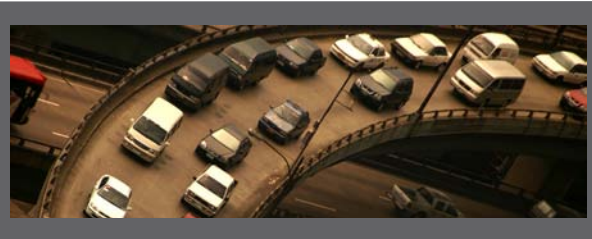


# Shared-Use Bus Priority Lanes on City Streets: Case Studies in Design and Management



MTI Report 11-10



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REPORT 11-10

# SHARED-USE BUS PRIORITY LANES ON CITY STREETS: CASE STUDIES IN DESIGN AND MANAGEMENT

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## EXECUTIVE SUMMARY

In recent years, cities around the country have created new Bus Rapid Transit (BRT) systems and pursued other strategies to make their regular bus services faster and more reliable. At the same time, a new emphasis on maximizing the productivity and livability of urban streets has led to new design and management practices to address the needs of their many users. As a result, an old approach to improving bus service in urban centers, the designation of street space for priority use by buses, has been getting a new look.

This study 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 the historical legal, institutional, engineering, and enforcement contexts for understanding the bus lane development and management strategies in seven cities out of the dozens that have chosen to adopt this practice. Bus lanes tend to be well suited for cities like the ones profiled here, which have high levels of bus transit demand and traffic operating conditions that are so dense and complex that it is impractical to physically segregate lanes solely for transit use. At their best, they reflect the ideal that a well-designed and well-managed street can help transit to operate more efficiently, while maintaining flexibility to accommodate the needs of other users of the street space.

This report is intended primarily for planners and policymakers interested in learning more about the development and implementation of bus lanes in other cities. It is hoped that students and researchers will also find these case studies valuable.

## METHODOLOGY

Although this study relied on a mix of methods, the primary one was the development of case studies about seven communities that currently have bus lane networks: Los Angeles, London, New York City, Paris, San Francisco, Seoul, and Sydney. The seven cities vary significantly in size, institutional structure, urban form, and relative importance of their bus systems. The cities were chosen not to represent typical experiences in the development and management of urban bus lanes, but to reflect a diverse range of approaches and challenges.

The study addressed four key questions about each city:

1. How do the many public agencies within any city region that share authority over different aspects of the bus lanes coordinate their work in designing, operating, and enforcing the lanes?
2. What is the physical design of the lanes?
3. What is the scope of the priority use granted to buses? When is bus priority in effect, and what other users may share the lanes during these times?
4. How are the lanes enforced?

To answer these questions we conducted interviews with local professionals working on bus lane planning, operations, and enforcement; reviewed available government reports, academic studies, and conference papers about the lanes; searched for discussion of the bus lanes in newspaper archives and websites; and searched local and state laws and regulations related to the lanes. In several of the cities, we also conducted direct observations in the field in order to confirm data about bus lane designs and posted regulations.

## **SUMMARY OF FINDINGS**

The findings on the four study questions are summarized as follows:

*1. How do the many public agencies within any city region that share authority over different aspects of the bus lanes coordinate their work in designing, operating, and enforcing the lanes?*

In most cities, responsibilities are split among agencies responsible for street engineering, transit services, and policing, as well as across multiple levels of government. In most of the cities examined here, there has been movement toward greater integration of these responsibilities. The most common development has been the emergence of urban transportation agencies with integrated responsibility for both urban transit services and city streets, such as Transport for London, the San Francisco Municipal Transportation Agency, and Seoul's City Transportation Headquarters. Less common has been integration of enforcement responsibilities into these broader transportation agencies. Short of formally granting these agencies policing powers, several of the cities have established formal contracts or personnel assignments across police and transportation agencies to ensure that bus lane enforcement remains a priority.

*2. What is the physical design of the lanes?*

Among the cases examined here, the most common physical arrangement for bus priority lanes on city streets is along the curbside. This position minimizes impacts on general traffic flow, but puts buses into competition with vehicles queuing to make turns, stopping at the curb to pick up or discharge passengers, standing at the curb to make deliveries to local business, or parking. Several of the cities examined here are shifting toward alternative approaches that mitigate some of these drawbacks, including offset lanes that preserve more curb access (New York, San Francisco), physical barriers (Paris), and median bus lanes (Seoul).

There has been trend over the past decade in most of these cities toward bus lane designs that more clearly declare their presence by using painted lanes. But one city (Seoul) is already pulling back from this due to safety and maintenance concerns, and it remains to be seen how many of the cities sustain the commitment to ongoing painting programs that such lane designs require.

One universal finding was that there is no single "one size fits all" bus lane design or alignment suitable throughout any of these cities. Each has had to adapt its bus lane designs and regulations to meet local conditions, often on a block-by-block basis.

*3. What is the scope of the priority use granted to buses? When is bus priority in effect, and what other users may share the lanes during these times?*

In general, bus priority lanes exist in urban environments where the goal of improving mobility for bus riders must be balanced against the access and mobility needs of other transportation system users. This “balance” can be achieved in multiple ways, such as allowing other vehicles to access the bus lane under defined conditions, scheduling different uses for the lane during different times of day, and positioning the bus lane in different ways to change the mix of users affected by the bus lane’s presence.

In general, nearly every city studied here allows all vehicles to use curbside bus priority lanes to make right turns (or left turns in the U.K. and Australia where vehicles travel on the left side of the road), and to access driveways on a given block. Taxis are universally allowed to use the lanes to pick up and discharge passengers. Several cities authorize bicycles and taxis to drive in a bus lane as well. Other exemptions are more unusual.

While bus lanes usually operate around the clock in a few of the cities, in most they only operate during peak hours of public transit use. As cities shift toward the new physical layouts for bus lanes discussed above, they have been able to extend the hours that bus lanes can operate.

*4. How are the lanes enforced?*

Transportation agencies rarely have the luxury to develop and implement optimal bus lane enforcement strategies; they must work with the limited tools they have been given in the political and legal systems under which they operate. In most cases, enforcement of laws concerning the operation of motor vehicles is a police responsibility, and the granting of police powers to a civilian transportation agency is not a possibility. Cities have dealt with this challenge in various ways. Some have passed laws reclassifying bus lane violations as civil infractions that can be enforced by civilian agents and/or by automated cameras. Others have developed contractual or supervisory relationships between police and transportation agencies to ensure that there are personnel directly responsible for bus lane enforcement. Others have pursued opportunities to install physical barriers, move bus lanes away from the curb, or adopt other design strategies that rely less heavily on enforcement to make bus lanes work.



---

## I. INTRODUCTION

In recent years, there has been a wave of interest and innovation in strategies to make bus operations more efficient and effective. Cities around the country have created new Bus Rapid Transit (BRT) systems and pursued other strategies to make their regular bus services faster and more reliable. At the same time, a new emphasis on maximizing the productivity and livability of urban streets has led to new design and management practices to address the needs of their many users. As a result, an old approach to improving bus service in urban centers, the designation of street space for priority use by buses, has been getting a new look.

This study examines the policies and strategies governing the design and, especially, the operations of bus lanes in major congested urban centers. It focuses on bus lanes that operate in mixed traffic conditions, and provides the historical legal, institutional, engineering, and enforcement contexts for understanding the bus lane development and management strategies in seven cities out of the dozens that have chosen to adopt this practice. Bus lanes tend to be well suited for cities with high levels of bus transit demand and traffic operating conditions that are so dense and complex that it is impractical to physically segregate lanes solely for transit use. A well-designed bus lane in a suitable place can help transit to operate more efficiently, while also preserving operational flexibility other vehicles, such as taxis, bicycles, or right-turning vehicles, to share the space. Four key questions addressed in the study are:

1. How do the many public agencies within any city region that share authority over different aspects of the bus lanes coordinate their work in designing, operating, and enforcing the lanes?
2. What is the physical design of the lanes?
3. What is the scope of the priority use granted to buses? When is bus priority in effect, and what other users may share the lanes during these times?
4. How are the lanes enforced?

There are numerous types of bus priority treatments in use on city streets. Bus lanes can be located along the near-side curb, in the median, or on the far-side curb of one-way streets. They can run with the direction of traffic (“concurrent” flow lanes), or against it (“contraflow” lanes). They can be physically segregated from traffic, or they can permit the mixing of buses with traffic. This study does not examine practices concerning bus priority lanes on urban highways or freeways.

The tremendous success of the *TransMilenio* bus rapid transit system in Bogotá (and the continuing, pioneering success of its widely known predecessor in Curitiba, Brazil) has prompted an explosion of other BRT development efforts in other cities in Latin America, East Asia, and elsewhere in the developing world. International development agencies like the World Bank and nonprofits like the Institute for Transportation and Development Policy and the World Resources Institute’s EMBARQ program have provided encouragement

and expertise to foster the implementation of BRT in developing cities around the world, including a wide array of urban contexts. These strategies are advanced as alternatives to rapid rail transit, and in some cases are capable of achieving equivalent or higher passenger capacities than is feasible with rail at significantly lower cost.

BRT has caught the attention and imaginations of planners and policymakers in industrialized nations as well. To many U.S. cities that had longstanding but unrealized dreams of building rail rapid transit systems, BRT promises a lower cost and more feasible pathway to development of an efficient urban transit system. To the U.S. federal government, BRT provides a way to extend the impact of its limited funding for new transit capacity projects. TransMilenio continues to provide much of the inspiration for these systems, and the greatest degree of popular and scholarly attention has accordingly focused on solutions that build transitways to physically segregate buses from traffic as much as possible.

The humble bus priority lane is often overlooked amid this excitement. It is far less glamorous, and far less effective than its higher-end cousins. Yet because it is cheaper, far more flexible, and a practical solution in a wider range of contexts, it can be implemented on a far more extensive basis, and can serve as an important part of the mix even in cities where exclusive busways are being developed. In recent years, many cities have updated their bus lanes networks, introduced new innovations, or struggled to get them off the ground. This study examines the current use of curbside bus lanes in cities around the world in order to identify the range of practices in use, thus providing planners and decision makers with an awareness of the wide variety of design and operational options available to them. In addition, the report highlights innovative practices that contribute to bus lanes' success where this is possible.

## **ORIGINS OF BUS PRIORITY LANES**

Bus priority lanes have been an enduring feature of the urban streetscape. As seen today, they began to appear in the mid-1950s, as an evolution of a number of other street management interventions:

- One key precedent in many U.S. cities were early 20th century laws granting the right-of-way to streetcars: other vehicles typically could drive on a trackway, but were required to exit when approached by a streetcar from behind.
- A second precedent was the regulation of the use of curb space to facilitate traffic flow. New York City passed regulations as early as 1897 prohibiting wagons from being loaded while parked perpendicular to the curb.<sup>1</sup> From these beginnings grew a complex set of regulations governing curb use, from parking meters to curbside bus priority lanes.
- Another key precedent was the use of paint to allocate street space. Marking of traffic lanes on city streets emerged as common practice in mid-century, although painted centerlines were in use much earlier. These were among many measures adopted to help bring safety, order, and improved flow to city streets by the rising profession of traffic engineering.

- Finally, there are also a few early examples of streets being managed for the primary or exclusive benefit of buses. In 1939, Chicago established contraflow lanes to facilitate buses and local traffic on a reversible one-way street that served heavy peak hour traffic volumes.<sup>2</sup> In 1948, Providence, Rhode Island, converted a street railway line and a dedicated transit tunnel for use by buses.<sup>3</sup>

Bus priority lanes inherited concepts from each of these innovations. They provide buses with preferential access, while preserving shared use of the street. They rely on active management of the curbside to facilitate the flow of traffic. They mark the street to allocate space for different purposes. And they manage street operations to help buses move more efficiently.

In the mid-1950s, bus priority lanes emerged as a popular solution to a set of problems confronting cities across the United States. The American postwar urban crisis was underway. Accelerating suburbanization brought economic stress to neighborhoods and downtowns. Traffic grew rapidly, as the automobile became an increasingly dominant commuting mode, bringing new forms of congestion and new challenges to the management of city streets.

Transit companies struggled to cope with overregulated fares and long-neglected capital stock, as ridership fell sharply from postwar highs. Failure or abandonment of privately-operated bus lines was increasingly common. States and cities studied and enacted institutional and financing arrangements for new public transit agencies and authorities. Cities also grappled with the traffic engineering challenges posed by rising automobile traffic, and the replacement of streetcar systems with buses.

Amid this climate, in the 1950s, cities across the country looked to bus priority treatments to help keep buses and downtowns competitive and viable. A landmark proposal for a system of bus lanes to relieve congestion in downtown Chicago was made in 1955 by Werner Schroeder, Vice-Chairman of the Chicago Transit Authority. Schroeder's report drew clear linkages among the crises of transit finance, urban congestion due to the rise of the automobile, and the viability of urban centers in the face of decentralization pressures. It also noted that Chicago's struggles in these areas were being shared by other urban centers across the country.<sup>4</sup>

In 1956, Nashville became the first city to install concurrent-flow bus priority lanes. In order to facilitate the flow of buses through this congested area near the State Capitol, it eliminated street parking on portions of four streets, and reserved the right-hand lanes for buses during the morning and evening peak hours. It marked the lanes with yellow lines and overhead neon signs.<sup>5</sup> It enforced the ban on parking by ticketing and towing vehicles, but did not take enforcement actions against motorists who drove in the bus lanes. Nashville also offered other service enhancements for bus passengers to help preserve the attractiveness of the city center as a destination, including free re-boarding privileges, and even the free use of baby carriages downtown.<sup>6</sup>

At the time, the Nashville experiment garnered a significant amount of attention. Traffic engineers from the City of Chicago and the Chicago Transit Authority visited Nashville to observe its exclusive bus lane system, and returned recommending that Chicago proceed with its own bus lane experiment.<sup>7</sup>

In June of that year, the Chicago City Council established the first bus lane in its central business district, in the center of Washington Street, a five-lane street running eastbound into the city. The lane ran 0.6 miles between Wacker Drive and Michigan Avenue, and featured 4.5-foot passenger loading zones designated by wide yellow stripes. It featured wide raised platforms with splash guards, and initially served about 90 buses per hour during periods of peak demand.

In June 1957, Baltimore became the first city to authorize the designation of bus lanes as an administrative power. Before this point, modifications to city streets, from the placement of traffic lights to the installation of parking meters, were powers closely held by elected officials (mayors and/or city councils, depending on the city), and were often highly politicized decisions. At the urging of Department of Traffic Engineering Director Henry Barnes, Baltimore's city council adopted and the mayor approved ordinances that allowed the Director of Traffic Engineering to designate bus lanes and make other engineering improvements on city streets without seeking approval from the council or a traffic commission. Locations for the implementation of bus lanes were selected on the basis of "warrants," which specified minimum bus frequencies or other quantifiable standards that had to be met before a bus lane could be put into place. Baltimore's designated its first bus lanes on eight blocks in 1958. Barnes later carried the model of the "strong" city Traffic Engineer to New York City and many other municipalities.<sup>8</sup>

By early 1959, other cities implementing bus lanes included Atlanta, Dallas, Newark, Rochester, and Winnipeg.<sup>9</sup> See Table 1 for the initial implementation dates for bus lanes in various cities.

**Table 1. Initial Establishment of On-street CBD Bus Lanes in Selected Cities**

Year	Cities
1956	Nashville, Chicago, Harrisburg, Newark, Philadelphia
1957	Rochester, Minneapolis, Washington
1958	Atlanta, Baltimore, Birmingham, Dallas, Winnipeg
1959	Peoria
1963	Hamburg, New York, Vancouver
1964	Buffalo, Paris
1966	Brussels, Montreal
1968	Providence, San Antonio, London
1970	San Francisco, Seattle, Syracuse
1971	Houston, San Juan
1974	Los Angeles
1984	Seoul
1992	Sydney

*Sources:* Herbert S. Levinson, William F. Hoey, David B. Sanders, and F. Houston Wynn, *Bus Use of Highways: State of the Art*, NCHRP Research Report 143 (Washington, D.C.: Highway Research Board, National Research Council, 1973), 221-223. Tables 12, 15-17, 19-20, with updates by the authors based on the case studies.



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In the 1960s, bus travel in the United States and Europe was declining in a self-reinforcing cycle in which the growth in car ownership depressed transit ridership, which led to higher fares and reduced service, and ultimately to changes in residential and employment locations to places that were more accessible by automobile.<sup>10</sup> In some cities, bus volumes declined to the point that they were deemed insufficient to justify reserving street space solely for their use. In others, no effective method for enforcement was implemented, so the lanes failed to provide any noticeable benefits. Some central cities emptied out at job centers, so the nature of traffic into and through them changed over time. In others, merchants' strong preference for curbside parking overwhelmed efforts to reserve the curb lane for traffic or buses.

Not all of these operations stood the test of time, and many of these bus lanes were ultimately abandoned, for a wide variety of reasons. Mid-street platforms like those adopted on Washington Street in Chicago, once commonplace in the streetcar era, came to be seen as safety hazards and maintenance problems. They were gradually removed in favor of painted pedestrian islands,<sup>11</sup> or moved to the curb (where the Washington Street lane runs today). Atlanta established exclusive bus lanes on four downtown streets in early 1958, but abandoned them in 1962-63 as streets were converted to one-way operations, or re-engineered to facilitate traffic flow.<sup>12</sup> Even Baltimore's bus lanes, which had been expanded by 1972 to include about 60 blocks (5 miles) of bus lanes, were largely abandoned by the 1980s.<sup>13</sup>

Nonetheless, bus lanes continued to be maintained and expanded in some U.S. cities with the right mix of conditions, most notably New York and San Francisco. These cities both had a vibrant enough economy to sustain high demand for access by buses. They also both had streets with high enough traffic congestion to impede bus flow, but enough buses to justify actions that might impede traffic. Although the political consensus favoring enforcement of the bus lanes waxed and waned, these two American cities were over time able to sustain extensive bus priority networks. Other American cities able to develop and maintain bus priority networks on downtown streets included Chicago, Houston, Los Angeles, Madison, Newark, and Seattle. In the 1970s, new pressures emerged for the development of bus lanes. The Clean Air Act of 1970 forced many U.S. cities to consider ambitious plans to reduce emissions of air pollutants from the transportation sector. This led some cities to redouble their efforts to make bus lanes work, as they struggled with gridlock in central business districts and the threat of draconian EPA-imposed regulations if they could not come up with an effective plan to cut air pollution, New York significantly expanded its bus lane network and adopted an aggressive public relations and enforcement operation to ensure that they would be effective. In the late 1990s and early 2000s, air quality concerns would also emerge as a key motivation for Paris' reinvention of its bus priority network.

Today, with many urban centers again thriving to a degree not seen in decades, urban efficiency, transit mobility, and livability have become key motivational factors in the development and improvement of bus lanes.

## PREVIOUS STUDIES

There is extensive existing literature on the design of urban bus lanes. In most cases, the focus of this literature has been on strategies for achieving higher-performing bus lanes through physical segregation on city streets, or on design standards for bus lanes more generally.

The analytical literature on bus priority treatments dates back to the mid-1950s, with the first comprehensive study being the NCHRP report *Bus Use of Highways: State of the Art*.<sup>14</sup> It provides a comprehensive snapshot of the state of practice in bus priority treatments for highways, streets, and terminals in the U.S. and Europe through the early 1970s. It includes brief case studies of the implementation of bus priority projects in numerous cities, as well as a chronological bibliography on bus priority treatments. A follow-up report provided bus priority lane design guidelines.<sup>15</sup> A somewhat more policy-oriented treatment of the topic, with more of a European focus, was published the following year.<sup>16</sup> More recently, there has been a renewed interest in bus lanes, especially as they relate to bus rapid transit (BRT) systems.<sup>17</sup> There have also been a few efforts to examine the policy processes that lead to the development of bus priority systems.<sup>18</sup> More specialized literature has emerged on various individual strategies for improving transit priority on urban streets. There is a large body of research on transit priority signals, often with an emphasis on modeling their impacts.<sup>19</sup> There has also been research into queue-jumping strategies for buses on urban streets, through the combination of transit priority signals and short bus lanes.<sup>20</sup> Another innovative strategy that has been the focus of some research has been the “intermittent” bus lane that prohibits general traffic only as buses approach, but reopens to general traffic after buses depart.<sup>21</sup>

The effectiveness of bus priority treatments at improving the speeds of buses in mixed traffic has long been a topic of great interest to planners and policymakers. Various reports and planning manuals for urban bus priority treatments incorporate estimates of the effectiveness of specific measures based on field data from multiple cities.<sup>22</sup> However, broader investigation of this topic in the peer reviewed literature has been somewhat limited, since the urban contexts in which bus priority treatments are implemented are so diverse, and because local evaluation data is scarce. Since multiple bus priority treatments are often implemented simultaneously, local evaluation studies rarely attempt to explore the effectiveness of individual design components. Even in cases where components like bus lanes are analyzed in isolation, evaluation studies are usually focused on relatively narrow questions of adverse traffic impacts and increased bus speeds. For these reasons, and because traffic conditions and street geometry vary so significantly from place to place, it is difficult to draw generalizable conclusions from these studies.

The evolving interest in bus priority lanes can also be understood in terms of the significant paradigm shift underway with regard to urban streets and arterials management. For decades, maximization of traffic flow and the availability of parking have been central objectives of urban traffic engineering. Over the past decade or more, there has been a significant shift toward treating urban streets as complex systems, which are to be managed to maximize their safety, productivity and livability for their full range of users. These changes are becoming institutionalized in various forms through the adoption of policies

and programs that implement complete streets, managed lanes, context sensitive design, road diets, parking policy reform, and other emerging planning principles. In many jurisdictions, bus lanes are increasingly being designed and managed as an integral part of a comprehensive strategy to meet the multiple objectives of transit mobility, access for goods delivery, pedestrian safety and livability, and traffic flow.<sup>23</sup> The present study builds upon the existing research by providing a design and system management perspective, taking a cross-cutting look at the historical, legal, design, and operational contexts of traditional curbside bus lanes, and drawing conclusions about innovative practices that have contributed to the successful implementation of bus lane networks in those cities.

## STUDY METHODOLOGY

Although this study relied on a mix of methods, the primary one was the development of case studies about seven communities that have or are developing bus lane networks: Los Angeles, London, New York City, Paris, San Francisco, Seoul, and Sydney. The case studies were chosen according to several criteria. The selection process favored cities that have:

- A reasonable network of bus lanes, rather than just a single segment or two.
- Policies allowing users other than buses to share the lanes (e.g., taxis or all right-turning vehicles).
- Bus lanes running through congested urban neighborhoods with a mix of land-uses along the corridors.

Four of the selected cities (London, Paris, New York, and San Francisco), each has four or more decades of experience planning and managing bus lanes, and in this time have gone through several phases in the evolution of their networks and policies. Seoul's and Sydney's bus lane networks are younger, but are already very extensive and have also seen various rounds of innovations. Los Angeles is a bit of an outlier among the cases: buses serve as the core of its public transit system, and the city has worked to develop bus lanes for over three decades, but has never developed an extensive bus lane network (it has, however, been a leader in the development of transit signal prioritization). All of these cities have both a history of bus lane development and recent efforts at innovation. Aside from these similarities, the seven cities represent a variety of sizes, political and institutional systems, and degree of reliance on bus transit relative to other modes.

For each of the seven cases we reviewed available government reports, academic studies, and conference papers about the lanes; searched for discussion of the bus lanes in newspaper archives and websites; and searched local and state laws and regulations related to the lanes. However, we discovered that for every city clear documentation was scarce about the planning, operations, and enforcement of the bus lanes, so a very important component of the research was interviews conducted with local professionals working on bus lane planning, operations, and enforcement.

These interviews were conducted by phone or in person and lasted from approximately 30 to 60 minutes. Between four and ten individuals were interviewed for each city. For each case, we identified interviewees from multiple agencies and/or multiple departments within large agencies. When possible, we spoke with staff responsible for planning, operations, and enforcement of bus lanes. Staff tended to come from a mix of transit operations, transportation planning, and in some cases the police. (Appendix H lists the interviewees.)

In Los Angeles, New York City, Paris, San Francisco, and Sydney the research team also spent time in the field observing the lanes, photographing them, and in some cases collecting a small amount of data on the available signage for or use of the lanes. In addition, when the team did not have its own visual data available we reviewed photographs from other sources and/or Google Earth street-level images.

After each case was drafted, it was sent to at least one person with expertise on bus lanes in that city for review, asking the reviewer to identify errors or omissions in the material presented. Some of these reviewers were the original interviewees, though we often relied in addition or instead on other experts.

When writing the case studies, all written sources are documented with endnotes. In all other cases, readers should presume that the information is either common knowledge or else came from the interviews and reviewers. The names of the interviewees and reviewers have not been included, in order to protect the confidentiality of agency staff who were often speaking about sensitive issues within their agencies.

Despite the authors' careful efforts to present accurate information in the report, readers should be aware that in some cases specific details may not be accurate at the time of their reading the report. Urban street designs and management policies evolve constantly and often without publicity. The case studies were initially developed over a period of a few years, and were updated to be as current as possible in the summer of 2010. As a result, readers seeking specific details for a particular city are advised to check the latest available information from other sources.

## **OVERVIEW OF THE CASE STUDY CITIES**

The seven cities examined in this report vary significantly in size, institutional structure, urban form, and relative importance of their bus systems. The cities were chosen, not to represent typical experiences in the development and management of urban bus lanes, but to reflect a diverse range of approaches and challenges. Table 2 summarizes when bus lanes were first established in each of these cities, and the relative extents of their bus priority networks.

London has developed one of the most comprehensive systems of actively managed bus priority lanes in the world. As of 2009, London's bus priority network included 1,200 segments, and extended about 177 miles. This network emerged gradually over a period of 40 years, but has been significantly upgraded and strengthened over the past six years as part of a comprehensive realignment of the surface transportation system. London's approach to the designation and enforcement of bus lanes has been unusually decentralized:

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it has been led by the metropolitan government on a network of key arterials, but by local authorities (“boroughs”) off this network. London’s bus lane program is also notable for its comprehensive approach to enforcement.

Los Angeles has the greatest relative dependence on buses as an urban transit mode, among the cities sampled here, and over the past decade has developed a 450-mile system of bus rapid transit services, but is at the earliest stages of developing a network of priority lanes to support these bus operations. Its current bus priority network extends about 4 miles. The network was first implemented in the 1970s, and while it has been modified over the years, it has not greatly expanded. The longest segment of the network functions as an on-street extension of a fully separated transitway that serves buses and carpools in the median of a freeway. The city also installed a demonstration bus lane of one mile along a congested stretch of Wilshire Boulevard from 2004 to 2007. The lanes were removed due to some local opposition, but the city has recently voted to reinstate the lane as part of a longer bus priority project in the corridor.

New York City has been developing a bus lane network for nearly five decades, during which time it has reinvented its system several times with new branding, design and enforcement strategies. Currently, the network extends about 50 miles, mostly in short segments distributed around the city. Recently, New York has started to introduce comprehensively planned, longer-distance bus priority lanes incorporating a variety of innovative features. Studies for additional lanes of this type on two additional corridors, totaling 26 miles, are currently underway. New York is just beginning to implement camera-based enforcement of bus lanes, on a limited basis.

Paris began developing a network of curbside bus lanes in the 1960s. Today, the system extends 118 miles. Over the past decade, bus lanes have been widened and low granite curbs have been installed on about one-third of the bus lane network to physically segregate the lanes from general traffic. They are not exclusive bus lanes, because taxis, bicycles, and other vehicles may also use them, but they have a greater degree of separation than can be achieved by paint alone.

San Francisco has about 18 miles of transit priority lanes, 14 of which are used by buses, and the remainder of which are used by light rail transit vehicles. To a greater extent than any of the other case study cities, San Francisco’s bus priority lanes are offset from the curb to allow other vehicles to access the curb lane throughout the day.

Seoul developed a comprehensive system of curbside bus lanes beginning in the 1980s. Since 2004, it has been upgrading many of its bus lane corridors to operate in the median, adapting its surface transit system to keep pace with the city’s extremely rapid urbanization and economic advancement. However, its median bus lanes retain some shared use, since other vehicles may use the lanes to make left turns in some locations.

Sydney is the smallest of the cities examined here, and has the newest bus priority lane network. It is unique for its reliance on fully automated camera-based bus lane enforcement. Its bus priority lanes also have a range of different levels of access granted to other

vehicles – including lanes that are intended for the exclusive use of buses, lanes that allow use by taxis, and lanes that allow use by all vehicles with two or more passengers.

**Table 2. Bus Priority Lane Networks in Case Study Cities**

Characteristic	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
Year bus lanes first established	1968	1974	1963	1964	1970	1984	1992
Extent of bus priority networks							
Miles	177 mi.	4 mi.	50 mi.	118 mi.	18 mi.	127 mi.	14* mi.
Kilometers	285 km	6 km	80 km	190 km	27 km	204 km	23* km

*Notes:* Ridership data exclude unscheduled services (e.g., vanpools, demand-responsive transit) and services primarily serving suburban travel markets (e.g., commuter rail, commuter express buses).

\* Network extent includes City of Sydney only and does not include significant bus lane mileage elsewhere in Inner Sydney.

*Sources:* See case studies for source notes.

The object of this research was not to develop generalizations about what works and what does not with regard to urban bus lanes, but rather to identify commonalities and differences among these diverse cities' experiences with urban bus lanes, and along the way to highlight innovative practices that may have applicability in other regions.

As a first step toward understanding the similarities and differences among the case study cities, we defined three concepts that also arise elsewhere in the report:

- “Urban transit” modes are scheduled transit services that primarily serve circulation within a city. Classic urban transit modes are subways and local bus services. For the purposes of this analysis, urban transit modes do not include commuter rail, commuter express buses, and other services that primarily provide access to the city from suburban areas, or provide intercity or inter-suburb connectivity, but contribute little to urban circulation. Of course, there are transit services that are not easily classified, like modern rail systems that provide both suburban access and intra-urban circulation. In these cases, the authors attempts to develop reasonable estimates of the urban share of travel on these systems.<sup>24</sup>
- A “city” represents the primary urban center of the metropolitan region. Since municipal boundaries often have little relevance to land uses and transportation patterns, the authors sought a less arbitrary urban definition that could be applied across all the cases and aligned better with transportation statistics. For the purposes of these summary statistics, the “city” is the service area of an urban region’s primary urban transit modes.<sup>25</sup>

A metropolitan region or “metro” is an area that corresponds to a city’s commute shed. For U.S. cities, this has been taken to correspond to the Census Bureau’s metropolitan statistical areas (MSA), which are defined as urban cores and surrounding counties that

have a high degree of economic and social integration, including commuting patterns. For non-U.S. cities, the authors identified similar regional definitions.<sup>26</sup>

Table 3 provides an overview of geography and population of the seven urban and metropolitan regions. The urban centers range in population from San Francisco, which has fewer than a million residents, to Seoul, which has over ten million residents. The cities also cover very different sized territories, from a mere 47 square miles in San Francisco to over 600 square miles in London. The metro areas have somewhat less variability in population and size.

**Table 3. Population and Area of Case Study Cities**

Characteristic	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
<b>City/urban center definition</b>	Greater London	City of Los Angeles	City of New York	Paris + Petite Couronne	City of San Francisco	Seoul Special City	Sydney Inner Region
Population (millions, 2010)	7.8	3.8	8.2	6.6	0.8	9.7	1.5
Land area – sq. mi.	607	469	303	294	47	234	137
Land area – km <sup>2</sup>	1,572	1,215	786	762	121	605	355
<b>Metro area definition</b>	London Larger Urban Zone	LA-Long Beach-Santa Ana MSA	New York-Northern NJ-Long Is. MSA	Paris Aire Urbaine	SF-Oakland-Fremont MSA	Seoul National Capital Area	Sydney Statistical Division
Population (millions, 2010)	11.9	12.8	18.9	12.1	4.3	23.6	4.6
Land area – sq. mi.	3,444	4,850	6,495	6,631	2,473	1,959	4,688
Land area – km <sup>2</sup>	8,920	12,562	16,821	17,175	6,405	5,075	12,143
<b>Metro/city ratios</b>							
Metro pop. / city pop.	1.5	3.4	2.3	1.8	5.4	2.4	3.2
Metro area / city area	5.7	10.3	21.4	22.5	53.0	8.4	34.2

Sources: See case studies for source notes.

Table 4 provides some comparative statistics on the intensity of bus system use in the urban center and the relative contribution of buses to overall public transit in the city. It shows that at 293 annual bus trips per resident, Londoners use their bus system more than residents of the other cities. And while it may not be a surprise that Los Angeles and San Francisco, which lack extensive rail rapid transit networks, rely heavily on buses for urban transit trips, nonresidents of London may be surprised to observe that buses are the dominant urban transit mode there as well. In contrast, buses play a far less central role in New York City's and Paris' transit pictures.

**Table 4. Urban Transit Ridership in Case Study Cities**

Characteristic	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
<b>Annual unlinked urban transit trips (millions, 2010)</b>	3944.3	501.9	3290.5	2677.0	216.0	3414.5	326.3
<b>Shares by mode</b>							
Heavy rail	39%	10%	74%	55%	0%	45%	34%
Light rail / cable car / monorail	3%	9%	0%	4%	27%	0%	2%
Bus / trolleybus	58%	81%	25%	41%	73%	55%	59%
Other / ferry	0%	0%	1%	0%	0%	0%	4%
<b>Annual transit ridership rates</b>							
Urban transit trips per city resident	504	132	402	407	268	352	225
Urban bus trips per city resident	293	107	102	167	197	194	132

*Note:* Ridership data exclude unscheduled services (e.g., vanpools, demand-responsive transit) and services primarily serving suburban travel markets (e.g., commuter rail, commuter express buses).

*Sources:* See case studies for source notes.

## OVERVIEW OF THE REPORT

Chapter 2 discusses the seven case study cities, summarizing some notable features about the bus priority lane system in each and presenting basic demographic and transit ridership data about each city and its region. Chapter 3 provides a summary of key findings, conclusions and suggestions for future research. Appendices A through G include detailed material on each of the case study cities.



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## II. FINDINGS FROM THE CASE STUDIES

### INSTITUTIONAL ARRANGEMENTS

The effective design and operation of bus lanes on city streets requires cooperation and coordination among several distinct functions of government, including transit operations, street management, and traffic and parking enforcement. In many cities, these responsibilities tend to be fragmented across different levels of government or different agencies within the same level of government. Over time, in several of the cities examined here, these responsibilities shifted around considerably among various agencies as governance philosophies changed.

