chicago Transit Authority	LOS, delay, CBD priority access
Central Ohio Transit Authority (Columbus)	
Golden Gate Transit	Congested mixed-flow operations with undesirable delay that effects on-time performance
Greater Richmond Transit Company	Traffic volumes, safety
King County Metro Transit (Seattle)	Benefit/cost analysis, LOS, study, bus headways 10 or more per hour
Miami-Dade Transit	Travel delay caused by heavy traffic conditions on roadway
MTA New York City Transit	Ridership, reliability, traffic volumes
New Orleans Regional Transit Authority	Delay, LOS, need to maintain on-time performance
OC Transpo (Ottawa, CA)	Ridership, delay, reliability, traffic volumes
Port Authority of Allegheny County (Pittsburgh)	Reliability, traffic volumes
Denver Regional Transportation District	Reliability, ridership, time savings
Rochester-Genesee Regional Transit Authority	Bus headways, LOS
San Francisco MUNI	Transit ridership, street width, traffic volume
Toronto Transit Commission	Pro-transit policy, transit lanes carry as many people as an auto lane
Tri-Met (Portland, OR)	Bus volumes, passenger loads, location of supporting bus stops
Utah Transit Authority (Salt Lake City)	Faster trip times, estimated higher ridership
Median Transitway	
Golden Gate Transit (San Francisco)	Congested mixed-flow operations with undesirable delay that effects on-time performance
Denver Regional Transportation District	Reliability, ridership, time savings
San Francisco MUNI	Transit ridership, lane width, traffic volume
Toronto Transit Commission	Pro-transit policy, transit lanes carry as many people as an auto lane

SOURCE: TCRP Synthesis 83



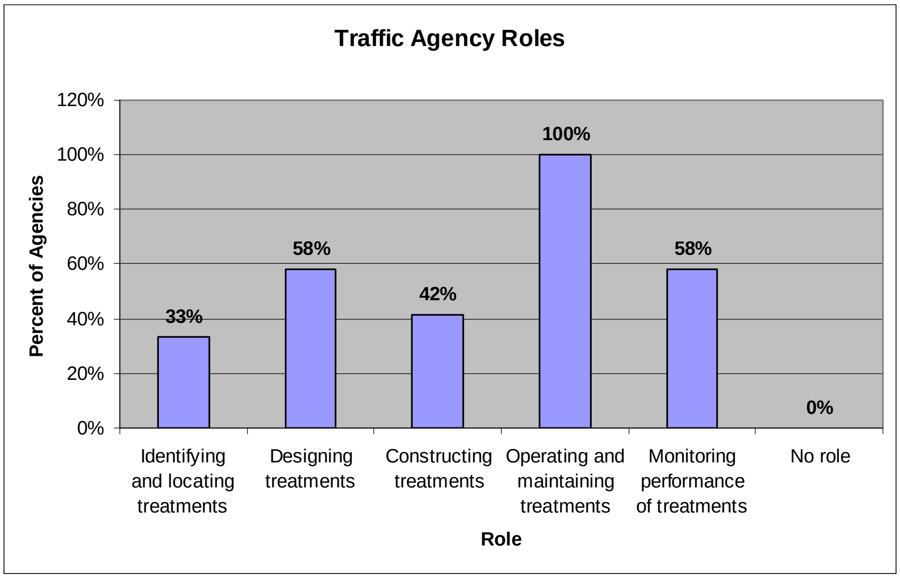
SOURCE: TCRP Synthesis 83

Figure 2-1: Roadway/Traffic Agency Perception of Impact of Transit Priority Treatments



SOURCE: TCRP Synthesis 83

Figure 2-2: Transit Agency Role in Transit Priority Implementation



SOURCE: TCRP Synthesis 83

Figure 2-3: Roadway/Traffic Agency Role in Transit Priority Implementation

2.3 Peer Review

To review how various U.S. cities have addressed bus lane development in downtown areas, three cites: Los Angeles, New York City, and San Francisco, were evaluated. Documentation for these case studies comes from the Mineta Transportation Institute Report, *Shared-use Bus Priority Lanes on City Streets: Case Studies in Design and Management*.

2.3.1 Los Angeles

Downtown Bus Lane Network

Los Angeles has had a small number of bus lanes in its downtown area since 1974. The first bus lane was an eight-block long contraflow lane along Spring Street. The intent of this bus lane was to facilitate access to and from the El Monte Busway along I-10. In the mid-2000s, the Los Angeles DOT staff became concerned with an extended contraflow lane causing operational and safety problems, in particular the inability of a bus to bypass another bus for lading large number of passengers or to account for a bus breakdown. Another problem for buses was that traffic signals were timed in the opposite direction of the contraflow lane to facilitate general traffic flow, thus resulting in very little travel time savings to buses operating in the contraflow bus. Finally, with increased development on Spring Street, local community began to complain that the contraflow lane reduced available parking and made it difficult to access properties on one side of the street.

In response to the problems with the contraflow lane, the Los Angeles City Council approve a plan to replace the contraflow lane with a concurrent flow bus lane on Spring Street(southbound), with a new northbound bus lane on the adjacent Main Street.

An added piece of the downtown bus lane network was a new concurrent flow bus lane on Figueroa Street, a one-way northbound street. The Figueroa bus lane is an extension of the Harbor Transitway along I-110.

Figure 2-4 identifies the location of the current Los Angeles downtown bus lane network.

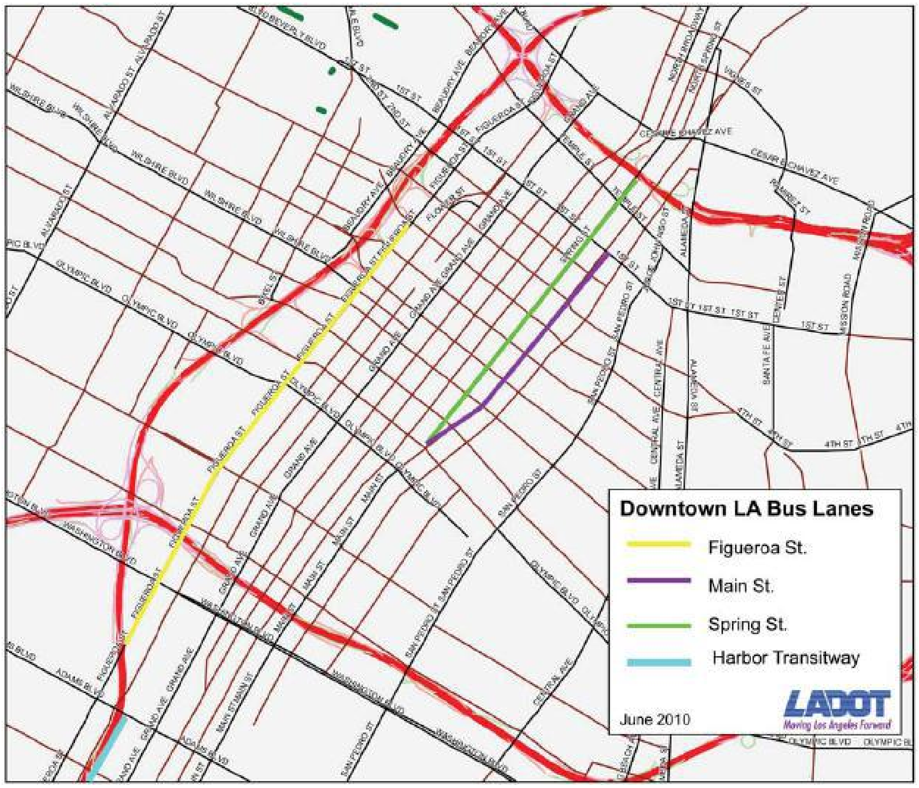
Wilshire Blvd. Bus Lane

As part of the Metro Rapid BRT system development in Los Angeles, the City of Los Angeles and the Los Angeles Metropolitan Transportation Agency (Metro) established a bus lane on a one-mile section of Wilshire Blvd. as a “demonstration” project from 2004 to 2007. Wilshire was thought to be a great candidate for a bus lane as it is the highest ridership corridor in the Metro system, with over 80,000 boardings per weekday. At the same time, bus speeds on Wilshire were very slow, no higher than five miles per hour during peak hours. The bus lane was created primarily in a lane of metered parking – for two blocks the bus lane operated in a former general traffic lane. The demonstration bus lane was open to public local and express buses, but not to tour or other commercial buses. Right-turning vehicles and bicycle were also allowed to use lane.

As the demonstration project proceeded, merchants (including the Chamber of Commerce) increasingly opposed the lanes, because of the loss in peak-hour parking. Motorist opposition for the bus lane also grew, as there was a perception that commuting time had doubled. The two blocks of the bus lane that had been developed by converting a general traffic lane were eliminated to alleviate traffic flow problems near the San Diego Freeway (I-405). In 2007, the City Council voted to temporarily suspend the bus lane operation, referring staff to come up with a plan to implement bus lanes along the entire Wilshire Blvd. corridor. The plan which was developed and approved (and subsequently is in the process of being implemented) includes two concurrent flow bus lanes (one on each side of the street) over a 7.7. mile section of Wilshire.

Institutional Arrangements

LADOT is responsible for implementing bus lanes in the City. The agency is authorized to designate the priority use of city streets for buses, jitneys, taxicabs, carpools and vanpools, subject to City Council approval. Moving violations are enforced by the Los Angeles Police Department, with parking violations handled by the LADOT Parking Enforcement Bureau. There have been no regular efforts targeting bus lane violations in the downtown, though the LAPD will act upon request by Metro to increase patrols for bus lane moving violations for 1-2 weeks at a time.



SOURCE: Mineta Transportation Institute

Figure 2-4: Downtown Los Angeles Bus Lane Network

<u>Physical Design and Signage</u>

The downtown bus lanes in Los Angeles are concurrent flow, except for a few blocks of contraflow lane on Spring Street. These are curbside lanes, 12 feet wide, and separated from the adjacent general traffic lane by a solid white line.

LADOT places a "Bus Lane Ahead" sign just before the beginning of each bus lane, behind the curb. In addition, all blocks with a bus lane have at least one sign (mounted behind the curb on street poles) indicating the presence of the bus lane. The signs specify the hours the lanes are in operation, and that bicycles and right-turning vehicles are permitted to use the lane. In addition, for the Spring and Main Street bus lanes, pavement markings displaying "BUS ONLY" text are placed once or twice in every block. For the Figueroa bus lane, a large diamond on the pavement is provided to designate lane use.

Access Policies

The City of Los Angeles Municipal Code identifies the types of vehicles that may use designated bus lanes. The Spring and Main Street bus lanes operate from 7 to 9 AM and from 4 to 6 PM on weekdays. The Figueroa bus lane operates from 7 to 9 AM on weekdays.

For concurrent flow bus lanes, the City Municipal Code indicates these as “preferential use lanes”, for use by public buses, jitneys, taxicabs, and two or more person carpools. However, actual signage on the street does not permit carpool use of the lane. Emergency vehicles operating in response to an emergency may also use the lane. Emergency vehicles are defined to include police and fire, public and qualified private ambulances, public utility vehicles, or a LADOT vehicle use for an official duty.

According to signage on the street, any vehicle may also use the bus lane to make a right turn at an intersection, or to cross the lane to enter or exit a local driveway. LADOT interpretation of this allowance is that a vehicle making such maneuvers should travel in the lane no more than 150 feet, though this specific distance is no monitored as part of enforcement. The Municipal Code does not explicitly state that either of these general traffic movements are allowed.

For contraflow lanes, the Municipal Code stipulates that buses have exclusive, full-time use of the lanes. Emergency vehicles may use a contraflow lane, and any vehicle may traverse a contraflow lane to enter or exit a local driveway.

Enforcement.

Parking or stopping in a bus lane is a civil offense, as defined by the Municipal Code. As of 2013, the fine was $88 (or up to $201 with late penalties). The Municipal Code also identifies that an illegally parked vehicle in a bus lane may be towed to the nearest garage or other place of safety. As of 2012, the vehicle owner was subject to a $100 impound fee in addition to towing and storage charges. There are also fines for moving violations within a bus lane.