This section summarizes the institutional arrangements in the seven case study cities, as they stand today. Overall, the cities each have unique structures of governance, so clear patterns across all of the cases are difficult to discern.

#### Transit Operations

The nature of the entities that provide bus transit services varies significantly across the seven cities (see Table 5). In London, San Francisco, and Seoul, all bus services are provided or managed by a branch of the municipal government. In Los Angeles, bus services are provided by both city- and county-level governments. In New York and Sydney, the agency responsible for bus transit is a unit of the state government, and in Paris, it is a corporation owned by the national government.

The actual role of these government units in providing public transit also varies significantly. Buses in San Francisco (and some in Los Angeles) are directly operated by branches of city governments. Most other buses in Los Angeles, as well as the bus operations in New York, are operated by special districts or public authorities that are part of government, but are buffered from direct control by any single elected office. In Seoul, Sydney, and London, government agencies establish routes, fare policies, and other rules, but contract out the actual operation of buses.<sup>27</sup> In Paris, buses are operated by a corporation owned outright by the national government.

In Paris, New York, and Los Angeles County, the entities that provide, procure, or regulate most bus transit services have no role in managing the streets over which their buses run. In all of the other case study cities, there is some integration of these responsibilities: agencies that provide bus transit services also administer street design and management.

**Table 5. Government Agencies Responsible for Transit Operations**

Level of government agency administering this function	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
National or state government			New York Metropolitan Transport. Auth. (T)	Régie Autonome des Transports Parisiens (T*)			Transport for New South Wales (I)
Regional or county government		LA County Metropolitan Transport. Auth. (T)					
Municipal or city government	Transport for London (I*)	City of LA Dept. of Transport. (I)			SF Municipal Transport. Agency (I)	Seoul City Transport. Headquarters (I*)	

*Notes:*

Agency types:

T = public transit agency.

I = integrated streets &amp; transit agency.

\* = Bus services are operated by private entities.

*Source:* Authors' analysis, based on case studies.**Street Planning, Design and Regulation**

In most of the cases examined here, street planning, design, and regulation are municipal responsibilities (see Table 6). In Los Angeles, New York, Paris, San Francisco, and Seoul, street engineering and management is handled by the city government. One key exception is Sydney, where these powers are held at a state level, and local governments have few responsibilities. In London, street design is handled at the city (Greater London Council) level on a designated network of priority streets, but it is controlled elsewhere by sub-city Borough governments. In greater Los Angeles, there are significant urban areas (including parts of the bus priority network) that are not part of any incorporated municipal government. In these areas, the county public works department performs functions normally conducted by a city government, such as street design.

**Table 6. Government Agencies Responsible for Street Planning, Design and Regulation**

Level of government agency administering this function	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
National or state government							Transport for New South Wales (I)
Regional or county government		LA County Dept. of Public Works (S)					
Municipal or city government	Transport for London (I)	City of LA Dept. of Transport. (I)	NY City Dept. of Transport. (S)	la Direction de la Voirie et des Déplacements (S)	SF Municipal Transport. Agency (I)	Seoul City Transport. Headquarters (I)	
Neighborhood or borough government	London Borough Councils (S)						

**Notes:**Agency types:<sup>a</sup>

S = street management agency.

I = integrated streets and transit agency.

*Source:* Authors' analysis, based on case studies.**Parking and Traffic Enforcement**

Responsibility for enforcement of bus lanes is often shared by multiple agencies (see Table 7). The agency with the most prominent role enforcing bus lanes may be determined in part by the nature of the violations that occur in the lanes. In cities with bus lanes that run along the curb, the key enforcement issue is ticketing and deterring illegally parked vehicles, and so agencies that enforce parking regulations play a more critical role. In cities with bus lanes located away from the curb, illegal driving in the bus lane is a more salient issue, and so agencies that enforce traffic laws tend to be more prominent.

In most of the cities, laws governing the operation of vehicles are enforced by police departments. In London and San Francisco, on-the-ground enforcement is conducted by the police, but is done under contract or direct supervision of the city's transportation agency. In Sydney and New York, powers are split differently: patrol-based enforcement is conducted by the police, while camera-based enforcement is conducted by the transportation agency. Seoul is the only city of the group in which traffic enforcement is directly conducted by transportation agencies.

In most cities, because violations of parking laws are minor civil infractions, they do not require the involvement of police officers. Enforcement can instead be carried out by agents of transportation departments or parking units of local or borough-level governments. In Paris, the transit operator itself is empowered to ticket vehicles illegally parked in a bus lane, but this is an unusual arrangement.

**Table 7. Government Agencies Responsible for Parking and Traffic Enforcement**

Level of government agency administering this function	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
National or state government			Metropolitan Transport. Auth. (T)	Parking: Régie Autonome des Transp. Parisiens (T); Traffic: Préfecture de Police (P)			Traffic: Transport for New South Wales (I) and NSW Police Force (P)
Regional or county government		LA Sheriff's Dept. (P)					
Municipal or city government	Metropolitan Police Service (P)	Parking: LA Dept. of Transport. (I) Traffic: LA Police Dept. (P)	NY City Police Dept. (P); NY City Dept. of Transport. (S)	Parking: City of Paris (P)	Parking: SF Municipal Transport. Agency (I); Traffic: SF Police Dept. (P)	Seoul City Transport. Headquarters (I)	
Neighborhood or borough government	Parking: London Borough Councils (S)					Local district offices (S)	Parking: City of Sydney (S)

**Notes:**

Agency types:

P = police agency.

S = street management agency.

I = integrated streets and transit agency.

*Source:* Authors' analysis, based on case studies.**Coordination**

A key motivational question behind this study was whether improved integration or coordination of bus operations, street management, and traffic enforcement responsibilities was an important precedent for a greater degree of commitment or success implementing bus lanes. This question was prompted by the renaissance in bus lane development that occurred in London after the former independent boroughs were united under a new mayor and the integration of transportation responsibilities under a single new agency.

Earlier waves of development of bus lanes often tended to rely on goodwill among the branches of government needed for effective implementation. This can work well enough under the watchful eye of a mayor committed to making bus lanes a political priority, but it can fall apart over time as agencies (especially traffic enforcement agencies) come to emphasize different priorities and may no longer see bus lane compliance as critical to (or even consistent with) their broader missions. In the latest wave of bus lane implementation, there has been greater attention than before to institutional arrangements that help ensure the sustainable success of bus lane implementation.

Through interviews, document analysis, and other research, this study examined two key dimensions of coordination, including:

- Arrangements for coordinating bus lane planning (e.g., integration of bus transit service objectives into street design and regulatory decisions); and
- Arrangements for coordinating bus lane operations (e.g., integration of bus lane design and regulatory decisions into the administration of traffic and parking enforcement).

In some cases, the material collected here yielded little insight into how these various functions are integrated beyond documentation of what type of coordination processes exist on paper. In other cases, the responses were rich with detail, but also strongly evaluative of how well the coordination process worked. Overall, while assessments of the effectiveness of coordination measures in place were mixed, and varied according to the perspective of the interviewee; there was general agreement that effective coordination was a desirable ingredient for the successful design and operation of bus lanes. Improved institutional arrangements were not, however, a prerequisite or necessary component of extensive bus lane development: New York, for example, has continued to expand and improve its bus lane network without any formal mechanisms for coordinating design or operations. Table 8 summarizes the forms of coordination that exist in each of the case study cities. It refers to three general types of coordination:

- Integrated responsibilities. The pair of responsibilities is assigned to the same government agency.
- Formal coordination. The responsibilities are assigned to separate government agencies, but there is a formal arrangement under which one agency conducts its work under contract to, or under the supervision of, the other agency.
- Informal coordination. This category covers a full spectrum of coordination mechanisms short of formal coordination. It includes situations in which one agency has a policy that requires it to consult with other agencies before taking an action.

### *Planning*

Coordination of bus lane planning between transit operators and street agencies has been a relatively recent development. London brought its street management and transit operations agencies under a new transportation superagency in the year 2000, and San Francisco did the same in 2002. Seoul accomplished the same objective in 2004, when it began to regulate transit services. But even integrated responsibilities do not guarantee a centralized or highly coordinated planning approach.

The key findings for the case studies cities were as follows:

- In London, Transport for London oversees bus operations citywide, but its control over much of the city's overall street network is shared with the London Boroughs. On the Red Route Network of primary routes, Transport for London has integrated responsibility for both street design and transit operations. Planning for bus lanes off this network, however, relies on informal coordination between Transport for London and the borough governments.

- The planning roles are partially integrated in the City of Los Angeles, where one agency has managed streets and some bus services since 1979. However, the largest bus transit agency in the region is a county-level entity, the Los Angeles County Metropolitan Transportation Authority, which does not have any street management responsibilities. Overall, coordination on planning for the bus lanes has been through informal project teams.
- In New York, there is no integration at an institutional level between the state-level agency, the Metropolitan Transportation Authority (MTA), which provides bus transit services, and the New York City Department of Transportation, which is responsible for street management. Informally, however, the agencies have cooperated over the years to study and implement various bus lane improvements. This cooperation has seen a significant boost in recent years, with no specific change in institutional arrangements.
- In Paris, powers are held by separate agencies, but there is a formal process to ensure coordination through a regional bus improvement program called Mobilien. The regional government provides planning grants not to an individual agency, but to interagency planning committees that form specifically to consider improvements along a particular route.
- In San Francisco, design and engineering of streets and operation of the transit system are now both administered by the same transportation superagency, the Municipal Transportation Agency. But the development of a coherent new institution out of two agencies with historically different objectives remains a work in progress, and planning for bus lanes does not yet reflect a coordinated set of policies.
- In Seoul, a single municipal transportation agency, the City Transportation Headquarters, has responsibilities for contracting for transit services, and for street planning and engineering.
- In Sydney, coordination is largely informal. The State Transit Authority, the government agency that oversees bus services (and provides these services in the central business district) keeps at arm's length through much of the planning process for bus lanes to avoid the appearance of conflicts of interest.

### *Operations and Enforcement*

A coordinated bus lane enforcement program can be effective in ensuring that bus priority treatments are enforceable from both operational and legal perspectives; providing ongoing channels for feedback from field officers to traffic engineers; keeping field officers updated on changes to the system; and educating the public about bus priority lane policies and regulations.<sup>28</sup>

Nonetheless, there are relatively few examples of fully integrated arrangements for bus lane operations or enforcement. It is fairly common for transit and street management agencies to establish formal agreements to monitor the effectiveness of transit priority

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treatments, such as transit signal priority systems, but these generally are not active on a daily operations level.<sup>29</sup>

The key findings for the case studies cities were as follows:

- Seoul is unique among the cities examined in this study in the extent to which it combines primary traffic enforcement responsibility within its integrated transportation agency. Local district governments also have enforcement powers, and coordination with them is informal.
- Sydney's and New York's transportation agencies administer their camera-based bus lane enforcement programs, but there is no formal coordination with the state police agency that has responsibility for patrol-based enforcement efforts.
- Two of the case study cities have established formal mechanisms to ensure that bus lane policies and administrative priorities remain in alignment. In London, the transportation agency purchases enforcement services by means of an administrative services contract with the police department. San Francisco has assigned a dedicated unit of the police department to work under the supervision of the transportation agency on bus lane and other traffic enforcement responsibilities.
- Two of the case study cities lack a formal coordinating mechanism. In New York, operation and enforcement of bus lanes take place entirely through informal arrangements among the relevant agencies. In the 1970s and 1980s, New York's street management agency had powers and personnel to enforce the laws governing its own bus lanes, but these responsibilities were shifted to its police department in the 1990s. In Paris as well, there are no formalized arrangements for bus lane enforcement.
- In Los Angeles, coordination of operations and enforcement issues has also been primarily through informal channels. During the Wilshire Blvd. bus lane pilot, the agencies coordinated their enforcement efforts through a formal contract. However, this contract to reimburse police departments for the enforcement of bus lanes was never utilized.

**Table 8. Coordination of Bus Lane Responsibilities**

Degree of coordination	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
Planning Transit operations/ street management	Integrated/ Informal	Informal	Informal	Formal	Integrated	Integrated	Informal
Operations Street management/ traffic enforcement	Formal	Informal/ Formal	Informal	Informal	Formal	Integrated/ Informal	Integrated/ Informal

*Notes:*

Integrated = integrated responsibilities (both powers are housed within the same agency).

Formal = formal coordination (pursuant to a contract or direct purchase of services).

Informal = informal coordination (no formal mechanism for coordination).

*Source:* Authors' analysis, based on case studies.

## PHYSICAL DESIGN AND SIGNAGE

### Bus Lane Design

The design of bus lanes requires balancing many competing factors. In addition to accommodating the safe and efficient operation of buses, bus lane design must account for the maintenance of traffic flow, the needs for curbside access, the safety of pedestrians and cyclists, and the activity patterns that can vary significantly on a block-by-block basis. The cities that have embraced bus lanes most extensively in this study tend to make highly contextual decisions about the design and alignment of these lanes, rather than relying on a fixed design template.

Standard transit vehicles in North America typically have bodies 8.5 feet (2.6 m) wide, or up to 10.5 feet (3.2 m) wide with side mirrors.<sup>30</sup> As a result, the minimum recommended bus lane width in the U.S. is 11 feet (3.4 m). In particularly constrained city centers, many bus lanes are considerably narrower. Minimum bus lane widths are 9.2 ft. (2.8 m) in Sydney, 9.8 ft. (3.0 m) in London and Paris, and 10 ft. (3.05 m) in New York. In some cases, the lanes are narrower than the buses that operate on them, as the authors observed on one street in New York, where buses routinely straddle an adjacent lane in order to navigate its bus lane safely.

While all of the case study cities have bus lanes with a variety of alignments (see Table 9), all except two cities (San Francisco and Seoul) rely primarily on bus lanes that run in the outermost lane immediately adjacent to the curb. Following local driving conventions, this is typically the left curb in London and Sydney, and the right curb in the other case study cities. This is the dominant practice as well in smaller cities in the U.S. and around the world as well, and follows the pattern established by many cities in the 1950s, as discussed earlier.

The advantage of the curbside alignment is that it minimizes impacts on the vehicular capacity of the street. Typically, traffic lanes remain traffic lanes during all hours. The bus priority lanes can be used for parking, deliveries, or general traffic in off-peak hours. However, the curbside alignment has significant drawbacks as well. During the hours that



the lane is in operation as a bus priority lane, it competes with other demands for curb access such as goods delivery, passenger pick up or drop off, and parking. Keeping the bus lane clear of encroachment from parked or stopped vehicles requires a vigorous and sustained enforcement effort. Furthermore, while most cities allow right-turning vehicles to use the bus lane for safety reasons, in areas with high pedestrian densities this can lead to vehicle queuing in the bus lane, further undermining the lane's utility for transit vehicles.

Over the past decade, many of the case study cities have explored alternative designs for bus lanes. While still short of the standards and effectiveness of higher-order bus rapid transit systems and other exclusive transitways, these designs can avoid many of the shortcomings of curbside lanes.

One alternative is the offset (or "interior") bus lane, which reserves space for a travel or stopping lane along the curb. These have long been used in San Francisco, where the bus lane can be separated from the curb by a travel or parking lane, or an offset bus lane can take the form of an extra-wide shared lane that incorporates bus stops, parking, and other curb uses. Offset lanes are now widely used in London, New York, Paris, and Sydney as well. Passengers board from bus bulbs, or buses pull over to the curb at bus stops. This approach preserves curb access for parking, loading, and turns, while reducing the degree to which these activities conflict with bus operations. Whereas many downtown curbside bus lanes must accommodate windows for commercial deliveries in the midday hours, offset bus lanes can more easily operate throughout the day. In addition, they are often said to be "self-enforcing" because their location away from the curb makes them much less prone to being blocked by stopped vehicles. The drawback of these lanes is that they involve removal of a traffic lane from general use.

Another alternative design is operating bus lanes along the median lanes of a two-way street. Median bus lanes can be an effective way of isolating buses even further from curbside traffic conflicts, and work well on long, wide corridors that serve many bus routes. However, they require construction of passenger platforms or loading areas in the middle of the street, which requires the removal of additional traffic capacity and creates safety challenges. Most cities that take these steps go one step further and provide full physical segregation for their median bus lanes. Seoul, however, has chosen to make its lanes permeable, both so that buses can enter and exit the lanes more easily and also so other traffic can enter the lanes to make left turns more safely.

Two other options locate buses in the "far curb" lane (e.g., the left lane of a one-way street in the United States), either concurrent with the flow of traffic on the street, or in the opposite direction. Both of these approaches have advantages in certain situations. Far-side concurrent flow lanes may be useful where a large volume of buses will need to make a left turn, or where large volumes of passenger vehicles are turning right. Contraflow lanes have the benefit of requiring very little enforcement effort, but can only accommodate delivery vehicles with difficulty and create unique pedestrian safety challenges. Both of these types of lanes comprise relatively small shares of the bus lane networks in the cities examined here.

**Table 9. Alignment of Bus Lanes Within the Street**

Feature	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
Lane type							
Concurrent-flow, adjacent to curb	●	●	●	●	○	●	●
Concurrent-flow, offset <sup>a</sup> from curb	○		○	○	●		○
Concurrent-flow, median or far curb	○		○		○	●	
Contraflow	○	○	○	○	○		○

*Notes:*

- = primary design choice(s).
- = also present in the system.

<sup>a</sup> “Offset” bus lanes reserve space for a travel or stopping lane along the curb.

*Sources:* See city case studies in the appendices for sources.

## Pavement Markings

For bus lanes to function well, drivers must be made aware of their presence, the times when their use is restricted, and what vehicles are permitted in the lanes when these restrictions are in place. If drivers are not aware of the rules they can unwittingly use the lanes when they should not, thus slowing buses and other permitted users. Alternatively, drivers may fail to use the lanes when they can do so, inconveniencing themselves and increasingly traffic volumes in the parallel lanes. Signs and street markings play an important role in communicating this information and, less tangibly, also signal to drivers how seriously the government itself takes these rules. Comprehensible, bold, and consistent markings all help provide a clear message to drivers that bus lane restrictions are meant to be taken seriously.

Since most cities vary the restrictions on what vehicle types may use the lanes by location and/or time of day, this communication task is complex. Cities rely on a mix of colored pavement, markings on the pavement, painted curbs, and signage. The case study cities use a variety of design treatments to designate bus priority lanes (see Table 10). All of the cities use distinctive lane separation lines to separate the lanes other lanes of traffic. In Paris, about one-third of the lanes use a low raised granite curb to separate the lanes, and dashed white lines elsewhere in the system. Seoul uses a single blue line to designate peak-hour bus lanes, and a double blue line to designate full-day bus lanes. The remaining case study cities use a solid white line. It is common to use dashed lines to indicate where other traffic may enter or exit the lane.

London, New York, Seoul, and Sydney all color the bus lane pavement red in some locations to raise the lanes’ visibility. All of the case study cities also use some version of the text “bus” or “bus lane” painted on the pavement to clarify the lanes’ purpose.

Where bus lanes permit users beyond just buses and/or are not in force all the time, these variations may be noted on the pavement or curb as well. Paris, for example, has pictures of either a cyclist or a cyclist marked with an “x” to indicate which lanes permit cyclists.

London indicates on the pavement which bus lanes may be used by delivery vehicles. In Sydney and Seoul the pavement markings sometimes indicate the hours the lane is reserved for buses—e.g., “AM BUS LANE.”

Finally, some cities use additional indicators at the curb to indicate where vehicles may stop at the curb adjoining a bus lane. London uses different types of striping along the curb of bus lanes to indicate if stopping is permitted for loading or unloading merchandise or passengers. Paris has created special spots that partially extend into the bus lanes for delivery vehicles to load and unload, and these are indicated with text and a large “X” on the pavement. San Francisco and Los Angeles color-code the curb itself to indicate stopping and parking rules.

**Table 10. Pavement Markings and Barriers Designating Bus Lanes**

Feature	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
Lane separation features							
Painted line	Solid	Solid	Solid	Dashed	Solid	Variable	Solid
Low curb or tactile barrier				•			
Markings on pavement							
“Bus Lane” or “Buses Only”	•	•	•	•	•	•	•
Painted or colored pavements	•		•			•	•
Non-bus vehicle types permitted	•			•			•
Hours regulations are in force						•	•
Markings on or along curb							
Stripe on pavement or colored curb denotes parking/stopping rules	•	•			•		

*Notes:*

- = yes, for at least some lanes in the system.
- Empty cell indicates *either* “no” or “don’t know.”

*Sources:* See city case studies in the appendices for sources.

## Signage

Given the complexity of the users and uses permitted in bus lanes, all the cities complement pavement markings with signage located at the curb that uses text or pictures (see Table 11). Some cities use simple signs (“Bus Lane”) that merely alert drivers to the basic bus lane concept. As a matter of policy in many of the cities, every block with a bus lane must have at least one such sign, but in cities with older bus lane networks, the completeness of this coverage has declined over time. Los Angeles and San Francisco also use warning signs a block before bus lanes begin to alert drivers (“BUS LANE AHEAD”).

Nearly all of the cities’ signs indicate bus priority lane hours of operation, but some omit this information in locations where the bus lanes are operational at all hours. Paris, where bus lanes all operate around the clock, does not specify hours on its signs.

With the exception of New York, which does not exempt any class of vehicles from the bus lane restrictions, all other cities indicate with words or pictures which types of vehicles may use their bus lanes.

Los Angeles, New York, and Paris explicitly indicate that vehicles may use the bus priority lanes to make turns. The other cities do not indicate this on their signs.

Finally, London and Paris use their bus lane signs to indicate times when freight loading and unloading are permitted. The other cities indicate this through other signage located at the curb.

There are two primary color schemes used in bus lane signage: white-on-blue, and black-on-white. London and Seoul use a white-on-blue color scheme. Los Angeles, San Francisco, and Sydney use a black-on-white color scheme. New York and Paris use hybrid signs that combine both color schemes. Several cities use red highlights to draw additional attention to the signs.

**Table 11. Content of Bus Lane Signage**

Features included on bus lane signs	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
Content of signs							
“Bus Lane” or “Buses Only”		•	•			•	•
Hours of operation	•	•	•		•	•	•
Text with permitted/prohibited users (e.g., “Taxis ok”)	•	•			•		
Symbols showing permitted/prohibited users	•			•		•	•
Sign indicates turns allowed from bus lane		•	•		•		
Instructions for loading/unloading	•			•			
Color scheme							
White-on-blue	•		•	•		•	
Black-on-white		•	•	•	•		•

*Notes:*

- = yes, for at least some lanes in the system.
- Empty cell indicates *either* “no” or “don’t know.”

*Sources:* See city case studies in the appendices for sources.

## ACCESS POLICIES

Unlike exclusive busways, bus priority lanes are the result of compromises between the goal of unimpeded transit operations and the needs of the many other users of street space. Access to this shared space can be allocated by time of day, or other classes of vehicles can be allowed access to the lane without opening it to general traffic.

In most cities, it proved difficult to get a precise definition of exactly what types of users and uses are permitted in the bus lanes. In most cases, municipal or other legal codes only provided a starting point for understanding these policies. Street signage and pavement markings indicated a somewhat different picture, since these were often necessarily simplified explanations of more complex regulations. In some cases, we learned from our interviewee comments that police on the street often had their own informal criteria for administering bus lane rules, which may not exactly match what was written into the law.

## Hours of Operation

Designating the hours of prioritized bus access is a key decision in the establishment of bus priority lanes: at all times, or only during peak hours. In addition, cities must choose between having a uniform set of hours that applies to all lanes or customizing the hours of operation for each lane based on such factors as the traffic conditions and roadway configuration in each location.

The hours of operation for bus lanes vary greatly, both between and within cities (see Table 12). The most common approach in most cities is for bus priority lane restrictions to be in force only on weekdays, during morning and/or evening peak periods, usually for two to four hours at a time. Outside of these hours, the lane may be used for general traffic, parking, or commercial deliveries. Among the case study cities examined here, peak-hour operations are the most prevalent in London, Los Angeles, New York, and Sydney. In Paris, San Francisco, and Seoul, full-time bus lanes are the most prevalent. Paris was the only city examined here with no part-time bus lanes. There are both advantages and disadvantages to having all or most of the lanes in a city follow the same hours of operation. An advantage of standardized hours is that drivers more easily learn when they can and cannot use the lanes. As one interviewee from a city with varied hours pointed out, some cars can be observed to avoid bus lanes even when the lanes are not in operation, presumably because the drivers are not confident that they can legally use them. However, allowing the hours to be tailored to local needs and conditions allows better coordination with patterns of congestion and bus volumes, both of which can vary greatly from street to street within a city. New York City has generally taken this approach and currently uses 13 different schedules for the various bus lanes segments on its network.

**Table 12. Bus Lane Hours of Operation (Approximate Percent of Total Lane Miles)**

Hours of Operation	Los			Paris	San		
	London	Angeles	New York		Francisco	Seoul	Sydney
24-hour, 7 days a week	29%		<2%	100%	66%	44%	12%
Daytime hours, typically weekdays	25%		40%		11%	32%	18%
Peak periods only (morning and/or afternoon rush hours; typically weekdays)	46%	100%	58%		23%	24%	70%

*Sources:* See city case studies in the appendices for sources.

## Access to Bus Lanes for Specific Vehicle Types

When bus priority lanes are in operation, buses share access with a variety of users. The rules are designed to keep buses moving efficiently, while sharing the space with users who either must use the lane (i.e., vehicles turning into a property) or users whose travel the city wishes to facilitate (i.e., taxis or bicycles) in order to use the bus lane capacity more fully and to allow its safe operation.

In every case study city, certain users are permitted in the bus lanes under any circumstances, while other specified users are permitted in the bus lanes only for limited, designated purposes. The rules often differ in terms of the users and uses for which traveling and stopping or parking in the lanes is permitted. Table 13 summarizes the findings on what types of non-bus users are allowed in bus lanes, either at all times or for limited purposes.

At a minimum, all the cities allow some or all emergency vehicles to travel in the lanes—fire, ambulance, and police vehicles. In some cities, the bus lane regulations specifically permit this, while in other cities, the bus lane regulations do not mention emergency vehicles as legal users but elsewhere the law specifies that emergency vehicles are allowed to use any portion of the roadway at any time. One variation among cities is that some allow any emergency vehicle to use the bus lanes at any time or for any reason, while others place limits on emergency vehicle use. For example, in some cities emergency vehicles may use the bus lanes only when traveling to an emergency. Also, in Paris the bus lane regulations for some time excluded privately owned ambulances. Another variation on the theme of emergency vehicle access is that Paris allows doctors on call traveling to a patient to use the lanes.

The case study cities are divided on whether to allow bicycles to use bus lanes. London, Los Angeles, Paris, and Sydney permit bicycles to travel in most bus lanes, except where particular locations raise safety concerns. In some cities, like Paris, this is a very deliberate policy to improve bicycle access. In contrast, New York, San Francisco, and Seoul do not allow bicycles to use bus lanes. Bicycle access to bus lanes is a matter of considerable debate in the street engineering community. Some see the two modes as fundamentally compatible because over longer distances, both travel at similar speeds. Others see them as incompatible because bicycles prefer moving at a constant speed while buses start and stop, creating potentially dangerous situation where buses and bicyclists repeatedly “leapfrog” each other.

Use of bus lanes by motorcyclists and other motorized two-wheel vehicles is also a contentious issue in several cities. Only Sydney currently permits motorcyclists to travel in bus lanes as regular policy. Interviewees from a couple of cities mentioned that the police do not prioritize ticketing motorcyclists in bus lanes, even though they are illegal users. In other cities, motorcycle advocates have pushed hard for permission to use the lanes. In London, they have succeeded to the point that some boroughs permit them, and Transport for London is (as of 2010) in the middle of a second trial to see if motorcyclists can be integrated into bus lanes safely and with meaningful timesavings benefits. And in Paris in

2009, the mayor announced an intended pilot to allow electrified scooters in bus lanes, but a few months later this plan was blocked by the police.

All of the case study cities except New York and Seoul permit taxis to travel in bus lanes. This policy is often based on the premise that taxis are a critical mode that supports residents who choose to live car-free or to use their cars minimally. In essence, these cities see taxis as a component of the public transit system. Similar to the premise that taxis should be allowed in bus lanes because they are a form of transit, all the cities except New York and Paris allow into the bus lanes “jitneys,” or privately-owned multi-passenger vehicles that serve a regular route but are not contracted service providers for a publicly-owned or managed transit system.

Four of the seven case study cities explicitly permit some travel in bus lanes by government-owned vehicles and/or utility vehicles. Examples include refuse collection vehicles, street-sweeping vehicles, city-owned cars used for official city business, and mail delivery trucks.

Finally, a few types of users are allowed to travel in the lanes by just one or two cities, with examples including carpools and vehicles bearing disabled placards.

**Table 13. Non-bus Users Permitted in Bus Lanes**

Feature	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
<b>Users permitted to travel in bus lanes at all times</b>							
Bicycle	•	•		•			•
Motorcycles/mopeds	T						•
Taxi	•	•		•	•		•
Municipal or utility vehicle on business	•	•				•	•
Disabled-placard holder						•	
Carpool						6+	
<b>Users permitted to travel in bus lanes under certain conditions</b>							
Any vehicle, to turn at nearest intersection (no more than 1 block)	•	•	•		•	•	•
Any vehicle, to enter/exit driveway or curb parking along block	•	•	•	•	•	•	•
<b>Users permitted to stop in bus lanes</b>							
Taxi, to load/unload only	•	•	•	•	•	•	•
Any vehicle, to load/unload only			•				
Disabled-placard holder to load/unload only	•						
Delivery or loading, according to posted hours and locations	•		•	•	•		

**Notes:**

- = yes, for at least some lanes in the system.
- T = trial ongoing at time report was prepared.
- Empty cell indicates *either* “no” or “don’t know.”

Sources: See city case studies in the appendices for sources.

## Access to Bus Lanes for Designated Purposes

All the case study cities also allow a private vehicle to travel in a curbside bus priority lane for some distance up to one block to access a driveway or parking space located in that block. And in all the cities except Paris, any vehicle may normally drive in a bus lane for a short distance in order to make a turn at the nearest approaching intersection. In San Francisco, vehicles may travel up to one whole block for the purposes of turning, while in New York a vehicle may travel longer distances, as long as it makes the first legal right turn. Other cities set various maximum distances that vehicles may travel before making a turn. In London, the limit is a short 66 feet (20 meters), while in Sydney the limit is much longer, 328 feet (100 meters).



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In New York City, Seoul, and Sydney, any vehicle may temporarily travel in a bus lane to avoid an obstacle.

All of the case cities permit taxis to stop in bus lanes for the purposes of loading and unloading passengers, and several cities grant the same right to private-hire vehicles like charter buses or limousines. New York, uniquely, grants the same privilege to any private vehicle, and London permits vehicles bearing disabled placards to stop in bus lanes to load or unload passengers.

Three of the cities allow delivery vehicles to stop in bus lanes for loading and unloading, at least during certain hours or in certain locations. Paris has perhaps the most sophisticated such system, having created special loading spots that permit buses to pass stopped delivery vehicles. These designated loading areas extend part way into the sidewalk and part way into the bus lane. Delivery vehicles may use these spots in off-peak hours, which are indicated on street signs. New York, for its part, permits commercial deliveries in some bus lanes during mid-day off-peak hours.<sup>31</sup>

## **ENFORCEMENT**

Effective enforcement is a perennial challenge to the effectiveness of bus lanes. In large cities, street and curb space are scarce, and a bus lane that is not as heavily occupied as adjacent lanes can be an attractive place to drive or park. If drivers come to expect that there is a high probability they will get caught for using a bus lane, they will generally heed the rules. But if they come to expect a low risk of getting caught, some will begin to venture into the lane. As more drivers witness others escaping penalty for using the bus lane, even more will tend to take similar risks, further feeding the perception that the rules are not enforced and degrading the availability of the lane to serve its intended purpose.

### **Laws and Penalties**

The legal systems of the case study cities and countries differ, but a key distinction can be made between the treatment of bus lane violations as an infraction and their treatment as an administrative violation. The distinction is important because although the penalties for infractions can be more severe, they are far more difficult to administer, and in the case of traffic laws that are not considered to be matters of public safety, are often unenforced.

Moving violations, or violations of laws concerning the operation of vehicles such as speeding or running a red light, are typically considered infractions or misdemeanors. In these cases, charges are usually filed by a sworn law enforcement officer directly against the operator of a vehicle, and the driver is subject to a hearing in court. In addition to fines, such offenses can result in penalties against the driver's license to operate a vehicle, or even in jail time, depending on the severity of the offence. In most of the case study cities, driving in a bus lane is considered to be a moving violation.

In contrast, the laws concerning the parking of vehicles (including parking illegally in a bus lane) are generally considered to be administrative violations of the law. Parking tickets are often administrative notices that can be issued by agents who are not fully sworn

police officers. These tickets do not require identification of the individual who parked the vehicle illegally, and are instead issued to the vehicle's registered owner. The ticket results in an automatic fine without the need for a court hearing, although the recipient of a parking ticket can typically request a hearing before a judge.

In some cities, there have been efforts to enable citations for moving violations in bus lanes to be handled as administrative violations, so that they may be issued by automated cameras or traffic control agents who are not police officers, and so that the evidentiary and procedural burden of enforcing them can be reduced. London, Paris, San Francisco, and Seoul have all defined laws concerning driving in a bus lane to enable enforcement by traffic agents or in some cases by camera (see Table 14). In Los Angeles and New York, bus lane moving violations remain infractions. New York has authorized camera-based enforcement on some new bus lanes, and in these cases, somewhat lower administrative fines are issued.

Sydney has a hybrid approach. There, bus lane moving violations are enforced either by police patrols or else by the state transportation agency using automated cameras. The violations are handled administratively (without court proceedings), but can result in points being added to a vehicle owner's license. To avoid these points, the onus is on the vehicle owner to prove that somebody else was operating the vehicle.

**Table 14. Penalties for Bus Lane Violations**

Feature	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
<b>Penalties</b>							
Fine for parking/stopping in bus lane	\$90-180	\$88+	\$115	\$176	\$103	\$34+	\$173
Fine for driving in bus lane	\$90-180	\$50+	\$115-150	\$176	\$60	\$34+	\$214
Points against driving license		•	•			•	•
Moving violations are a civil infraction		•	•				•
Towing of illegally parked cars	•	•	•		•		•

*Sources:* See city case studies in the appendices for sources.

## Patrol-based Enforcement

It is generally difficult for the police to sustain bus lane enforcement efforts amid the many other issues pressing for their attention. There are several ways in which cities have sought to maintain a focus on bus lane enforcement (see Table 15). In London, the municipal transportation agency contracted with the police department to provide services related to safety, maintenance of traffic flow, enforcement of bus lanes, and other objectives, and a dedicated command unit was established to carry out the agreement. In San Francisco, the police have established a dedicated unit with a focus on bus lane enforcement (sometimes in association with other traffic-related issues), which operates under the supervision of the transportation agency.

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There have been few published studies on the costs and benefits of sustained bus lane enforcement. One unpublished study turned up by our research,<sup>32</sup> found that on two pilot routes tested in Manhattan, the fiscal benefits of sustained patrol-based enforcement was about 65 percent higher than the costs. Overall, the costs of enforcement broke about even with the revenues it brought in, but the net benefits were produced by the transit agency's productivity gains due to schedule adjustments that would be enabled by the faster running times.

A common alternative to the continuous enforcement of bus lanes is "sweep" or "blitz" style enforcement, where intensive enforcement activities are conducted periodically for brief periods. Because of their high resource requirements, these efforts cannot be sustained for long, but can help raise public awareness of the law, but have little residual effect if some visible enforcement effort is not maintained between sweeps. Both Paris and Los Angeles have used such brief but intensive enforcement campaigns when first introducing bus lanes.

All of the case study cities rely primarily on civilian enforcement agents to issue violations for parking in a bus lane, usually as part of units that enforce parking regulations more generally. In most, these are employees of the city's transportation agency, a separate parking agency, or some other administrative unit. Police agencies in London, New York, and Paris have dedicated units for parking enforcement consisting of non-sworn (civilian) employees. New York and Paris also empower certain transit agency employees to issue parking tickets for bus lane violations. Additional parking enforcement powers are held by some sub-municipal entities, including London's boroughs and Seoul's Gu (districts).

Since in many cities, moving violations are charged as a civil infraction against a driver, enforcement actions against the driving of vehicles in a bus lane generally fall within the domain of the police. But as discussed earlier, some cities have tailored their laws to facilitate more effective enforcement, either converting the offense to an administrative matter, like a parking ticket, or by empowering certain civil enforcement agents to issue tickets for it. In Sydney and Los Angeles, enforcement of moving violations remains a traditional police function. In San Francisco, it is conducted by a special unit of the police that reports directly to the city's transportation department. In London, New York and Paris, enforcement is done by a mix of police and civilian agents who work under police supervision. Seoul and London allow local-level entities to enforce bus lanes.

**Table 15. Patrol-based Enforcement**

Feature	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
<b>Enforcement of parking laws</b>							
Police department	• <sup>a</sup>		• <sup>a</sup>	• <sup>a</sup>			
Other municipal agency	•	•			•	•	•
Transit agency			•	•			
Borough or local-level agency	•					•	
<b>Enforcement of traffic laws</b>							
Police department	• <sup>a</sup>	•	• <sup>a</sup>	• <sup>a</sup>			• <sup>c</sup>
Other municipal agency					• <sup>b</sup>	•	
Borough or local-level agency	•					•	

*Notes:*

- <sup>a</sup> Civilian employees of the police department.
- <sup>b</sup> Police officers under transportation agency supervision.
- <sup>c</sup> State-level agency.

*Sources:* See city case studies in the appendices for sources.

## Camera-based Enforcement

Automated, camera-based enforcement of bus lanes provides an emerging alternative to patrol-based enforcement strategies. While it does not eliminate the need to commit personnel resources to the overall enforcement effort, it largely shifts this to a more manageable back-office operation. There are no gaps in enforcement as long as the equipment is working properly, and the high detection rate provides a strong deterrent to potential bus lane violators.

However, camera-based enforcement has a number of political, legal, and administrative challenges or drawbacks, and it has only been implemented widely in a few cities (see Table 16). In places where driving in bus lanes is treated as an infraction, it can be difficult for camera-based systems to meet the evidentiary standards (e.g., proof of the driver's identity). Bus lane enforcement cameras also face the same public concerns that make speed- and red light-cameras unpopular: the potential for privacy violations, questions about reliability, perceptions that the cameras are implemented only to generate revenue, and concerns that drivers trying to avoid fines will drive unsafely.<sup>33</sup>

Stationary bus lane cameras have been implemented most extensively in London, and have also been adopted in New York, Paris, Seoul, and Sydney. London and Paris both experimented with bus-mounted cameras, but neither found the technology to be practical. New York, San Francisco, and Seoul also have bus-mounted camera trials planned or underway. London, New York, and Seoul have also experimented with portable or car-mounted cameras that can be deployed to problem areas as needed. Of the case study cities, only Los Angeles has not implemented camera-based bus lane enforcement.

The technologies used for bus lane cameras vary from city to city, and have also been evolving rapidly as technology advances. In general, there has been a trend toward collecting both high-resolution photos (to aid in vehicle identification) and video evidence (to demonstrate the context for the bus lane violation) in order to provide the strongest case possible in court proceedings. In most of the cities, agents review either raw footage or electronically selected excerpts to identify cases where violations have occurred and should be prosecuted.

Sydney is an exception to this approach. It relies on computer processing of high-resolution photos. Cameras are stationed at intervals along the bus lanes, and violation notices are automatically issued to vehicles detected by consecutive cameras.

**Table 16. Camera-based Enforcement**

Feature	London	Los Angeles	New York	Paris	San Francisco	Seoul	Sydney
Camera-based enforcement employed	•		•	•	P	•	•
Type of laws enforced by camera							
Moving violations	•		•	•		•	•
Parking/stopping violations	•			•	•	•	•
Administrating agency							
Police department	•			•			
Transit operator or other municipal agency			•		•	•	•
Camera placement							
On-board buses			P	P	P	P	
Stationary (along street)	•		•	•		•	•
Mobile units, patrol vehicles	•		P			•	
Analysis of images to verify violations							
Automated							•
Manual	•		•	•	•	•	

*Note:* P = pilot program.

*Sources:* See city case studies in the appendices for sources.



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## III. CONCLUSIONS AND RECOMMENDATIONS

### SUMMARY OF KEY FINDINGS

This survey examined the design and administration of bus priority lanes in cities with a broad range of political cultures and institutional environments. Overall, it found an array of different strategies being used to make bus priority lanes work in congested urban environments, rather than convergence on a single universal set of strategies.

As discussed in the introduction, there were four key questions examined in this report:

- 1. How do the many public agencies within any city region that share authority over different aspects of the bus lanes coordinate their work in designing, operating, and enforcing the lanes?*

In many cities, responsibilities for street engineering, transit services, and policing have long been split across multiple agencies, or even across multiple levels of government. This fragmentation of responsibilities often produces bus lanes that are ineffective, or if effective at achieving transit mobility improvements, cannot sustain the institutional or political support needed for long-term success. In most of the cities examined here, institutional reform to achieve greater integration of these responsibilities has been a central component of efforts to create a high performance bus priority network.

One area where this integration has taken place has been system planning and design. In many cities, streets have long been managed by streets or public works departments that have defined their missions rather narrowly in terms of maintenance of traffic flow. This framework often produced bus lane networks that operated during limited hours and were relegated to the curb lanes, where they are particularly vulnerable to blockages by stopped vehicles. In recent years, several high profile large-city mayors have attempted to transform their cities' streets as key, legacy-defining projects. A common strategy has been merging streets departments with transit agencies and establishing new policy priorities that emphasize safety, sustainability, livability, and other objectives. These new transportation departments are charged with addressing the needs of all street users, including motorists, transit riders, bicyclists, pedestrians, and businesses requiring access for goods deliveries, and have a mandate to be bolder and more creative in the design and allocation of street space. Several of the cities examined here, including London, San Francisco, Seoul, and Sydney, have undergone some form of integration of responsibilities under transportation superagencies in recent years.

Notably, in the three cities examined here that did not undergo this type of institutional reform (Los Angeles, New York, and Paris), the primary transit agency is not under control of the city mayor. Instead, specifically for the purpose of providing coordinated planning for new bus lanes, Paris created a new interagency "Mobilitien Route Committees." New York has not developed a formal interagency structure, but has reinvented its city Department of Transportation with a renewed focus on safety, livability, and multimodal planning objectives.

Integration of enforcement responsibilities into these broader transportation agencies has proven much more difficult. In many legal systems, policing powers are required in order to intercept vehicles and to issue a citation against the driver, and these powers cannot simply be delegated to other government agencies. As a result, they often remain the responsibility of police departments, which face many competing demands at any given time and cannot always make bus lane enforcement a priority. Short of formally granting these agencies policing powers, which only Seoul has been able to do, some of the cities established formal contracts or personnel assignments across police and transportation agencies to ensure that bus lane enforcement remains a priority. In London, the relevant agencies negotiated an interagency contract, whereby the transportation agency directly procures bus lane enforcement services from the police. In San Francisco, a dedicated unit of the police was placed under the daily management and supervision of the new Metropolitan Transportation Agency.

The advent of camera-based bus lane enforcement has created a new approach to integrating traffic management and enforcement responsibilities. In London, New York and Sydney, management of bus lane enforcement cameras has been placed under the responsibility of a transportation agency, with bus lane infractions administered like parking violations, in that they are levied against vehicles rather than their drivers.

## *2. What is the physical design of the lanes?*

The most common physical arrangement for bus priority lanes on city streets has long been along the curbside. This position minimizes impacts on general traffic flow, but puts buses into competition with vehicles queuing to make turns, stopping at the curb to pick up or discharge passengers, standing at the curb to make deliveries to local business, or parking. Among the cases examined here, curbside remains the most common alignment for bus lanes.

However, several of the cities examined here are shifting toward alternative approaches that mitigate some of the drawbacks associated with curbside bus lanes. San Francisco has long used offset lanes that preserve more curb access for other uses, a practice that is increasingly being adopted in New York City as well. Paris has created physical barriers between bus lanes and other traffic lanes, while still attempting to maintain some flexibility in street operations and limited access for certain classes of vehicles. Seoul, after rapidly building out an extensive network of curbside bus lanes, has equally rapidly converted a large proportion of its network to operate in the median, while also maintaining access to other vehicles that may need to use the lanes to make turns.

Signage, lane markings, and other practices all varied significantly among the case studies. There was no clear common trend with regard to the visual design of the bus lanes. Some cities have sought to maximize the visibility and driver understanding of the bus lanes, while others have not singled out bus lanes for special treatment among the cacophony of urban street signage and regulations.

But one universal and important finding was that there is no single bus lane alignment suitable throughout any of these cities. Each has had to adapt its bus lane designs and



regulations to meet local conditions, often on a block-by-block basis. On some blocks without intensive curbside activities, a curb-aligned bus lane may work perfectly well. On neighboring blocks, a school requiring access for school buses, or a furniture store requiring curb access for pickups and deliveries, or a high-volume intersection requiring queuing space for right-turning vehicles may make a curbside lane untenable. In the 1970s, several of the cities examined here installed many miles of bus lanes without regard to these factors. Enforcement tended to wane over time, both because police departments' priorities drifted elsewhere and because the design of these lanes ensured that enforcement was impractical or politically impossible. Today, in many of these cities, the design of bus lanes employs a much more diverse and flexible design toolkit, and often involves painstaking block-by-block study to ensure that the design of a bus lane is suitable for its context.

*3. What is the scope of the priority use granted to buses? When is bus priority in effect, and what other users may share the lanes during these times?*

In general, bus priority lanes exist in urban environments where the goal of improving mobility for bus riders must be balanced against the needs of other competing system users, including “through” vehicular traffic; traffic requiring curbside access, including goods deliveries; bicyclists; and pedestrians. In traditional curbside bus lane designs, this “balance” is achieved by rationing of access to the curb lane to buses during peak hours and to other users at other times of day, while through traffic faces minimal competition for the remaining street space. The search for a different balance that more effectively prioritizes public transit has led to the growing popularity of offset and median alignments for bus lanes. These options separate bus operations from local access and goods delivery, allowing each activity to operate efficiently over longer hours, and instead sacrificing some of the street capacity previously dedicated to the flow of through traffic.

In Paris and San Francisco, most bus lanes accommodate loading zones that allow them to operate around the clock. In Los Angeles, New York, and Sydney, most bus lanes lack these zones and operate only during peak hours of public transit use. London and Seoul have more of a mix of full-time, daytime, and peak hour operations. Cities that have been shifting toward the new physical layouts for bus lanes, such as offset or median bus lanes, also generally have been extending the hours that bus lanes can operate.

In general, nearly every city studied here allows all vehicles to use curbside bus priority lanes to make right turns (or left turns in the U.K. and Australia, where vehicles travel on the left side of the road), and to access driveways on a given block. Taxis are universally allowed to use the lanes to pick up and discharge passengers, and most cities allow taxis to drive in the bus lanes as well.

The cities are divided on the question of bicycle use of bus lanes. While buses and bicycles tend to operate at similar average speeds, they have very different operating behaviors, with bicycles favoring maintenance of a constant speed and buses needing to make frequent stops. The result is often a leapfrogging pattern, where each takes turns overtaking the other. On a narrow bus lane, this can be dangerous, but on a wide bus lane, this may be safer than bikes operating in general traffic. New York, San Francisco and Seoul generally disallow bikes from using bus lanes. The remaining cities either allow it, or determine

bicycle access on a site-specific basis. But regardless of whether cities allow bicycles in bus lanes, most of these cities are also making bicycle lane development a strong priority. In New York, for example, the major redesign of the streets hosting the city's busiest bus route also included installation of a separate, dedicated bicycle lane, and included bicycle-related performance criteria in its evaluation of the overall street design.

#### *4. How are the lanes enforced?*

Effective bus lane enforcement has been the key ingredient missing from many early bus transit priority networks. Transportation agencies rarely have the luxury to develop and implement optimal bus lane enforcement strategies; they must work with the limited tools they have been given in the political and legal systems under which they operate. In most cases, enforcement of laws concerning the operation of motor vehicles is a police responsibility, and the granting of police powers to a civilian transportation agency is not a possibility. As discussed earlier, cities have dealt with this challenge in various ways. Some have passed laws reclassifying bus lane violations as civil infractions that can be enforced by civilian agents and/or by automated cameras. Others have developed contractual or supervisory relationships between police and transportation agencies to ensure that there are personnel directly responsible for bus lane enforcement.

Others have adopted design strategies that achieve self-enforcement through passive means, instead of relying heavily on active police enforcement. The effectiveness of an offset bus lane may be compromised if there is a high rate of encroaching traffic, but rarely as severely as a curbside bus lane blocked by a single parked car. Similarly, Paris' physically separated bus lanes may suffer from enforcement problems, but the presence of the barrier does deter most illegal blocking of the lane.

But overall, bus lane enforcement cameras potentially represent the single most significant innovation in the decades-long struggle to improve the operation of buses on urban streets. If comprehensive enforcement regimes can be established, as they have in London, the effectiveness of bus lanes at improving urban transit operations can be transformed. With the exception of Los Angeles, all of the case study cities are now using or testing camera-based enforcement of bus lanes on at least part of their networks. But to continue to expand their network coverage, these agencies will need to be careful to sustain public confidence that the technology is being applied appropriately and is not being abused as a revenue-generating tool.

## **AREAS FOR ADDITIONAL RESEARCH**

This research encountered a number of limitations in the available information available on this topic. Most of the case study cities do not make data readily available on the extent, locations, or characteristics of their bus lane systems. Some, of the cities had this information available internally and provided it upon request, while others had never compiled these data as far as we were able to discern. A periodically updated GIS database with bus lane networks and key characteristics would be beneficial to both researchers and system managers.

Also, as far as this research was able to discern, none of the case study cities has ever performed a system wide evaluation of its bus priority network. Nearly all bus lane evaluation studies consider the effectiveness and impacts of individual bus lanes in isolation or in combination with other operational improvements made on the same street. This is certainly appropriate for many applications, but it ignores others. System-wide evaluation studies could identify areas where additional bus priority lanes would be most beneficial, or areas where bus lane hours of operation are out of balance with peaks in ridership. It could also be used to track bus speeds, reliability and ridership relative to routes that operate outside without bus priority treatments, as well as the sources of bus delay on and off the bus priority lane system. Independent scholarship on this topic would also be beneficial.

## **CONCLUSIONS AND RECOMMENDATIONS**

Central business districts in major cities around the world have experimented with bus lanes for over half a century. For much of this history, success has been episodic and fleeting; bus lanes have worked when elected officials directed resources and attention to enforcement and public awareness, only to degrade into ineffectiveness when attention and priorities turned elsewhere. In many cities, bus lane signs and markings have been allowed to gradually fade from the urban landscape as their sponsoring agencies gave up hope that they could be made to work.

In recent years, large cities around the world have brought renewed focus and innovation to their bus lane networks. Big-city mayors have sought to reprioritize city street management around new values of safety, livability and sustainability rather than the optimization of traffic flow. Inspired by the success of bus rapid transit systems in Bogotá and elsewhere, elected officials have also sought to improve the quality, capacity, and reliability of urban bus service as a cost-effective alternative to rail transit network expansion. All of these are challenging goals, and any effort to address them requires innovative street design and management strategies to avoid the problems encountered by earlier bus priority initiatives.

While the details of each city's approach are unique, four key hallmarks of this new wave of urban bus network planning have included: (1) institutional reforms, (2) creative and carefully tailored physical designs, (3) strategies to balance competing uses, and (4) sustainable approaches to enforcement. Other cities considering expansions of their bus priority networks may benefit from examining options in each of these categories. This research identified a number of specific innovative practices in each of these areas, including:

### *Institutional Reform*

- Merge transit agencies with street management agencies, or otherwise enact reforms to make bus system efficiency and reliability a key driver of street management planning.
- If transit and street management agencies remain separate, establish formal inter-agency route planning committees.

- Enable the city's transportation agency to manage bus lane enforcement agents, either through purchase of services through an interagency agreement, or assigning police personnel to work under the supervision of transportation system managers.
- Handle bus lane violations like parking violations, to enable enforcement by non-sworn officers.

### *Physical Design*

- Offset bus lanes from the curb to reduce conflicts with curbside activity and turning vehicles.
- Use a flexible toolkit to optimize bus lane design for the conditions on each block.

### *Accommodation of Competing Uses*

- Where offset lanes are not feasible, explore the feasibility of wider bus lanes that allow passing, or the construction of small pocket loading zones.
- Recognize that not every street can be optimized for through traffic, local access, efficient transit operations, and bicycle and pedestrian safety, and consider whether some functions could more effectively be accommodated elsewhere.

### *Bus Lane Enforcement*

- Adopt "self-enforcing" bus lane designs that do not rely on active policing for effectiveness.
- Implement camera-based bus lane enforcement, with violations administered like parking tickets.
- Roll camera enforcement technology out gradually, with ongoing accuracy monitoring, and in-the-field capabilities for traffic managers to disable cameras temporarily in disrupted traffic conditions, in order to maintain public confidence in the fairness and reliability of the system.

## APPENDIX A: LONDON CASE STUDY

### INTRODUCTION

London has developed one of the most comprehensive systems of actively managed bus priority lanes in the world. While its bus lane network emerged over period of 40 years, London significantly upgraded and strengthened it over the past six years, as part of a comprehensive realignment of its surface transportation system. London's approach to the designation and enforcement of bus lanes emphasizes central control over a network of key arterials, but local control over bus lanes off this network.

Despite London's diversified public transportation network that includes subways, commuter rail, and light rail, buses remain its most widely used transit mode. About 8,000 buses operate along 700 bus routes. 34 In 2010 the system served more than 2.2 billion passenger trips (see Table 17). In the past few years, public transit usage has increased as the city has made various efforts to shift travelers out of private cars, including adoption of a cordon pricing scheme for motor vehicles entering the city center. Passenger trip segments by bus have risen more than 62 percent from 1998 to 2008, while the population of London has grown by only 7.8 percent over the same decade.

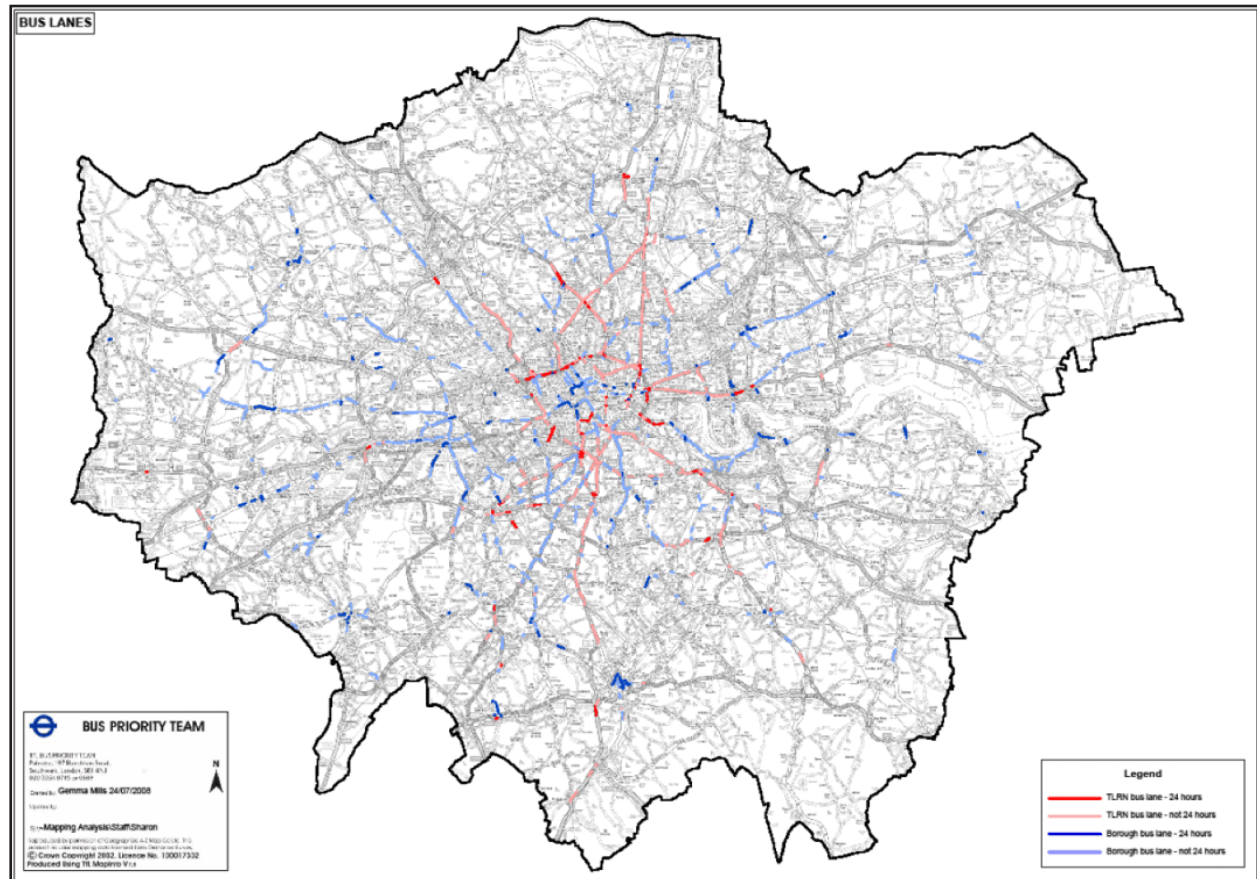
**Table 17. Metropolitan Profile (London)**

<b>City population<sup>a</sup></b>	7.8 million	Greater London
<b>Metropolitan population<sup>b</sup></b>	11.9 million	London Larger Urban Zone
<b>Annual unlinked urban transit trips<sup>c</sup></b>	3,944.3 million	
Heavy rail <sup>d</sup>	1545.0 million	39% of urban transit trips
Light rail (Docklands & Tramlink)	106.2 million	3% of urban transit trips
Bus	2,289.0 million	58% of urban transit trips
Ferry	4.1 million	0% of urban transit trips
<b>Ratios calculated from data above</b>		
Urban transit trips per city resident	504 annual trips per capita	
Urban bus trips per city resident	293 annual trips per capita	
Urban transit trips per metro resident	331 annual trips per capita	
Urban bus trips per metro resident	192 annual trips per capita	

*Sources:*

- <sup>a</sup> United Kingdom Office for National Statistics, Annual Mid-Year Population Estimates, 2010 (June 2011), <http://www.ons.gov.uk/ons/rel/pop-estimate/population-estimates-for-uk--england-and-wales--scotland-and-northern-ireland/mid-2010-population-estimates/index.html> (accessed December 9, 2011).
- <sup>b</sup> London Larger Urban Zone (LUZ) as defined by European Commission - EUROSTAT Urban Audit [Data for 2004], <http://www.urbanaudit.org>.
- <sup>c</sup> Transport for London, Annual Report and Statement of Accounts for 2010/11, 10, <http://www.tfl.gov.uk/assets/downloads/corporate/tfl-annual-report-2010-11-final-interactive.pdf> (accessed December 9, 2011).
- <sup>d</sup> Includes London Underground, plus travel on National Rail within Greater London, based on the authors' estimates. The National Rail contribution was calculated as 1,274 annual National Rail trips overall (United Kingdom Department for Transport. "Rail," Statistical Table RAI0101, <http://www.dft.gov.uk/statistics/tables/rai0101> (accessed December 30, 2011)), multiplied by 47.5% originating in London, and 68% of those trips also terminating in London (United Kingdom Department for Transport. National Rail Travel Survey: Overview Report, 16-17, <http://assets.dft.gov.uk/statistics/series/rail/nrtsupdate.pdf> (accessed December 30, 2011)).

As of 2009, London had 1,200 bus lane segments, covering about 5 percent of the total bus transit network. Five hundred of the lanes segments, totaling 121 km (75 mi.) ran on the primary regional road network (the “red route network”).<sup>35</sup> The remaining segments, totaling 164 km (102 mi.), ran on roads controlled by the boroughs at a local level. Figure 1 illustrates the extent of the network as of April 2009.



**Figure 1. Bus Lane Network Map (Greater London)**

*Notes:*

- Red indicates routes managed by Transport for London.
- Blue indicates routes managed by local authorities.
- Darker colors indicate routes that operate 24 hours/day.

*Source:* Transport for London, *Guidance on the Design of Bus Lanes in London* (London: Transport for London, April 2009).

## HISTORICAL DEVELOPMENT

The Greater London Council (GLC) began experimenting with the establishment of bus lanes in the late 1960s. It installed the first curb bus lane in London on Park Lane in 1968, where a short segment served as a queue-jumper for the high volumes of buses that were approaching a busy intersection during the afternoon peak hours. Other early bus lanes introduced on Brixton Road (1969) and Albert Embankment (1971) showed more success at improving bus travel times, and by 1975 London had introduced concurrent flow bus lanes in 29 locations.<sup>36</sup> When the GLC was abolished in 1986, London had 229 bus lanes.<sup>37</sup>

In the early 1990s, following the abandonment of planning for most major road building projects, the region saw growing interest in corridor-length strategies for improving the efficiency of bus service. A series of successful pilot studies using queue-jumping lanes, pre-signals, and other bus priority strategies on six corridors in South and West London became a model for a region-wide initiative.<sup>38</sup> In 1994, the 33 boroughs of Greater London came together to establish the London Bus Priority Network (LBPN). But the core of the strategy was taking a whole-route approach using a broad toolbox of strategies to make the bus lanes work as effectively as possible. This system covered over 800 km (497 mi.) of bus routes and introduced a wide range of operational strategies to improve the bus system, including a simpler fare structure, bus signal priority, changes and additions to the route structure, and new bus lanes. Between 1993 and 2001, the London boroughs added more than 400 bus lanes.<sup>39</sup>

Following Greater London's political reorganization, the newly elected Mayor of London, Ken Livingstone, set out his transportation policies in *The Mayor's Transport Strategy* (2001).<sup>40</sup> The Strategy introduced central London's congestion charging scheme, and sought to improve public transit services as an alternative to private cars. It identified bus reliability as the most significant problem for travelers, along with overcrowded vehicles and poor traveler information as other key concerns. The factors found to contribute to poor reliability included congestion and illegally parked vehicles.

This first Mayor's Transport Strategy supported a new approach to combating these problems, the London Bus Initiative (LBI), which was to be implemented in conjunction with the ongoing London Bus Priority Network. The LBI was a pilot effort launched in 2001 and financed with a £60 million grant from the national government. Partners in the LBI included Transport for London (TfL), the 32 boroughs and the City of London, private bus operators, and the police. The LBI focused on 27 high-ridership lines using a "whole route" approach, and sought to improve the entire passenger experience, not just mitigating choke points or improving line haul bus speeds. Measures to improve bus reliability emphasized improved bus designs, camera-based traffic enforcement, along with enhanced support by the police.<sup>41</sup>

After the first phase of the LBI initiative ended in 2005, TfL embarked on LBI2, which encompassed a new set of bus corridors and took a more multi-modal approach. LBI2 set the stage for the most recent initiative, Third Generation Bus Priority (3GBP). This program includes multi-modal planning for corridors. Although bus priority improvements may be part of the work in many corridors, the process is no longer focused exclusively on buses, as were the earlier initiatives. It now includes an emphasis on safety and access for pedestrians and cyclists; provision of adequate parking and curb access, and other improvements to the overall street environment.<sup>42</sup>

London elected a new Mayor, Boris Johnson, in 2008. After an extended period of review and consultation, the government issued a new Mayor's Transport Strategy in 2010. This strategy generally supports the continued development and enforcement of bus priority measures, but does not set any specific objectives or policy changes for the system. It generally emphasizes improving the overall quality of the passenger experience, including

safety, accessibility, and other improvements, and provides a greater role for the boroughs in shaping local transport to serve their particular needs.<sup>43</sup>

## **INSTITUTIONAL ARRANGEMENTS**

Greater London consists of the City of London plus 32 London Boroughs, each of which is a general-purpose government with an elected Council. Greater London also has a directly elected, regional London Assembly, and a directly elected Mayor. It possesses significantly more autonomy than the eight other administrative regions of England, and has some similarities to the devolved National Assembly for Wales and Scottish Parliament.

Over time, transportation powers in Greater London have shifted between unified and fragmented control. Between 1970 and 1984, a single regional entity, the Greater London Council (GLC), administered transportation planning, roads management (a power jointly held between GLC and the Boroughs), and the London Underground and London Bus systems. But the GLC was abolished in mid-1980s, and these responsibilities were divided among different agencies. Many of these activities were recentralized when a new Greater London Authority was established in 2000.

### **Transit Operations**

Between 1970 and 1984, the GLC administered the London Underground and London Bus systems. In 1984, the London Regional Transport Act shifted responsibility for the transit systems to London Regional Transport, a board appointed by the Central Government, which began privatizing transit operations.

In 1999, the Greater London Authority Act created a new Greater London Authority (GLA), headed by a regional Assembly, and Greater London's first directly elected Mayor. Beginning in 2000, the GLA took over many of the functions previously controlled by the London Boroughs. A new agency, Transport for London, was created under the GLA to manage London's roads, traffic, and public transportation system, including the provision of bus service through contracts with private operators.<sup>44</sup>

TfL has three main divisions: London Underground, which manages the city's subway system; London Rail, which manages some of London's commuter rail, light rail, and tram systems; and Surface Transport, which includes street management, a wide range of rubber tire services, and other modes.

### **Street Planning and Design**

Between its creation in 1965 and its dissolution in 1986, the GLC had primary responsibility for planning transportation and roads within its jurisdiction, and shared responsibility for management of roads with the London Boroughs. Following the 1985 Local Government Act, the London Boroughs assumed sole responsibility for the management of the road system.



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Today, management of streets and roads is again a shared responsibility. London Streets, a unit within the Surface Transport division of TfL, manages the Transport for London Road Network, or “Red Routes,” a 580-km network of main routes for through traffic. London Streets shares management of an additional 500-km Strategic Road Network with the London Boroughs. All other streets and roads remain under the administration of the London Boroughs. London Streets also manages the Congestion Charge, traffic signals, and bus lane enforcement cameras.

## **Traffic Enforcement**

The Metropolitan Police Service (MPS) has primary responsibility for law enforcement in Greater London.<sup>45</sup> Before the year 2000, it reported to a national minister, the Home Secretary. In 2000, the GLA assumed oversight for the Metropolitan Police Service through a new Metropolitan Police Authority (MPA).

In 2002, MPS and TfL signed a Special Services Agreement to establish a new Transport Operational Command Unit responsible for reducing crime on buses and taxis, minimizing disruptions to bus services through policing of the bus lanes, and enforcing parking, stopping, and loading regulations on the Red Routes. In 2009, as part of a larger reorganization toward “Territorial Policing,” this unit was renamed the Safer Transport Command, and was reorganized around borough-based patrols.

In addition to the Safer Transport Command, two other MPS units also have responsibilities for traffic control:

The Traffic Operational Command Unit focuses on maintaining safety and security in the regional road network, investigating vehicle collisions, and maintaining traffic operations on trunk roads and highways.

The Traffic Criminal Justice Unit, created in 2004, prosecutes route traffic violations, processes traffic tickets, and runs camera-based speed and red light violation enforcement (but not bus lane camera enforcement) as part of the London Safety Camera Partnership.

Violations of bus lane regulations are civil penalties that are contestable before a civil tribunal of adjudicators employed by the independent Parking and Traffic Appeals Service.

## **Coordination**

Although responsibility for the road network is divided among TfL and the 32 London Boroughs, there is a significant degree of policy coordination. In 2002, following adoption of The Mayor’s Transport Strategy, the London Boroughs, the Association of London Government, Transport for London (TfL), and the police and bus operators established a regional Bus Priority Partnership. This group provides recommendations on the allocation of funds; the development of bus priority action plans; bus service improvement initiatives and their outcomes; program implementation and expenditures; coordination with other local projects; and other innovative measures.<sup>46</sup>

To establish a bus lane, a local authority must follow a rigorous planning process. It must conduct a feasibility study, develop a detailed design and subject it to network modeling, develop a business case demonstrating that public benefits are maximized, conduct a safety audit of the proposed design, and engage in a series of public consultations and notifications.<sup>47</sup> At the end of the process, the authority issues a Traffic Regulation Order that codifies the new policy.

Although in many cases TfL and the boroughs work cooperatively on bus lane planning and design, not all boroughs have been enthusiastic supporters of bus lanes. The boroughs of Ealing and Barnet, for example, have removed some bus priority lanes on the roads that they control, leading to direct conflicts with TfL.<sup>48</sup>

The 2002 Special Services Agreement between Transport for London and the Metropolitan Police Authority ensures that the two agencies have a unified approach to bus lane enforcement matters. TfL also leads a group called the Enforcement Task Force, which has representatives from the Association of London Governments, the Metropolitan Police Service, and the City of London Police. The Task Force facilitates cooperation on improving the enforcement process, such as finding ways to collect penalties from cars licensed outside the United Kingdom.