2.3.2 New York City

Bus Lane Network

Bus lanes were first introduced in New York City in 1963. Since then a 50-mile network of bus lanes in the City has been developed, in 43 corridors. Figure 2-5 shows the current bus lane network, while Table 2-2 identifies specific bus lanes and their features. Even with such a network, competition for street and curb space for parking and deliveries in the City has put some limit on the ability of expanding the bus lane network. The system has grown incrementally through a series of specific projects, with different operating rules and design

SOURCE: Mineta Transportation Institute

Figure 2-5: New York City Bus Lane Network

features. This is reflective of the various policies in place at the different times when bus lanes were created, but with a general guideline that bus lanes operate along the curb and only during peak hours. Recently the bus lane network has been expanded to accommodate new bus rapid transit (BRT) routes in the different city boroughs.

The first study of bus lanes in New York City was initiated in 1962. The study was conducted jointly by the Transit Authority and the City Department of Traffic, with input from the Police Department, and examined potential bus lanes in all five boroughs. The first two bus lanes were developed on Livingston Street in Brooklyn (0.7 miles) and on Victory Blvd. in Staten Island (about one mile). Inbound lanes operated from 7 to 9 AM, and outbound lanes from 4 to 7 PM, six days a week. Bus drivers were prohibited from leaving the bus lanes except to pass a disabled vehicle. The bus lane program expanded into Manhattan in 1969, including bus lanes on 42nd Street and 1st and 2nd Avenues. Also in 1969, the City introduced an alternate strategy to improve the flow of buses, called "bus zones". Curbside lanes on Fifth and Madison Avenues were designated No Standing zones from 7 AM to 7 PM. Other vehicles were allowed to drive in the lanes, but not to park or use them as loading zones.

Table 2-3: New York City Bus Lane Locations and Features

#	Borough	Street	Dir	From	To	Length (mi.)	Alignment	Days	Hours
1	Manhattan	First Ave.	NB	Houston St.	40th St.	1.9	Offset	5	7a-7p
				40th St.	58th St.	0.9	Curb	5	7-10a; 2-7p
				61st St.	79th St.	0.9	Curb	5	7-10a; 2-7p
				79th St.	125th St.	2.3	Offset	5	7a-7p
2	Manhattan	Second Ave.	SB	125th St.	100th St.	1.3	Curb	5	7-10a; 2-7p
				68th St.	Houston St.	3.4	Curb	5	7-10a; 2-7p
3	Manhattan	Third Ave.	NB	36th St.	58th St.	1.1	Curb	5	7a-7p
4	Manhattan	Lexington Ave.	SB	96th St.	60th St.	1.8	Curb	5	7-10a
				60th St.	47th St.	0.65	Curb	5	7a-7p
				47th St.	30th St.	0.85	Curb	5	7a-1p
5	Manhattan	Madison Ave.	NB	42nd St.	59th St.	0.85	Dual Curb	5	2-7p
6	Manhattan	Fifth Ave.	SB	86th St.	59th St.	1.35	Curb	5	7a-7p
				59th St.	34th St.	1.3	Dual Curb	5	7a-7p
7	Manhattan	Sixth Ave.	NB	40th St.	57th St.	0.85	Curb	5	4-7p
8	Manhattan	Eighth Ave.	NB	42nd St.	57th St.	0.75	Curb	6	4-7p
9	Manhattan	Amsterdam Ave.	NB	71st St.	73rd St.	0.09	Left	7	All times
10	Manhattan	Eleventh Ave.	SB	42nd St.	37th St.	0.25	Curb	5	7a-7p
11	Manhattan	34th St.	EB	Eleventh Ave.	First Ave.	1.7	Curb	5	7a-7p
12	Manhattan	34th St.	WB	First Ave.	Eleventh Ave.	1.7	Curb	5	7a-7p
13	Manhattan	42nd St.	EB	Eighth Ave.	Third Ave.	1.05	Curb	5	7-10a; 4-7p
14	Manhattan	42nd St.	WB	Third Ave.	Eighth Ave.	1.05	Curb	5	7-10a; 4-7p
15	Manhattan	57th St.	EB	Eighth Ave.	Sixth Ave.	0.4	Curb	5	4-7p
				Sixth Ave.	Second Ave.	0.85	Curb	5	7-10a; 4-7p
16	Manhattan	57th St.	WB	Second Ave.	Eighth Ave.	1.25	Curb	5	7-10a; 4-7p
17	Manhattan	60th St.	WB	Queensboro	Second Ave.	0.045	Contraflow	7	All times
18	Manhattan	Broadway	SB	Houston St.	Battery Pl.	1.7	Curb	5	7a-6p
19	Manhattan	Church St.	NB	Battery Pl.	Warren St.	0.7	Curb	5	7-10a; 4-7p
20	Manhattan	Sixth Ave.	NB	White St.	Watts St.	0.4	Left	5	4-7p
21	Manhattan	W 207th St.	WB	Ninth Ave.	Broadway	0.4	Curb	5	7-10a
22	Manhattan	W 207th St.	EB	Vermilyea Ave.	Ninth Ave.	0.3	Curb	5	4-7p
23	Staten Is.	Victory Blvd.	NB	Bay St.	Forest Ave.	0.8	Curb	6	7-9a
26	Queens	Hillside Ave.	EB	166th St.	F. Lewis Blvd.	2.1	Curb	5	4-7p
27	Queens	Hillside Ave.	WB	F. Lewis Blvd.	166th St.	2.1	Curb	5	7-9a
29	Queens	Jamaica Ave.	WB	168th St.	Parsons Blvd.	0.5	Curb	7	4-7p

SOURCE: Mineta Transportation Institute

Another wave of bus lane development began in the late 1970s, spurred by the City having to meet the Federal Clean Air Act of 1970 with help from transit enhancements. In 1977 the Fulton Street bus zone was converted to a transit mall as part of an effort to create a number of pedestrian malls in the City. In 1981, the dual bus lane treatment on Madison Avenue was instituted. For the first time, such lanes were separated from the adjacent traffic lanes by a two-foot wide thermoplastic strip and red and white raised reflectors.

In the 1980s, the City re-designated many bus lanes to so-called “Red Zones”, with stricter rules prohibiting parking or vehicle standing in bus lanes. To provide more visibility for these zones, the City added thermoplastic red lane stripes between the lanes and along the cur, with enhanced signage. These Red ones brought great uniformity to eleven bus lane corridors that were previously governed by inconsistent rules.

Most recently, starting in 2004 the Metropolitan Transportation Authority (MTA) and the New York City Department of Transportation (NYCDOT) launched a study to create a BRT system in the City. This new service was rolled out as “Select Bus Service”, with corridors along Fordham Road/Pelham Parkway in the Bronx, First and Second Avenues and 34th Street in Manhattan, Nostrand Avenue in Brooklyn, and Hyland Blvd. in Staten Island (see Figure 2-6). Cornerstone of these new BRT routes were highly visible bus lane, with colored pavement and camera-based bus lane enforcement. Sixteen added candidate corridors have been identified.

<u>Institutional Arrangements</u>

Currently the NYCDOT has primary responsibility for the design and regulation of city streets, including new and improved bus lanes. The City Police Department is primarily responsible for enforcing both parking and moving traffic violations within bus lanes. Field supervisors at New York City Transit are also authorized to issue citations to vehicles parking in bus lanes. With the introduction of camera-based enforcement of selected bus lanes in 2010, NYCDOT and New York City Transit have begun to play a more direct role I the enforcement of bus lanes.

There is no formal operations center or other mechanism to facilitate coordination among NYCT, NYCDOT, NYPD, and the Department of Sanitation to keep the bus lanes clear. Staff from the agencies is in contact on an informal basis to request assistance as needed.

<u>Physical Design and Signage</u>

The design standards for bus lanes in New York City has evolved significantly over the years. The city’s first bus lanes were located against the curb, separated from other lanes by a solid yellow line, and featured two parallel series of dashed white lines within the lane. The Red Zone program then gave many of the city’s bus lanes greater visibility by adding thermoplastic

SOURCE: Mineta Transportation Institute

Figure 2-6: New York City Select Bus Service Network

red strips between the bus lane and adjacent lane, and along the curb. Most recently, NYCDOT has introduced bus lanes painted dark red, bounded by white stripes, and marked “Bus Only”. This was the first widespread use of colored bus lanes in the U.S. In 2009, the City formalized its bus lane design standards into an updated Street Design Manual, which includes a toolkit of innovative design features. In the 2000s, NYCDOT introduced offset bus lanes, allowing for curbside parking, deliveries, and the development of curb extensions to increase pedestrian circulation space and facilitate pedestrian crossings of the street. Figure 2-7 shows a typical offset bus lane treatment associated with the Select Bus Service.

On-street bus lanes in New York City are a minimum of 10 feet wide, with up to 12 feet where there is available space. Currently about 84 percent of the bus lanes in the City run along the right side curb. Offset bus lanes currently exist only on First Avenue and Livingston Street, and represent about 9.5 percent of the network. About two percent of the network consists of transit malls. The remainder of the network is located in contraflow or left side concurrent flow curb lanes, usually for the purpose of facilitating access to key bridges, or for left turns in heavy traffic.

SOURCE: Mineta Transportation Institute

Figure 2-7: Offset Bus Lane on 1st Avenue in New York City

Signage of bus lanes in New York City has evolved over the years. Figure 2-8 illustrates the transition in signage of bus lanes and Red Zones. The City's first standard regulatory bus lane signs were white and black letters and blue bus symbols, usually ground-mounted behind the curb. The signage has evolved to become simple back-and-white signs indicating "Buses Only " or "Buses and Right Turns Only" along with the effective hours. Greater use of overhead signs has also occurred, referring to certain bus lanes by proper name (e.g. "Broadway Bus Lane").

In addition to the standard regulatory signs, NYCDOT also use signage to increase public awareness of the bus lanes and their operating rules. With the opening of the Select Bus Service bus lanes on First and Second Avenues, the City launched a broad public awareness campaign with the theme "Bus Lanes are for Buses" It posted advertisements on buses bus shelters and billboards towed by bicycles to improve motorist awareness of the new bus lanes.

Many original bus lane signs have been left in place since their installation, unless changes in lane use hours, fines or other regulations require their replacement. This has resulted in a wide variety of different bus lane signs on the City streets, including gaps in sign coverage, with some blocks lacking bus lane signs altogether and other blocks having clusters of signs. NYCDOT plans to update and standardize its bus lane signs and markings over time as part of a broader effort to provide enhanced street signage throughout the City.

Figure 2-8: Current Bus Lane Signage in New York City

Access Policies

Most of New York City's bus lanes over the years have operated only during the morning and/or evening peak hours, usually 7 to 10 AM, and 4 to 7 PM. With the recent implementation of Select Bus Service, operating hours for these bus lanes has been extended beyond the peak hours. Today, 39 percent of the bus lane miles operate only during one of the peak periods, another 25 percent operating during both peaks. Most of the remainder of the bus lanes operate continuously during the day, usually 12 hours (7 AM to 7 PM). Only three percent of the bus lane miles operate 24 hours a day.

According to New York City's Highway & Traffic Rules, bus lanes many be used by any type of bus, including school buses and tour buses, as long as the vehicle has a seating capacity of 15 or more in addition to the driver. Also the City's rules exempt the following types of vehicles from using a bus lane:

- Authorized emergency vehicles
- Traffic/parking control vehicles
- Sweepers and refuge trucks
- Snow plows and sand spreaders
- Highway work and inspection vehicles
- Bicycles

There is no specific maximum distance that a vehicle can drive in a bus lane, other than the requirement that the vehicle turn right at its first opportunity. Any vehicle may also use a bus lane to avoid conflict with other traffic or when directed by a police officer.