## **PHYSICAL DESIGN AND SIGNAGE**

London has adopted a flexible set of design standards intended to customize bus lanes for the conditions unique to each corridor. The 2009 Guidance on the Design of Bus Lanes in London emphasizes that:

*The main purpose of bus lanes, in London, is to minimise delay to buses and their passengers and provide an efficient reliable bus operating service, accessible to all. Because bus lanes occupy valuable road space and thus restrict kerbside access each bus lane must demonstrate value for money in the context of network utilisation. Justification should be robust and the overall design and planning will need to consider the impact on other road users (such as pedestrians, cyclists and general traffic), and their safety requirements.<sup>49</sup>*

The design guidelines proceed to recommend criteria for the establishment of planning objectives for a bus lane.

### **Lane Design**

London's bus lanes are normally marked with solid painted lines and not separated by physical markers. Dashed lines indicate the locations where buses are to enter the lanes well as the 20 m (66 ft.) prior to an intersection where private vehicles may enter the lane to make a turn.

London's bus lanes are set into the roadway in a wide variety of configurations. While many are on the curb side (the left side) and run with traffic flow, London also has bus lanes that run in interior lanes, along medians, or as contraflow lanes.<sup>50</sup>

To help drivers identify bus lanes, the lanes are indicated in multiple ways beyond the solid white line that separates them from other lanes of traffic. The pavement of bus lanes is typically painted red, and the lanes are marked with text on the pavement. When special classes of vehicles are permitted, this may be indicated in painted text on the pavement (Figure 2).

The bus lanes vary in width from 3.0 to 4.5 m (9.8 ft. to 14.8 ft.), depending on the available street space, traffic volumes, and safety considerations. The preferred width to accommodate cyclists is 4.5 m (14.8 ft.), but in short segments where special circumstances require a lane as narrow as 3 m (9.8 ft.) may be opened to cyclists.<sup>51</sup>



**Figure 2. Pavement Text Indicating that Goods Vehicles are Allowed in the Bus Lane (London)**

Source: Transport for London, *Guidance on the Design of Bus Lanes in London* (London: Transport for London, April 2009).

In most cases, the bus lanes run directly along the curbside, but TfL's flexible design standards enable a wide range of variations to fit local conditions and needs.

Access to the curb is regulated by means of "Red Route" painted pavement lines and signage. Double red lines along the curb indicate that stopping is not allowed at any time. Single red lines indicate that stopping for commercial vehicle loading or picking up or dropping off of passengers may be allowed during posted hours (usually 7 p.m. to 7 a.m.). A wide, single red line at a bus stop indicates that taxis may not pick up or discharge passengers in that location. On streets outside the Red Route network, yellow lines indicate stopping regulations that are enforced by local authorities.

Special loading zones are indicated by the absence of a curbside line, or by specially marked boxes (see Figure 2 and Figure 3).



**Figure 3. Additional-width Bus Lane to Allow for Parking (London)**

Source: Transport for London, *Guidance on the Design of Bus Lanes in London* (London: Transport for London, April 2009).

## Signage

The bus lanes are marked with blue signs indicating the types of vehicles that may use them and the hours of operation (Figure 4). If no hours are indicated, then the bus lane is active at all times.

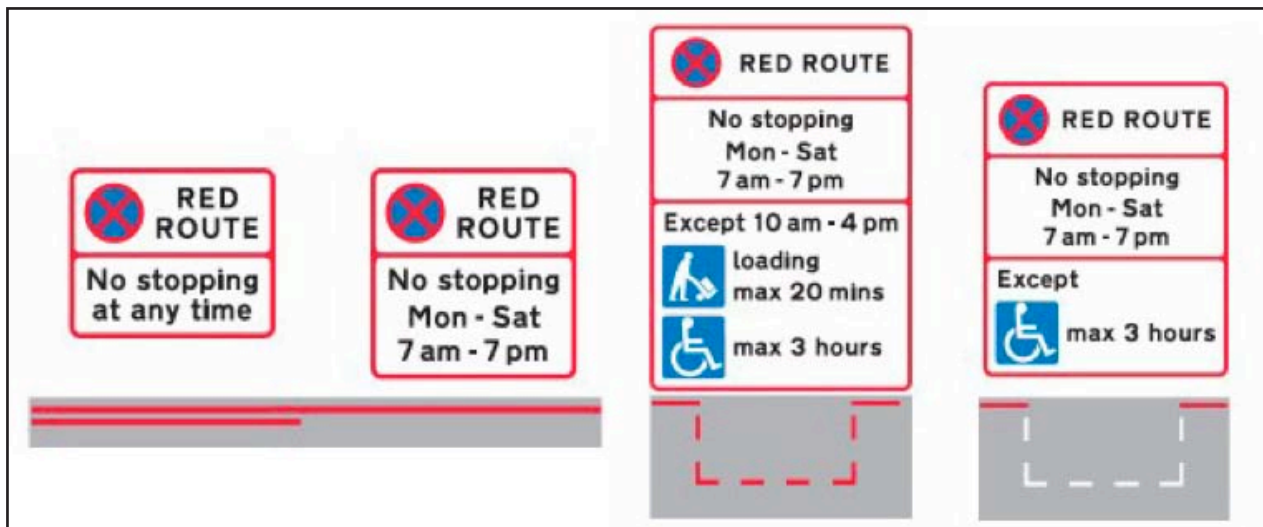


**Figure 4. Sign Indicating Buses, Cycles, and Taxis May Use the Lane (London)**

Source: Transport for London, "Road Signs and Regulations" (no date), <http://www.tfl.gov.uk/roadusers/finesandregulations/959.aspx> (accessed March 10, 2010).

If some curb access is permitted, regulations are indicated with a white sign indicating the hours and authorized users.

Figure 5 illustrates sample pairings of signs and curbside pavement markings.



**Figure 5. Sample Curbside Regulation Signs (London)**

Source: Transport for London, "Road Signs and Regulations" (no date), <http://www.tfl.gov.uk/roadusers/finesandregulations/959.aspx> (accessed March 10, 2010).

## ACCESS POLICIES

The London bus lanes are shared by a variety of permitted users. The users permitted varies by location, as TfL sets rules for the Red Route network lanes, and each borough sets rules for access to all other bus lanes within its boundaries. The following explanation of permitted users is based upon the TfL policies.

### Hours of Operation

Hours of operation for the bus lanes vary according to local conditions. Approximately 29 percent of the network is reserved for exclusive bus use on a 24-hour basis. About 25 percent is reserved for buses for 12 hours each day, and the remainder (54 percent) is in force during one or both peak periods, or some other designated hours.<sup>52</sup>

### Users Permitted

Taxis are permitted in about 90 percent of bus lanes, excluding locations of particularly severe congestion or where there are safety concerns, such as in contraflow lanes.<sup>53</sup> Taxis may also stop in bus lanes to pick up or drop off passengers, unless a broad red line indicates that only buses may stop in that location.

Private hire vehicles generally may not drive in bus lanes. However, with a special windshield permit, they may access bus lanes for the purpose of dropping off and picking up passengers.<sup>54</sup> Like private hire vehicles, vehicles carrying disabled persons that have a so-called “blue badge” are also allowed to drop off and pick up passengers in most bus lanes.

Most of London’s bus lanes allow bicycle access. Bicycles are only excluded in cases where there are specific safety risks, such as in lanes narrower than 3 m (9.8 ft.) or streets otherwise too narrow to allow safe passing.

Motorcycle access has been controversial for some time. Although certain boroughs have allowed motorcycle riders to use the bus lanes, TfL and most boroughs have prohibited this until recently. TfL commissioned a trial allowing motorcycles into the Red Route bus lanes from September 2008 to May 2010. The trial’s results showed that allowing motorcyclists into the bus lanes benefited them by improving their journey times, but also led to higher risk of collisions.<sup>55</sup> As a result of these findings, in July 2010 TfL began a new trial of motorcycles in bus lanes to see whether safety can be improved.<sup>56</sup>

Police, emergency services, mail vans, street sweeping vehicles, and garbage trucks are customarily allowed to travel in the bus lanes when on official business.

Drivers of private vehicles who plan to turn left into a driveway or an adjacent street are allowed to use the bus lanes for the 20 m (65.7 ft.) before an intersection. This is a safety policy to prevent drivers from cutting in front of a bus to make a left turn.<sup>57</sup>

Light or heavy goods vehicles are generally allowed to cross a bus lane to access a loading zone or parking bay between the hours of 10:00 a.m. and 4:00 p.m.<sup>58</sup> In a few designated locations, heavy goods vehicles are also permitted to drive in the bus lanes.

## **ENFORCEMENT**

Enforcement is a central component of Greater London's bus lane strategy. It relies on an aggressive, layered enforcement strategy that combines steep penalties with camera- and patrol-based enforcement.

### **Relevant Traffic and Parking Codes**

The responsibility for enforcing traffic laws related to the London bus lanes has evolved considerably over the past decades. Until the early 1990s, enforcement was the responsibility of the Metropolitan Police. During this time the bus lanes and other traffic laws were enforced somewhat sporadically, because the effort lacked dedicated resources and had to compete with other priorities for police officers' attention.<sup>59</sup>

Under the Road Traffic Act of 1991, the United Kingdom decriminalized parking regulations, empowering local authorities to issue "penalty charge notices" (PCN) via civilian enforcement officers. PCNs are enforceable and contestable through civil courts. Nonpayment is enforceable through seizure of a vehicle, but not through prosecution of a driver. Because local authorities keep the revenue from these administrative penalties, they have a powerful incentive to take parking enforcement seriously.

The Traffic Management Act of 2004 extended this principle to the management of congestion and traffic flow on the street system. With traffic enforcement duties and the resulting revenues under the control of local authorities, a much greater emphasis on bus lane enforcement has now become possible.<sup>60</sup>

Responsibility for enforcing bus lanes is shared between the local borough governments and TfL. TfL enforces the lanes along the Red Route Network, which covers about 5 percent of London's street network and carries around 33 percent of the traffic.<sup>61</sup> The boroughs are responsible for enforcement on other streets.

### **Penalties**

Vehicles that drive, stop, or park in a bus lane during operational hours are subject to a PCN of £120 (about \$180), with a 50 percent discount if paid within 14 days. These administrative penalties are legally distinct from more serious traffic violations that are ticketed through the Metropolitan Police. The driver, as an individual, is not subject to a criminal penalty fine or points added to his/her driver's license.

### **Patrol-based Enforcement**

Under the 2002 Special Services Agreement, TfL and the Metropolitan Police Service (MPS) established five objectives: 1) protecting public safety on the LBPN, 2) ensuring the

efficient movement of buses, 3) enforcing laws governing taxis and private hire vehicles, 4) managing congestion at agreed priority locations, and 5) enforcing bus lane and parking regulations.

A new Transport Operational Command Unit was created to administer this agreement. It employs civil enforcement officers who help with enforcement of traffic laws, including bus lane violations. These Police Community Support Officers (PCSO) are staff members of the MPS.<sup>62</sup> These officers usually patrol by foot or bicycle.

In 2007, in response to rising concerns over bus crime, the MPS began establishing Safer Transport Teams. The teams consisted of up to 18 PCSOs, located at key transit hubs in Outer London, in areas that had grown particularly problematic for low-level crime and anti-social behavior on the transit system. These increased patrols were considered highly successful, and the newly elected mayor of London, Boris Johnson, expanded the program significantly in 2008.<sup>63</sup> The success of this localized strategy to fighting transit crime led to a 2009 reorganization of the Transport Operational Command Unit into a Safer Transport Command organized around dedicated borough-based patrols.

Finally, vehicles with three or more outstanding penalty charges may be booted or towed. TfL occasionally relies on towing vehicles that have been illegally parked in a bus lane for a considerable length of time. In the mid-2000s TfL set up a roving unit of tow trucks to tow illegal parkers, but this program was halted because it was found that most cars being towed, while parked in the bus lane illegally, were not causing a safety hazard or obstructing traffic.<sup>64</sup>

### **Camera-based Enforcement**

London's bus lane program is particularly noteworthy for its expansive use of camera-based enforcement, a program that began in 1997. Over the years, it has experimented with a range of different video-based enforcement strategies.

The boroughs and TfL all have closed circuit television (CCTV) cameras installed to monitor bus lanes for vehicles illegally parked or moving in the lanes. These cameras are situated at fixed locations, but can pan and zoom. They are operated in real time by an enforcement officer, with images recorded to provide supporting evidence in enforcement proceedings. They may also be used as mobile units, allowing targeted deployment as necessary.

London has also used a variety of automatic cameras for bus lane enforcement. The early bus-mounted cameras recorded continuously on videotape while a bus drove in a bus lane. Tapes were collected at the bus depot and reviewed for violations. Similarly, London also used static roadside cameras that were permanently trained on locations with high violation rates, with tapes collected periodically and manually reviewed. However, this system has since been phased out, and the bus-mounted cameras are now used for crime and public security purposes.



Lately, TfL has been phasing in a new “Digital Traffic Enforcement System” that incorporates automatic vehicle location, automatic license plate recognition, and wireless telecommunications technologies. This system uses license plate recognition to trigger recording of video showing potential bus lane violations and the time and locations at which they occurred, writing each case as a separate encrypted digital record to DVD for later review. This approach dramatically reduces the amount of video that needs to be reviewed, and also automatically packages digital evidence records for use in enforcement proceedings. Recently, some local authorities have used this digital traffic enforcement technology in roving “smart car patrols” (vehicle-mounted cameras), but TfL has no current plans to adopt this approach. The London boroughs and TfL are also currently cooperating on a camera-sharing initiative that will help alleviate the expense of CCTV installation.<sup>65</sup>

## **Enforcement Effort**

London’s bus lane enforcement strategy is comprehensive and well coordinated. It came about at a unique historic moment. Its newly elected mayor, leading a new system of government and a newly integrated region, chose transformation of the city’s surface transportation system as one of the central objectives of his administration. His strategy included the Congestion Charge, an expanded and improved bus system, initiatives to keep intersections clear, and many others. With the freedom to develop new policy on a relatively blank slate, power to cut across institutional barriers while they were still fluid, and the urgent need to demonstrate results, conditions were ideal for the establishment of new interagency protocols so that the mayor’s initiatives were well supported by effective enforcement.

## **PERFORMANCE**

London’s expansion of its bus lane network, promotion of new design standards, and implementation of an enhanced enforcement framework took place in the context of a dramatically changing surface transportation environment. Following implementation of London’s Congestion Charging Scheme, automobile traffic in the congestion charging zone dropped by one-third, and bus service was significantly increased citywide. As a result, it is difficult to study the impact of the bus lanes independently.<sup>66</sup>

New enforcement programs adopted after the Mayor’s Transport Strategy (the congestion charge, bus lane cameras, speed cameras, intersection blocking cameras, etc.) initially identified a growing number of violations. However, as the programs became more familiar to drivers, they began to have a deterrent effect, and the number of citations issued dropped. An evaluation study noted, “Bus-mounted cameras have attained a strong deterrent status with the widespread knowledge that any one of London’s 8,000 buses could, potentially, be carrying an enforcement camera.”<sup>67</sup>

The tapering-off effect is shown in TfL’s analysis of data on the number of violations identified from the CCTV cameras. TfL found that in the two years from January 2003 to the end of December 2004, the hourly rate of incidents fell by 60 percent. Then, in the two-year period from January 2005 to December 2006, the rate of violations remained stable.<sup>68</sup>

In September 2007, the agency issued an upbeat news brief on enforcement activities, claiming that the number of bus lane violations was decreasing. Among other statistics, TfL claimed:

*...the enforcement of bus lanes has been very successful with the number of contraventions [violations] from bus mounted cameras between July 2000 and July 2005 per hour of viewed footage reduced from 12 to 0.1. Between the end of 2004 and the end of 2005, bus speeds in bus lanes increased by 5 percent - and buses now travel 12.6% faster in bus lanes than between bus lanes.<sup>69</sup>*

The news brief also claimed that the number of bus lane contraventions per hour in lanes monitored through CCTV enforcement fell from 8.8 to 6.1.

The general consensus among interviewees contacted for this study is that bus lane violations are no longer a significant source of bus delay or unreliability.

## APPENDIX B: LOS ANGELES CASE STUDY

### INTRODUCTION

The City of Los Angeles has had a small number of bus lanes on its downtown streets since the 1970s. That system has been modified over the years, but not greatly expanded. There is little documentation evaluating the success of these lanes, though staff interviewed for this project report that the lanes work fairly well. Of more recent interest, the City of Los Angeles and Los Angeles County installed a temporary one-mile demonstration bus lane on Wilshire Boulevard from 2004 to 2007. The performance of this lane was evaluated fairly thoroughly and deemed by staff to perform well, but the lane was eventually removed in the face of opposition from the local community, especially certain local merchants. As of 2010, the City of Los Angeles is working to permanently re-install and expand the Wilshire bus lane.

Metropolitan Los Angeles (the Los Angeles-Long Beach-Santa Ana, CA Metropolitan Statistical Area) stretches over 4,800 square miles and includes over 100 incorporated cities. It had a population of 12.8 million in 2010 (see Table 18). The Los Angeles region is famous for its heavy reliance on an extensively developed network of freeways and major arterials.

The City of Los Angeles, the county's central city, covers 469 square miles with a population of about 3.8 million. Like the county, the city is mainly connected by its freeway and arterial street systems.

**Table 18. Metropolitan Profile (Los Angeles)**

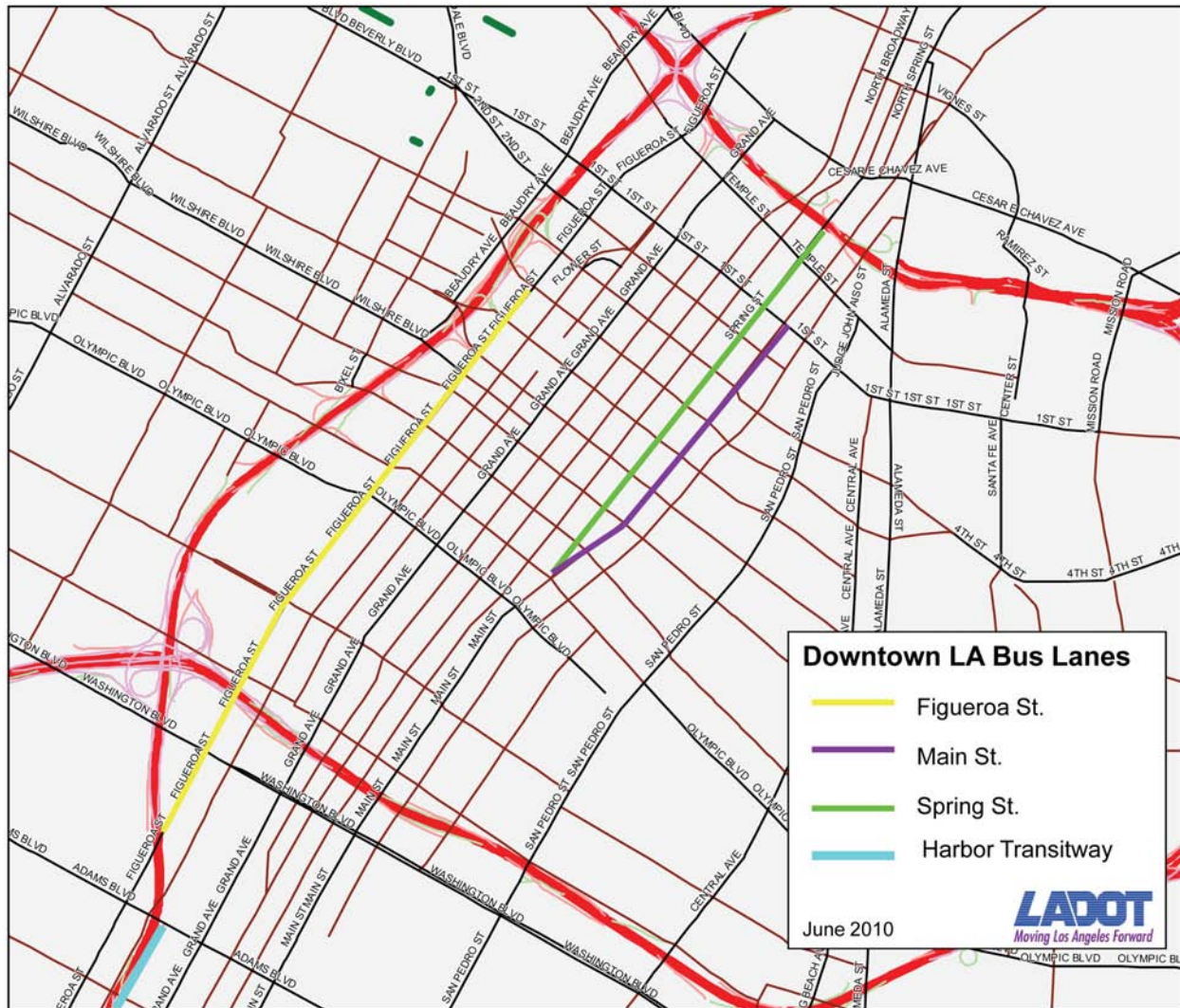
<b>City population<sup>a</sup></b>	3.8 million	City of Los Angeles
<b>Metropolitan population<sup>a</sup></b>	12.8 million	Los Angeles-Long Beach-Santa Ana, California Metropolitan Statistical Area
<b>Annual unlinked urban transit trips<sup>b</sup></b>	501.9 million	
Heavy rail	47.9 million	10% of urban transit trips
Light rail	46.4 million	9% of urban transit trips
Bus	407.6 million	81% of urban transit trips
<b>Ratios calculated from data above</b>		
Urban transit trips per city resident	132 annual trips per capita	
Urban bus trips per city resident	107 annual trips per capita	
Urban transit trips per metro resident	39 annual trips per capita	
Urban bus trips per metro resident	32 annual trips per capita	

Sources:

<sup>a</sup> U.S. Census Bureau, 2010 Census, <http://factfinder2.census.gov> (accessed December 9, 2011).

<sup>b</sup> Federal Transit Administration, 2010 National Transit Database, "Table 19: Transit Operating Statistics: Service Supplied and Service Consumed," <http://www.ntdprogram.gov/ntdprogram/data.htm> (accessed December 9, 2011). These totals include data for City of Los Angeles Department of Transportation, Los Angeles County Metropolitan Transportation Authority (LACMTA), and LACMTA-subsidized small operators.

The map in Figure 6 displays the bus lanes in downtown Los Angeles as of June 2010. Totalling approximately four miles, the system includes a one-mile lane along Main Street, 1.8 miles along Figueroa Street and 1.26 miles along Spring Street (also listed in Table 19 at the end of this case study). The Wilshire Boulevard demonstration lane is discussed elsewhere in this document.



**Figure 6. Downtown Bus Lane Network (Los Angeles)**

Source: Map courtesy of Los Angeles Department of Transportation (June 2010).

## HISTORICAL DEVELOPMENT

The City of Los Angeles first installed bus lanes in its downtown in the 1970s. Since then it has expanded the downtown system. In addition, in recent years it participated in a high-profile pilot project of a bus lane that ran on Wilshire Boulevard, mostly on city land but also through Los Angeles County land. This section discusses first the downtown lanes and then the Wilshire project.

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## The Downtown Bus Lanes

Los Angeles has had bus lanes operating in its downtown since 1974, when it introduced a contraflow bus lane on eight blocks of Spring Street. The new bus lane was designed to help buses travel efficiently towards the El Monte busway. After several years, the city added a second bus lane, in order to allow buses to pass one another;<sup>70</sup> this second lane was eliminated at some point before 2005. Over the decades, bus lanes were added to several other downtown streets as well.

In the mid-2000s, city transportation staff became concerned that the Spring Street contraflow bus lane was creating operational and safety problems. A particularly serious concern was that the single lane provided no safe means for a bus to pass other buses stopped for an extended period, such as for loading large numbers of passengers or on account of a bus breakdown. When these situations occurred, buses stopped behind the stationary bus either had to wait or would use the oncoming traffic lanes to pass. The latter option was quite dangerous. Yet another problem for buses was that the traffic lights were timed to speed flows in the direction of the all-purpose lanes, so the contraflow buses had no signal timing benefit. Overall, bus travel time through the eight-block stretch was quite slow, at an average of 7.5 minutes. Finally another set of problems had arisen as land uses changed in the downtown. With increased development and activity on Spring Street, the local community began to complain that the contraflow lane reduced available parking and made it difficult to access properties on the east side of the street.<sup>71</sup>

In response to these various problems with the Spring Street contraflow lanes, in 2005 the Los Angeles City Council approved a plan to close the contraflow lane on Spring Street and replace it with concurrent-flow bus lanes on Spring Street (southbound between Arcadia and 9th Streets) and new bus lanes on Main Street (northbound between 1st and 9th Streets).<sup>72</sup>

A final piece of the downtown bus lane network runs on Figueroa Street, a one-way northbound street. The bus lane on Figueroa Street is an extension of the Harbor Transitway, a fully separated transitway that opened in the late 1980s for buses and carpools. The Transitway could not be extended all the way to downtown, so in the late 1990s the city created bus lanes to serve as an extension into the downtown. The bus lane is about 1.8 miles long and runs between 22nd Street and 4th Street.

## The Wilshire Boulevard Bus Lane

In addition to its downtown bus lanes, Los Angeles installed a high-profile bus lane on a one-mile segment of Wilshire Boulevard in West Los Angeles from 2004 to 2007.

Wilshire made a good candidate for new bus lanes because it has more bus traffic than any other corridor in Los Angeles County, with over 80,000 boardings per weekday.<sup>73</sup> At the same time, the corridor is quite congested because of trips generated by the land uses along the corridor, traffic coming from the Santa Monica freeway, and traffic heading toward the 405 freeway. According to an Environmental Impact Report prepared in 2001, traffic along Wilshire often moved at no more than five mph during peak hours.<sup>74</sup>

The area along Wilshire Boulevard where the bus lanes were installed has a mix of land uses, including many commercial buildings. Some of the latter are 15- to 20-story office buildings. Offices along the corridor tend to have parking within the building, but many mom-and-pop stores rely on the metered street parking. The side streets intersecting Wilshire are mostly residential.

The Los Angeles County Metropolitan Transportation Agency's (LACMTA) initial plan to implement bus lanes on Wilshire Boulevard was approved by its board in August 2002 as part of a \$232 million package to improve bus services on the corridor.<sup>75</sup> Early plans for the corridor had called for a 24-hour median lane, but in response to concerns from business owners, this vision was scaled down to a peak-hour-only curb lane in the final plan approved by the board. The approved plan stipulated that no bus lanes would be created without the approval of the city or county that controlled the roadway. Because the lanes were controversial, the plan also stipulated that they would be implemented as demonstration projects.

The Los Angeles City Council voted down implementation of the 13-mile bus lane as originally planned by the LACMTA but approved a pilot project to operate just one mile of the bus lane for six months. In March 2004, one mile of peak-hour<sup>76</sup> bus lane opened on Wilshire Boulevard between Centinela and Federal Avenues (see Figure 7).<sup>77</sup> For all but two blocks, the bus lane was created in a lane of metered parking. (This stretch was the only section of Wilshire where parking had been allowed during peak hours.) In the remaining two blocks, the bus lane was placed in what had been a general-purpose travel lane.



**Figure 7. Wilshire Boulevard Bus Lane (Los Angeles)**

*Source:* Rice and D, "The 720" (June 10, 2006), <http://www.flickr.com/photos/ricemaru/164157938/> (accessed March 26, 2010).

The demonstration bus lane was open to public local and express buses, but not to tour or other commercial buses. Right-turning vehicles and bicycles were allowed, as indicated by the “Bikes OK” signs tagged on poles.

Various evaluation studies conducted by Metro found the bus lanes to be improving bus speeds and reliability (see more details below). Consequently, the City Council approved the one-mile segment as permanent in September 2004, and Los Angeles Department of Transportation (LADOT) was directed to monitor the bus lane operation for another six-month period and explore the possibility of extending the bus lanes through other jurisdictions along Wilshire.

In 2006, LADOT began to study the possibility of extending the Wilshire Bus Rapid Transit improvements, including the bus lanes, along the rest of Wilshire Boulevard within the city of Los Angeles. However, as it turned out the lanes were not to expand at that time. In fact, the new “permanent” lanes proved to be short-lived. Merchants continued to oppose the bus lanes because of the lost peak-hour parking, although staff argued that a parking study showed there to be plenty of parking available on side streets in the area.<sup>78</sup> Business owners were not convinced, and the Chamber of Commerce began aggressively opposing the bus lanes. One business owner made the lost parking an issue in a local city council race.

Drivers’ opposition also grew as the commuting time reportedly doubled for private vehicles,<sup>79</sup> and two blocks of the original one-mile bus lane were eliminated to alleviate traffic flow problems near the San Diego Freeway.<sup>80</sup> These blocks were the most congested stretch of the bus lane and appeared to be diverting traffic onto neighborhood streets. This was the one segment of Wilshire that had previously provided no curbside parking, so introduction of the bus lanes reduced the mixed-flow lane capacity. Other objections from the public included increased use of parking spots in the neighborhood residential streets and anecdotal reports that buses were seen violating the speed limit. Finally, businesses and residents along the bus lane complained that it was unfair that they had to deal with increased congestion in the general-purpose lanes, while communities along the rest of Wilshire did not.

All these factors—complaints from drivers and business constituents, traffic congestion in mixed-flow lanes, and reluctance to extend the bus lanes beyond the demonstration project segment—led the Los Angeles City Council to vote in 2007 to “temporarily” suspend the one-mile bus lane. At the same time, the Council directed LADOT to work on developing a new plan to implement bus lanes along the entire Wilshire corridor.<sup>81</sup> However, neither funding commitment nor a time frame was clearly set for implementing the plan at the time of the Council’s voting.<sup>82</sup>

Since then, the City of Los Angeles, the County of Los Angeles, and the LACMTA have been gradually doing additional planning work and securing funding for the project. In 2009, plans for completing the Wilshire lanes advanced considerably when the federal government authorized \$23 million in funding for the lanes and the Los Angeles City Council and the LACMTA board approved initiation of an Environmental Impact Report and National Environmental Protection Act (NEPA) Environmental Assessment for the project.

Late in 2010 a modified version of the project was approved by a unanimous vote of the Los Angeles County Metropolitan Transportation Authority board.<sup>83</sup> The bus rapid transit project will consist of 7.7 miles of bus lanes on both sides of the street between South Park View Street and Centinela Avenue. A one-mile section was eliminated from the original plan (between Comstock Avenue and Selby Avenue, a neighborhood coined “condo canyon”) because of local residents’ objections. The dedicated curb lanes will operate during weekday rush hours from 7 a.m. to 9 a.m. and 4 p.m. to 7 p.m.

## **INSTITUTIONAL ARRANGEMENTS**

### **Transit Operations**

In addition to its extensive freeway system, the Los Angeles region is also connected by a wide range of transit services operated by dozens of agencies. Among these, the Los Angeles County Metropolitan Transportation Authority (LACMTA), the county’s regional public transit service agency, operates the largest transit fleet. The regional high capacity transit service includes 73 miles of light rail, regional express buses (Metro Rapid), and commuter rail (Metrolink) connecting the southern California region.<sup>84</sup> LACMTA operates over 2000 buses on weekdays.<sup>85</sup>

The City of Los Angeles Department of Transportation (LADOT) operates the second largest transit fleet in the county, with almost 400 vehicles serving about 30 million passenger boardings per year.<sup>86</sup> LADOT provides two fixed-route services that operate in the downtown area (the DASH and Commuter Express), as well as paratransit services.<sup>87</sup>

### **Street Planning and Design**

LADOT is responsible for designating bus lanes within the City of Los Angeles. It is authorized to designate the preferential use of city streets and highways for buses jitneys, taxicabs, carpools, and other high occupancy vehicles, subject to the approval of the City Council.<sup>88</sup> The Los Angeles County Department of Public Works is responsible for planning, design, and regulation of streets in unincorporated areas of the county. The LACMTA has regionwide planning responsibilities, especially with regard to planning and financing transportation capital projects.

### **Traffic Enforcement**

Moving violations are enforced by the Los Angeles Police Department (LAPD) and Los Angeles Sheriff’s Department (LASD). Parking violations are primarily handled by the LADOT Parking Enforcement Bureau and the LASD.

### **Coordination**

When the Wilshire lanes were being planned, the LACMTA coordinated a multi-disciplinary project team that met weekly. The team included staff members from LACMTA (contracts, planning, transit operations, and public affairs), LADOT (engineering and planning), LAPD, LASD, and the Big Blue Bus, a public transit operator running a line on Wilshire.



As a general matter for all traffic regulations, LADOT coordinates enforcement efforts with the LAPD, but these efforts are not specific to bus lane violations. According to one interviewee there have been no special enforcement efforts targeting bus lane violations in the downtown.<sup>89</sup> According to another interviewee, the LAPD will act upon request by the LACMTA to increase patrols for bus lane moving violations for a week or two at a time.

When the Wilshire lanes opened, the LACMTA contracted with the City of Angeles to enforce the bus lane through the LADOT and LAPD.<sup>90</sup> LAPD increased its enforcement efforts in the early days of the bus lane, and LADOT brought out extra tow trucks and parking enforcement officials for the first two months. The LASD also increased enforcement efforts on Wilshire Boulevard when the bus lanes opened, targeting both parking and moving violations.<sup>91</sup> These extra enforcement efforts were most energetic for the first few weeks, and in total lasted for a couple of months.

## **PHYSICAL DESIGN AND SIGNAGE**

### **Lane Design**

The downtown bus lanes are concurrent flow, except for a few blocks of contraflow lane on Spring Street. The lanes are placed directly next to the curb and delineated by a solid white line. The lanes are 12 feet wide.

### **Signage**

LADOT places a sign saying “Bus Lane Ahead” just before the beginning of a bus lane (see Figure 8). In addition, all blocks with a bus lane have at least one sign indicating the presence of the bus lanes. The signs are hung high on poles. The signs specify the hours the lanes are in operation, and also that bicycles and right-turning vehicles are permitted uses (see Figure 9).



**Figure 8. Sign Indicating the Beginning of a Bus Lane (Los Angeles)**

*Source: Photo by Gregory Pierce (2010).*



**Figure 9. Detail of Bus Lane Signage (Los Angeles)**

*Source: Photo by Gregory Pierce (2010).*

In addition, pavement markings displaying “BUS ONLY” text are also placed once or twice in every block on the Spring Street and Main Street bus lanes (see Figure 10). One

interviewee noted that because the pavement markings say “Bus Only” without specifying the hours, some drivers think that the bus lanes are in effect at all times and stay out of them even during non-peak hours.

On Figueroa Street, the lanes do not have the “BUS ONLY” text but instead have a large diamond painted in the pavement.



**Figure 10. “Bus Only” Text Painted on the Pavement of a Bus Lane (Los Angeles)**

Source: Photo by Gregory Pierce (2010).

## ACCESS POLICIES

The City of Los Angeles Municipal Code defines the types of vehicles that may use designated bus lanes in two sections concerning restricted use of streets. One section defines contraflow lanes 92 and the other preferential use of traffic lanes.<sup>93</sup>

### Hours of Operation

From the authors’ March 2010 review of signage along the bus lanes, it appears that most of the bus lanes are in effect during the peak commute hours of 7 a.m. to 9 a.m. and 4 p.m. to 6 p.m., Monday through Friday; the Figueroa Street lane operates between 7 a.m. to 9 a.m. on weekdays.

### Users Permitted

#### *Concurrent Flow Lanes*

Most bus lanes within Los Angeles run with the flow of traffic and are designated under local law as “preferential use lanes.”<sup>94</sup> The municipal code section 80.36.8(c) indicates that the lane may be designated for use by public buses, jitneys, taxicabs, and vehicles with

two or more occupants (a car pool). However, the actual signage on the lanes, as well as the information provided by our interviewees, indicates that as implemented, these lanes do not permit carpools.

According to one interviewee, bicycles are allowed to share this type of bus lane. Signage on some streets confirms this (see Figure 9).

According to the municipal code section 80.36.8(d), emergency vehicles operating in response to an emergency may use the lane.<sup>95,96</sup> This section of the code also specifies that the lanes may be used by emergency vehicles (including police and fire, public and qualified private ambulances), public utility vehicles, or a traffic officer or any LADOT vehicle used for the performance of an official duty.

According to our interviewees and review of existing signage, any vehicle may also use the lane to make a right turn at an intersection (traveling in the lane no more than 150 ft.). Further, interviewees indicated that a vehicle may cross the lane in order to enter or exit a driveway, again, travelling no more than 150 ft. in the bus lane. However, the municipal code section that describes the preferential use type of lane does not state explicitly that either of these practices is allowed.

### *Contraflow Lanes*

Contraflow lanes are regulated under municipal code section 80.36.7.<sup>97</sup> According to this section, buses have exclusive, full-time use of these lanes. Emergency vehicles traveling to respond to an emergency may use a contraflow lane, and any vehicle may traverse the contraflow lane to enter or exit a private driveway. This code applied to a contraflow lane on Spring Street contraflow lane that is no longer active.

## **ENFORCEMENT**

Parking laws are enforced by traffic officers of the LADOT Parking Enforcement Division.<sup>98</sup>

Traffic laws are enforced by the LAPD and the Los Angeles County Sheriff's Department, as outlined in the City of Los Angeles Municipal Code and in the California Vehicle Code.

### **Relevant Traffic and Parking Codes**

The City of Los Angeles Municipal Code documents parking restrictions and fines,<sup>99</sup> as well as traffic laws concerning traveling in a bus lane.<sup>100</sup> Traffic codes and penalties for moving and standing violations on state highways are defined in the California Vehicle Code.<sup>101</sup>

### **Penalties**

Parking or stopping in a bus lane is a civil offense, as defined in the municipal code.<sup>102</sup> The fine for parking or stopping in a bus lane is \$88 (or up to \$201 with late penalties applied).

All parking citations are administrative offenses, like those issued for parking in other restricted zones.

Municipal code also specifies that an illegally parked vehicle may be towed “to the nearest garage or other place of safety.”<sup>103</sup> The vehicle owner is subject to a \$100 impounding fee, in addition to towing and storage charges.<sup>104</sup>

The documented penalty for a moving violation within a bus lane is located in section 80.76(b) of the municipal code,<sup>105</sup> and the state’s government code.<sup>106</sup> A first offense is punishable by \$50, a second offense within a year \$100, and additional offenses within a year are \$500.<sup>107</sup> Technically, a judge may alternatively require jail time for these offenses. Because this offense is classified as a misdemeanor, it may result in points being added to the driver’s license.

### **Patrol-based Enforcement**

Traffic enforcement officers of the LADOT Traffic Enforcement Division have primary responsibility for parking enforcement and citation.

The LAPD Operations Division is divided into bureaus by community (geographical area).<sup>108</sup> Each bureau has its own Traffic Division. Traffic enforcement officers have primary responsibility for enforcement of traffic (moving) laws, but may also cite parking violations.

## **PERFORMANCE**

### **The Downtown Lanes**

We were not able to identify or obtain any published evaluations of the downtown lanes (other than the Spring Street study noted above). However, a number of interviewees commented on their impressions of how the various downtown lanes performed.

One interviewee noted that on some streets, right-turning vehicles significantly delay buses when the turning vehicle must wait for crossing pedestrians. Figueroa Street in particular suffers from this problem, as there are many intersections with high pedestrian volumes combined with many right-turning vehicles. In an effort to counter this obstruction of buses, LADOT has adapted the signal timing to delay the pedestrian light for a short while after the traffic light turns green, so that right-turning vehicles will not have to wait. However, pedestrians often ignore the delay, and the interviewee acknowledged that the signal timing does not solve the problem, though it may help somewhat.

One other operational difficulty on Figueroa Street, which carries a wide range of buses, is that express buses like the MetroRapid often get stuck behind local shuttles like the DASH.

One interviewee we spoke to explained that the newly configured downtown bus lanes put into place in 2005, after the Spring Street contraflow lane was mostly removed, had brought mixed results, though he noted a number of specific positive changes. For example, he noted that the signal timing worked better for buses in the new, concurrent

flow lanes than it had in the previous contraflow lane. Also, he reported that a study of the DASH buses found that their travel time had improved by 10 percent to 12 percent. The interviewee explained that a more complete evaluation of the new arrangements had not been conducted because a wide range of changes in downtown would have affected operation of the bus lanes. For example, construction of a new LAPD building between 1st and 2nd Streets led to the suspension of the bus lanes for one block.

### **The Wilshire Lanes**

Because the Wilshire lanes were initially installed as a pilot project, they were subject to considerable formal evaluation. This work was conducted by a consultant on behalf of LACMTA, as well as by LADOT.

Both studies found that the lanes improved bus operations. According to the studies by Korve Engineering, the bus lane installation improved both bus speed and travel time reliability. Korve's evaluations determined that the average bus run time in the one-mile corridor improved 2 percent to 6 percent in the morning peak and 14 percent in the afternoon peak. In addition, travel time reliability for the buses improved by 13 percent to 16 percent in the morning peak and from 12 percent to 32 percent in the afternoon peak.<sup>109</sup> LADOT only evaluated bus performance in one way, comparing bus travel times with travel times for a floating car in the mixed-flow lanes for one hour during the peak period in August of 2004. This data showed average bus travel times to be slightly faster in one direction but slower in the other direction.<sup>110</sup>

More anecdotal evidence suggested that during days of the heaviest traffic the bus lanes benefited bus travel much more substantially. According to one interviewee, LACMTA found that during one of the worst periods of traffic congestion on Wilshire, it took about 30 minutes to drive 1.5 miles in the regular traffic lanes while buses went through in about 2.5 minutes. Similarly, a newspaper article reported that, on average, bus riders saved only forty seconds in the bus lane, but the time saved increased to as much as twelve minutes during the worst traffic.<sup>111</sup>

The problem of bus lane violations received considerably less study. However, according to the various interviewees, moving violations were more problematic than parking violations in the Wilshire bus lane. Right-turning vehicles were not a particular problem on Wilshire, which has few crossing pedestrians to block turning vehicles. One type of violation that was studied formally by Korve was the number of vehicles that illegally traveled through an intersection in the bus lane (instead of making the required right turn). Korve found that at most intersections no more than a couple of percent of vehicles travelled through the intersection, but that at a few intersections the violation rate rose as high as 11 percent.<sup>112</sup>

**Table 19. Bus Priority Lanes on City Streets (Los Angeles)**

Street	Dir.	From	To	Length (mi.)	Days	Hours
Figueroa St.	NB	22nd St.	4th St.	1.8	5	7-9 a
Main St.	NB	9th St.	1st St.	1.0	5	7-9a, 4-6p
Spring St.	SB	Arcadia St.	9th St.	1.26	5	7-9a, 4-6p

Source: Authors' estimates.





## APPENDIX C: NEW YORK CITY CASE STUDY

### INTRODUCTION

Bus priority lanes were first introduced in New York City in 1963. The system has been developed incrementally, so the city's 50-mile network of bus lanes reflects a patchwork of different design treatments. In recent years, the city has initiated an effort to expand and upgrade this system to improve its effectiveness.

The urban form of New York City has limited the establishment of bus lane networks as extensive as might be found in other transit-oriented cities of its size. Most of the city lacks alleys or minor service streets, and many buildings lack loading docks or driveways. As a result, curb space is heavily contested territory, both amid the skyscrapers of Manhattan and in the smaller commercial districts throughout the city. This importance of street frontage for access to buildings has been a significant impediment to New York City's wider use of bus lanes.

Furthermore, New York City's subway system plays an unusually dominant role in serving its most important transit corridors. Only 25 percent of the city's urban transit trips are carried on its bus system, a smaller share than in any of the other large cities in this study (see Table 20 for trip share profile). New York City's bus system primarily serves diffuse markets within each of the city's five boroughs. Relatively few corridors carry the passenger volumes or frequency of service needed to justify physically segregated busways.<sup>113</sup>

**Table 20. Metropolitan Profile (New York City)**

<b>City population<sup>a</sup></b>	8.2 million	City of New York
<b>Metropolitan population<sup>a</sup></b>	18.9 million	New York-Northern New Jersey-Long Island, NY-NJ-PA Metropolitan Statistical Area
<b>Annual unlinked urban transit trips<sup>b</sup></b>	3,290.5 million	
Heavy rail	2,439.2 million	74% of urban transit trips
Light rail	0.0 million	0% of urban transit trips
Bus	829.8 million	25% of urban transit trips
Ferry	21.5 million	1% of urban transit trips
<b>Ratios calculated from data above</b>		
Urban transit trips per city resident	402 annual trips per capita	
Urban bus trips per city resident	102 annual trips per capita	
Urban transit trips per metro resident	174 annual trips per capita	
Urban bus trips per metro resident	44 annual trips per capita	

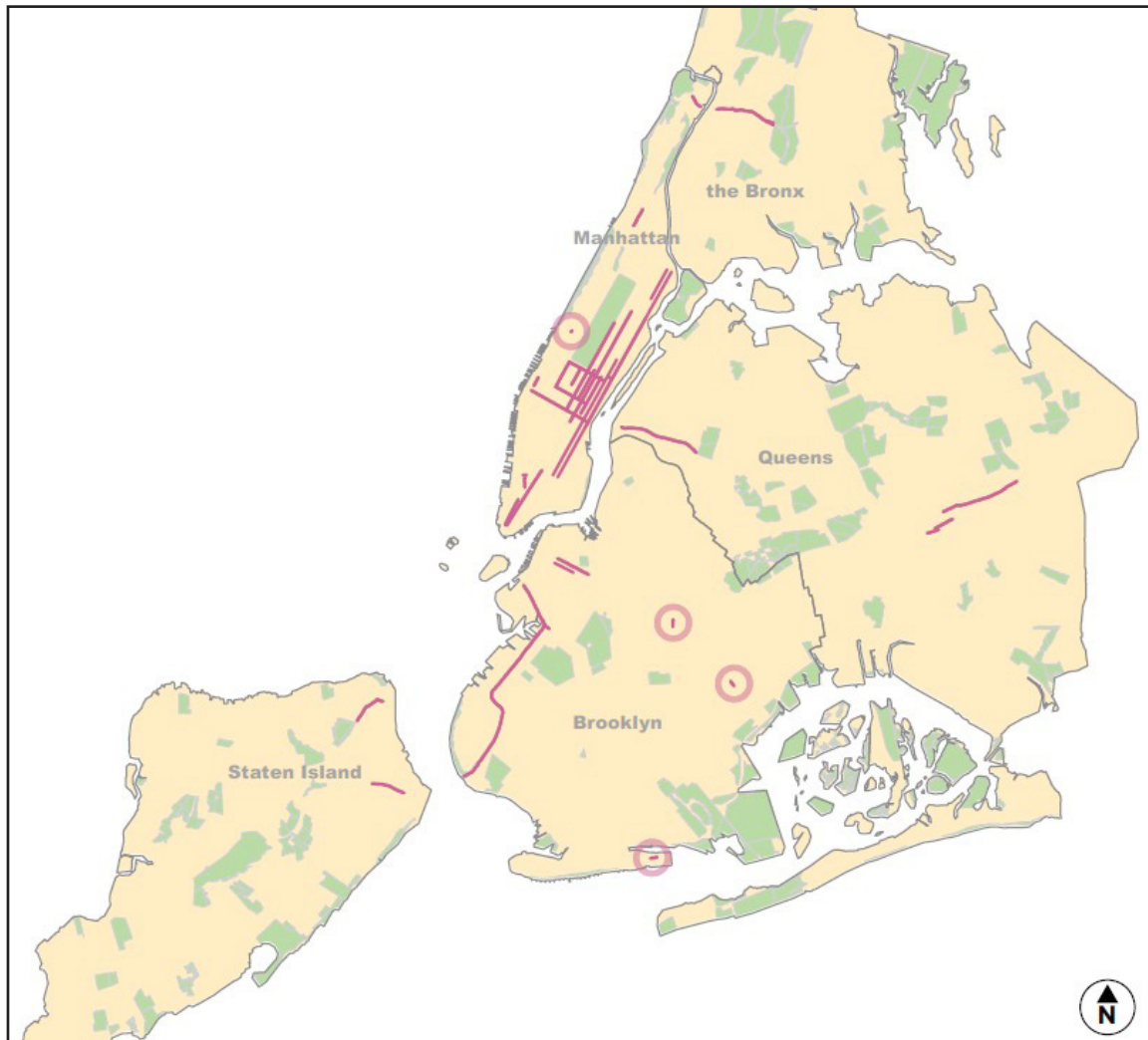
*Sources:*

<sup>a</sup> U.S. Census Bureau, 2010 Census, <http://factfinder2.census.gov> (accessed December 9, 2011).

<sup>b</sup> Federal Transit Administration, 2010 National Transit Database, "Table 19: Transit Operating Statistics: Service Supplied and Service Consumed," <http://www.ntdprogram.gov/ntdprogram/data.htm> (accessed December 9, 2011). Includes Metropolitan Transportation Authority and NYC Department of Transportation operations. Excludes the PATH system and commuter rail services.

Today, New York City has about 49.7 miles of bus lanes, on 43 corridors (see map in Figure 11 and Table 22 at the end of this case study).<sup>114</sup> New York's network of bus lanes has grown incrementally, as a set of discrete projects, rather than as a comprehensive system. Currently, the system is a patchwork of rules and designs, reflecting the various policies in place at the different times when the bus lanes were installed, but in general most operate along the curb and only during peak hours.

New York also has a modest but intensively used system of part-time bus lanes that operate on highways, but these are not included in this study.<sup>115</sup>



**Figure 11. Bus Lane Network Map (New York City)**

Source: New York City Department of Transportation, "Bus Lanes in New York City," [http://www.nyc.gov/html/brt/downloads/pdf/bus\\_lanes\\_map.pdf](http://www.nyc.gov/html/brt/downloads/pdf/bus_lanes_map.pdf) (accessed February 28, 2011).

## HISTORICAL DEVELOPMENT

The development of bus lanes in New York City has gone through a series of phases, driven by different policy concerns at different times.

## Buses as a Special Interest

Bus lanes were debated in New York City as early as the 1950s. In 1959, when the city converted DeKalb and Lafayette Avenues in Brooklyn to one-way operations, the Transit Authority asked it to designate the curbside lanes for priority bus use during peak hours. A particular concern for the Transit Authority, and a key justification for this request, was minimizing the transit fare box revenue loss usually experienced as a result of the conversion to one-way streets. The chairman of the Transit Authority cited bus lanes elsewhere in the U.S. and Canada as evidence that the bus lanes could be successful. The city's Traffic Commissioner refused, arguing that even Manhattan's Fifth Avenue did not reserve lanes for buses. In the words of a contemporary news account, he argued that "the city could not put the driving needs of buses ahead of those of the general public."<sup>116</sup>

## Moving People Efficiently

In the 1960s and early 1970s, the efficiency of city streets became a prime concern, with an explicit focus on passengers and goods delivery rather than vehicles per se. In 1962, newly appointed Traffic Commissioner Henry Barnes initiated a new study of bus lanes, importing an idea that he had implemented extensively while commissioner in Baltimore. The study was conducted jointly by the Transit Authority and the Department of Traffic, with input from the Police Department, and examined potential bus lane routes in all five boroughs. In May 1963, the city's first two pilot bus lanes were installed on Livingston Street in Brooklyn (about 0.7 miles between Flatbush Avenue and Boerum Place), and on Victory Boulevard in Staten Island (about 1 mile between Bay Street and Forest Avenue). On both routes, the inbound bus lanes operated from 7 a.m. to 9 a.m., and the outbound bus lanes operated from 4 p.m. to 7 p.m., six days a week. Motorists were permitted to enter the curbside lanes during these hours only to make right turns. As a safety precaution, bus drivers were prohibited from leaving the lanes except to pass a disabled vehicle. Overall, the experiment was considered a success on Staten Island, but met mixed success in Brooklyn due to enforcement challenges.<sup>117</sup>

In 1969, the city began expanding its bus lane program into Manhattan. Bus lanes were first introduced on 42nd Street (between Third and Eighth Avenues) in June 1969, and operated both directions. In early 1970, bus lanes were added on a 38-block stretch of First and Second Avenues as part of a larger congestion relief plan that called for the complete removal of metered parking in Midtown. Under this scheme, during peak hours the bus lane side of the streets was designated a No Stopping zone, while the opposite side of the street was designated a No Parking zone. Between 10 a.m. and 4 p.m., both sides of the street were reserved as commercial vehicle loading zones.<sup>118</sup>

The city, also in 1969, introduced an alternative strategy to improve the flow of buses, called "bus zones." Under this approach, the curbside lanes on Fifth and Madison Avenues were designated No Standing zones from 7 a.m. to 7 p.m. Other vehicles were permitted to drive in the lanes, but not to park or use them as loading zones. This approach was extended to Lexington Avenue, Third Avenue, and a stretch of Lower Broadway in 1970, and on Fulton Street in Brooklyn in 1972.<sup>119</sup>

## Fighting Congestion Under Federal Scrutiny

A third wave of bus lane policy began in the late 1970s, as New York City was faced with the challenge of meeting its obligations under the Federal Clean Air Act of 1970. After an extended struggle among city policymakers, environmentalists, and federal regulators, the city agreed in 1977 to expand and improve enforcement on its bus lanes. Its actions during this time received considerable scrutiny because its bus lane strategies were a substitute for much more aggressive anti-pollution measures that the city had failed to implement. Projects completed during this era included establishing a new lane on the Avenue of the Americas (1978), extending the Second Avenue bus lane to four miles (1979), converting the Lexington Avenue bus zone to a bus lane (1981), and adding a bus lane on Church Street/Trinity Place in Lower Manhattan (1981).<sup>120</sup>

The city also experimented with other innovations during this time. In 1977 it converted the Fulton Street bus zone to a transit mall as part of an effort to establish a number of pedestrian malls throughout the city. In 1979, the city created an additional variety of priority treatment, combined bus and taxi corridors, on 49th Street and 50th Street between Third and Seventh Avenues. Private vehicles were banned from these streets during the midday hours on weekdays.<sup>121</sup>

In 1981, the city created its first truly exclusive bus lanes on Madison Avenue. All vehicles except buses were prohibited from the two right-hand lanes of Madison Avenue for 17 blocks through Midtown on weekdays between 2 p.m. and 7 p.m. These lanes were separated from other lanes by a “two-foot-wide thermoplastic painted strip” with red and white raised reflectors.<sup>122</sup>

### Red Zones

Beginning in 1982, the city overhauled the design and enforcement of its bus lane network in Midtown Manhattan and, at the same time, promoted the visibility of its bus lanes with an aggressive public awareness and enforcement campaign. The city re-designated many of its bus lanes as so-called “Red Zones,” with tighter rules prohibiting parking or standing in bus lanes. Targeted enforcement efforts focused on keeping the bus lanes clear, preventing illegal parking and double-parking, and generally maintaining the flow of traffic during peak hours.<sup>123</sup> To draw attention to these zones the city added thermoplastic red lane stripes between the lanes and along the curb, and posted humorous and attention-grabbing signs.

The Red Zones helped bring some uniformity to eleven bus lane corridors that were previously governed by inconsistent rules, including First, Second, Third, Lexington, Fifth, Sixth, and Eighth Avenues; 42nd and 57th Streets; and Church Street and Broadway in Lower Manhattan. A \$495,000 grant from the Federal Highway Administration paid for the new signs and markings used in this program.<sup>124</sup>

## Select Bus Service and Red Lanes

In 2004 the Metropolitan Transportation Authority (MTA) and New York City Department of Transportation (NYCDOT) jointly launched a study of options to create a bus rapid transit system for New York City. The initial phase of the study identified 100 bus corridors with high bus travel and then applied a series of screens to identify those routes most suitable for improvement. Ultimately, the study recommended five pilot corridors for the city's BRT system.<sup>125</sup>

The program was ultimately rolled out under the name "Select Bus Service." After some adjustments to the list of corridors, the final list of Phase I projects included Fordham Road/Pelham Parkway in the Bronx (completed in 2008), First and Second Avenues in Manhattan (opened in 2010), 34th Street in Manhattan and Nostrand Avenue in Brooklyn (planned for 2012), and Hylan Boulevard in Staten Island (planned for 2013). Figure 12 shows the locations of these corridors. The City's plans for its new BRT system include dedicated branding, highly visible bus lane designs, transit priority traffic signals, low-floor buses, off-board fare payment systems, and camera-based bus lane enforcement.<sup>126</sup> In 2009, the City completed a second phase of its Select Bus Service system, which proposes sixteen additional candidate corridors.<sup>127</sup>



**Figure 12. Planned Select Bus Service Network (New York City)**

Source: New York City Department of Transportation, "Next Routes" (no date), <http://www.nyc.gov/html/brr/html/next/routes.shtml> (accessed July 27, 2010).

Along with the unveiling of the Select Bus System, the City began updating some of its older bus lanes. It painted several bus lanes red, including lanes on 34th Street and 57th Street in Manhattan, introduced more visible new signs on a few corridors, began testing transit priority traffic signals on Victory Boulevard and 34th Street, and experimented with other improvements such as the introduction of widened lanes, bus bulbs, and camera-based enforcement.<sup>128</sup>

## **INSTITUTIONAL ARRANGEMENTS**

### **Transit Operations**

Bus transit services in New York City are provided by the Metropolitan Transportation Authority (MTA), a public authority established by the State of New York. The MTA is governed by a board of directors nominated by the New York State Governor and approved by the New York State Senate, based on recommendations by the Mayor of New York City and the county executives of surrounding suburban counties.

Historically, the City of New York controlled bus services within its boundaries. Like most U.S. cities, the City originally offered franchises to private firms to operate bus and streetcar services on specified routes, subject to regulatory oversight. In the mid-twentieth century, as many of these private firms began to fail, the City began acquiring and operating many of these services. Others remained under private operation, but were subsidized by the City.

The State of New York established the New York City Transit Authority (NYCTA) in 1953 to take over operations of the subway and bus systems that the City had been accumulating due to bankruptcies of their private operators. NYCTA became an affiliated agency under the umbrella of the MTA in 1968, and is now known as MTA New York City Transit. MTA also includes the Triborough Bridge and Tunnel Authority, the Long Island Railroad, and later, Long Island Bus (serving suburban Nassau County) and the Metro-North Railroad.

Until recently, many bus lines were still operating as private franchises subsidized by the New York City Department of Transportation. These services, primarily in Brooklyn and Queens, were finally taken over by a new unit within MTA, the MTA Bus Company, in 2006.

### **Street Planning and Design**

Currently the New York City Department of Transportation (NYCDOT) has primary responsibility for the design and regulation of city streets. Authority over the development of bus lanes in the city has changed over time, largely paralleling the evolution of NYCDOT's capabilities and priorities.

New York City's struggles to accommodate and control the automobile after World War II led it to begin developing a modern administrative apparatus for transportation planning and engineering. In 1950, it created an expertise-driven Department of Traffic led by a single commissioner, consolidating the powers of the earlier Traffic Commission and Department of Traffic Engineering. But while the new commissioner controlled narrow

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questions of traffic engineering and safety, other city agencies and City Hall often blocked more ambitious strategies to address traffic congestion.<sup>129</sup>

In 1962 the City hired a nationally prominent traffic engineer, Henry Barnes, as the city's third Traffic Commissioner. Barnes insisted on greater autonomy as a condition of employment. New York City agreed, thus becoming just the fourth city nationally to provide a traffic commissioner with unconditional powers over traffic control.<sup>130</sup>

In 1968, the City created a Transportation Administration, which was granted statutory authority over various commissions and bureaus that had separate responsibility for highways and parkways, bridges, traffic engineering and enforcement, signals, parking regulations and meters, and ferries. Upon its creation, the former position of Traffic Commissioner became a Deputy Administrator with broad and sole responsibility for all traffic regulation, traffic engineering, and parking regulation matters.<sup>131</sup> The Transportation Administration is the direct predecessor of NYCDOT.

## Traffic Enforcement

Currently, the New York City Police Department (NYPD) is primarily responsible for enforcing both parking and moving traffic violations. As with traffic planning, however, responsibility for traffic enforcement in New York City has shifted considerably over time.

Until the early 1960s, traffic enforcement was the domain of the Police Department.<sup>132</sup> Then, in the 1960s, the City created a corps of 100 “meter maids”—civilian parking enforcement agents—under the Department of Traffic. In 1965 their role was expanded from enforcing just parking meter violations to also encompass illegal parking at hydrants, bus stops, or taxi stands, and violations in no-standing and no-stopping zones, including bus lanes. The agents could exercise these powers everywhere in the city outside the central business district (south of 60th Street in Manhattan). Even after this change, the Police Department retained its authority to issue citations for these violations throughout the city. It also stepped up its ticketing and towing efforts in Midtown, one of the areas where the meter maids did not have the expanded enforcement powers.<sup>133</sup>

In 1970, administration of parking ticket fines was shifted from the city's Criminal Courts to a new Parking Violations Bureau in the city's Department of Transportation. Together with a new computerized system for following up on collection of parking fines, this shift significantly improved the administrative efficiency and revenue recovery of parking citations in the city.<sup>134</sup>

In 1973, the City established a corps of civilian “traffic control agents” to direct and maintain the flow of traffic, including bus lanes. This corps grew into a substantial enforcement effort that by 1986 included 2,000 agents citywide and a large fleet of tow trucks. In the 1990s, however, under Mayor Rudolph Giuliani, the civilian force was scaled back significantly and recentralized under Police Department supervision. Today, although the Department of Transportation retains its enforcement powers on paper, the Police Department has primary responsibility for enforcement of both parking and traffic rules.<sup>135</sup> Field supervisors

at New York City Transit are also authorized to issue citations to vehicles parking in bus lanes, and the agency has been increasing its use of this tool.

With the introduction of camera-based enforcement of selected bus lanes in 2010, NYCDOT and New York City Transit began to play a more direct role in the enforcement of bus lanes.

## **Coordination**

The original bus lanes implemented in the 1960s involved cooperation between the Transit Authority and the Department of Traffic, with input from the Police Department. The same process tends to be followed today: development of the Select Bus Service lanes are formally a joint effort between NYCDOT and MTA New York City Transit. Many other agencies, including the Police Department, are involved on a consulting basis.

Bus lane designs increasingly account for enforcement considerations, which are critical to the lanes' effectiveness. Previously, the city's spotty bus lane signage proved to be a hindrance to the proper enforcement of bus lanes; in some cases, police would not bother writing tickets because a lack of proper signage meant that the violations were likely to be overturned in court. As the city refreshes its bus lanes, interagency discussions helped highlight the need for a more methodical approach to ensuring that signs and markings are visible and present on every block.

There have been periods of intensive cooperation between the transportation agencies and the police on enforcement of bus lanes and other traffic control measures, and other periods when the departments have worked less closely together.<sup>136</sup>

The NYPD has historically devoted substantial resources for enforcing bus lanes when they are first installed, in order to help make their launch a success. But competing demands make it difficult for the NYPD to sustain this effort continuously. The NYPD does not currently have a dedicated unit that focuses on bus lane enforcement.

There is no formal operations center or other mechanism to facilitate coordination among New York City Transit, NYCDOT, NYPD and the Department of Sanitation to keep the bus lanes clear. Relevant staff from the various agencies are in contact with each other on an informal basis to request assistance as needs arise.

The NYCDOT Construction Coordination Office permitting process specifies that non-emergency work in city streets by water, gas, electric, and communications utilities usually should be done in off-peak hours, but these rules are often ignored. This office does not explicitly take bus lanes into account in its permitting process. Emergency repairs can take place at any time.



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## PHYSICAL DESIGN AND SIGNAGE

### Lane Design

The design of bus lanes in New York City has evolved considerably 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 in the lane itself.<sup>137</sup> This design was used through the mid-1970s, sometimes with the words "Bus Lane" replacing the dashed white lines.

In the 1980s, the Red Zone program gave many of the city's bus lanes greater visibility by adding thermoplastic red stripes between the bus lane and other traffic lanes, as well as along the curb. At various other times, other designs were tried. In 2002, for example, the city installed a new bus lane on Fordham Road in the Bronx that featured white lanes on the street and a yellow thermoplastic stripe on the curb itself. The lane was simply marked by the word "Bus" and a series of large "X" markings. Diamonds were another method used to mark some bus lanes around the city. Both diamonds and X's are now reserved for other purposes in the Federal Highway Administration (FHWA) Manual on Uniform Traffic Control Devices, and are being phased out on New York City's bus lanes.

With the City's renewed commitment to bus lanes in the 2000s, it introduced at a few locations bus lanes painted dark red, bounded by white stripes, and marked "Bus Only." This was the first widespread use of colorized bus lanes in the United States. In 2009 the City formalized these new designs into policy with the publication of its first Street Design Manual, which encouraged use of a toolkit of innovative design components in order to meet the city's diverse needs.<sup>138</sup>

In the 2000s the city also introduced "interior" or "offset" bus lanes, which run adjacent to a lane that can be used for parking or deliveries and can be served by large bus bulbs (curb extensions) at bus stops. This strategy was first pursued on lower Broadway in 2008, and the city has adjusted the design to provide amenities for passengers, as well as to address safety and drainage needs. An important objective of the interior bus lanes and other design improvements is to make the lanes self-enforcing to a greater degree than they were before. Putting bus lanes in lanes of traffic rather than in curb lanes (where stopping to discharge passengers is legal and illegal standing is common) will improve bus lane speeds, regardless of the level of enforcement that is being conducted on the street at any given time.

On-street bus lanes are a minimum of 10 feet wide, with up to 12 feet provided where street space allows.

Curb markings have no legal standing under local law, and with a few exceptions New York City has traditionally not applied markings to the curb itself. As noted in the preceding section, there have been some isolated efforts to mark bus lanes with a colored strip along or on the curb, but this approach has never been implemented on a broad scale. An alternative approach under consideration would include brightly colored tactile warning strips similar to those used on subway platforms.

The city has several major new bus priority corridors in the works, each of which will further test these new design strategies. The first of these corridors, completed in late 2010, includes a comprehensive redesign of First and Second Avenues in Manhattan. This corridor is home to the M15 bus route, which is the busiest bus line in the city, serving over 54,000 riders daily. At full build-out (delayed until 2018 because of construction on the Second Avenue Subway), the lanes will stretch 6.2 miles between Houston Street and 125th Street. The designs are tailored to fit the traffic conditions and street widths in different parts of the corridor, but include a mix of curbside lanes and interior lanes with bus bulbs, as well as separate, protected bicycle lanes for much of their length (Figure 13).<sup>139</sup>



**Figure 13. First Avenue Select Bus Service Lane, November 2010 (New York City)**

Source: New York City Department of Transportation (November 2010).

Currently, about 84 percent of bus lanes in New York City run directly along the right-hand curb. Offset bus lanes currently exist only on First Avenue and Livingston Street, and represent about 9.5 percent of the current network. This share will likely increase in the coming years as the city rolls out its corridor-by-corridor BRT plans. About 2 percent of the network consists of transit malls, where only buses and vehicles making local deliveries may operate. The remainder of the network is located in contraflow or left-side concurrent flow curbside lanes, usually for the purpose of facilitating access to key river crossings, or for left turns in heavy traffic.

## Signage

Each era in the development of New York City's bus lane network has had a distinctive approach to bus lane signs and markings. The city's first standard regulatory bus lane signs were white with black letters and blue bus symbols, usually mounted curbside.<sup>140</sup> Newer versions of these signs dropped the blue bus icons and became simple black-and-white signs indicating "Buses Only" or "Buses and Right Turns Only," along with the effective hours for the restriction. Variations on these black-and-white designs remain the most common bus lane signs across the city (see Figure 14).

Over the past several years, the city marked some bus lanes with new curbside signs and much larger overhead signs with a distinct black, blue, and white color scheme. Besides their much larger size, these signs were notable for referring to bus lanes by proper names (e.g., "Broadway Bus Lane"). Treating bus lanes as transportation facilities with distinct identities was intended to create a public perception that the bus lane is a distinct facility, rather than a mere traffic regulation. However, the city has recently moved away from this practice, in order to simplify the information communicated to drivers.

In addition to the standard regulatory signs, New York also uses signage to increase public awareness of the bus lanes and the rules governing them. As the city began implementing increasingly aggressive ticketing and towing programs during the Red Zone program, it designed signs to grab drivers' attention (see Figure 14). The black-and-red signs installed by Deputy Commissioner Samuel Schwartz conveyed a confrontational but humorous tone and became cultural icons in their own right. Few of these signs make specific reference to bus lanes, instead focusing on rules prohibiting the blocking of bus lanes and other curbside lanes needed to maintain traffic flow more generally. Many of the advisory signs posted in the 1990s or later dropped references to specific rules entirely, instead referring generally to the "Red Zone" or "Bus Lane" and highlighting the fines charged to vehicles that are towed. Other public awareness signs used orange highlights and the heading "Help Keep NY Moving."