City regulations prohibit standing or parking in a bus lane during restricted hours, though stopping for receiving or discharging passengers is permitted. Thus passenger pickup or dropoff in a car is allowed in the bus lanes if it is done quickly and a driver does not proceed straight through the next intersection in the bus lane. Along some streets there are more restrictive curb regulations including No Standing.

One of the biggest challenges for bus lanes in New York has been how to accommodate truck deliveries. Given the lack of alleys and service streets in the City, there is a major volume of delivery and service vehicles parking curb side all over the City. Bus lane hours have historically needed to be limited to a few peak hours to allow for delivery access to businesses.

NYCDOT is exploring further implementation of offset bus lanes because of the opportunity to extend bus lane operating hours while increasing the window of time for commercial deliveries. In locations where offset bus lanes are not possible, NYCDOT has had to make special arrangements for midday or evening deliveries. On Fordham Road, while the bus lane operates 7 AM to 7 PM, deliveries are allowed on the south side of the street from 10 AM to noon, and on the north side of the street from noon to 2 PM.

Enforcement

The bus lane related traffic and parking laws are included in the NYCDOT Highway & Traffic Rules publication. The rules prohibit vehicle standing or parking during the restricted bus lane operating hours. Taxis, commuter vans and for-hire vehicles are allowed to pickup or discharge passengers in no standing or parking areas along a bus lane. The current fine for standing or parking in a bus lane is $115, and illegally parked vehicles are towed from bus lanes as part of the City's Violation Tow program (an added $100 fee). For a vehicle to be considered operating illegally in a bus lane, it must cross an intersection without making a right turn. It caught by a police officer, the fine would be $150 and two points on a driver's license. If caught by a camera, the fine is $115 and does not include license points.

At its outset, enforcement of bus lanes in New York City focused on police enforcement. As the Red Zone program came into existence, a civilian "traffic control agent" force was established to identify violators with the power of issuing tickets. This was supplemented by stepped up towing operations. For offset bus lanes, double parking was identified as a moving violation. A 1994 study concluded that bus lanes are ineffective in the absence of sustained enforcement, and that surveys conducted after enforcement ended revealed that bus lanes were still used illegally. Based on discussions with City staff recently, the opposite feeling was expressed, indicating that a "blitz" enforcement strategy, with a high level of enforcement if only done periodically, was more effective.

In 2010, New York began implementing camera enforcement of its bus lane system associated with the new Select Bus Service, starting with fixed cameras. This has been supplemented by bus and street supervisor vehicle cameras.

Performance

The City's Red Zone program was credited with improving the average speed of buses by 17 percent. On Madison Avenue, previously the slowest bus corridor in the City, speeds have improved by up to 83 percent with the dual bus lanes operation. A 2011 evaluation of the 1st and 2nd Street Select Bus Service revealed that with the new bus lanes with enhanced enforcement, bus travel times improved by 15-18 percent, with a 9 percent increase in ridership, and negligible changes in general traffic speed and volume. However, there have been some problems that continue to plague bus lane operations:

- Insufficient horizontal clearance – narrow rights-of-way on some streets have led the City to adopt substandard bus lane widths, to squeeze bus operations into marrow parking lanes. As a result, buses have tended to straddle the bus with the adjacent general traffic lane, thus being held up by general traffic even if there is a clear bus lane ahead.
- High competition for access to curb space, which increases the number of stopping vehicles in a bus lane.

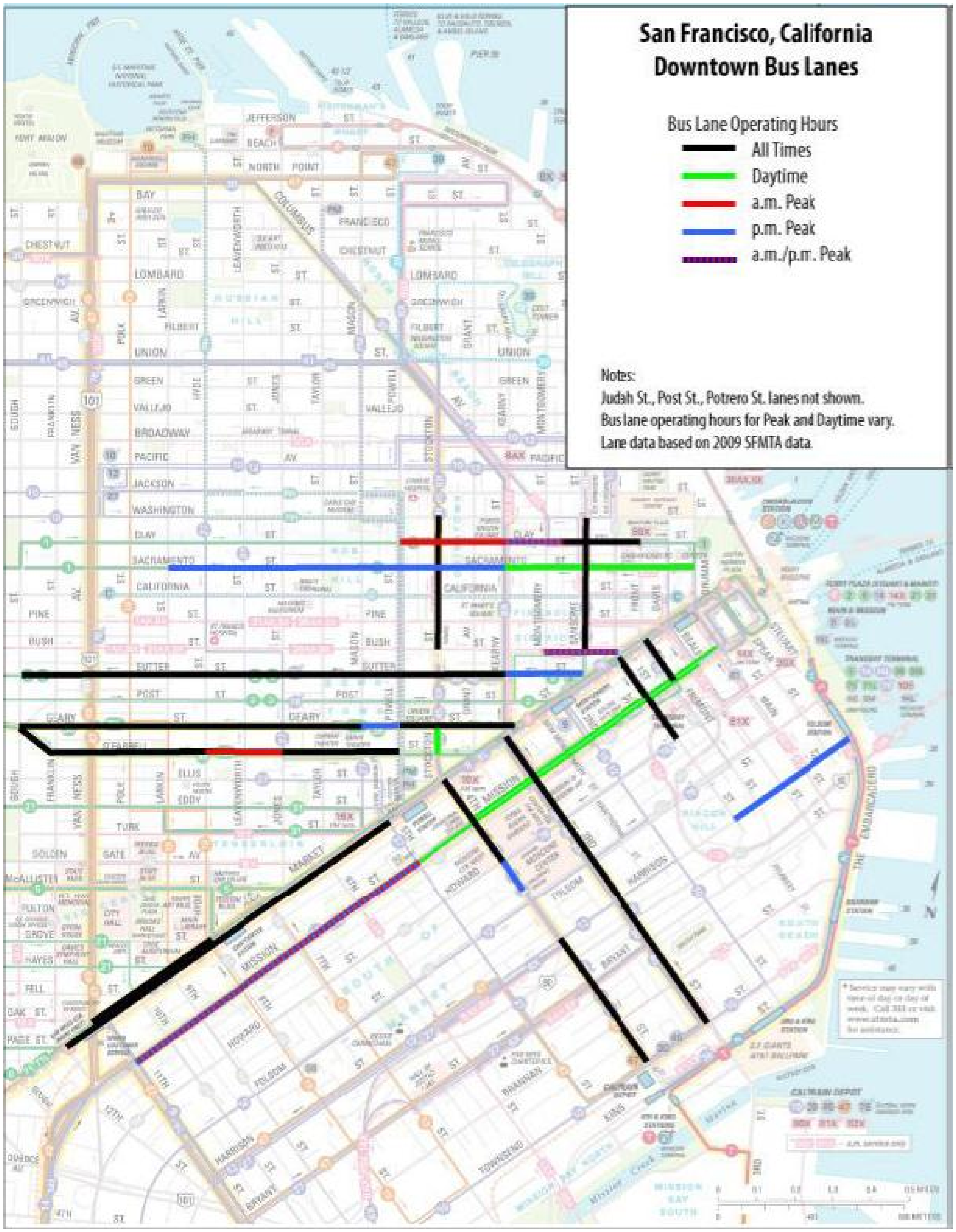
- High pedestrian volumes – in the State of New York there is a “no turn on red” law, and given the high pedestrian volumes in Manhattan and the other boroughs, right turning vehicles must often wait one cycle before being able to turn, thus delaying buses behind these vehicles.

2.3.3 San Francisco

<u>Bus Lane Network</u>

In San Francisco, the City has an extensive network of bus lanes focused on the center city area. San Francisco has about 17.8 miles of transit priority lanes, of which about 14.3 miles are used by buses (the remainder being used by light rail transit (including streetcar) vehicles. There is significant variation in the street alignment, regulations and hours of operation of the transit priority lanes. About two-thirds of the network has lanes offset from the curb to allow for parking and/or right turn lanes. About 60 percent of the priority lane network is in operation at all times. Table 2-3 identifies the bus lane locations, operating hours and lengths as of 2009, while Figure 2-9 shows the locations of lanes in the network.

The city adopted its first bus priority lanes in 1970-71, along 5 miles (8 km) of Clay, Geary, O’Farrell, Sacramento, and Sutter Streets.218 Each bus lane operated either 7-9 a.m. eastbound or 4-6 p.m. westbound on weekdays. At the same time the lanes were created, the city also converted several key downtown streets (including Geary, Sutter, Howard, and Folsom) from two-way to one-way operation. This had the benefit of improving traffic flow, particularly at the complex intersections along downtown’s central Market Street spine.



SOURCE: Mineta Transportation Institute

Figure 2-9: San Francisco Downtown Bus Lane Network

Table 2-4: San Francisco Bus Lane Locations and Features

#	Hours of operation	Street	Dir	Alignment		From	To	Length (mi.)
1	All Times	1st St.	SB	Left	Offset	Market St.	Howard St.	0.24
2	All Times	3rd St.	NB	Right	Offset	Townsend St.	Market St.	0.85
3	All Times	4th St	SB	Right	Offset	Market St.	Howard St.	0.24
	3-7p, M-F		SB	Right	Curb	Howard St.	Clementina	0.08
	All Times		SB	Left	Offset	Harrison St.	Townsend St.	0.36
4	7-9a, 3-7p, M-F	Bush St.	EB	Right	Curb	Montgomery St.	Sansome St.	0.09
	7-9a, 3-7p, M-F		EB	Left	Curb	Sansome St.	Battery St.	0.07
5	7-9a, M-F	Clay St.	EB	Right	Curb	Powell St.	Kearny St.	0.25
	7-9a, 3-6p, M-F		EB	Right	Curb	Kearny St.	Leidesdorff St.	0.16
	All Times		EB	Right	Offset	Leidesdorff St.	Front St.	0.17
6	All Times	Fremont St.	NB	Left	Offset	Mission St.	Market St.	0.12
7	All Times	Geary St.	WB	Right	Offset	Market St.	Gough St.	1.21
8	4-7p, M-F	Harrison St.	WB	Right	Curb	Embarcadero	1st Street	0.33
9	All Times	Market St.	EB	Median		12th St.	5th St.	0.95
10	All Times	Market St.	WB	Median		8th St.	S. Van Ness Ave.	0.35
11	7-9a, 4-6p, M-F	Mission St.	EB	Right	Offset	11th St.	5th St.	0.82
	7a - 6p, M-F		EB	Right	Offset	5th St.	4th St.	0.17
	7a - 6p, M-F		EB	Right	Curb	4th St.	Beale St.	0.66
12	7a - 6p, M-F	Mission St.	WB	Right	Curb	Main St.	Beale St.	0.06
	7a - 6p, M-F		WB	Right	Offset	Beale St.	4th St.	0.66
	4-6p, M-F		WB	Right	Offset	4th St.	11th St.	0.99
13	All Times	O'Farrell St.	EB	Right	Offset	Gough St.	Mason St.	0.82
	All Times		EB	Right	Curb	Mason St.	Powell St.	0.09
14	All Times	Post St.	EB	Right	Offset	Gough St.	Grant St.	1.09
15	All Times	Potrero	NB	Right	Offset	24th St.	22nd St.	0.30
16	7a - 7p, M-F	Sacramento St.	WB	Right	Curb	Drumm St.	Kearny St.	0.45
	4-6p, M-F		WB	Right	Curb	Kearny St.	Larkin St.	0.81
17	All Times	Sansome St.	SB	Contra	Offset	Washington St.	Bush St.	0.32
18	All Times	Stockton St.	SB	Right	Offset	Bush St.	Geary St.	0.16
	All Times		SB	Right	Curb	Geary St.	Ellis St.	0.18
19	3-6p, M-F	Sutter St.	WB	Right	Curb	Sansome St.	Kearny St.	0.15
	All Times		WB	Right	Curb	Kearny St.	Grant St.	0.09
	All Times		WB	Right	Offset	Grant St.	Gough St.	1.09

SOURCE: Mineta Transportation Institute

In 1973, San Francisco officially adopted a “Transit First” policy that gave public transit vehicles priority over private vehicles in policymaking related to city streets. To implement that policy, the city began its Transit Preferential Streets (TPS) program through which the city greatly expanded its implementation of bus lanes, queue jumping lanes, contraflow lanes, bus bulbs, transit signal priority, targeted enforcement of bus lanes, and other strategies.

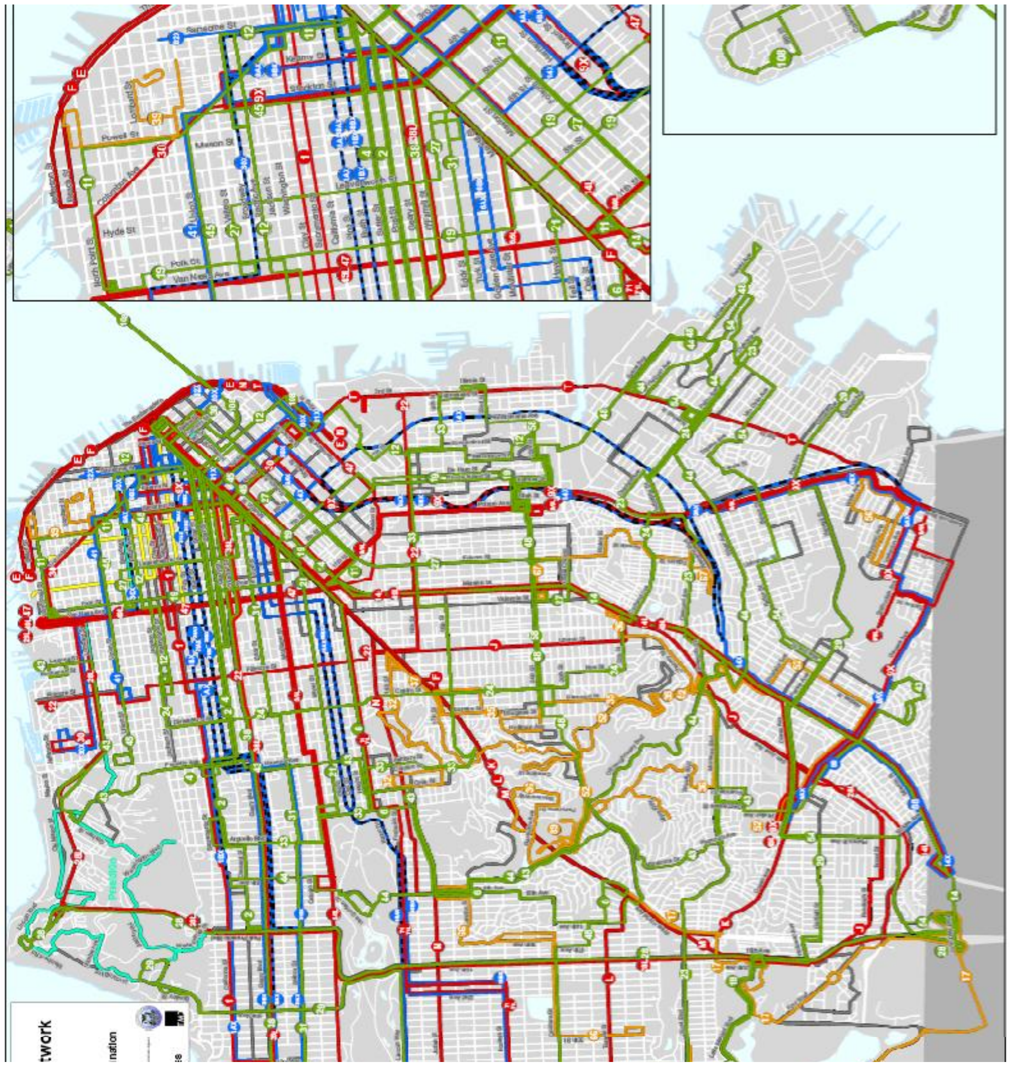
In 1999, San Francisco voters approved a landmark reform package known as Measure E, which set the groundwork for a new wave of innovation on the management of the city’s streets. This initiative strengthened the Transit First policy and created the new Municipal Transportation Agency (SFMTA) responsible for both transit services and street management.

Bolstered by its new mandate, the city began developing proposals to establish physically separated median transitways on Van Ness Avenue and Geary Boulevard, as part of new bus rapid transit systems crossing the city. In November 2003, voters approved Measure K, which established a 30-year, one–half percent sales tax and a legally binding expenditure plan. The plan included $110 million for a “Bus Rapid Transit/MUNI Metro Network,” including BRT corridors on Van Ness Avenue, Geary Boulevard, and Potrero Avenue, and an expanded Transit Preferential Streets network on key transit corridors citywide. The following year, the County Transportation Authority approved the Countywide Transportation Plan that identified a specific set of corridors that would be the focus of future TPS planning efforts (see Figure 2-10). Planning and design studies for these corridors have ensued, with the Van Ness corridor recently awarded FTA Small Starts funding.

Institutional Arrangements

The San Francisco Municipal Transportation Authority (known as “MUNI”) provides the majority of transit services in the City. Added bus service is provided by Golden Gate Transit (North Bay Area), SamTrans (San Mateo County), and AC Transit (Alameda/Contra Costa Counties). MUNI has a Sustainable Streets Division which designs and manages all traffic engineering functions within San Francisco, including the development of bus lanes, and the placement of signs, signals, and curb markings in implementing the City’s Transit First policy. The Sustainable Streets Division plans the location and specific design of bus lanes on a case-by-case basis, given site conditions, street geometry and specific warrants.

An added public agency with significantly input on street improvements is the San Francisco County Transportation Authority (SFCTA), that conducts planning and evaluation studies related to transit operations. This agency established in 1989 to manage implementation of a plan for transportation improvements associated with a new half-cent sales tax, which was renewed in 2003 for a 30-year period.



SOURCE: TCRP Synthesis 83

Figure 2-10: San Francisco Transit Preferential Streets Network

SFCTA has assumed added responsibilities over time, including managing the City's congestion management program, transportation system performance measurements, and air quality-related transportation projects.

<u>Physical Design and Signage</u>

As mentioned previously, most of bus lanes (two-thirds) in San Francisco are offset from the curb (see Figure 2-11 for examples). This includes 60 percent on the right side of the street, five percent on the left side, and two percent in a contraflow configuration. In this configuration, depending on location, the street may be painted under one of four configurations:

1. Full-width travel lane between the bus lane and curb (typically for right turn lanes)
2. A narrower bus stop and parking lane,

3. A series of parking/delivery bays set into the sidewalk, or
4. An extra-wide shared lane that may include bus stops, parking and other curb uses.

The remainder of the bus lanes in the City either run adjacent to the curb (24 percent) or along a central median (9 percent). On certain one-way streets, the bus lane is in the left lane with bus stops on islands.

Solid white lines separate the bus lanes from other traffic. Typically the lane is marked with a diamond and “Bus Only” or “Bus Taxi Only” text. The City is in the process of removing the diamond symbols associated with street resurfacing or repainting, to comply with the latest federal Manual of Uniform Traffic Control Devices (MUTCD). No physical barrier is used for right side bus lanes. Left side and median buses usually include a raised island at bus stops that acts as a localized lane barrier (see Figure 2-12).

San Francisco has implemented various traffic signal treatments to facilitate buses turning from bus lanes. This includes queue jump signals, including a video detection system that detects buses in a left-side bus lane a queue jump phase to allow buses to cross adjacent general traffic lanes in making right turns.

Most bus lanes have curbside signs indicating operating hours, parking and stopping prohibition hours, and/or inclusion of taxis. The City generally places a bus lane sign at the beginning of the block with a bus lane, with added signs on blocks over 250 feet long. Figure 2-13 shows some typical bus lane signage treatments.

Access Policies

There is no standard operating pattern for bus lanes in San Francisco. About 18 percent of the bus lane mileage only operates during weekday morning or afternoon peak periods. An added eight percent operate during both morning and afternoon peak periods. Operating hours for the afternoon peak period, for example, can vary from 4 to PM, 3 to 6 PM or 3 to 7 PM. Most of these lanes are operate next to the curb, where parking and/or deliveries are allowed the rest of the day. Some bus lanes operate continually on weekdays, from 7 AM to 6 PM, or 7 AM to 7 PM. These are a mixture of curb and offset lanes.

SOURCE: Mineta Transportation Institute

Right side Curb Lane with Bus Stop and Parking Lane

SOURCE: Mineta Transportation Institute

Right-side Curb Lane with Parking Bays

Figure 2-11: Offset Bus Lane Configurations in San Francisco

SOURCE: Mineta Transportation Institute

Figure 2-12: Left Curbside Bus Lane with Boarding Island in San Francisco

SOURCE: Mineta Transportation Institute

Figure 2-13: Newer Bus Lane Signage in San Francisco

The City's Municipal Code identifies conditions under which a vehicle can use a transit only lane. This includes separate sections in the code for bus lanes as well as streetcars and cable cars. Taxis are allowed to use bus lanes at all times. A private vehicle is allowed to drive in a bus lane for up to one block to make a turn or to leave curbside parking to access non-curb side bus lane. Delivery vehicles are allowed in yellow zones marked as truck loading zones. For bicycles, a cyclist may not use a bus lane except to make a turn or access parking or a driveway. Motorcycles are not allowed to use a bus lane.

<u>Enforcement</u>

The rules related to legal use of bus lanes is identified in the California Vehicle Code and the San Francisco Municipal Code. As of 2012, the penalty for driving illegally in a bus lane was $60, and the penalty for parking in a bus lane was $105. Significant added fees are charged for vehicles that have to be towed.   Bus lane use violation is not treated as a traffic infraction, and thus does not result in points assessed to the driver's license.

The SFMTA Enforcement Division enforces parking laws in bus lanes. Parking control officers often refrain from citing a vehicle stopped in a bus lane if that vehicle pulls away quickly, since issuing a citation would extend the time the vehicle would be in the lane.

In 2008, SFMTA initiated the Transit Lane Enhancement Pilot Project, a program to test camera-based enforcement of vehicles illegally stopped or parked in transit lanes. Two cameras were installed on the windshields of buses, one camera capturing the transit lane and the other focusing on the license plate number of the illegal vehicle. Images are transferred to the SFMTA camera surveillance team for an initial review, who then coordinate with parking control officers in the field to issue citations. In the first 18 months of this program, 686 citations were issued.

<u>Performance</u>

There is the perception on the part of SFMTA staff that the City's bus lanes continue to be impacted by chronic violations. A 2003 SFCTA survey of transit lane violations on Market Street indicated that over 25 percent of vehicles on the street were violating bus lane laws. Some 13 percent of transit vehicles experienced delay due to such violations. A more comprehensive survey in 2006 of ten bus lane segments revealed that violation rates varied widely by location and in some case the transit lanes were congested more by vehicles making turns than by vehicle driving legally in a lane.

2.3.4 Key Findings from the Case Studies

The case study review assessed the administration, design and enforcement of bus lanes in urban streets in three U.S. cities: Los Angeles, New York and San Francisco. An array of different strategies have been used in these cities to make bus lanes work effectively, that have lead over time to the expansion of their bus lane networks. The following provides some key findings related to agency coordination, physical design, lane access, and enforcement.

<u>*Agency Coordination*</u>

Historically, responsibilities for street engineering, transit services and policing have been split across multiple agencies, or levels of government. This fragmentation of responsibilities often has produced bus lanes that are ineffective, or it they are effective, cannot sustain the institutional or political support needed for long-term success. In all three cities examined, institutional reform to achieve greater integration of responsibilities has been a central part of efforts to create a high performing bus lane network. This has included in San Francisco the merger of traffic and roadway development functions, through its Sustainable Streets Division, with the transit agency to assure seamless coordination related to planning, design, construction, and performance monitoring for new and improved bus lanes.