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 mobile billboards towed by bicycles in order to improve motorists' awareness of the new bus lanes.

Many original bus lane signs have been left in place from the time they were first installed, unless changes in bus lane hours or other regulations have required their replacement. As a result, a wide variety of different bus lane signs can be seen in use today on city streets. Over time, this approach has resulted in uneven sign coverage, with some blocks lacking bus lane signs altogether and other blocks containing clusters of different signs. Some signs also provide out-of-date information on fines. The city plans to update and standardize its bus lane signs and markings over time as part of a broader effort to upgrade signs throughout the city.



**Figure 14. Examples of Bus Lane Signage Currently in Use (New York City)**

*Note:* All images were cropped and then modified to reduce reflections and keystone effects.

*Sources:*

- 1980s-era signage: New York City Department of Transportation (NYCDOT), “No Parking Signs” (no date), <http://www.nyc.gov/html/dot/html/signs/parking.shtml> (accessed September 30, 2010).  
Note that the images are of souvenir versions of NYCDOT traffic signs posted during the 1980s. The actual NYCDOT signs include a red border with the words “Red Zone.”
- 1990s-2000s-era signage:
  - (a) Photo courtesy of Gerard Soffian, NYCDOT (2007).
  - (b) Photo by authors, 2010.
  - (c) Photo by authors, 2010.
  - (d) Photo by authors, 2010.
  - (e) Photo courtesy of Gerard Soffian, NYCDOT (2007).
- Current-issue signage:
  - (a) StreetsWiki, “Madison Avenue Bus Lanes” (no date), <http://streetswiki.wikispaces.com/Madison+Avenue+Bus+Lanes> (accessed September 30, 2010).
  - (b) Photo by authors, 2010.

## ACCESS POLICIES

### Hours of Operation

Most of New York City's bus lanes have traditionally operated only during the morning or evening peak hours, usually 7 a.m. to 10 a.m. or 4 p.m. to 7 p.m., depending on the peak direction of transit ridership on the facilities (refer to Table 21). This policy has started to change, as the recent upgrades to Broadway, Fordham Road, and First and Second Avenues have included longer operating hours. Today, about one-third of bus lane miles operate only during one or the other peak. About one-quarter of bus lane miles operate during both peaks, the midday period reserved for commercial deliveries. Most of the remainder either operate continuously between the morning and evening peaks (usually 12 hours per day, 7 a.m. to 7 p.m.); only a few locations operate at all times.<sup>141</sup>

**Table 21. Bus Lane Mileage by Hours of Operation (New York City)**

Hours of operation	Total Length of segments	Share of total
a.m. peak or p.m. peak hours	19 mi. (31 km)	39%
a.m. peak and p.m. peak hours	12 mi. (19 km)	24%
12-hour	17 mi. (28 km)	28%
24-hour	1.5 mi. (2.4 km)	3%
<b>Total</b>	<b>50 mi. (80 km)</b>	<b>100%</b>

*Source:* Authors' estimates. Figures may not sum exactly due to rounding errors.

Most of New York's bus lanes operate Monday through Friday, but about 10 percent of the network operates six or seven days per week.

### Users Permitted

According to New York City's Highway & Traffic Rules, bus lanes may 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 (Sec. 4-01(b)).<sup>142</sup> Also, the city's traffic rules generally exempt the following types of vehicles which may, therefore, use the lanes: authorized emergency vehicles; traffic/parking control vehicles; snow plows, sand spreaders, sweepers and refuse trucks; and highway work and inspection vehicles (Sec. 4-02(d)). Based on Sec. 4-02(a) of the Highway & Traffic Rules, the city's traffic rules, including its rules concerning bus lanes, apply to bicycles as well as to other vehicles.

During a bus lane's operational hours a vehicle other than a bus may use the bus lane only to "make the first available right hand turn" at an intersection or private drive.<sup>143</sup> There is no explicit 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 the lane to "avoid conflict with other traffic" or when directed by a law enforcement officer. The Madison Avenue dual bus lanes have special rules: they prohibit right turns completely, except for taxis turning at 46th Street.

City regulations prohibit standing or parking in a bus lane during the restricted hours. However, as these terms are defined in the traffic code, stopping “temporarily for the purpose of and while actually engaged in receiving or discharging passengers” is permitted.<sup>144</sup> Thus, passenger pick-up or drop-off is allowed in the bus lanes if it is done quickly and if the driver does not proceed straight through the intersection in the bus lane. Some bus lanes also have more restrictive curb regulations (such as “No Stopping”), which do not allow pickups and drop-offs of passengers.

One of the greatest challenges for bus lanes in New York has been the accommodation of commercial deliveries. Most of New York City lacks alleys or minor service streets, and many buildings lack loading docks or driveways. This situation forces a tremendous volume of delivery and service vehicles to park at the curbside in the central business districts and neighborhood commercial districts. Bus lane hours have historically needed to be restricted to a few peak hours in order to provide this access.

The City is exploring interior bus lanes in part because of the opportunities they create to extend bus lane operating hours while simultaneously extending windows for commercial deliveries. In situations where interior bus lanes are not feasible, the city has had to make special arrangements for midday delivery windows. For example, while the bus lane on Fordham Road is nominally operational from 7 a.m. to 7 p.m., commercial deliveries are allowed on the south side of the street from 10 a.m. to noon, and on north side of the street from noon to 2 p.m.<sup>145</sup>

## **ENFORCEMENT**

As noted in a previous section, New York City’s bus lane laws restrict the act of driving in bus lanes, unless a vehicle subsequently makes a right turn. But since the city’s bus lanes have traditionally been located in the curbside lane, the primary focus of bus enforcement in New York has been preventing vehicles from blocking a bus lane by illegally standing or parking. As a result, bus lane enforcement has been more about enforcing parking laws than laws concerning the operation of motor vehicles. As the city begins to create offset bus lanes, the primary enforcement challenge will likely shift from parking violations to moving violations, although double parking will remain a key concern.

## **Relevant Traffic and Parking Codes**

The bus lane related traffic and parking laws are specified in the City of New York, Department of Transportation publication, Highway & Traffic Rules, Title 34, Chapter 4.<sup>146</sup> The following sections apply, directly or indirectly, to bus lane restrictions:

- Title 34, Chapter 4, Section 4-08(f)(4): General No Standing zones (standing and parking prohibited in specifies places), Bus lanes. This section prohibits standing and parking during the posted restricted times.
- Title 34, Chapter 4, Section 4-11(c): Pickup and discharge of passengers by taxis, commuter vans and for-hire vehicles. This section allows a taxi to pick up or drop off passengers in an area that is otherwise categorized as a no standing or parking.

- Title 34, Chapter 4, Section 4-12(m): Bus lane restrictions on city streets. This section defines allowable use of the bus lane during restricted hours.

## Penalties

The current fine for standing or parking in a bus lane is \$115.<sup>147</sup> Illegally parked vehicles that are towed from bus lanes as part of the city's Violation Tow Program are subject to an additional \$100 fine. Operating a vehicle illegally in a bus lanes (i.e., crossing an intersection in a bus lane without making a right turn) can incur a fine of \$150 fine and two points on a driver's license if caught by a police officer. If caught by a traffic camera, the penalty is \$115 and does not include license points.

## Patrol-based Enforcement

From the earliest days of bus lane operations in New York City, ongoing enforcement was recognized as essential to the success of the program. Police staged two tow trucks near each of the two pilot bus lanes when they first opened in May 1963, in order to tow illegally parked cars. But within two weeks of the beginning of the pilot, the Traffic Commissioner was noting that the bus lanes were often blocked for the first 30 to 40 minutes of their operations because it took so long to tow illegally parked cars, and that the police were not always available to maintain a continuous enforcement effort.<sup>148</sup> As a result of these problems, the Traffic Department began to seek dedicated resources for uninterrupted enforcement of its bus lanes and other regulations.

The city's most sustained effort at bus lane enforcement was a series of escalating enforcement strategies between the early 1970s and the late 1980s. In 1970, the Traffic Department established a unit of parking enforcement agents to focus on enforcement of parking, standing, and stopping prohibitions to keep traffic moving in its new Manhattan bus lanes and elsewhere in Midtown. In 1973, the City introduced "traffic control agents" who enforced traffic rules from within the street itself, instead of just from the curbside.<sup>149</sup>

Over time, this effort evolved into a sizable civilian force focused on maintaining the flow of traffic in Midtown Manhattan, culminating in the Red Zone program. Deterring violations through a diligent and publicly visible towing program was a central component of the Red Zones effort. To an even greater degree than during previous towing sweeps, the city embraced media attention as part of its effort to use enforcement to change motorists' expectations of what they could get away with. The Department of Transportation employed a fleet of 40 tow trucks to keep the bus lanes and other critical locations clear, plus two "scaretrucks" to cruise the lanes, acting as a deterrent to illegal parking. The city also adopted a new regulation classifying double parking as a "moving violation," subject to greater penalties plus two points on the driver's license. Mayor Edward I. Koch and Deputy Transportation Commissioner Samuel I. Schwartz held press conferences to recite the latest statistics of the number of cars they had towed, with special attention to the number of vehicles belonging to the press, diplomats, and public agencies.<sup>150</sup>

After resources were shifted from the Department of Transportation to the Police Department in the mid-1990s, enforcement efforts on the bus lane network appeared to decline significantly.<sup>151</sup>

Given the difficulty of a continuous enforcement effort, an alternative strategy has been the periodic enforcement crackdown. These varied in character, focus, and location over time. They were generally effective at improving short-term compliance with traffic regulations in the target area, but there is less evidence their impact spilled over into surrounding areas or had a lasting impact.<sup>152</sup> A 1994 study concluded that “exclusive bus lanes are ineffective in the absence of sustained enforcement” and that “surveys conducted... a few weeks after enforcement ended indicated that bus lanes were still utilized illegally.”<sup>153</sup> Nonetheless, today, according to a city transportation official contacted for this study, the city generally believes that “within a given budget the ‘blitz’ enforcement strategy, with a high level of enforcement irregularly, is more effective than a constant low level of enforcement.” In 2010, the city received a \$5 million grant to fund heightened enforcement of the Select Bus Service bus lanes by the NYPD on an interim basis. In addition to the NYPD, NYC Transit field supervisors also issue citations for parking in bus lanes.

### **Camera-based Enforcement**

New York City has long sought authority to use camera-based enforcement for bus lanes, as well as speeding and red light violations, but it lacks the home-rule authority needed to adopt these enforcement techniques. The New York State Legislature, which must authorize any use of camera-based enforcement in the state, has traditionally preferred to allow very small numbers of cameras to be used under limited conditions, rather than giving municipalities authority to determine the appropriate scopes for their camera-based traffic enforcement. Until recently, the legislature refused the city’s request to begin implementing video-based bus lane enforcement.

While awaiting authorization to use video cameras more broadly, New York City began testing camera-based enforcement with a pilot program targeting taxicabs, over which it has greater regulatory control. In February 2009, NYCDOT announced a pilot test manually reviewing video images to identify taxis illegally traveling in the 34th Street bus lanes.<sup>154</sup> Once a reviewer identifies a taxi in the lane illegally, the reviewer signs an affidavit to the image’s authenticity and the NYCDOT submits this evidence to the Taxi and Limousine Commission (TLC), which issues a summons to the taxi owner. TLC administrative judges adjudicate. The fine for illegal use of the bus lane is \$150. Images captured during the test period are also being used to collect data on what other types of vehicles violate the bus lane use rules.

In June 2010, the New York State Legislature passed its first authorization for the city to begin using camera-based enforcement on general traffic. The new law grants the city permission to use video-based enforcement only on the corridors being developed under the Select Bus Service program, including Fordham Road in the Bronx; 34th Street, First Avenue, and Second Avenue in Manhattan; Hylan Boulevard in Staten Island; Nostrand Avenue in Brooklyn; and a corridor yet to be designated in Queens. The legislation leaves some key decisions to the city, including the choice of technology and the number of



cameras to install, but it specifies that all violations are to be adjudicated through the city's Parking Violations Bureau. Under the program, the New York City Department of Transportation began enforcing bus lanes using fixed cameras on 1st and 2nd Avenues in November, 2010. New York City Transit has supplemented these fixed cameras with bus- and car-mounted cameras.

## **Enforcement Effort**

As described in the introduction to this enforcement section, enforcement has been periodic. Since the early 1960s, there have been periodic sweeps and crackdowns, and periods of enhanced enforcement to coincide with the launching of new traffic initiatives.

In recent years, the city has started to explore strategies that would make the effectiveness of bus lanes less dependent on enforcement efforts by patrolling agents. Where possible, the replacement of curb bus lanes with interior bus lanes allows vehicles to access the curb for loading and unloading, reducing conflicts between buses and stationary vehicles. And soon the city will begin rolling out its first bus lane enforcement cameras on the "Select Bus Service" routes in the Bronx and Manhattan.

## **PERFORMANCE**

The city credited its 1982-83 Red Zone program of heightened bus lane enforcement and public awareness with improving the average speed of buses by 17 percent. This was a noteworthy result, since all of these facilities already were bus lanes (or "bus zones") before implementation of the program, and enforcement programs had already been in place years on these corridors. City officials also claimed that the dual bus lanes on Madison Avenue—previously the slowest bus corridor in the city—increased bus speeds by 83 percent between 1981 and 1985.<sup>155</sup>

However, there have been a number of problems with the performance on New York's traditional bus lane designs:

- **Insufficient clearance.** In some cases narrow rights-of-way have led the city to adopt substandard bus lane widths, in order to squeeze bus operations into former curb lanes. As a result, many of the city's bus lanes are so narrow that a standard bus (8.5 feet or 2.6 meters wide, plus up to 20 inches or 0.5 meters for side mirrors) cannot drive in it without risking striking objects along the curb. As a result, buses often straddle the bus lane and the adjacent traffic lane, held up by congested traffic despite a completely clear bus lane ahead.
- **High competition for curb space.** New York's dense commercial activity and lack of off-street loading zones create a demand for curb access that cannot easily be diverted to other locations or times of day.
- **High pedestrian volumes.** Because of New York's "no turn on red" law, and Manhattan's extremely high pedestrian volumes, right-turning vehicles must often

wait for nearly an entire cycle before being able to turn. These vehicles often queue up in the bus lane.

New bus lane designs may mitigate some of these problems. As part of its more recent bus lane upgrades, the New York City Department of Transportation has been reducing the number of traffic lanes to enable it to widen the remaining lanes to improve safety and operational efficiency. Interior bus lanes can preserve curbside loading zones, and provide queuing space for right-turning vehicles so that they don't block buses.

In November 2011, NYCDOT released its first biannual evaluation of the 1st and 2nd Avenue Select Bus Service. According to this report, the redesign of the street and the operational and enforcement improvements implemented as part of the program produced a 15-18 percent improvement in bus travel times, a 9 percent increase in bus ridership, and maintenance of existing traffic speeds and volume. The project also included installation of a new bicycle and pedestrian safety improvements, which resulted in an 18-177 percent increase in bicycle volumes and up to a 21 percent reduction in traffic injuries.<sup>156</sup>

**Table 22. Bus Priority Locations, Lengths and Hours (New York City)**

#	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
				100th St.	68th St.	Postponed for subway construction			
				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 Br.	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
24	Staten Is.	Victory Blvd.	SB	Forest Ave.	Bay St.	0.8	Curb	6	4-7p
25	Staten Is.	Capodanno Blvd.	NB	Midland Ave.	Lily Pond Ave.	2.3	Curb	5	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
28	Queens	Jamaica Ave.	EB	Parsons Blvd.	168th St.	0.5	Curb	7	4-7p
29	Queens	Jamaica Ave.	WB	168th St.	Parsons Blvd.	0.5	Curb	7	4-7p

#	Borough	Street	Dir	From	To	Length (mi.)	Alignment	Days	Hours
30	Queens	Archer Ave.	EB	150th St.	160th St.	0.3	Curb	7	All times
31	Queens	Archer Ave.	WB	160th St.	150th St.	0.3	Curb	7	7a-7p
32	Brooklyn	Fulton St.	WB	S. Oxford St.	Flatbush Ave.	0.4	Curb	5	7-10a
				Flatbush Ave.	Boerum Pl.	0.5	Bus Mall	7	All times
33	Brooklyn	Fulton St.	EB	Boerum Pl.	Flatbush Ave.	0.5	Bus Mall	7	All times
				Flatbush Ave.	Ft Greene Pl.	0.2	Curb	5	4-7p
34	Brooklyn	Livingston St.	WB	Flatbush Ave.	Boerum Pl.	0.5	Curb	5	7-10a
35	Brooklyn	Livingston St.	EB	Boerum Pl.	Flatbush Ave.	0.5	Offset	5	4-7p
36	Brooklyn	Rockaway Pkwy.	NB	Flatlands Ave.	Glenwood Rd.	0.1	Curb	5	7-10a
37	Brooklyn	Rockaway Pkwy.	SB	Glenwood Rd.	Flatlands Ave.	0.1	Curb	5	4-7p
38	Brooklyn	Utica Ave.	SB	E Pkwy.	Carroll St.	0.15	Curb	5	7-10a; 4-7p
39	Brooklyn	Utica Ave.	NB	Carroll St.	E Pkwy.	0.15	Curb	5	7-10a; 4-7p
40	Bronx	Fordham Rd.	EB	Sedgwick Ave.	Southern Blvd.	1.6	Curb	5	7a-7p
41	Bronx	Fordham Rd.	WB	Crotona Ave.	Sedgwick Ave.	1.5	Curb	5	7a-7p
42	Bronx	Willis Ave.	NB	147th St.	148th St..	0.05	Bus Mall	7	All times
43	Queens- Manhattan	Queensboro Br.	WB	Thomson Ave.	59th St.	1.7	Contraflow	5	6-9:30a

*Sources:* Authors' compilation and estimates from various sources, including NYCDOT data, site visits, and Google Maps street view.

## APPENDIX D: PARIS CASE STUDY

### INTRODUCTION

The city of Paris has implemented an extensive network of bus lanes. Most recently, new bus lanes have been created as part of a comprehensive regional program of bus service improvements known as “Mobilien.” Notable features of the current Paris bus lane program include the use of a low curb barrier to separate many of the bus lanes from regular traffic lanes, as well as the city’s policy to allow taxis and bicycles to share the lane with buses.

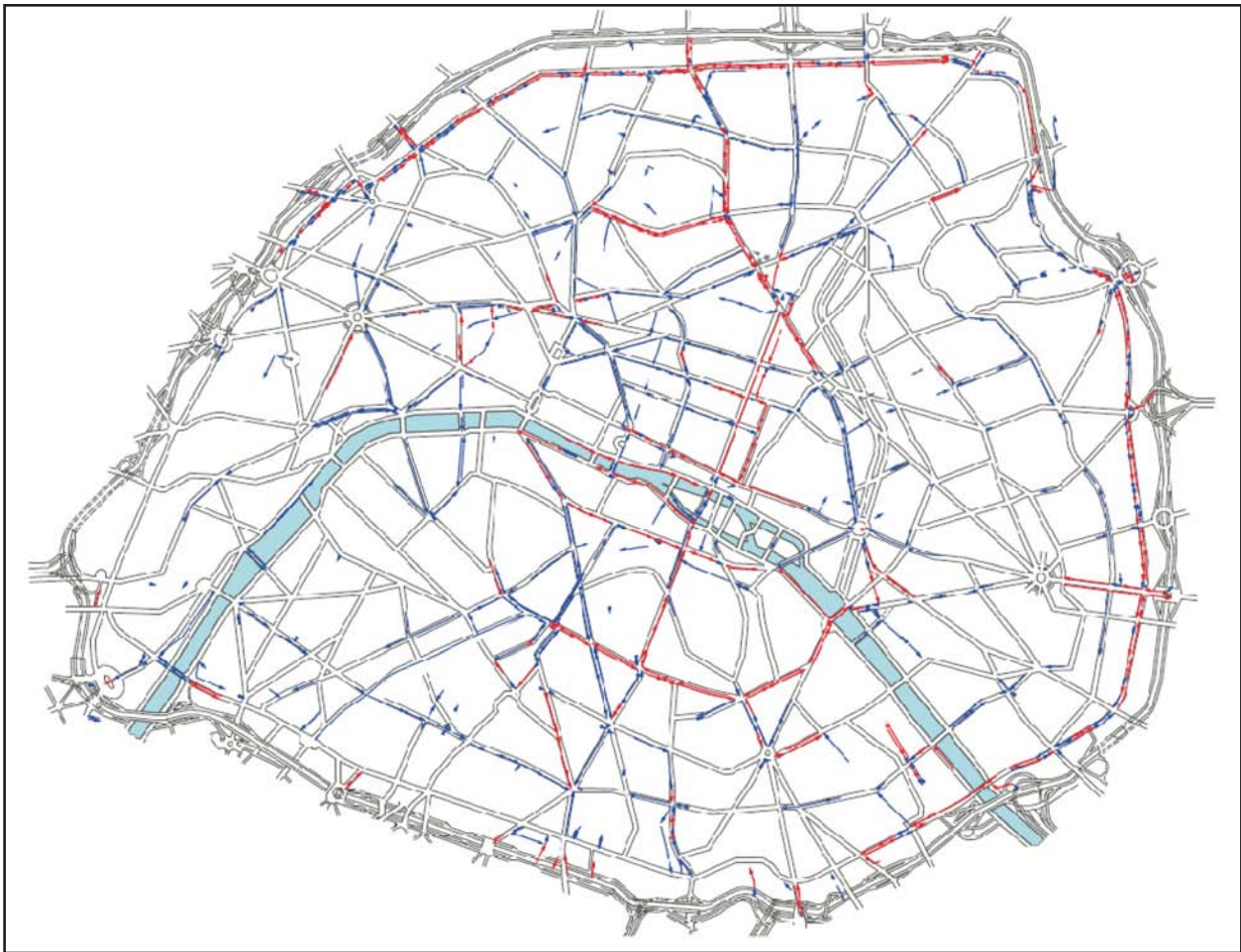
**Table 23. Metropolitan Profile (Paris)**

<b>City population<sup>a</sup></b>	6.6 million	Paris + Petite Couronne
<b>Metropolitan population<sup>b</sup></b>	12.1 million	Paris Aire Urbaine
<b>Annual unlinked urban transit trips<sup>c</sup></b>	2677 million	
Heavy rail	1473 million	55% of urban transit trips
Light rail, tram	108 million	4% of urban transit trips
Bus	1096 million	41% of urban transit trips
Ferry	0 million	0% of urban transit trips
<b>Ratios calculated from data above</b>		
Urban transit trips per city resident	407 annual trips per capita	
Urban bus trips per city resident	167 annual trips per capita	
Urban transit trips per metro resident	221 annual trips per capita	
Urban bus trips per metro resident	91 annual trips per capita	

*Sources:*

- <sup>a</sup> Institut National de la Statistique et des Études Économiques (INSEE), Populations légales 2008 pour les départements et les collectivités d’outre-mer, <http://www.insee.fr/fr/ppp/bases-de-donnees/recensement/populations-legales/france-departements.asp?annee=2008>. The area that most closely matches the service area of the Paris Metro includes the Petite Couronne, the three départements that ring Paris (Hauts-de-Seine, Seine-Saint-Denis, and Val-de-Marne).
- <sup>b</sup> Institut National de la Statistique et des Études Économiques (INSEE), RP2007 exploitation principale, Paris Aire urbaine 1999 <http://www.recensement.insee.fr/tableauxDetaillies.action?zoneSearchField=PARIS&codeZone=001-AU1999&idTheme=12&idTableauDetaille=43>. The Paris Aire urbaine, as defined by the national statistical agency, is the most commonly used definition for the extent of the Paris metropolitan area.
- <sup>c</sup> L’Observatoire des Déplacement à Paris. Le Bilan des Déplacements À Paris En 2008. Paris: Mairie de Paris, 2009. <http://www.paris.fr/portail/viewmultimediacocument?multimediacocument-id=80551> (accessed February 24, 2010). Transilien and RER services not included.

The City of Paris has a 190 km (118 mi.) network of bus lanes as of 2008 (see Figure 15). Of this total network, 102 km (63 mi.) are concurrent flow bus lanes designated only by signs and markings; 18 km are contraflow lanes; and 69 km (43 mi.) are “protected” lanes separated from other traffic by barriers ranging from low curbs to wide planted medians.<sup>157</sup>



**Figure 15. Bus Lane Network Map, 2007 (Paris)**

*Notes:*

- Blue and red lines indicate bus lanes:
- Blue lines are lanes designated with paint.
- Red lines are lanes demarcated with raised curbs.

*Source:* L'Observatoire des Déplacements à Paris, *Le Bilan des Déplacements À Paris En 2007* (Paris: Mairie de Paris, 2007) 11, <http://www.paris.fr/portail/viewmultimediacdocument?multimediacdocument-id=6615>.

## HISTORICAL DEVELOPMENT

Paris began establishing a network of bus lanes in the mid-1960s. As part of a comprehensive effort to tame automobile traffic and improve bus service, the *Régie Autonome des Transports Parisiens* (RATP) proposed the creation of separate bus lanes.<sup>158</sup> The first of these opened in 1964.<sup>159</sup> It was a concurrent-flow curb bus lane that ran for 1 km (0.62 mi.) along the riverfront and which served more than 95 buses during the peak hour. By 1968, Paris had about 12.5 km (7.5 mi.) of bus lanes (5.5 miles of concurrent flow curb lanes and 2 miles of contraflow lanes) in 36 segments around the city.<sup>160</sup> Many of these segments were very short, and served primarily as queue bypasses at traffic signals. Two extensive studies from the 1970s demonstrated the safety and operational improvements provided by the bus lanes, and the expansion of the system continued into the 1970s.<sup>161</sup> By 1974, Paris had 165 bus lane segments, totaling about 74 km (46 mi.) and serving 62 bus lines.<sup>162</sup>

The bus lane system continued to evolve through the 1970s, and then more slowly in the 1980s and 1990s. The number of bus lanes gradually increased during this period; by 1991, the City of Paris had over 150 km (93 mi.) of bus lanes.<sup>163</sup> Also, in the late 1990s, the Parisian Mayor Jean Tiberi experimented with curb barriers to protect a few bus lanes at the periphery of the city.

Starting in 2000 and 2001, bus lane planning and implementation received a major boost of energy from two events: the establishment of a regional bus improvement initiative, and the election of a new Paris government led by a coalition of the Socialist and Green parties. The new government immediately began action on a major effort to improve transit, walking, and cycling conditions and to discourage auto travel.

The regional program to improve bus service, Mobilien, was established through a 2000 Paris regional transportation plan titled the Plan de Déplacements Urbains d'Ile-de-France (PDUIF). This plan was created in response to a 1996 national law requiring all large urban areas to create plans to reduce air pollutants and energy consumption from the transport sector.<sup>164</sup> One portion of the PDUIF targeted for eventual improvement around 70 bus lines in Paris that form the core of the bus network, plus an additional 80 lines in the suburbs of Paris. In addition to focusing on specific bus routes, Mobilien also targeted various key transit transfer points for improvements, and sought to improve transportation access for bicyclists, the disabled, and delivery vehicles.

Under the Mobilien program, designated bus routes were upgraded to meet a number of key performance targets and service standards. These included guaranteeing bus service seven days a week from 6:00 a.m. to 12:30 a.m.; establishing minimum service frequency standards; making buses and stops more accessible for disabled passengers; improving passenger comfort; and displaying expected arrival times at bus stops. The goal for the central city bus lines was to achieve speeds at least 18 km/hour (11 mph), or else an improvement of 20 percent over pre-existing speeds. In terms of reliability, the target was for 90 percent of buses to arrive within five minutes of the scheduled time. One important strategy for achieving these two goals was expansion and improvement of the city's bus lanes.<sup>165</sup>

Just as the Mobilien program was taking shape, bus lanes also received a major boost with the 2001 Paris municipal election. That year, a coalition of the Socialist and Green parties took control of the city government and pushed for various measures to reduce auto use. The new Socialist mayor, Bertrand Delanoë, and his deputy mayor for transportation, Green Party member Denis Baupin, immediately began an energetic campaign to promote transit, walking, and bicycling, and to discourage car use.

One of the new administration's early actions, immediately after the election, was to announce a plan to create 41 km (25 mi.) of widened bus lanes that would be separated from other traffic lanes with raised curbs. The administration began immediate implementation of the plan by having 7 km (4 mi.) of existing bus lanes widened and protected with newly constructed curb barriers. These changes were installed over the summer, a time when large numbers of Parisians leave the city on vacation.<sup>166</sup> Parisians returned from their holidays to find the new lanes in operation, amid considerable controversy. A commentary

in the newspaper *Le Monde* described the scene in—and next to—the new bus lanes as follows:

*In the first rays of dawn, this stretch of the arterial that crosses the center of Paris from east to west . . . offers an astonishing spectacle. The roadway is divided into two parts of almost equal width by a mini-sidewalk, 70 centimeters wide, called a “banquette.” The roadway is, on one side, entirely covered with vehicles practically immobilized. In the other lane, repaved with a brand new, elegant, mouse-grey surface, a cyclist pedals tranquilly, with a bus overtaking him at full speed.*<sup>167</sup>

As noted by the newspaper, the new bus lanes caused considerable congestion. One key problem with the new lanes was that delivery vehicles were expected to stop in the regular traffic lanes, alongside the bus lanes. As became immediately apparent, this created both major traffic jams and also a safety risk for delivery personnel, who had to carry their goods across the bus lane. The Prefect of Police immediately intervened, requiring the city to establish zones where delivery vehicles could park safely out of the main traffic lanes. These zones were installed partially on the sidewalk and partially extending into the bus lanes.<sup>168</sup>

Since the summer of 2001, additional bus lanes in Paris have primarily been planned and installed through the Mobilien program, led by staff from the City of Paris. The first Mobilien line in the city, route 38, opened in 2004. As of 2009, the City of Paris has undertaken work on 18 of the planned Mobilien bus routes within its boundaries.

## **INSTITUTIONAL ARRANGEMENTS**

### **Transit Operator**

Bus service within Paris is provided by the *Régie Autonome des Transports Parisiens* (RATP), a regional transit provider owned by the national government. The RATP also operates the regional metro system.

### **Bus Lane Planning and Design**

The design of bus lanes within the City of Paris is coordinated and implemented by the city’s agency for roads and transport, *la Direction de la Voirie et des Déplacements*. For the last decade, most of the planning has been conducted through a regional bus improvement program named “Mobilien.”

### **Traffic Enforcement**

The City of Paris and the Prefecture of Police in Paris (*la Préfecture de Police*) share responsibility for traffic enforcement. The Prefecture of Police, an agency of the French national government, is responsible for issuing traffic rules. In addition, until 2002 the Prefecture was responsible for enforcing moving violations throughout the City of Paris. In 2002 the laws were changed so that the Prefecture retained responsibility for enforcing traffic regulations on the major streets in Paris, a network known as *les grandes axes* that



makes up about 20 percent of the streets in the city. Moving violations on the remaining streets are now enforced by employees of the City of Paris working under the supervision of the Prefecture of Police.

Agents of the City of Paris also enforce parking regulations, including restrictions on parking in bus lanes.

Finally, some enforcement of the bus lanes is provided by the transit operator, the RATP. The RATP has inspectors who walk along the bus lanes and can ticket illegally parked vehicles. These inspectors work under the supervision of the Prefecture of Police.

## Coordination

In 2001, when Mayor Delanoë first introduced the new, wider bus lanes with fixed barriers, the City was immediately criticized for failing to consult adequately with other stakeholders. In response, the Mayor and the Prefect of Police jointly hosted a meeting to discuss the bus lanes and other traffic issues with a wide number of elected officials and stakeholder groups.<sup>169</sup> From this point on, the bus lane planning process has been much more inclusive.

For the bus lanes developed through the Mobilien process, a complex planning and coordination process is required. The planning for each Paris bus route is guided by a so-called “Mobilien Route Committee” (Comité d’Axe Mobilien); these committees are led by staff from the agency responsible for the road on which the bus routes operate, typically the City of Paris.<sup>170</sup> The planning process for one route typically takes two or three years, with implementation usually taking another two or three years.<sup>171</sup> The planning processes are funded by means of grants awarded to route committees by the Ile de France (a national administrative region that contains most of the Paris metropolitan area).

The planning work begins with studies to evaluate service along the route. This evaluation includes speed and accident studies along the route, as well as a detailed examination of neighborhood conditions along the route that might impact bus performance. These studies allow planners to pinpoint problem locations that will require special treatments, such as blocks where the surrounding neighborhoods generate many delivery trucks. Once these preliminary studies are completed, a proposed plan is crafted and put forward for public discussion. Finally, after public comment and discussion among the many government agencies and stakeholders involved in Mobilien, a final plan for the bus route is established and construction begins.

The City of Paris posts detailed summaries of this planning process for each of its Mobilien lines. Users can go to the website to see what problems were identified in the initial evaluation studies, the specific designs recommended to address them, the dates of public meetings, and highlights of the final plan to be implemented.<sup>172</sup>

The coordination process includes a very wide range of institutional players, because so many different agencies are involved in planning, financing, and implementing the Mobilien routes and their associated bus lanes.<sup>173</sup> The *Préfet de Région*, a division of

the French national government, led the planning effort that created the regional transportation plan, the PDUIF, which set out the concept for the Mobilien program. Much of the funding for Mobilien has since come from the regional government, *la Région Ile-de-France*. Technical guidance, planning support, and some funding has been provided by a regional planning body, the *Syndicat des Transports d'Ile-de-France* (STIF).<sup>174</sup> The City of Paris, and especially its Department for Roads and Transportation (Direction de la Voirie et des Déplacements), leads the planning effort to prepare a highly detailed design for each Mobilien bus line. Elected neighborhood leaders also hold some influence over the bus lane planning, though little direct authority.<sup>175</sup> The RATP, the bus operator, is of course involved as well. The Prefecture of Police is involved with enforcement issues and setting regulations. Finally, the national government's regional office for historic preservation, *Architecte des Bâtiments de France Historique*, which is housed within the regional government (the *Préfet de Paris*), has veto power over any physical changes that could be seen from, or when looking at, listed historic monuments. Given that Paris is full of such listed historic monuments, many bus lane projects must go through review by this body.

In addition to these agencies, the planning process reaches out to private sector and civic groups representing involved parties such as residents along the bus routes, taxis, bicyclists, and delivery companies.

## PHYSICAL DESIGN AND SIGNAGE

### Lane Design

Paris uses a mix of both concurrent flow and contraflow lanes. The concurrent flow lanes are placed directly next to the curb, sometimes on the right-hand side of the street and sometimes on the left-hand side. Many of the lanes are placed on one-way streets.

When bus lanes were first installed in the 1960s, many were only 3 meters (10 feet) wide.<sup>176</sup> Today, within the city of Paris, most new bus lanes are designed to a much wider standard. Nearly a third of the bus lane network (about 38 mi.) has lanes as wide as 4.5 meters (14.8 feet), in order to allow buses and bicycles to share the lanes safely.<sup>177</sup>

Bus lanes are demarcated in the street pavement with either a painted line or a low curb. About two-thirds of the bus lanes, or 103 km (64 mi.), are concurrent flow ones demarcated with a dotted line of paint (see Figure 16).<sup>178</sup> The remaining third of the lanes are physically separated from other traffic lanes, using different types of low curb barriers.<sup>179</sup> Figure 17 and Figure 18 show two different types of barrier used. These median barriers are made of the same granite used for street curbs, for aesthetic reasons, and they range from 30 to 70 cm (12 to 28 inches) wide.



**Figure 16. Bus Lane with Painted Border (Paris)**

*Source: Photo by Asha W. Agrawal.*



**Figure 17. Bus Lane with a Raised Curb Separating It from the Regular Traffic Lane (Paris)**

*Source: Photo by Asha W. Agrawal.*



**Figure 18. Bus Lane with a Raised Curb and Planter Separating Buses from the Regular Traffic Lane (Paris)**

*Source:* Photo by Asha W. Agrawal.

In addition to using striping and curb barriers to delineate the bus lanes, painted text and symbols within the lanes alerts motorists to the lanes and indicate whether bicycles are permitted. Figure 19 illustrates the marking used on the pavement within the lanes: the word “BUS” and also a picture of a white bicycle against a green box. After a cyclist was involved in a fatal accident in a bus lane in 2008, the city developed a new pavement marking to place in those bus lanes where bicycles are not permitted, a black bicycle painted against a yellow box, with a red X through the image (Figure 20).<sup>180</sup>



**Figure 19. Pavement Markings Indicating a Bus Lane that Permits Cyclists (Paris)**

Source: Photo by Asha W. Agrawal.



**Figure 20. Pavement Marking Indicating That Bicyclists May Not Use the Lane (Paris)**

Source: Mairie du 10e Arrondissement [Paris], "Vélo dans le 10e" (no date), [http://www.mairie10.paris.fr/mairie10/jsp/site/Portal.jsp?page\\_id=341](http://www.mairie10.paris.fr/mairie10/jsp/site/Portal.jsp?page_id=341) (accessed March 30, 2010).

Along the bus lanes, prominent markings designate spots marked for loading and unloading delivery vehicles. As shown in Figure 21, the loading zone extends partially into the sidewalk and partially into the bus lane. Yellow paint marks an “X” over the spot where delivery vehicles may park. In addition, the word *livraisons* (“deliveries”) is marked in yellow paint on the pavement.



**Figure 21. Marked Delivery Parking Spot in a Bus Lane (Paris)**

Source: Photo by Asha W. Agrawal.

In many places, the bus lanes feature fences or bollards along the curb. The bollards are also used to prevent delivery vehicles from parking on the curb (Figure 21). The practice of installing safety chains along curbs next to some bus lanes started in the 1960s, after a pedestrian was killed by a bus in a contraflow lane.<sup>181</sup>

## Signage

In addition to painted text and symbols on the bus lane pavement, Paris liberally uses curb signs to alert motorists to the presence of bus lanes and specific rules about who may use the lane in that location. Earlier, white-on-blue round signs at the curb read, “*Voie RÉSERVÉE aux AUTOBUS*” (lane reserved for buses), but now typical signs rely on pictures to identify permitted users in bus lanes. In Figure 22, the icons of a bus and a bicycle indicate that these vehicles are permitted in that particular lane. In addition, this sign includes text at the bottom explaining that deliveries are strictly forbidden, except during the hours indicated and in the spots designated for them.

## ACCESS POLICIES

### Hours of Operation

Currently, Paris bus lanes are in effect at all times. However, when bus lanes were established in the 1960s, bus lanes on commercial streets operated only from 1:00 p.m. until 8:30 p.m., to allow time for deliveries. Bus lanes that did not interfere with curb access for businesses were operational from 8 a.m. until 9 p.m.<sup>182</sup>



**Figure 22. Signage Indicating a Bus Lane (Paris)**

*Source: Photo by Asha W. Agrawal.*

### Users Permitted

Paris bus lanes are open to a variety of non-bus users. Fire trucks, police vehicles, ambulances, doctors on call, and taxis may all use the lanes. Taxis may also stop in the lanes to drop off or pick up passengers.

Cyclists are allowed to use 98 miles (157 km), or 83 percent, of the bus network.<sup>183</sup> The underlying policy is to allow cyclists in those bus lanes where they can safely share the space. Cyclists are allowed in all lanes that are at least 4.5 m wide and demarcated by paint, and also allowed on a case-by-case basis in some narrower lanes demarcated by paint. Fewer of the lanes demarcated with a solid barrier allow cyclists.<sup>184</sup>

Motorized two-wheeled vehicles are not legally allowed to use the bus lanes, although there has been considerable pressure from interest groups to allow them into the lanes. Motorcyclists have been advocating for access as early as the 1990s and continue doing so to the present. In late 2009, Mayor Delanoë announced that he would support a trial to allow electric scooters in the bus lanes, but early in 2010, Prefect of Police announced that he would not permit even a trial allowing motorcyclists in the bus lanes.<sup>185</sup>

Private vehicles are allowed to drive in the bus lane in order to access a property along that block.

Delivery vehicles are allowed to drive into a bus lane to access a loading zone on the block, except during the peak hours. The specific hours when deliveries are forbidden is specified on curb signage along the bus lanes.

## **ENFORCEMENT**

The Prefecture de Police, the City of Paris, and the RATP are all involved in enforcing the bus lanes. The Prefecture has been intimately involved in developing the rules by which bus lanes operate, as well as providing enforcement. The City, for its part, has hired enforcement personnel who work under police supervision. The RATP plays a more limited role in enforcement, but does have agents who can ticket vehicles parked illegally in bus lanes.<sup>186</sup>

### **Relevant Traffic and Parking Codes**

The establishment and operation of bus lanes in Paris is guided by a large number of national laws and decrees issues by the Prefect of Police.<sup>187</sup>

### **Penalties**

Motorists illegally driving, stopping, or parking in a bus lane are typically subject to a fine of €135 (US\$190). These infractions do not cause drivers to lose points from their license.<sup>188</sup>

### **Patrol-based Enforcement**

Traffic and parking enforcement in Paris is carried out by police officers and also by the Agents de Surveillance de Paris (ASPs), who are employees of the City of Paris put under the supervision of the Prefect of Police. Originally, these city employees enforced only parking violations; later, their duties were expanded to helping to direct traffic. In 2001, a new national law granted them power to enforce moving violations, working under the management of the Prefecture of Police.<sup>189</sup>

In addition to patrols of police officers and ASPs, the RATP also has some foot patrol officers who ticket illegally parked vehicles interfering with bus operations.



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## Camera-based Enforcement

Within Paris, both bus-based and stationary cameras have been used to document and ticket illegal driving and parking in bus lanes. The RATP has installed driver-activated cameras on some buses, while the Prefecture of Police has installed stationary cameras to monitor four locations.

The RATP has worked with the Prefecture of Police on the on-board camera program. Some buses have digital cameras mounted on the front and back of the bus, and drivers can activate them when they sees a vehicle illegally driving in a bus lane or parked either in a bus lane or at a bus stop. According to reports in newspapers and magazines in 2004, the bus drivers have resisted using these cameras, even when they were only being tested and not used to issue tickets. The drivers argued that it is not their job to act as police.<sup>190</sup> The report authors were unable to determine whether these bus-based cameras have ever been used to issue citations, or if their use was restricted to the testing phase only.

Officials within the City of Paris and Prefecture of Paris began looking into stationary camera enforcement of bus lanes in 2002. Officials were concerned about the continuing high level of violations of the lanes by automobile drivers and motorcyclists, but they also recognized that increased patrol-based enforcement was not practical. Therefore, the Prefecture of Police announced that it would study camera-based enforcement in bus lanes as one part of a larger effort to ensure compliance with traffic laws.<sup>191</sup> After a long period of testing the cameras in bus lanes in 2003 and 2004, four locations with cameras were put into operation in the summer of 2005.<sup>192</sup>

Each location is equipped with two digital video cameras that film continuously. The video footage is reviewed by staff at the Prefecture de Police to identify illegitimate vehicles, and fines are sent by mail.<sup>193</sup>

By the end of the 2005, the police reported that in six months of operations the cameras had captured violations by 13,000 drivers.<sup>194</sup>

## Enforcement Effort

The City of Paris and Prefecture of Police have worked together to improve enforcement of the bus lanes, relying on a variety of approaches and at times instituting special enforcement campaigns.

One intensive enforcement campaign occurred in the summer and fall of 2001, when Mayor Delanoë's administration opened the newly widened and curb-separated bus lanes. At that time, the Prefect of Police issued a set of new regulations for use of the lanes and also distributed a press release explaining that the police would hold a short educational campaign, to help drivers learn the new rules, and then begin to ticket violators aggressively.<sup>195</sup>

In early September, the newspaper *Le Figaro* reported that the police had made a major deployment of more than 50 officers around the newly widened bus lanes, issuing almost 4,000 tickets.<sup>196</sup> A few days later, another article noted that during a four-day period, the

police had issued 2,077 tickets for illegal use of bus lanes, and that 253 vehicles had been towed.<sup>197</sup>

Enforcement efforts were reduced after some months, but violators continued to be a problem, and so the police again increased their enforcement effort. The City of Paris eventually saw the need for more police assigned to enforcement duties. It was at this time that the city-employed ASPs were given legal power to enforce traffic regulations, working under the management of the Prefecture of Police. Hundreds of new ASPs were hired, bringing the total to 800 and allowing the police to double their traffic enforcement efforts.<sup>198</sup> By June of 2002, a representative of the Prefecture of Police said in an interview that the enforcement efforts were paying off, with the number of tickets issued per day for illegal driving in the bus lanes having fallen to an average of 100 to 200.<sup>199</sup>

However, in 2002 the City of Paris and the Prefecture of Police began looking into camera enforcement, because officials felt there were still too many vehicles driving illegally in the bus lanes.<sup>200</sup> As described above, in 2005 the Prefecture installed camera enforcement at four locations in the city, and these have continued to operate ever since.

Since 2001, the Prefecture of Police has published data on the number of citations issued for illegal driving and parking in bus lanes. As shown in Table 24, the total number of citations issued for illegal driving in bus lanes rose from 2001 to 2005, but has since dropped off to 24,934 tickets issued in 2008, an improvement that the police attribute to the introduction of the stationary video-surveillance.<sup>201</sup> Since 2005, a high percentage of the infractions have been caught through video-surveillance rather than by foot patrol officers. Another trend lying beneath the overall drop in citations has been an increase in citations issued to motorized two-wheeled vehicles. As for parking violations, the number of tickets issued rose from 2001 to 2002, but has been declining steadily ever since, to a total of 28,446 tickets issued in 2007.

To complement ticketing, the police and the City of Paris have tried to improve compliance with bus lanes through public education campaigns. Both a City-sponsored campaign in 2006 and one sponsored by the police in 2008 targeted a large number of illegal behaviors, included bus lane infractions.<sup>202</sup>

In addition to these citywide enforcement efforts, our interviewees reported that, because illegal use of the bus lanes varies by neighborhood, city leaders have tried to tailor enforcement efforts to meet local conditions. For example, there has been a problem with illegally parked delivery vehicles in the bus lanes along bus Route 38, which runs through a neighborhood with many wholesale businesses. In response, the RATP and the mayor of the local neighborhood<sup>203</sup> have worked to educate the business owners and delivery drivers about the bus lane policies.

An interviewee also noted that in some locations the city has dealt with bus lane violations by widening the sidewalk to narrow the bus lane. When the lane is narrower, drivers are more aware that they will block the lane if they stop illegally, and this awareness reduces violations.

**Table 24. Numbers of Citations Issued for Illegal Traveling and Parking in Bus Lanes, 2002-2008 (Paris)**

Year	Illegal traveling			Illegal parking
	Total	Issued through video-surveillance	Issued to motorized two-wheelers	
2001	14,000	N.A.	N.A.	48,300
2002	20,460	N.A.	N.A.	98,080
2003	27,092	N.A.	3,558	88,256
2004	28,427	N.A.	4,874	66,593
2005	35,751	14,568	3,595	43,653
2006	32,230	14,221	7,458	33,107
2007	32,383	8,578	9,635	28,446
2008	24,934	N.A.	N.A.	N.A.

Sources: *Bilan de Déplacements, 2002-2008* (e.g., *L'observatoire des Déplacements à Paris, Le Bilan Des Déplacements à Paris en 2007* (Paris: Mairie de Paris, 2008), pp. 11, 30; Préfecture de Police, "Sécurité Routière et Accidentologie à Paris: Bilan 2008" (April 15, 2009), [http://www.prefecturedepolice.interieur.gouv.fr/content/download/2233/11556/file/version\\_complete.pdf](http://www.prefecturedepolice.interieur.gouv.fr/content/download/2233/11556/file/version_complete.pdf) (accessed February 24, 2010).

## PERFORMANCE

A limited number of formal evaluations have been published or presented that estimate the effectiveness of the Mobilien improvements. Most of the analyses uncovered in the research for this study suggest that the bus lanes and associated improvements have modestly improved the buses' on-time performance, even though bus speeds have not increased as much as might have been technically possible. In most cases where changes in bus speeds and on-time performance have been documented, it is impossible to completely separate the impact of bus lanes from the impact of associated improvements implemented through the Mobilien program. Also, traffic in central Paris has slightly lessened over the past decade, a factor that would improve bus travel times independently of the bus lanes.

The experts interviewed for this case study generally agreed with this conclusion that the bus lanes have improved bus speeds very modestly, but that the lanes have had a much more significant impact in terms of improving on-time performance.

Paris has seen an unusually high number of evaluation studies, but overall their results have been contradictory and inconclusive. One 2005 paper concluded that speeds on Mobilien bus lines had dropped by 1 percent to 2 percent between 2000 and 2004.<sup>204</sup> A 2007 analysis found that on-time performance improved even if there were no major time savings for buses.<sup>205</sup> A third study found that the Mobilien Line 91, launched in 2006, had led to operating speed increases up to 10 percent during peak hours, a 40 percent improvement in on-time performance, and a 24 percent reduction in accidents involving buses.<sup>206</sup> A fourth study reviewed changes in bus performance between 2001 and 2006/2007 and found mixed results, due in part to limited data availability, the difficulty of separating the

effects of improvements implemented simultaneously, and external factors that influenced traffic conditions.<sup>207</sup>

The RAPT reported another set of data evaluating Mobilien in a separate 2007 publication that documented speed improvements ranging from 3 percent to 16 percent and a decrease in accidents ranging from 24 percent to 38 percent on certain lines between 2001 and 2006. The report also cited significant gains in on-time performance.<sup>208</sup>

The average cost for the infrastructure in the Mobilien projects has run from €1 million to €2 million per kilometer (US\$2 million to US\$4.5 million per mile).<sup>209</sup> Reports state that for one of the early projects, the 8 km (5 mi.) Line 38, the total cost was €9.37 million (US\$13.3), of which 76 percent came from the STIF/State/Region, and 25 percent from the City of Paris.<sup>210</sup>

In 2008, the buses carried 387 million passenger trips, of which just under 187 million were on Mobilien routes.<sup>211</sup> In that year, almost half of all buses within the Paris region ran on a Mobilien line.<sup>212</sup>

## APPENDIX E: SAN FRANCISCO CASE STUDY

### INTRODUCTION

The city of San Francisco has an extensive network of bus lanes, concentrated in its downtown core. The network was first established in the 1970s, and has been gradually modified ever since. Recently, the city has begun a pilot program using bus-mounted cameras to cite stopped and parked vehicles blocking the bus lanes.

San Francisco is a dense city with over 800,000 residents (see Table 25). It is served by a diverse array of public transit modes, including motorbuses, electric trolley buses, light rail, cable cars, rapid transit, and ferries. The city covers 47 square miles on a peninsula bounded by the Pacific Ocean to the west, and the San Francisco Bay to the east. Its metropolitan area (the San Francisco-Oakland-Fremont Metropolitan Statistical Area) has 4.3 million residents and 2,473 square miles.<sup>213</sup> The region surrounds a large bay and is ringed by steep hills. These geographic constraints, combined with the compactness of San Francisco's CBD, generate high bus and rail ridership among commuters to the central business district.

**Table 25. Metropolitan Profile (San Francisco)**

<b>City population<sup>a</sup></b>	0.8 million	City of San Francisco
<b>Metropolitan population<sup>a</sup></b>	4.3 million	San Francisco-Oakland-Fremont, CA Metropolitan Statistical Area
<b>Annual unlinked urban transit trips<sup>b</sup></b>	216.0 million	
Heavy rail	0.0 million	0% of urban transit trips
Light rail, cable car	57.4 million	27% of urban transit trips
Bus, trolley bus	158.6 million	73% of urban transit trips
Other	0.0 million	0% of urban transit trips
<b>Ratios calculated from data above</b>		
Urban transit trips per city resident	268 annual trips per capita	
Urban bus trips per city resident	197 annual trips per capita	
Urban transit trips per metro resident	50 annual trips per capita	
Urban bus trips per metro resident	37 annual trips per capita	

*Sources:*

<sup>a</sup> U.S. Census Bureau, 2010 Census, <http://factfinder2.census.gov> (accessed December 9, 2011).

<sup>b</sup> Federal Transit Administration, 2010 National Transit Database, "Table 19: Transit Operating Statistics: Service Supplied and Service Consumed," <http://www.ntdprogram.gov/ntdprogram/data.htm> (accessed December 9, 2011). Data from the Bay Area Rapid Transit System, Caltrain, ferries, and regional commuter buses are excluded because they do not serve trips primarily within the urban center.

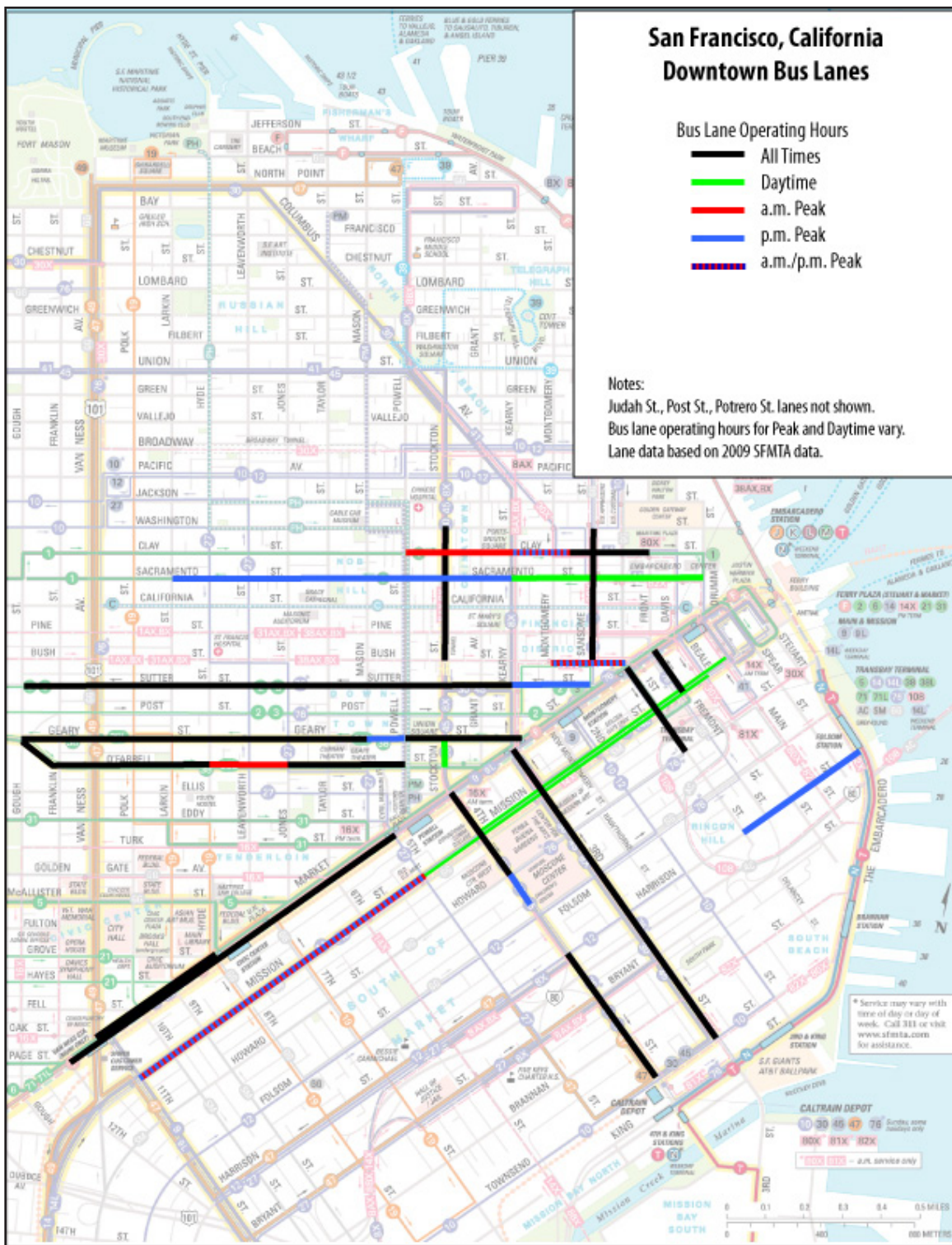
San Francisco has about 17.8 miles (28.6 km) of transit priority lanes, about 14.3 miles (23.1 km) of which are used by buses (the remainder are used by light rail transit vehicles).<sup>214</sup> There is significant variation in the alignments, regulations, and hours of operation used by San Francisco's transit priority lanes. About two-thirds of the network is offset

from the curb to allow space for separate parking and/or turn lanes, and about three-fifths of the network is in operation at all times. Table 26 lists the bus lane locations, operating hours, and lengths as of 2009. The map in Figure 23 displays the network in the downtown area.<sup>215</sup>

**Table 26. Bus Lane Locations, Lengths and Hours (San Francisco)**

#	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
							<b>Total miles</b>	<b>14.35</b>

Sources: Authors' estimates calculated from Google Earth and bus lane data attributed to SFMTA (Kristen Holland, Public Relations Officer, SFMTA), as included in: Michael Rhodes, "Violations in SF's Transit-Only Lanes Rampant and Rarely Enforced," Streetsblog San Francisco (August 11, 2009), <http://sf.streetsblog.org/2009/08/11/violations-in-sfs-transit-only-lanes-rampant-and-rarely-enforced/> (accessed April 1, 2010).



**Figure 23. Downtown Bus Lane Network Map (San Francisco)**

Sources: Authors' adaptation of a map from San Francisco Municipal Transportation Agency (SFMTA), "Downtown System Map" (December 2009), <http://www.sfmta.com/cms/mmmaps/official.htm> (accessed April 1, 2010); Bus lane data: attributed to SFMTA (Kristen Holland, Public Relations Officer, SFMTA), as included in: Michael Rhodes, "Violations in SF's Transit-Only Lanes Rampant and Rarely Enforced," Streetsblog San Francisco (August 11, 2009), <http://sf.streetsblog.org/2009/08/11/violations-in-sfs-transit-only-lanes-rampant-and-rarely-enforced/> (accessed April 1, 2010).



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## HISTORICAL DEVELOPMENT

San Francisco has placed a significant emphasis on its public transportation system since the city's so-called "Freeway Revolt" in the 1960s, when city residents and leaders rejected state plans to run additional freeways through the heart of the city.<sup>216</sup>

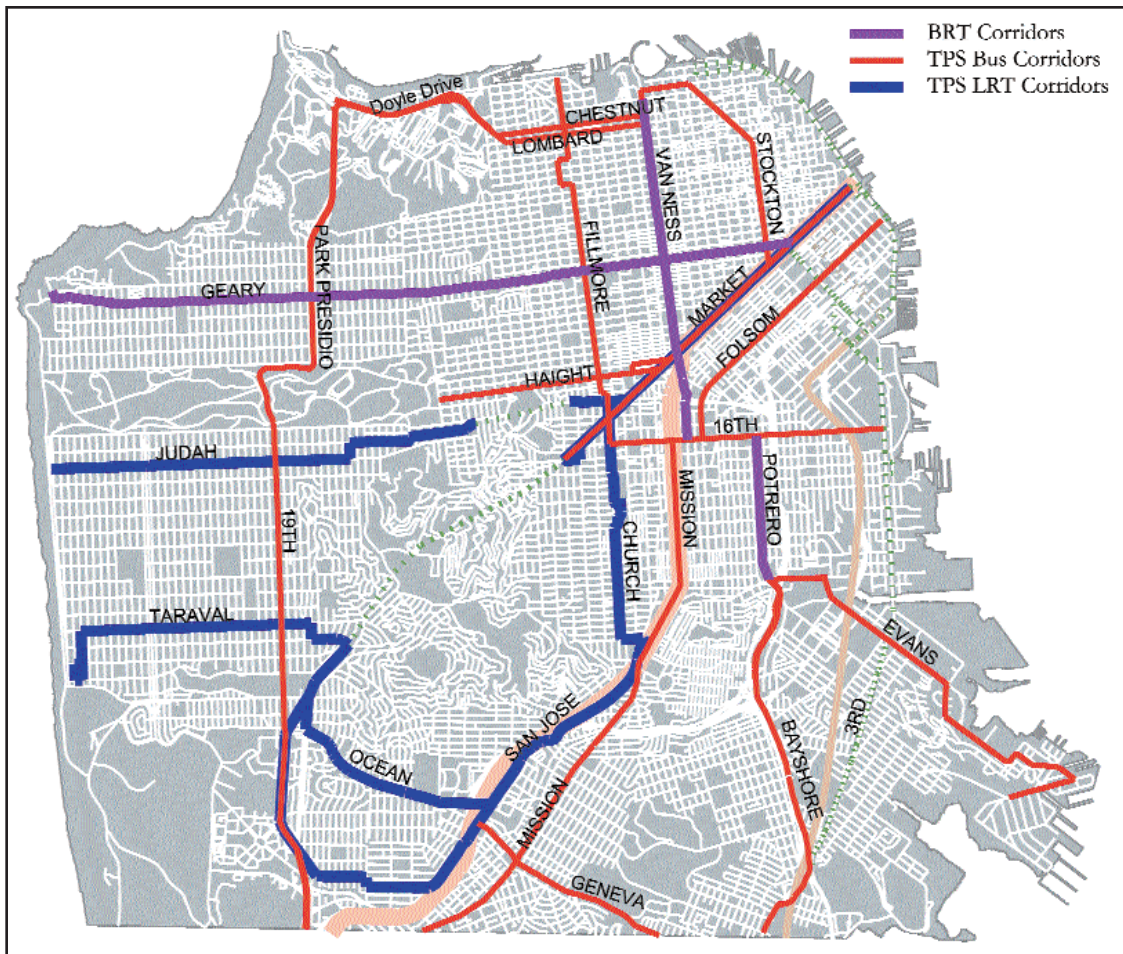
San Francisco had long given transit vehicles priority on Market Street, where streetcars and buses shared the two median lanes, and served passengers with mid-street loading islands. As of the early 1970s, Market Street had the "highest observed hourly transit volume on any surface street in the United States."<sup>217</sup> While passenger vehicles were not strictly prohibited from using these median lanes, the platforms, high transit vehicle volumes, and left-turn prohibitions generally served as an effective deterrent.

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.<sup>218</sup> 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.

In 1973, San Francisco officially adopted a "Transit First" policy that nominally gave public transit vehicles priority over private vehicles in policymaking related to city streets. To implement that policy, the city began a 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. Some early pilot projects were implemented as part of the TPS program, but the program did not receive ongoing staff and funding until 1989.<sup>219</sup>

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.<sup>220</sup>

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.<sup>221</sup> 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 city-wide.<sup>222</sup> 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 24).<sup>223</sup> Planning studies for several of these corridors are underway.



**Figure 24. Bus Rapid Transit (BRT) and Transit Preferential Street (TPS) Corridors Identified for Further Improvements in the 2004 Countywide Transportation Plan (San Francisco)**

Source: San Francisco County Transportation Authority, *2004 Countywide Transportation Plan* (2004), 67.

## INSTITUTIONAL ARRANGEMENTS

### Transit Operations

The San Francisco Municipal Railway (known as “Muni” or MUNI) provides the bulk of transit services within the city. Unlike most transit agencies in the United States, which exist as independent public authorities or service districts, Muni has historically been a branch of the city government. Before 1999, Muni was a city department governed by a Public Transportation Commission, but the mayor and board of supervisors had significant influence over its planning and management decisions. Under the Measure E reforms of 1999, Muni is now part of the Municipal Transportation Agency, which has an independent board of directors consisting of qualified professionals; a more independent budget process; its own administrative infrastructure; and a statutory mandate to achieve certain transit performance standards.<sup>224</sup>

Muni carries most of its passengers on buses (motor, trolley cars, and trolley buses), operating over 80 bus lines along approximately 1,000 miles of roadway.<sup>225</sup> The various bus lines together carry an average weekday ridership of around 500,000 passengers. Light rail and cable cars carry another 140,000 or so passengers a day. Additional transit service connecting with areas outside the city boundaries is provided by other operators, including Bay Area Rapid Transit (heavy rail), Golden Gate Transit (bus), Caltrain (commuter rail), SamTrans (bus), and AC Transit (bus).

## **Street Planning and Design**

Prior to Measure E, San Francisco's Department of Parking and Traffic (DPT) governed street planning and design in the city. DPT's mandate included the safe and efficient movement of people and goods throughout the city. This mission included facilitating transit services, but it often included a strong emphasis on traffic flow that critics considered damaging to the quality of access for pedestrian and transit customers.

After Measure E, DPT joined Muni under the umbrella of the new SFMTA in 2002. In 2010, the transition to an integrated agency was completed with the phase-out of the DPT and the assignment of its remaining responsibilities to a new Sustainable Streets Division.<sup>226</sup> This new unit designs and manages all traffic engineering functions within San Francisco, including the placement of bus lanes, signs, signals, and curb markings with an explicit mandate to implement 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, considering the site conditions, street geometry, and traffic guidelines.

An additional public agency with significant input in transportation planning in the city is the San Francisco County Transportation Authority (SFCTA), an independent agency that conducts planning and evaluation studies related to transit operations. This agency was established in 1989 to manage implementation of the expenditure plan for San Francisco's half-cent sales tax for transportation improvements, a responsibility that was renewed in 2003 with voter approval of a 30-year extension of the tax. Over time, SFCTA has gained a number of additional responsibilities, including management of the city's congestion management program, transportation system performance measurements, and manager of a grant program for transportation projects that improve air quality.

## **Traffic Enforcement**

The SFMTA's Enforcement Division is responsible for enforcing parking violations, including those in bus lanes and violations in city-owned and metered parking lots.<sup>227</sup>

Moving violations are enforced by a unit of the San Francisco Police Department (SFPD) known as the Traffic Company, a unit of 79 sworn officers attached to the SFMTA that enforces traffic laws, investigates collisions, manages traffic during major events, and provides safety education.<sup>228</sup> The Traffic Company includes a 40-officer motorcycle unit, known as Company K, which provides a high-profile traffic enforcement presence. In 2009, the SFMTA was given greater control over how the Traffic Company officers are deployed.<sup>229</sup>

## Coordination

Measure E sought to institutionalize interagency coordination of planning and policymaking for transit priority streets and other policy objectives. It brought the city's transit operator and traffic department under the same leadership, which later sought to erase the remaining institutional divisions pushing these two units toward divergent objectives. At the same time, Measure E strengthened the city's Transit First policy in order to provide clearer direction to other city agencies about their responsibility to support these policies.

However, while Muni and DPT have been brought into alignment, a new planning entity has arisen and brought new coordination challenges. With approval of Measure K in 2003, the SFCTA gained new planning responsibilities for transit networks and performance improvements. SFMTA and SFCTA have good communication channels and work cooperatively, but approach issues from different perspectives. SFMTA has the operational responsibilities for transit services and traffic management, while SFCTA has responsibility for strategic and capital planning to fulfill the policy mandates of Measure K. In the case of bus lanes, SFCTA has sought to follow through on Measure K's commitment to developing BRT corridors on Geary Boulevard and Van Ness Avenue by designing exclusive, median bus lanes. In contrast, SFMTA has argued that a curbside bus lane would better optimize the overall performance of the street. As a result, planned BRT projects on Geary Boulevard and Van Ness Avenue, which promote the dedicated median bus lane, have been pushed by SFCTA without SFMTA's full support.

Formerly, the various agencies involved in operation and enforcement of bus lanes came together for monthly Transit Streets Management (TSM) meetings to facilitate coordination and communication. At these meetings, engineers and planners from SFMTA and SFCTA, as well as enforcement officers from the former Department of Parking and Traffic and the SFPD, exchanged information on their work progress and priorities at the meeting. However, SFMTA found that this forum was not an effective way to coordinate all stakeholders and no longer holds the monthly meetings.

## DESIGN

### Lane Design

San Francisco has adopted a number of different bus lane designs to suit local conditions (see Table 27). About 67 percent of San Francisco's bus priority lanes are located in right-side travel lanes that are offset from the curb to allow space for bus stops, parking, deliveries, and vehicles making right turns (see examples in Figure 25).<sup>230</sup> Depending on the location and the street space available, the street may be painted to indicate a full-width travel lane between the bus lane and the curb, a narrower bus stop and parking lane, or a series of parking/delivery bays set into the sidewalk. Alternatively, the bus lane itself is often painted as an extra-wide shared lane that may incorporate bus stops, parking, and other curb uses.

**Table 27. Bus Priority Lane Alignment (San Francisco)**

Alignment	Curbside	Offset
Right	24%	60%
Left	0.5%	5%
Contraflow	-	2%
Median	9%	

Source: Authors' estimates.

The remainder of the bus priority lanes run either hard against the curb (24 percent) or along a central median (9 percent). On some one-way streets, the bus lane is on the left lane with bus stops on islands (as in Figure 26). Market Street is bi-directional and has bus lanes at the median. Uniquely, Sansome Street has contraflow bus lanes.<sup>231</sup>

**Figure 25. Offset Lane Configuration Examples (San Francisco)**

Source: Photos by Jennifer Donlon (2007).