Physical Design

The most common physical configuration for bus lanes on city streets has been curbside. This location minimizes impacts on general traffic flow, but mixes buses with vehicle queuing at intersections and driveways to make turns, stopping at the curb to pick up or drop off passengers, standing at the curb to make deliveries to local businesses or parking. However, there is a trend toward the development of more offset bus lanes, which mitigate some of the drawbacks with curbside bus lanes. San Francisco has long use this practice and New York City with its new Select Bus Service has moved to such lanes. Bus lanes in general have been 10 to 12 foot wide, with 12 feet being a preferable width.

Signage, lane markings and other practices all vary significantly among the case studies. Signing and markings are being more standard associated with the Manual of Uniform of Control Devices, and there has been increased use of colored or textured pavement to better distinguish bus lanes from adjacent general traffic lanes.

Access Policies

Bus lanes exist in urban environments where the goal of improving mobility for bus riders must be balanced against the needs of other street users, including general through traffic, traffic requiring curbside access for parking or loading, and bicyclists and pedestrians. In curbside bus lane designs, this balance is achieved by focusing bus access to the curb lane during peak hours and to other users during the rest of the day., with general traffic not having to compete for street space. Greater priority, which is obtaining greater acceptance, can be given to transit associated with offset or median lanes, which separate bus operations from local access, parking and delivery movements, but sacrifice some general traffic capacity.

In general, all three cities evaluated allow vehicles to use curbside lanes to make right turns and to access driveways on a given block, taxis are allowed to use bus lanes to pick up and discharge passengers, and allow taxis to also drive in the bus lanes. The cities are divided on bicycle use of bus lanes. While buses and bicycles operate at similar average speeds, they have different operating behaviors, with bicycles maintaining a constant speed and buses frequently stopping, this resulting in one leapfrogging the other. On a narrow bus lane, this can be dangerous, but in a wider lane, bicycles may be safer than operating in general traffic. New York and San Francisco do not allow bicycles using bus lanes.

Enforcement

Effective bus lane enforcement was in general lacking in the early implementation of bus lanes in the three cities. In most cases, enforcement of laws concerning the operating of vehicle is a police department responsibility, and the granting of police powers to a transit agency is not a possibility. Some cities like New York have passed laws reclassifying bus lane violations as civil infractions that can be enforced by civilian agents or automated cameras.

Camera-based enforcement represents the most effective strategy to monitor illegal use of bus lanes. New York and San Francisco are now using camera-based enforcement on a portion of their networks. Continued use of this tool will require sustaining public confidence that the technology is being applied fairly and not abused as a revenue-generating tool.

3.0 APPLICABLE GUIDANCE

3.1 Warrants and Conditions for Application

3.1.1 In-Street Bus Lanes

Bus lanes within the street right-of-way require: 1) a sufficient frequency of bus service 2) traffic congestion along the roadway 3) adequate street geometry and 4) ability to enforce lane use regulations. Bus lanes must establish a clear identify to assure their effective use. There are nine basic guidelines for the operation of in-street bus lanes on urban streets:

1. Concurrent flow lanes may operate along the outside curb, in the lane adjacent to a parking lane (interior or offset lane) or in a paved median area (without a dedicated, physically separated median transitway).
2. Concurrent flow lanes can operate at all times, for extended hours (e.g. 7 AM to 7 PM) or just during peak hours.
3. Contraflow lanes should operate at all times.
4. Under conditions of heavy bus volumes, .dual concurrent flow or contraflow lanes may be desirable.
5. Where the bus lanes operate at all times, special colored pavement may be desirable to improve the identity of the bus operations.
6. Bus lanes should be at least 11 feet wide to accommodate an 8.5-foot bus width (mirror to mirror).
7. The bus lanes should carry as many people as in the adjacent general traffic lane(s). Ideally there should be at least one bus per signal cycle to give buses a steady presence in the bus lane. There should be at least one lane available for general traffic in the same direction.
8. Parking should be prohibited where bus lanes are along the curb, but it may remain where interior bus lanes are provided.
9. There should be suitable provisions for goods delivery and service vehicle access, either during off-hours or off-street.

Table 3-1 identifies bus volume warrants for in-street bus lane application, identified in National Cooperative Highway Program (NCHRP) Report 155 – Bus Use on Highways – A State of the Art. The table identifies a minimum one-way peak hour volume of 50 buses in a downtown area, and 30 buses outside of a downtown area, The minimum volume for a contraflow lane ranges from 20 buses per hour for a short segment (1-2 blocks) and 40 buses per hour for an extended segment.

Table 3-1: Volume Warrants for In-Street Bus Lanes

In-Street Bus Lane	Minimum Daily Bus Volume	Range in One-Way Peak Hour Volume	
		Bus	Passengers
Concurrent flow			
In Downtown	500	50-80	2000-3200
Outside Downtown	300	30-40	1200-1600
Contraflow			
Short Segment	200	20-30	800-1200
Extended Segment	400	40-60	1600-2400

SOURCE: TCRP Report 165 (TCQSM 3rd Edition)

3.1.2 Median Transitways

Given the more extensive capital cost to develop a median transitway within a street, the minimum number of one-way peak period buses should be higher than for in-street lanes to justify the investment. NCHRP Report 155 identified 80 buses per hour as a minimum threshold for a transitway treatment.

3.1.3 Benefit-Cost Comparison

The primary basis for determining whether a bus lane is justified involves a comparison of benefits vs. costs. For a mixed-traffic vs. dedicated running way scenario. Benefits can be analyzed in terms of the change in total person travel time for all travelers along the particular street irrespective of mode the analysis can take into account potential shifts by motorists to parallel streets if general traffic capacity is removed from the street where the bus lane is to be implemented.

The most critical factors impacting the evaluation of bus lanes is the number of buses in the peak direction during the peak hour and the number of passengers on the buses. Travel time savings for current and newly attracted transit riders, along with potential operating and maintenance savings, should be compared to changes in travel time for general traffic, and access and parking impacts at adjacent developments.

3.2 Capital and O&M Costs

The cost of implementing dedicated bus lanes depends on the existing roadway configuration and the extent of planned changes to accommodate bus lanes. Units costs for both initial construction and subsequent operation and maintenance can be obtained from the local roadway jurisdiction; in downtown Miami, that would be the City of Miami and FDOT. Capital costs are impacted by right-of-way needs and costs, the extent of utility relocation, whether a median needs to be cleared and paved, and the extent to which sidewalks need to be rebuilt.

If existing lanes are used with no new construction, initial capital costs will be modest and focus on re-striping and signage modifications.

The capital cost of adding new bus lanes ranges from $2 to $3 million per lane mile for curb or offset lanes, to $5 to $10 million per lane mile for median transitway for bus. Converting existing lanes to bus lanes can range from $50,000 to $100,000 per lane mile, focused on restriping and signing.

The operating and maintenance (O&M) costs for dedicated bus lanes include the cost for street lighting and routine maintenance (e.g. cleaning, pothole filling, resurfacing). This could be no more than $10,000 per lane mile per year (based on national average O&M costs for arterial streets). For bus lanes created from converted parking or general traffic lanes, the incremental O&M costs should only be associated with increased maintenance due to added wear and tear of the pavement from bus operation, less than for a new lane.

A bus lanes can also result in O&M cost savings to bus operations, if the travel time savings and improved service reliability results in a reduced number of buses required to provide the same level of service.

3.3 Impact Assessment

3.3.1 Actual Observations

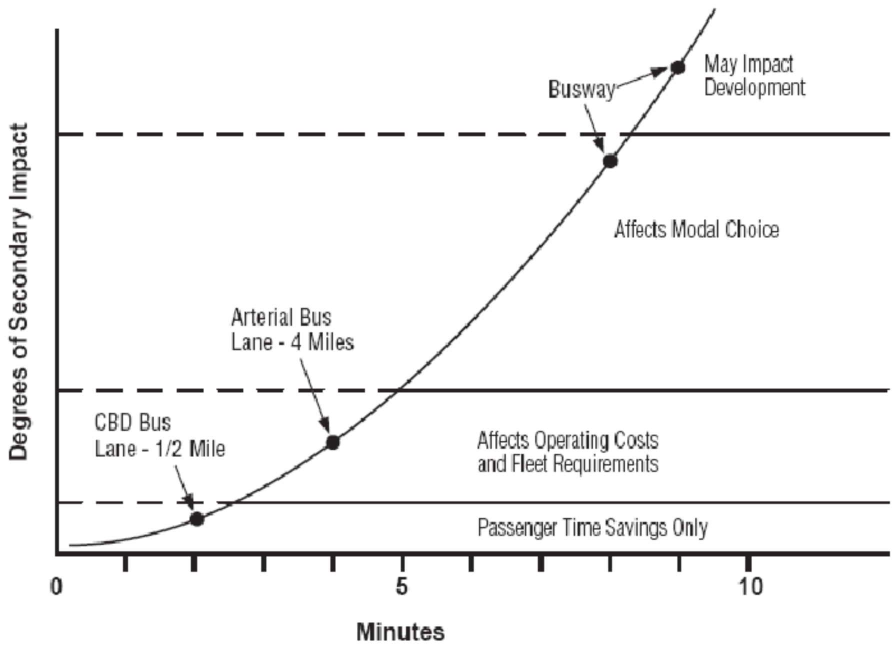
The primary reasons for implementing on-street bus lanes are to reduce travel time and improve on-time performance for transit operations as opposed to their prior mixed-traffic operation. These benefits must be compared against the potential increased travel times for other roadway users and potential diversion of traffic to other corridors (with associated impacts).if the new bus lanes are developed by removing general traffic lanes. Likewise if parking is removed during a part or all day to develop curb bus lanes, then the impact on overall parking to an area and the ability of providing replacement parking needs to be assessed.

The benefits of bus lane operation depend on the length of the lane and the amount of time saved. Figure 3-1 illustrates the degree of bus lane impacts relating passenger time savings to secondary impacts such as reduction of O&M costs and impact on mode choice and attracting new development. The trend assessment is as follows:

- With a small amount of bus travel time savings, benefits relate primarily to passenger time savings
- As the bus travel time savings increases, it may reduce fleet requirements and operating costs

- A bus travel time savings of five minutes can affect modal choice and under a busway type treatment over an extended distance even attract urban development.

Examples of travel time savings observed with actual arterial bus lanes implemented is shown in Table 3-2, with observed reliability improvements shown in Table 3-3.



SOURCE: TCRP Synthesis 83

Figure 3-1: Degree of Bus Lane Impacts

Table 3-2: Observed Travel Time Savings with Arterial Bus Lanes

City	Street	Savings (Minutes Per Mile or % Decrease)
Los Angeles	Wilshire Blvd.	0,1 to 0.2 (AM peak), 0.5 to 0.8 (PM peak)
Dallas	Harry Hines Blvd.	1.0
Dallas	Ft. Worth Blvd.	1.5
New York City	Madison Ave. (dual bus lanes)	43% express bus, 34% local bus
San Francisco	1st Street	39% local bus

Source: TCRP Synthesis 83

Table 3-3: Observed Reliability Improvements with Arterial Bus Lanes

City	Street	% Improvement*
Los Angeles	Wilshire Blvd.	12 to 27
New York City	Madison Ave.	57

*Coefficent of variation multiplied by 100
Source: TCRP Synthesis 83

3.3.2 Analysis Methods

There are various methodologies for assessing the impacts of arterial bus lanes on bus and general traffic operations:

1. Analogy (estimate based on an analysis of actual operating experience, with vale ranges presented in TCRP Synthesis 118)
2. Application of the *Transit Capacity and Quality of Service Manual 3rd Edition* Bus Capacity Analysis methodology
3. Computer simulation

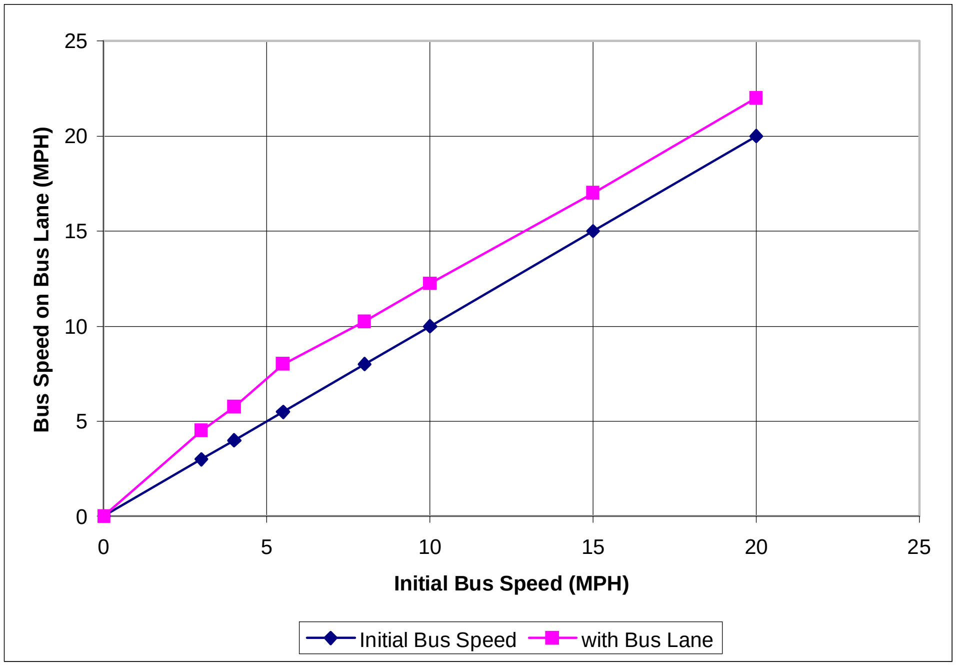
<u>Analogy</u>

Estimated travel time rate reductions based on analogy are shown in Table 3-4. These values provide an initial order of magnitude estimate of time savings. More refined estimates of travel time savings and speed increases can be obtained from the various scenarios presented in Table 3-5 and Figures 3-2 and 3-3. For a given base bus speed or travel time, the reduction in travel time is estimated for an in-street bus lane scenario.

Table 3-4: Order of Magnitude Estimate of Travel Time Savings with In-Street Bus Lanes - Analogy

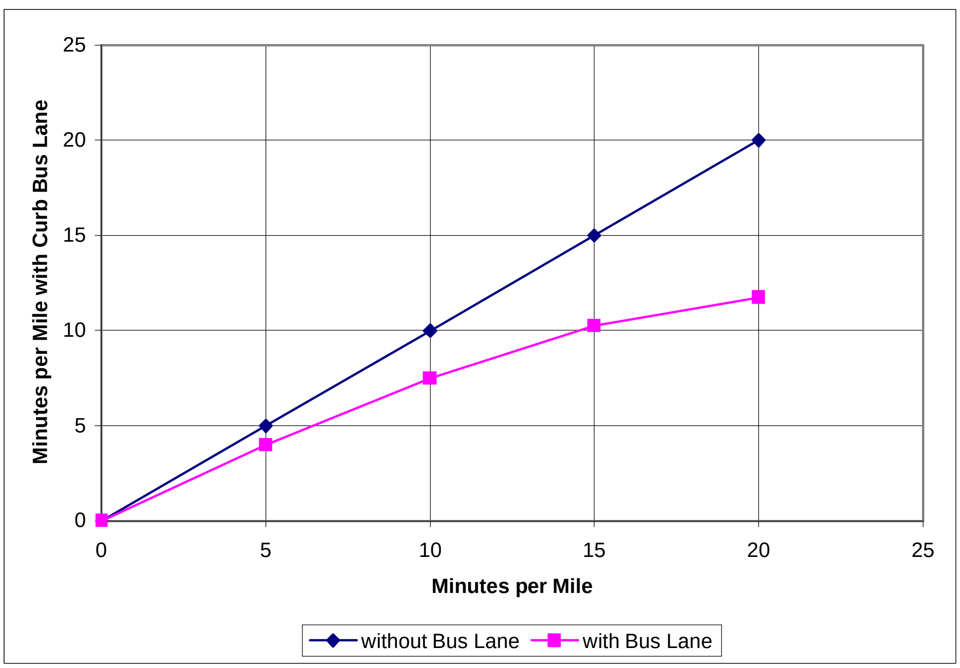
Location	Minutes Per Mile Reduction
Highly Congested Downtown	3 to 5
Typical Downtown	1 to 2
Typical Suburban Arterial	0.5 to 1

Source: TCRP Synthesis 83



Source: TCRP Synthesis 83

Figure 3-2: Impact of Curb Bus Lanes on Bus Speed



Source: TCRP Synthesis 83

Figure 3-3: Travel Time Savings with Curb Bus Lane

Table 3-4: Estimated Travel Time Rate Reduction with Arterial Bus Lanes - For Specific Cases Based on Analogy

Item	Case A	Case B	Case C	Case D	Case E
Initial Speed (mph)	3.0	4.0	6.0	8.0	10.0
Speed with Curb Bus Lane (mph)	4.4	5.7	8.0	10.2	12.2
MPH Gain	1.4	1.7	2.0	2.2	2.2
% Gain	47.0	42.0	33.3	27.5	22.0
Initial Minutes/Mile	20	15	10	7.5	6.0
Minutes/Mile with Bus Lane	13.5	10.5	7.5	5.9	4.0
Minutes/Mile Gain	6.5	4.5	2.5	1.6	1.1
% Gain	32.5	30.0	25.0	21.3	18.3

SOURCE: TCRP Report 90 (4)

TCQSM Methodology

The TCQSM includes a more detailed macroscopic analysis procedure to estimate the capacity and travel time savings of different bus lane configurations. For this analysis, three types of bus lanes are identified, as shown in Figure 3-4. The types are distinguished by the ability of buses to move around other vehicles in their lane. Type 1 bus lanes do not allow buses to leave the lane. Type 2 bus lanes allow buses to move into the adjacent lane, general traffic permitting, to move around other vehicles using the lane. Type 3 bus lanes provide bus lanes for the exclusive use of buses.

A spreadsheet model has been developed to assess the capacity, speed and travel time of the different bus lane types, which has been incorporated as a supplement to the TCQSM 3rd Edition. Figure 3-5 shows the typical format of the spreadsheet, and the input and output variables to be included. This analysis tool will be used to assess the capacity and operational impacts of the different bus lane treatments identified in the Downtown Miami study.

Type 1

Buses have no use of adjacent lane

- Physically channelized bus lanes
- Contraflow bus lanes
- Busway stations without passing lanes
- Mixed-traffic operations with only one travel lane

(a) Denver, (b) Orlando, (c) Eugene, (d) Portland

Type 2

Buses may move into adjacent lane, traffic permitting

- Part-time exclusive bus lanes
- Full-time exclusive bus lanes with passing opportunities
- Mixed-traffic operations with two or more lanes

(e) Montréal, (f) Madison, (g) Portland, (h) Milwaukee

Type 3

Buses have full use of adjacent lane

- Dual bus lanes
- Busway stations with passing lanes

(i) New York, (j) Miami

SOURCE: TCRP Report 165 TCQSM 3rd Edition

Figure 3-4: Bus Lane Types for Capacity Analysis Purposes

The procedures provided in this spreadsheet automate the bus capacity and speed calculation methods given in Chapter 6 of the TCQSM, 3rd Edition. The spreadsheet allows the analysis of both directions of a facility consisting of up to 20 bus stops. For longer facilities, divide the facility into sections and use one copy of the spreadsheet for each section.

This spreadsheet assumes the user is already familiar with Chapter 6 of the TCQSM.

This spreadsheet is provided as-is, without support or warranty as to its accuracy, completeness, or reliability. No responsibility is assumed by TCRP or the developers for incorrect results or damages resulting from the use of this spreadsheet.

Step 0: Calculate Average Dwell Time (Optional)

This sheet allows average dwell times to be calculated based on passenger on/off demand, fare collection method, and vehicle characteristics (e.g., floor height, number of doors). This step is optional--the user can simply enter an average dwell time in Step 1.

Step 1: Calculate Bus Stop Capacity

This sheet calculates the bus capacity of individual stops along a facility, along with the overall facility capacity, for both directions of a facility.

Step 2: Skip-stop Operations (Optional)

This optional sheet is used to estimate bus facility capacity (both design and maximum capacity) when skip-stop operations are used.

Step 3: Calculate Bus Speeds

This sheet calculates average bus speeds in both directions along the facility. Because capacity is an input to determining speeds, Step 1 must be completed first, along with Step 2 if skip-stops are being analyzed.

Default Values

This sheet contains default values that the user can override based on local conditions. The default values affect the calculation of clearance time (Step 1) and passenger service time (Step 0).

Lookup (hidden)

This sheet stores the values used by drop-down menus in Steps 0-3, along with other values used in calculations.

Revision History

This sheet describes the changes made with each spreadsheet version.

Figure 3-5: Input/Output Spreadsheet from New Bus Capacity Analysis Tool

Computer Simulation

A microsimulation model such as VISSIM can be applied to assess bus lane impacts on the affected roadway and intersection operations. A simulation model will require calibration and will be more data intensive, including an estimation of vehicle queuing impacts.

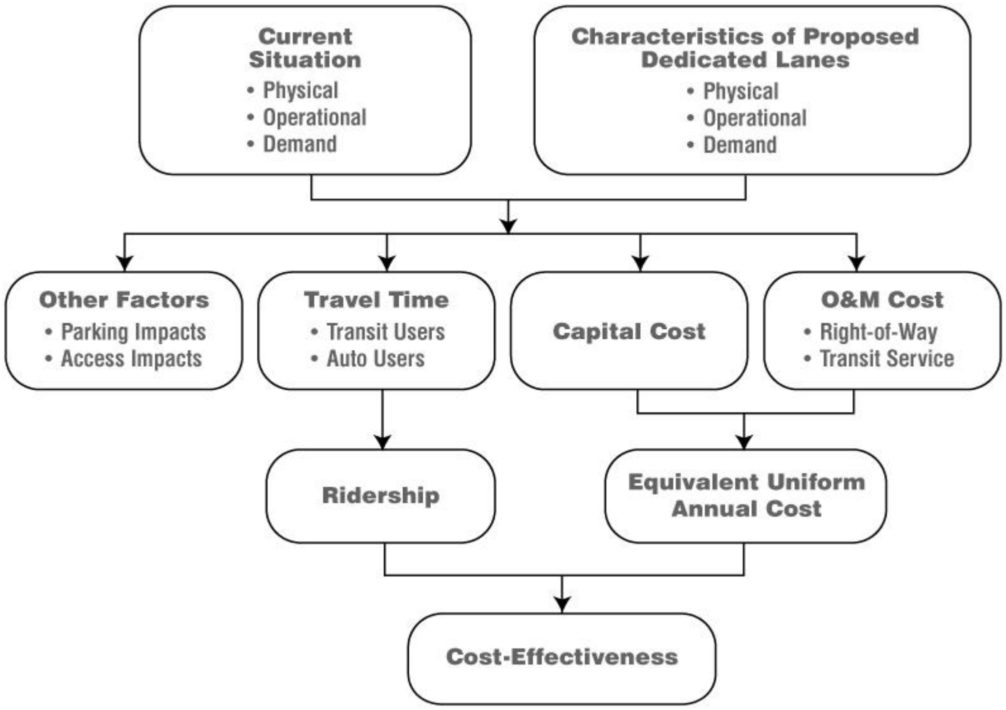
3.4 Decision Marking Framework for Bus Lanes

The decision to develop dedicated bus lanes within a street right-of-way, whether in in-street bus lanes or a median transitway, appears to be dependent on answers to three questions:

1. Is the transit demand high enough to warrant service so frequent that exclusive bus lanes will be well used and even self-enforcing?
2. Is there adequate roadway right-of-way available to develop a median transitway or added traffic lanes that could be dedicated to transit use?
3. Will the development of exclusive bus lanes still allow adequate local access in a corridor, recognizing that median transitways block local driveway and unsignalized intersection left turn access, and curbside bus lanes have to share the lanes with local driveway traffic and right turns at intersections?

In evaluating the feasibility of developing dedicated bus lanes in a street right-of-way, the costs and impacts of such treatments must be evaluated. Figure 3-6 identifies a flow chart from TCRP Synthesis 83 that identifies the different factors that should be considered and their relationship.

The decision where to locate a bus lane if developed outside of the median, and the hours of operation of the lane by buses, will be dependent on the desired length and limits of the bus lane, the importance of keeping on-street parking all day, and the general traffic volume temporal pattern along the street. If on-street parking can be eliminated during peak hours, then a curbside bus lane is doable during those hours. Operating an “offset” bus lane is desirable where parking must be maintained all day. Contraflow lanes typically are only applied for short lengths, and operate all day as exclusive transit facilities.



SOURCE: TCRP Synthesis 83

Figure 3-6: Evaluation Process for Dedicated Transit Lanes

3.5 Regulatory Restrictions/Enforcement Provisions

Bus lanes will require pavement marking and proper signage to alert general motorists on the hours of operation of the lane for buses and any shared use by motor vehicles. Figure 3-6 illustrates different treatments. To provide greater visibility of signage, overhead mounted signs are typically applied over the lane, which can supplement ground-mounted signage. Colored pavement can also be applied to further delineate bus lane use.

Related to enforcement, "self-enforcing" bus lane designs should be adopted that do not rely on active policing for effectiveness There is a trend toward use of cameras to identify violators in a bus lane, with violations administered like parking tickets. Experience has been to roll camera enforcement technology out gradually, with ongoing accuracy monitoring and in-the-field capabilities by jurisdiction traffic managers to disable cameras temporarily in disrupted traffic conditions, in order to maintain public confidence in the reliability of the system.

3.6 Intergovernmental Agreements

The TCRP Synthesis 83 research revealed that most bus lanes and other transit priority treatments have been developed over the years without formal intergovernmental agreements. Further application of intergovernmental agreements related to bus lanes is certainly desirable, and should identify transit vs. traffic agency responsibility with respect to the following:

- Design and construction/installation of facilities
- Operations monitoring of lane use
- Maintenance of bus lane (pavement markings, signage, street cleaning, etc.)
- Replacement of equipment, such as upgrade of cameras for enforcement
- Monitoring of impact on traffic operations (system traffic detection, field surveys)
- Coordination meetings to review project implementation/operations/monitoring issues and strategize on future improvements

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APPENDIX A

BUS LANE REFERENCE DOCUMENTS

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- Miller, Mark A. *"Bus Lanes/Bus Rapid Transit Systems on Highways: Review of the Literature."*, California PATH Working Paper, UCB-ITS-PWP-2009-1, January 2009.
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- New York City Department of Transportation. *Red Bus Lane Treatment Evaluation*. New York: 2012.
- Poole Jr, Robert W., and Ted Balaker. *"Virtual Exclusive Busways: Improving Urban Transit While Relieving Congestion."* Reason Foundation, 2005.
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APPENDIX B

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PARSONS BRINCKERHOFF

Draft Meeting Notes

Attendees: **Miami-Dade County**

- Frank Aira, Miami-Dade County Public Works and Waste Management Department

Consultant Team to FDOT

- Alan Danaher, Parsons Brinckerhoff
- Adriana Rodriguez, Parsons Brinckerhoff
- Thomas Rodrigues, Parsons Brinckerhoff

Date: June 15, 2015
Time: 10:30 am to 11:15 am

Meeting Agenda

1. Review of signal system configuration in downtown Miami
2. Signal system hardware and software programmed/planned improvements
3. County philosophy towards Transit Signal Priority (TSP), particularly to downtown Miami
4. Added data/information available

Meeting Discussion

Alan opened the meeting with a brief review of the agenda items. The meeting then proceeded with general discussion on each item, as summarized below:

- The downtown Miami area signal system is currently a grid system. The City of Miami is planning to implement a coordinated system. Existing controllers are 170, with Econolite system. Firmware support has been provided by Kimley-Horn Associates.

- Data related to signal timing is available. The Miami-Dade County Public Works would need a list of the intersections to be analyzed to provide data. There is some data available online and PB will verify if there is need for added data.

- The City of Miami has started the implementation of TSP along Kendall Dr. The TSP system will be expandable to other areas in Miami-Dade County. TSP will be implemented to about 10 signals in this corridor for testing. This system will operate in a centralized architecture. The implementation of TSP in the downtown Miami area will be limited. MDT can be contacted to obtain documentation related to this program. Rosie Perez is the MDT contact,

- Frank Aira suggested coordination with the Downtown Development Authority in relation to its Vision Plan for streets in the downtown area and their desire for certain streets to become more multimodal in nature and hence greater opportunity for provision of transit lanes.

- The roadway level of service for inner streets within downtown Miami is likely to be at a level C or better. However, roadways that provide access to downtown Miami such as I-95 and Brickell are more congested and TSP implementation at selected signalized intersections on the fringe of downtown could benefit traffic flow.

Action or Follow-Up Items

- PB will send e-mail to Frank Aira with a list of signalized intersections and data requirements.
- PB will contact MDT for documentation related to TSP implementation in the City of Miami, in particular the Kendall Drive project. .
- PB will coordinate with the Downtown Development Authority related to obtaining any further information and insights related to their Vision Plan for certain streets in our study area.

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APPENDIX C

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MEETING MINUTES

Re: **Coordination Meeting with Miami-Dade Transit (MDT) Street Supervisors**
WO # 29: Bus Lanes in Downtown Miami

Date: June 23, 2015

Time: 9:00 – 10:00 a.m.

Location: Miami-Dade Transit

In Attendance: See attached sign-in sheet

The meeting purpose is for a discussion with MDT Street Supervisors to better understand the existing bus operating conditions experienced throughout the study area. An aerial map with the project limits was used to facilitate discussion and identify those locations of concern related to the Miami Bus Lanes study objective. A "mark-up" of the aerial map is attached and corresponding notes for the meeting are provided below.

- Omni Terminal traffic movements are hindered by the traffic signal at NE 14th Street and Biscayne Boulevard (Traffic Signal Asset ID: 2367). These routes in turn "conflict" with traffic exiting the Macarthur Causeway particularly during special events at the Adrienne Arsht Center for the Performing Arts.
  - MDT has rerouted some routes to NE 13th Street to Biscayne or NE 2nd Avenue for south bound movements to address this problem. While northbound traffic is routed east on NE14th Street to North Bayshore Drive, where bus stacking on North Bay shore occurs during peak travel time.
  - MDT would like to see signal timing modifications to NE 14th Street light to ensure south bound left movements can be made safely.
- NE 2nd Avenue is considered a key transit corridor.
- Due to events at the American Airlines Arena (AAA), Police close Biscayne Boulevard at the arena. As a result, MDT buses are detoured to NE 1st and 2nd Avenues. This triggers delays throughout the system.
- Intersection of NE 1st Avenue and NE 5th Street is regularly blocked.
- Impacts of Brickell Avenue Bridge opening is a significant cause of delays for MDT on NE 2nd Avenue.
- On-street parking on both sides of NE 2nd Avenue commonly results in damage to buses; mirrors knocked off, etc.
- Queue of cars accessing I-95 ramps at South Miami Avenue and South 1st Street results in congested transit travel conditions and conflicts with bus stop on near side of Miami Avenue during peak travel periods.
- Pedestrian/car/transit conflicts are of concern at SW 1st Street between SW 2nd Avenue and SW 1st Avenue. Supervisors requested an additional crosswalk before the intersection of SW 1st Avenue and SW 1st Street to minimize turning movement conflicts with buses.
- Detours within downtown core are hindered by the relatively few north-south avenues. There is no direct access to NW 1st Avenue from NW 14th Avenue. Evaluate the possibility of extending NW 1st Avenue south of NW10th Street to provide a direct connection between NW14th Street and Overtown Metrorail Station. AAF station combined with elevated tracking might create an opportunity to reestablish this road as an arterial.

- Access to new Downtown Terminal from Biscayne Boulevard will potentially necessitate improvements/transit only designation to an east-west street. Streets to consider for proposing transit improvements include: N 6th Street, N 5th street, N 3rd Street, N 2nd Street, N 1st Street, S 1st Street.

- On-street parking on NW 7th Avenue is restricted to off-peak hours. However, there is little enforcement of this provision and buses are often put in to conflict with other traffic on what is constricted to a one-lane road.

- Critical Mass (bike event that occurs on the last Friday of every month) causes significant delays and overtime costs for transit operations in downtown Miami as the ride congregates at NW 1st Street at Government Center. Coordination between MDT organizers is needed to request they use a different gathering place.

- Little activity on Miami Avenue and its relative distance from Biscayne Boulevard means that it is not commonly used as a transit detour route. However, Miami Avenue is used as an alternate when Biscayne is closed during special events (e.g., AAA events, Miami Heat games).

- NW 2nd Avenue and NW 3rd Street presents a significant conflict for bus drivers during peak travel periods due to congested travel conditions. The combination of peak traffic coming from I-95, and the presence of the Law Enforcement Officers Memorial High School presents challenges for MDT to operate in these congested conditions (e.g., slow travel speeds). A site on the north side of NW 3rd Street and adjacent to Government Center has been identified as a potential location for the MDT downtown bus terminal.

- Need to preserve bus stop spaces throughout downtown Miami to prevent operation conflicts with autos and commercial vehicles.

MIAMI-DADE COUNTY

Downtown Miami Bus Lanes Study
MDT Operating Conditions in Downtown Miami
June 23, 2015
9:00 a.m.

Sign-In Sheet

Print Name	Agency/Organization	Email Address	Phone No.
Jackie Carranza	MDT-Planning	carraj@miamidade.gov	786-469-5310
Felipe Hermida	MDT-Bus OPS.	hermida@miamidade.gov	786-402-1500
CEDRIC DALLAS	MDT. BUS OPS	CDALLAS@MIAMIDADE.GOV	305-638-7270
JOSE VILLARMARZO	MDT-BUS OPS	JVILLAR@MIAMIDADE.GOV	305 638-7422
Derrick Gordon	MDT " "	? dgo@ " "	305 637-3808
John LAFFERTY	Parsons Brinckerhoff	lafferty@pbworld.com	305 514 3163
TOM RODRIGUEZ	" "	RODRIGUEZ TR@PBWORLD.COM	305 514 3142

APPENDIX D

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MIAMI-DADE METROPOLITAN PLANNING ORGANIZATION

MEETING MINUTES

Re: **Joint Transportation Planner's Technical Advisory Committee (TPTAC)/ Transportation Improvement Program (TIP) September Meeting**

Date: September 2, 2015

Time: 2:00 p.m.

Location: Stephen P. Clark Center 10th Floor CITT Conference Room

In Attendance: See attached sign-in sheet [requested from MPO]

Alan Danaher, John Lafferty and Thomas Rodrigues from Parsons Brinckerhoff (PB) made a presentation on the current status of the Downtown Bus Lanes study, including a review of the data collection efforts and

Comments on presentation:

Monica Cejas, MDT:

- Consider additional transportation projects for the downtown area, including Biscayne Green, Miami World Center, Tri-Rail Coastal Link, Flagler B RT, SR 90 Bus Lanes, etc.
  - Jitender Ramchandani, MPO: There are lots of plans for Downtown, but we have to ensure they go through a screening process, therefore, this study is only considering funded projects.
- Directional Bus Volumes slide (slide 14) should include more street segments. For example, SE 1st Street is traveled by 17 routes, while E 2nd Avenue is traveled by 9 routes.
- The warrants cited on slide 23 are from a 1970s NCHRP Report. PB should consider using studies that are more current.
  - Alan Danaher, PB – the numbers cited in the NCHRP report are still the basis for establishing warrants today, the information is still current.
- The study should also consider future bus volumes.

Miami DDA:

- Please consider the DDA's ongoing efforts to establish Biscayne Green when making recommendations in this study. Biscayne Green will reduce capacity on Biscayne Boulevard to improve the pedestrian environment.

Jarice Rodriguez, City of Miami

- What are the implications for loading zones in the Downtown area?
  - Jitender: City will have to ramp up enforcement to ensure loading zones are used appropriately.

Carlos Cruz-Casas, City of Miami

- City is advocating for a vision of Downtown Miami that includes satellite parking garages, and a number of transit circulators to connect people to the urban core.

- Remember that the City, DDA, and County have all adopted the Pedestrian Priority Zone ordinance, which applies to all of Downtown Miami.
- AM Peak bus volumes look lighter than they should on NE 1st Street (by Government Center)
- Miami Streetcar alignment depicted in presentation maps is incorrect.

Julian Guevara, City of Miami Beach

- Consider mode shifts in the future
- Consider jurisdictional aspect of developing a bus lane plan – County, City, and State have varying degrees of control of Downtown streets. Maintenance, traffic signals, engineering standards, etc.

Carlos Roa, MPO

- BCT routes were not factored in this study, but they will have an impact in the area. Data from their routes should be included.
    - Jitender: adding BCT routes will only fortify the demonstration of need.
- Will the study consider counter-flow bus lanes?
    - Alan: That's up to the committee; Counter-flow lanes' applicability in Downtown Miami would need to be evaluated further.

Wilson Fernandez, MPO

- Beach Connection would require a streetcar only street, potentially. What other examples exist around the country of this application?
- Future conditions may change drastically, including All Aboard Florida, etc. Try to focus on helping future Downtown rather than focusing on present conditions.

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APPENDIX E

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Parking Occupancy Data (AM Peak)

X = Need data
NP=denotes no parking within the segment
(-) = Data not collected

AM Peak 7 - 9 AM
PM Peak 5 - 7 PM
Mid-day 12 - 2 PM

Date: 5/27/2015

Priority	Street	Segment	AM Peak	Parking Data		Parking Utilization (%)
				Utilized	Inventory	
High	NW 2nd Ave	NW 6th St to NW 5th St	X	0	8	0.0%
	NW 2nd Ave	NW 5th St to NW 3rd St	X	14	33	42.4%
	NW 1st Ave	NW 6th St to NW 5th St	X	0	8	0.0%
	NW 1st Ave	NE 3rd St to NE 2nd St	X	22	22	100.0%
	NE 1st Ave	NE 6th St to NE 2nd St	X	2	31	6.5%
	NE 2nd Ave	NE 6th St to NE 2nd St	X	32	72	44.4%
	NE 1st St	NW 1st Ave to NE 3rd Ave	X	8	19	42.1%
	NE 1st St	NE 3rd Ave to Biscayne Blvd	X	1	1	100.0%
	SE 1st St	SE 2nd Ave to Biscayne Blvd	X	21	22	95.5%
Medium	NW 7th Ave	NW 20th St to NW 5th St	X	NP	NP	
	NW 3rd Ave	NW 20th St to NW 14th St	X	9	52	17.3%
	NW Miami Ct	NE 1st St to Flagler St	X	14	14	100.0%
	Miami Ave	NE 6th St to NE 5th St	X	0	12	0.0%
	Miami Ave	NE 3rd St to Flagler St	X	8	24	33.3%
	NE 1st Ave	NE 16th St to NE 6th St	X	4	93	4.3%
	NE 2nd Ave	NE 20th St to NE 6th St	X	28	61	45.9%
	NW 20th St	NW 7th Ave to NW 2nd Ave	X	NP	NP	
	NE 15th St	NE 1st Ave to Biscayne Blvd	X	5	8	62.5%
	NW 10th St	NW 5th Ave to NW 3rd St	X	6	65	9.2%
	NW 8th St	NW 3rd Ave to NW 1st Ave	X	9	35	25.7%
	NW 6th St	NW 7th Ave to NW 1st Ave	X	71	180	39.4%
	NW 5th St	NW 5th Ave to NW 2nd Ave	X	23	77	29.9%
	NW 5th St	NW 2nd Ave to Railroad	X	8	40	20.0%
	NW 5th St	Railroad to NW 1st Ave	X	0	8	0.0%
	NE 3rd St	SE 1st Ave to Biscayne Blvd	X	20	35	57.1%
	Flagler St	NW North River Dr to NW Miami Ct	X	40	58	69.0%
	SE 2nd St	SW 2nd Ave to Miami Ave	X	37	45	82.2%
Low	NW 4th Ct	NW 20th St to NW 17th St	X	–	–	
	NW 5th Ave	NW 11th St to NW 5th St	X	–	–	
	NW 3rd Ave	NW 14th St to NW 9th St	X	–	–	
	NW 2nd Ave	NW 14th St to NW 6th St	X	–	–	
	Miami Ave	NE 20th St to NE 6th St	X	–	–	
	NE 1st Ave	NE 17th St to NE 16th St	X	NP	NP	
	NE 20th St	NW 2nd Ave to NE 2nd Ave	X	–	–	
	NE 17th St	Miami Ave to NE 1st Ave	X	–	–	
	NE 16th St	NE 1st Ave to NE 2nd Ave	X	–	–	
	NW 11th St	NW 5th Ave to NW 3rd Ave	X	–	–	
	NW 9th St	NW 3rd Ave to NW 2nd Ave	X	–	–	

Parking Occupancy Data (MD Peak)

X = Need data
NP=denotes no parking within the segment
(-) = Data not collected

AM Peak 7 - 9 AM
PM Peak 5 - 7 PM
Mid-day 12 - 2 PM

Date: 6/10/2015

Priority	Street	Segment	MD Peak	Parking Data Utilized	Parking Data Inventory	Parking Utilization (%)
High	NW 2nd Ave	NW 6th St to NW 5th St	X	3	8	37.5%
	NW 2nd Ave	NW 5th St to NW 3rd St			33	0.0%
	NW 1st Ave	NW 6th St to NW 5th St	X	5	8	62.5%
	NW 1st Ave	NE 3rd St to NE 2nd St			22	0.0%
	NE 1st Ave	NE 6th St to NE 2nd St	X	31	31	100.0%
	NE 2nd Ave	NE 6th St to NE 2nd St			72	0.0%
	NE 1st St	NW 1st Ave to NE 3rd Ave			19	0.0%
	NE 1st St	NE 3rd Ave to Biscayne Blvd	X	1	1	100.0%
	SE 1st St	SE 2nd Ave to Biscayne Blvd			22	0.0%
Medium	NW 7th Ave	NW 20th St to NW 5th St	X	NP	NP	
	NW 3rd Ave	NW 20th St to NW 14th St	X	4	52	7.7%
	NW Miami Ct	NE 1st St to Flagler St	X	14	14	100.0%
	Miami Ave	NE 6th St to NE 5th St	X	7	12	58.3%
	Miami Ave	NE 3rd St to Flagler St	X	24	24	100.0%
	NE 1st Ave	NE 16th St to NE 6th St	X	24	93	25.8%
	NE 2nd Ave	NE 20th St to NE 6th St	X	37	61	60.7%
	NW 20th St	NW 7th Ave to NW 2nd Ave	X	NP	NP	
	NE 15th St	NE 1st Ave to Biscayne Blvd	X	8	8	100.0%
	NW 10th St	NW 5th Ave to NW 3rd St	X	21	65	32.3%
	NW 8th St	NW 3rd Ave to NW 1st Ave	X	9	35	25.7%
	NW 6th St	NW 7th Ave to NW 1st Ave	X	75	180	41.7%
	NW 5th St	NW 5th Ave to NW 2nd Ave	X	26	77	33.8%
	NW 5th St	NW 2nd Ave to Railroad			40	0.0%
	NW 5th St	Railroad to NW 1st Ave	X	3	8	37.5%
	NE 3rd St	NE 1st Ave to Biscayne Blvd	X	30	35	85.7%
	Flagler St	NW North River Dr to NW Miami Ct	X	26	35	74.3%
	SE 2nd St	SW 2nd Ave to Miami Ave			45	0.0%
Low	NW 4th Ct	NW 20th St to NW 17th St	X	11	34	32.4%
	NW 5th Ave	NW 11th St to NW 5th St	X	25	101	24.8%
	NW 3rd Ave	NW 14th St to NW 9th St	X	22	34	64.7%
	NW 2nd Ave	NW 14th St to NW 6th St	X	30	86	34.9%
	Miami Ave	NE 20th St to NE 6th St	X	62	165	37.6%
	NE 1st Ave	NE 17th St to NE 16th St	X	NP	NP	
	NE 20th St	NW 2nd Ave to NE 2nd Ave	X	34	34	100.0%
	NE 17th St	Miami Ave to NE 1st Ave	X	9	49	18.4%
	NE 16th St	NE 1st Ave to NE 2nd Ave	X	6	40	15.0%
	NW 11th St	NW 5th Ave to NW 3rd Ave	X	17	80	21.3%
	NW 9th St	NW 3rd Ave to NW 2nd Ave	X	NP	NP	

Parking Occupancy Data (PM Peak)

X = Need data
NP=denotes no parking within the segment
(-) = Data not collected

AM Peak 7 - 9 AM
PM Peak 5 - 7 PM
Mid-day 12 - 2 PM

Date: 5/27/2015

Priority	Street	Segment	PM Peak	Parking Data		Parking Utilization (%)
				Utilized	Inventory	
High	NW 2nd Ave	NW 6th St to NW 5th St	X	6	8	75.0%
	NW 1st Ave	NW 6th St to NW 5th St	X	5	8	62.5%
	NE 1st Ave	NE 6th St to NE 2nd St	X	23	31	74.2%
	NE 1st St	NE 3rd Ave to Biscayne Blvd	X	1	1	100.0%
Medium	NW 7th Ave	NW 20th St to NW 5th St	X	NP	NP	
	NW 3rd Ave	NW 20th St to NW 14th St	X	4	52	7.7%
	NW Miami Ct	NE 1st St to Flagler St	X	10	14	71.4%
	Miami Ave	NE 6th St to NE 5th St	X	8	12	66.7%
	Miami Ave	NE 3rd St to Flagler St	X	18	24	75.0%
	NE 1st Ave	NE 16th St to NE 6th St	X	5	93	5.4%
	NE 2nd Ave	NE 20th St to NE 6th St	X	26	61	42.6%
	NW 20th St	NW 7th Ave to NW 2nd Ave	X	NP	NP	
	NE 15th St	NE 1st Ave to Biscayne Blvd	X	5	8	62.5%
	NW 10th St	NW 5th Ave to NW 3rd St	X	8	65	12.3%
	NW 8th St	NW 3rd Ave to NW 1st Ave	X	2	35	5.7%
	NW 6th St	NW 7th Ave to NW 1st Ave	X	78	180	43.3%
	NW 5th St	NW 5th Ave to NW 2nd Ave	X	11	77	14.3%
	NW 5th St	Railroad to NW 1st Ave	X	3	8	37.5%
	NE 3rd St	SE 1st Ave to Biscayne Blvd	X	24	35	68.6%
	Flagler St	NW North River Dr to NW Miami Ct	X	16	35	45.7%
Low	NW 4th Ct	NW 20th St to NW 17th St	X	5	34	14.7%
	NW 5th Ave	NW 11th St to NW 5th St	X	15	101	14.9%
	NW 3rd Ave	NW 14th St to NW 9th St	X	19	34	55.9%
	NW 2nd Ave	NW 14th St to NW 6th St	X	21	86	24.4%
	Miami Ave	NE 20th St to NE 6th St	X	51	165	30.9%
	NE 1st Ave	NE 17th St to NE 16th St	X	NP	NP	
	NE 20th St	NW 2nd Ave to NE 2nd Ave	X	18	34	52.9%
	NE 17th St	Miami Ave to NE 1st Ave	X	10	49	20.4%
	NE 16th St	NE 1st Ave to NE 2nd Ave	X	0	40	0.0%
	NW 11th St	NW 5th Ave to NW 3rd Ave	X	3	80	3.8%
	NW 9th St	NW 3rd Ave to NW 2nd Ave	X	NP	NP	

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