Solid white lines separate the bus lanes from other traffic. Typically, the lane is also marked with a diamond and “Bus Only” or “Bus Taxi Only” text (see example in Figure 26). According to staff interviewed for the project, the city is in the process of removing the diamond symbols from bus lanes because their use does not comply with Manual on Uniform Traffic Control Devices (MUTCD) guidelines. As streets are repaved or repainted, the lane markings are updated to remove the diamond signs.

No physical lane barriers are used for right-side bus lanes. Left-side and median bus lanes usually incorporate a raised island at bus stops that also acts as a lane barrier (see Figure 25 and Figure 26).



**Figure 26. Left-Curbside Lane with Island (San Francisco)**

*Source: Photo by Jennifer Donlon (2007).*

San Francisco has implemented various transit priority signal measures to facilitate buses turning from bus lanes.<sup>232</sup> Examples include transit priority signals that enable buses to jump queues. Another example is a video detection system that detects specific buses in a left-side bus lane and provides a queue jump phase, which allows buses to make right turns from the left lane across three through-traffic lanes.<sup>233</sup>

Under state law, California municipalities may adopt a color-coded system of curb markings to indicate curb lane restrictions.<sup>234</sup> In parts of the state that are not subject to snow accumulations, these curb markings have the same standing as regulatory signs. According to the state's standards, no-stopping zones are painted red; five-minute standing zones are marked white; commercial loading zones are colored yellow; short-term parking zones are painted green; spaces reserved for the disabled are coded blue; and other curb spaces appear grey or unpainted. Curbside lanes that include a parking lane generally have red-zone curb paint along the length of each bus stop and bus lane re-entry.

## Signage

Most bus lanes are accompanied by curbside signs indicating operating hours, parking/stopping prohibition (hours, if applicable), and/or inclusion of taxis (see examples of signage in Figure 27). The City generally places a bus lane sign at the beginning of each

block with a bus lane, and where appropriate, it places additional signs on blocks over 250 feet long.

Over the past several years, San Francisco has been phasing out older signage featuring diamond notation with new MUTCD-compliant signage intended to clarify traffic rules. They have also sought to achieve greater consistency in ensuring that each block is signed clearly, and that signs are not blocked by trees.



**Figure 27. Bus Lane Signage Examples (San Francisco)**

Source: Photos by Jennifer Donlon (2007).

## ACCESS POLICIES

### Hours of Operation

The hours of operation for San Francisco's bus lanes are tailored to local conditions, with the result that there is no standard set of operating patterns (see list in Table 26). About 18 percent by mileage of San Francisco's bus lanes operate only during weekday morning or afternoon peak periods. An additional 8 percent of the bus lanes operate during both morning and afternoon peak periods. The specific hours of operation are not standardized. For example, evening peak-hour bus lanes operate from 4 p.m. to 6 p.m. in some places,

from 3 p.m. to 6 p.m., in others, and from 3 p.m. to 7 p.m. in yet others. In most cases, these lanes are located adjacent to the curb, where accommodations for parking or loading zones are needed at non-peak times of day. An exception is on Mission Street, which has stretches of bus lanes offset away from the curb that nevertheless operate only during peak hours.

Some bus lanes operate continuously on weekdays, including some stretches of Mission Street (7 a.m. to 6 p.m.) and Sacramento Street (7 a.m. to 7 p.m.). These are a mix of curbside and offset lanes.

The largest group of bus lanes, 60 percent of the total by mileage, are bus lanes that operate at all hours (labeled “All Times” in Table 26). Some of these lanes are located directly along the curb, but most are offset to allow other vehicles to access the curb without disrupting bus operations.

### **Users Permitted**

The city’s municipal code defines the conditions under which other vehicles may use a transit-only lane.<sup>235</sup> This code includes specific subsections describing operations in lanes designated for streetcars and cable cars (Subsections 1 through 4), as well as a subsection covering other designated bus lanes (Subsection 5).<sup>236</sup> Under this policy, taxis are allowed to use bus lanes at all times. While most signs indicate that taxis are permitted, some signs and most pavement markings indicate “Bus Only,” which may create some confusion about the actual policy.

A private vehicle is allowed to drive in a bus lane for up to one block in order to make a turn. A private vehicle may also drive in a bus lane in order to access a parking lot or driveway, or to leave from curb-side parking (for non-curb-side bus lanes).

Delivery vehicles are allowed in yellow zones marked as truck loading zones. According to some interviewees, the Enforcement Division’s parking-control officers also sometimes allow delivery trucks to park in transit lanes if they do not create a hazard.

According to the city’s municipal code, a bicycle is subject to the same traffic laws as a motorized vehicle.<sup>237</sup> That is, as described above for private vehicles, a cyclist may not use a bus lane except to make a turn or access parking or a driveway. Nevertheless, the 2009 San Francisco Bicycle Plan discusses a “lack of clarity” concerning whether bicycles are allowed in curb-side bus lanes, and recommends that state law be clarified to allow bikes to use transit lanes if this is determined to be safe.<sup>238</sup>

Motorcycles are not allowed to use the bus lanes according the transportation code, but some of our interviewees noted that these vehicles are rarely ticketed for using the lanes; the only likely exception being if the vehicle were creating some sort of significant safety hazard.



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## ENFORCEMENT

### Relevant Traffic and Parking Codes

The rules regarding legal use of the bus lanes are laid out in the California Vehicle Code (for moving and standing violations), and two separate sections of the San Francisco municipal code.<sup>239</sup> A section of the city's municipal code defines transit-only lanes,<sup>240</sup> authorizing the designation of exclusive transit areas and specifying streets where this designation is implemented. The section also specifies rules on exceptions for specified areas. For example, streetcars, taxicabs, vehicles preparing to make a turn, and vehicles entering into or exiting from a stopped position at the curb are allowed in most but not all lanes. Also of note, Section 601 codifies a network of transit-only lanes in the city. However, the City has expanded the hours and geographic extent of this network administratively, so the network described in the municipal code is not complete (Table 26 provides a more comprehensive list).

### Penalties

The penalty for driving illegally in a bus lane is \$60.<sup>241</sup>

The penalty for parking in a transit-only lane is \$105, and the penalty for parking at a bus stop is \$255.<sup>242</sup> Significant additional fines are charged for vehicles that are towed to clear the bus path. This violation is not treated as an infraction, and does not result in points on the vehicle operator's license.

### Patrol-based Enforcement

The SFMTA's Enforcement Division enforces parking laws throughout the city. It seeks to enforce parking restrictions in bus lanes in ways that benefit the transit system's on-time performance. Interviewees explained that parking-control officers often refrain from citing a car illegally stopped in a bus lane that pulls away quickly, since issuing a citation would prolong the time lane is blocked.

According to several interviewees (and according to the authors' personal experience in San Francisco), both driving and parking bus lane violations remain significant problems that downgrade the effectiveness of the city's bus lanes. Interviewees explained that many non-transit drivers travel in the bus lanes to escape the city's severe traffic congestion. Also, private vehicles often park in bus lanes before the bus-only hours end, and even block the offset lanes by double-parking, clogging the lanes during the peak hours. Further problems are delivery trucks parking in bus lanes, even in zones where commercial loading is not allowed, and sometimes bicycles riding illegally in bus lanes. Parking at bus stops tends to be less of a problem, most likely because the penalties are more severe, and the law is enforced more vigilantly. The variety of lane hours and exceptions was also cited as adding to the complexity of enforcement efforts.

The views expressed by the interviewees are echoed in a 2009 article in which interviewed Muni operators cite lack of consistent enforcement efforts.<sup>243</sup> According to this article, the

chief of the Traffic Company had only recently begun making transit-lane enforcement a higher priority.

### **Camera-based Enforcement**

In an attempt to resolve the enforcement issue with a limited number of staff, and to improve the reliability of bus operation, City officials sought and received approval from the state legislature and governor for the Transit Lane Enforcement Pilot Project, a program to test camera-based enforcement of vehicles illegally stopped or parked in transit lanes.

The project started in early 2008. The first trial set of cameras were supplied free of charge to the City. During the first phase, cameras were installed on eight buses on the two longest transit lanes in the city: Line 38 Geary (outbound from Market Street to Gough Street and inbound from Gough Street to Powell Street) and Line 14 Mission. For the second phase, which started in October 2008, cameras were installed in 22 more buses to cover the remaining transit lanes. State law permits the trial to continue until January 1, 2012.

Each set of two video cameras is installed behind bus windshields.<sup>244</sup> One camera captures the transit lane, the other focuses on the license plate of the target vehicle in the lane. Images are captured automatically. However, the bus driver may also trigger capture of a still image of a violating vehicle's license plate.

The images are transferred to the SFMTA camera surveillance team for an initial review. The team sends the selected images of violation to parking control officers, who then confirm the violation and issue citations to the registered owner of the violating vehicle. This camera enforcement is applied only for vehicles stopped or parked in the bus lane. It is not yet applicable to the enforcement of traffic laws for moving violations in a bus lane.

According to an SFMTA spokesperson in a 2009 interview, 636 citations had been issued after 18 months of operation.<sup>245</sup>

### **PERFORMANCE**

Evaluation is difficult in part because the city does not have a mechanism in place for compiling and tracking data on bus lane violations. In SFPD reporting, citations related to bus lane violations are generally not differentiated from citations for other moving violations, and are not compiled across the various patrol units across the department. Also, even reported bus lane violations are not always carefully recorded, due to the lack of full-time data entry staff.

As discussed above, there is a general perception among the staff interviewed for this case study, and public transit advocates, that San Francisco's bus lanes are impacted by chronic violations.<sup>246</sup> But there has been very little systematic analysis of the system's actual performance. A 2003 SFCTA survey of transit lane violations on Market Street found that over 25 percent of the vehicles on the street were violating the bus lane laws.<sup>247</sup> Some 13 percent of transit vehicles experienced delay due to these violations. A more comprehensive SFCTA study from 2006 looked at the types of vehicles using the lanes, including

violators, on 10 different bus lane segments.<sup>248</sup> That study concluded that violation rates varied widely by location and that in some cases the transit lanes were clogged more by vehicles making turns than by vehicles driving in the lanes illegally. The study authors also concluded that most lanes carry fewer vehicles than adjacent lanes, and therefore are effective at providing a less-congested path for buses.



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## APPENDIX F: SEOUL CASE STUDY

### INTRODUCTION

Seoul has one of the largest bus priority lane networks in the world. The city first installed bus lanes in 1984, and today the network covers 205 km (127 mi.). Since 2004 when Seoul made major changes to its bus system, it has been upgrading bus lanes on key corridors so that nearly half now operate on median alignments.

Seoul is the national capital of the Republic of South Korea, and is one of the world's largest and fastest growing megacities. The city's dramatic population growth and accompanying rapid economic development have generated enormous increases in travel demand and car ownership.<sup>249</sup> Today, 9.7 million people live in the city of Seoul, known officially as the Seoul Special City, and administered by the Seoul Metropolitan Government. More than 23 million people live in Seoul's greater metropolitan region, known as the Seoul National Capital Area (see Table 28).

During this same timeframe, the real per-capita income of the region increased forty-fold, allowing the burgeoning middleclass to afford private autos. As Seoul's size and prosperity have grown over the past four decades, private passenger vehicle ownership has skyrocketed, and public transportation services have struggled to keep up. Seoul has created an extensive network of bus lanes, and has built one of the world's largest subway systems. Currently, bus transit remains the city's most extensively used transit mode overall, but it is gradually losing market share to the subway system.<sup>250</sup> The first lines of a planned seven-route light rail network are scheduled to open in 2011.

**Table 28. Metropolitan Profile (Seoul)**

<b>City population<sup>a</sup></b>	9.7 million	Seoul Special City
<b>Metropolitan population<sup>a</sup></b>	23.6million	Seoul National Capital Area
<b>Annual unlinked urban transit trips<sup>b</sup></b>	3414.5 million	
Heavy rail <sup>c</sup>	1528.8 million	45% of urban transit trips
Light rail	0.0 million	0% of urban transit trips
Bus	1885.7 million	55% of urban transit trips
Other	0.0 million	0% of urban transit trips
<b>Ratios calculated from data above</b>		
Urban transit trips per city resident	352 annual trips per capita	
Urban bus trips per city resident	194 annual trips per capita	
Urban transit trips per metro resident	145 annual trips per capita	
Urban bus trips per metro resident	80 annual trips per capita	

*Sources:*

- <sup>a</sup> Statistics Korea, "Preliminary Results of the 2010 Population and Housing Census" (January 2011), <http://kostat.go.kr/portal/english/news/1/1/index.board?aSeq=245048&bmode=download&ord=1> (accessed December 9, 2011). The Seoul National Capital Area consists of the administrative districts of Seoul, Incheon, and Gyeonggi.
- <sup>b</sup> Annual data were estimated by the authors from daily ridership data, assuming a ratio of 326.8 annual trips/daily trips. This ratio was derived from the annual ratios of line-specific passenger counts on the subway system.
- Seoul Metropolitan Government, "Transportation Statistics," <http://www.seoulmetro.co.kr/page.action?mCode=G030030000> (accessed December 9, 2011);
  - Seoul Metropolitan Rapid Transit Corporation, "Transportation Income," <http://www.smrt.co.kr/main/publish/view.jsp?menuID=002005007> (accessed December 9, 2011). Boardings only.
  - Seoul Metropolitan Transportation Headquarters, "Subway," [http://www.seoul.go.kr/info/organ/subhomepage/transport/traffic\\_data/statistcs/statis/1203437\\_11156.html](http://www.seoul.go.kr/info/organ/subhomepage/transport/traffic_data/statistcs/statis/1203437_11156.html) (accessed June 9, 2010);
  - Seoul Metropolitan Transportation Headquarters, "Bus," [http://www.seoul.go.kr/info/organ/subhomepage/transport/traffic\\_data/statistcs/statis/1203436\\_11156.html](http://www.seoul.go.kr/info/organ/subhomepage/transport/traffic_data/statistcs/statis/1203436_11156.html) (accessed June 9, 2010).
- <sup>c</sup> Data excludes Korail operations.

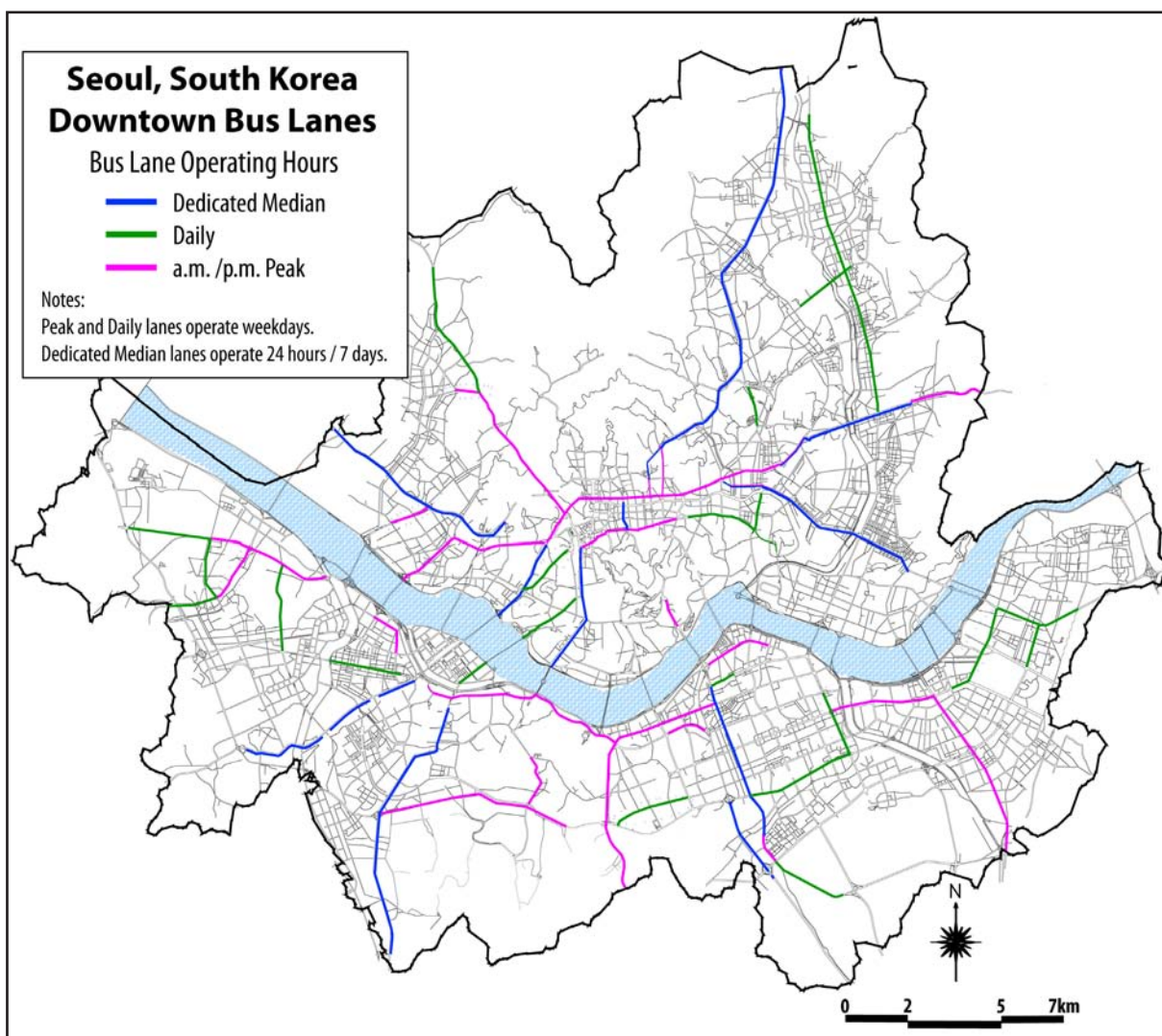
As of 2009, Seoul had a 205 km (127 mi.) bus lane system. See Table 29 for mileage share and Figure 28 for a 2008 map of bus lanes. The lanes are divided into three categories: curbside daily, curbside peak, and dedicated median. Curbside daily lanes operate between 7 a.m. and 9 p.m. on weekdays. Curbside peak lanes operate during the peak commute times of 7 a.m. to 9 a.m. and 5 p.m. to 9 p.m. on weekdays. The dedicated median bus only lanes operate 24 hours per day, all days of the week.

Approximately 44 percent of the bus lane mileage has been shifted over to the median. The other 56 percent of the network operates as curbside lanes, either on a peak period or a full day basis. Seoul plans to continue the implementation of median lanes wherever feasible, as Seoul sees these as crucial for the continued modernization of its transit network.

**Table 29. Bus Lane Types, Lengths and Hours, 2009 (Seoul)**

Bus lane type	Length	Percent	Operating hours
Curbside daily hours	66 km (41 mi.)	32%	7a-9p, weekdays
Curbside peak hours	49 km (30 mi.)	24%	7a-10a and 5p-9p, weekdays
Median dedicated	90 km (56 mi.)	44%	All hours, all days
Total	205 km (127 mi.)	100%	--

Source: Seoul Metropolitan Transportation Headquarters, "Bus Only Lane Installation Status" (no date), [http://www.seoul.go.kr/info/organ/subhomepage/transport/traffic\\_data/statistics/statis/1202625\\_11156.html](http://www.seoul.go.kr/info/organ/subhomepage/transport/traffic_data/statistics/statis/1202625_11156.html) (accessed June 9, 2010).

**Figure 28. Bus Lane Network Map (Seoul)**

Source: Authors' adaptation of a map from Seoul Metropolitan Government City Transportation Headquarters (2008).

## HISTORICAL DEVELOPMENT

Seoul became the capital of South Korea after World War II. The city was devastated by the Korean War but rose swiftly after the war's end in 1953. The first buses of Seoul's modern era began serving the public in that year.<sup>251</sup> Those first buses were either given by the United Nations or pieced together from parts left over from the war. To this day, the bus companies are private companies that cooperate and follow the mandates set forth by the government to serve the public.<sup>252</sup>

Bus usage increased dramatically along with the city's rapid growth until the early 1980s. However, several factors contributed to a decline in bus ridership beginning around 1985. First, and probably most significantly, the ongoing expansion of the city's subway system directly competed with the bus system for transit riders. Second, the nation's growing economic prosperity led to a rapid rise in private auto ownership, drawing more passengers away from buses. Third, congestion on city streets eroded the performance of bus transit. Finally, cutthroat competition among the city's many private bus companies produced confusing schedules and poorly coordinated services.

The City of Seoul made several attempts to speed up bus services in the hope of boosting ridership. To protect buses better from worsening roadway congestion, it installed the first curbside bus lanes in 1984.<sup>253</sup> The curbside bus lane system expanded quickly, reaching 78 miles by 2003. Median bus lanes were first introduced in 1996.

The Seoul Metropolitan Government adopted comprehensive public transportation reforms in July 2004 that placed a renewed emphasis on improving bus services instead of continued expansion of the subway system. The new policy launched a process of converting key corridors throughout the city from curbside bus lanes to median bus lanes. The city also reformed bus operations by overhauling and centralizing management of routes and schedules; aligning subsidies to provide incentives for improved service; creating a simplified, color-coded system of bus routes; deploying a GPS-based vehicle location and management system; adopting a smart card-based fare payment system, and many other changes. The 2004 reforms have been credited with significant improvements in bus system performance, ridership, and customer satisfaction.<sup>254</sup>

## INSTITUTIONAL ARRANGEMENTS

### Transit Operations

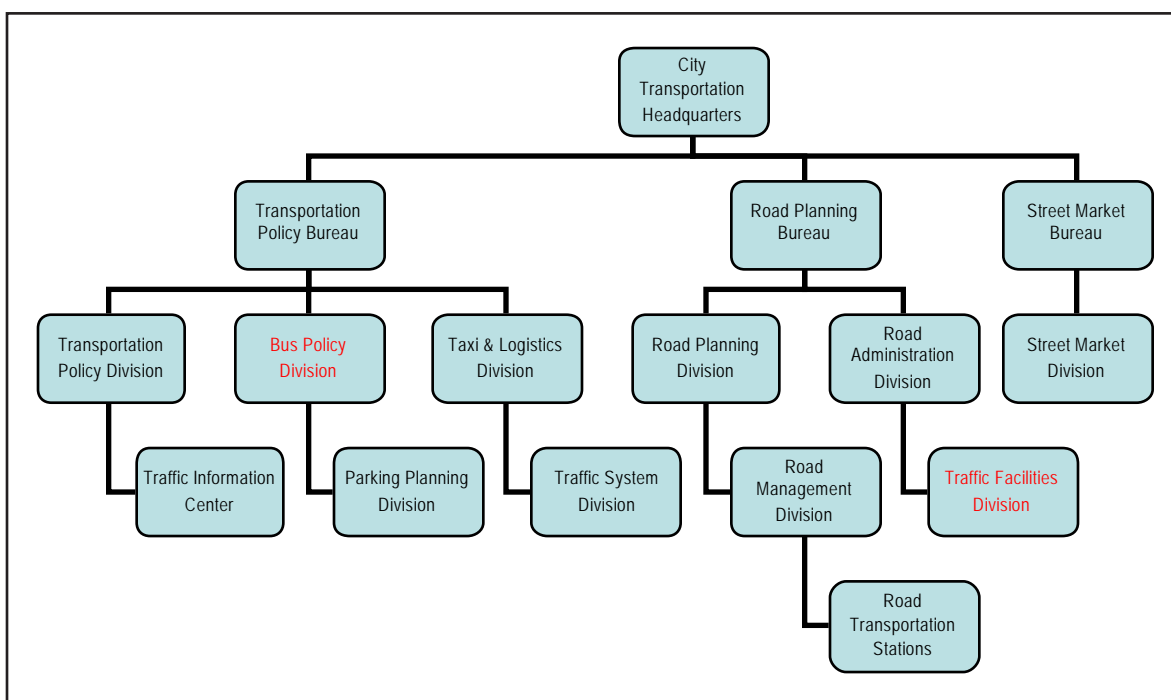
Bus service in Seoul is operated by 73 private firms. Collectively, these operators run a network of 8,012 buses on over 408 routes within the city.<sup>255</sup>

Until the public transportation reform of 2004 there had been virtually no government control of routes, schedules, or other aspects of their service.<sup>256</sup> The public transportation reform changed this by introducing a "semi-public" system that retains private bus firms but leaves decisions on routes, schedules, fares, and overall system design to the Seoul Metropolitan Government's City Transportation Headquarters, discussed in the next section.<sup>257</sup>



## Street Planning and Design

Strategic transportation planning, including bus lane development and bus operations, is handled by the Seoul Metropolitan Government's City Transportation Headquarters, which is the institutional equivalent of a local government's department of transportation in the United States. Figure 29 shows the Headquarters' intricate web of three bureaus, under which 53 teams and 6 stations are clustered into 10 divisions.<sup>258</sup> Contained within the Traffic Facilities Division, the Exclusive Lanes Team plans and manages all bus lanes, including median and curbside lanes. Within the same division, the Safety Signage Team is responsible for determining where to put markings and signs. In the Bus Policy Division, the General Policy Team is in charge of bus operations.



**Figure 29. Seoul City Transportation Headquarters: Bureaus and Divisions (Seoul)**

*Note:* Divisions in red are involved in bus operations and bus lane planning. Modified by author.

*Sources:* Seoul Metropolitan Government, City Transportation Headquarters, "Organization Chart" (no date), [http://www.seoul.go.kr/info/organ/subhomepage/traffic/seoul\\_traffic/intro/organinfo/index.html](http://www.seoul.go.kr/info/organ/subhomepage/traffic/seoul_traffic/intro/organinfo/index.html) (accessed July 30, 2008); Seoul Metropolitan Government, Organization, "Bureaus & Divisions" (no date), [http://english.seoul.go.kr/gover/organ/organ\\_02bur.htm](http://english.seoul.go.kr/gover/organ/organ_02bur.htm) (accessed July 30, 2008).

## Traffic Enforcement

Responsibility for enforcing bus lane regulations is divided among the Transportation Headquarters, local district government offices known as Gu, and police. The first two agencies enforce moving and parking violations on local roads, while police focus on violations on highways.<sup>259</sup> Police officers can technically enforce bus lane violations on local roads but choose not to, deferring this responsibility to the City government and local district offices.

The Traffic Enforcement Division reviews and develops programs to facilitate enforcement, such as a payment system using email and phone, as well as a website where one can pay fines, appeal, and confirm the process. Civil appeals and complaints are not handled by the City Transportation Headquarters, but by the Organization for Customer Satisfaction, a public agency created in 2007 to improve service to the public.

## **Coordination**

The Exclusive Lanes Team (within the City Transportation Headquarters' Road Planning Division; see Figure 29) plans and manages all bus lanes, including median and curbside lanes. One interviewee, formerly responsible for planning and engineering curbside bus lanes, stated that he consulted with police when planning curbside bus lanes but not with other departments or local district offices. Instead, local district (Gu) offices were notified after the fact. The interviewee noted that his team had sufficient resources and information to develop their plans. Planning median bus lanes is more complicated, and the interviewee indicated that the Exclusive Bus Lanes Team worked with other teams, such as the Bus Policy Division, and with staff members from adjacent cities that would be affected by the installation of a new median bus lane.

The Headquarters' camera system is managed by the Director's Team under the Road Administration Division (see Figure 29). Local district offices manage and operate their own camera surveillance programs. The Headquarters' Transportation Information Center works with the Transportation Policy Division to analyze traffic situations, receive public input, and determine implementation strategy (for instance, what equipment to use, camera placement, and number of cameras to be placed). The Transportation Information Center also consults with the Transportation Facilities Division and External Relations Division (not shown in Figure 29) in determining the implementation strategy.

The Traffic Enforcement Division consults with a number of different teams in developing enforcement programs, including the Transportation Information Center, the Transportation Planning Division, the Tax and Accounting Department, and local district offices and outsourcing consultants. Bus companies are not involved at all in the development of bus lane violation enforcement program.

## **PHYSICAL DESIGN AND SIGNAGE**

The Seoul Metropolitan Government manages three types of bus lanes (median, peak-hour curbside, and daytime curbside) as complementary components of its bus priority network. It evaluates a number of factors to determine which types of bus lanes are appropriate in a given corridor, including public transportation demand, street conditions, connectivity to other roads, and the street's level of service. In general, a street used by 60 to 120 buses per hour is considered appropriate for a curbside bus lane (either peak-hour or daily), while a street used by more than 120 buses per hour may be considered for a daily curbside or a 24-hour dedicated median bus lane.<sup>260</sup>

## Lane Design

Peak-hour curbside lanes are separated from regular traffic lanes by a single blue line, and daily curbside lanes are marked with double blue lines. The width of lines for daily curbside bus is 45 centimeters (17.7 inches) for higher visibility. Median bus lanes are distinguished by red pavement and separated from regular traffic lanes by a blue line. Two-way median lanes are divided by a double, yellow line (see examples in Figure 30). Dashed lines indicate portions of bus lanes where non-buses are allowed, usually to make a turn or to enter a traffic lane (see Figure 30c and Figure 31).



**Figure 30. Bus Lane Types, Showing Pavement Markings (Seoul)**

*Note:* Text on curbside bus lanes translates “Bus Only.”

*Sources:*

- Top: Photos by Kiyeol Lee, Traffic Facilities Division, Seoul City Transportation Headquarters, in email attachment to the authors (January 17, 2008).
- Bottom: Seoul Metropolitan Government, City Transportation Headquarters, “FAQs,” [bus] (no date), [http://english.seoul.go.kr/residents/transport/trans\\_05bus\\_02.html#4](http://english.seoul.go.kr/residents/transport/trans_05bus_02.html#4) (accessed October 23, 2007).



**Figure 31. Dashed Lane Lines Indicating Vehicle Lane Entry Segment (Seoul)**

*Source:* Photo by Kiyeol Lee, Traffic Facilities Division, Seoul City Transportation Headquarters, in email attachment to the authors (January 17, 2008).

The use of red bus lanes is a common practice in Korea. It is not an official engineering design standard promulgated by the national police, but is often adopted on an informal basis by local governments. However, colorized bus lanes have not become universal in Seoul due to cost and safety concerns. As part of the 2004 transportation reform, Seoul's mayor initiated an effort to color the curbside bus lanes red, matching the new median bus lanes. According to the Maintenance Team, the colorized coatings proposed as a lower-cost alternative to red asphalt-concrete mix lowered the friction coefficient, potentially making the pavement slippery and less safe. Moreover, maintaining the coating is expensive, since the color coating does not last long. Consequently, the effort to pave curbside bus lanes in red has been suspended, and whether to stop paving median bus lanes in red is now being discussed.

A similar attempt to install red pavement on bus lanes adjacent to bus stops was planned in 2005.<sup>261</sup> Partly due to illegally parked cars on bus lanes, buses were frequently required to stop far away from bus stops, making it dangerous for passengers who had to walk across lanes to board the bus. The purpose of installing red pavement on bus lanes around bus stops was to facilitate bus access to bus stop areas while deterring illegal parking. Such "Red Zones" were planned for installation in 366 bus stops by the end of 2005, but the plan has yet to be fully realized.

Bus lanes are clearly marked according to their type and hours. All bus lanes have markings on the pavement that indicate the hours of operation and the text "Bus Only" (see examples in Figure 30).

## Signage

Supplementary signs are posted on poles or streetlights on sidewalks. Figure 32 shows three types of signage used above and along bus lanes: instructional signage, regulation signage, and informational signage.<sup>262</sup> The blue field with white lettering instructional signage over the bus lane designates the lane as a bus lane and indicates the hours of restriction. The round, red-outlined with blue field regulation sign on the post indicates “no parking.” The white field with black illustrations and lettering of the informational sign further indicates that this is a no parking/tow-away zone.



**Figure 32. Bus Lane Signage Examples (Seoul)**

*Notes:*

- Blue sign with bus symbol translates “Median Lane Bus Only.” The round, blue sign directs drivers to execute a P-turn in order to turn left, rather than turning left from the median lane.
- Peak hour, curbside bus lane signage. The sign with the bus symbol translates “Only.” The operating hours are indicated on the panel to the right of the bus lane sign. This sign also reads “Except Saturdays and Holidays.” Note the additional signage on the signpost. The red-outlined, round sign indicates no parking. The sign below it indicates that violating vehicles will be towed.

*Sources:*

- Photo by Kiyeol Lee, Traffic Facilities Division, Seoul City Transportation Headquarters, in email attachment to the authors, January 17, 2008;
- Associated Press, “Seoul, curbside bus lanes open on Saturdays,” Naver News (July 5, 2007), <http://news.naver.com/main/read.nhn?mode=LPOD&mid=etc&oid=098&aid=0000239122> (accessed November 15, 2007).

## ACCESS POLICIES

### Hours of Operation

Hours of operation are uniform within the three types of bus lanes (see Table 29).<sup>263</sup> Curbside lanes operate on one of two schedules. Approximately 49 km (30 mi.), or 24 percent of the bus lanes network, operates during peak commute hours during weekdays: 7 a.m. to 10 a.m. and 5 p.m. to 9 p.m. Another 66 km (41 mi.) or 32 percent of the bus lanes operate during “daily” hours on weekdays: 7 a.m. to 9 p.m. The dedicated median lanes operate 24 hours per day on all days of the week.

## **Users Permitted**

During the restricted operating hours, curbside bus lanes are also open to vehicles with six or more occupants, vehicles with disabled persons, emergency vehicles responding to a call, and law enforcement vehicles (including vehicles on patrol, transferring troops, or escorting prisoners).<sup>264</sup>

Median bus lanes allow vehicles of 36-passenger or greater capacity only.<sup>265</sup>

According to transportation specialists interviewed, vehicles other than buses may access a curbside bus lane to bypass an unavoidable obstruction or at the direction of a law enforcement officer. Curbside bus lanes may also be used during emergency utility work. Urgent postal deliveries are also allowed.

Taxis are allowed to load or unload passengers in bus lanes if the stop is brief and does not disrupt bus operations.

All types of vehicles may access a curbside bus lane approximately 50 m (164 ft.) before an intersection in order to make a right turn at the intersection. The actual distance where this access is permitted varies according to the intersection, and is marked by a dashed line along the outer edge of the curbside bus lane.<sup>266</sup>

At marked, major intersections, all types of vehicles may enter the bus-only median lane to make a left turn.<sup>267</sup> For intersections where vehicles are not allowed to enter the median lane to make a left turn, signage instructs drivers to loop back to the intended destination street by making right turns.<sup>268</sup>

According to interviewees, bicycles, although technically classified as vehicles in the traffic code, are not allowed in bus lanes or any traffic lanes.

## **ENFORCEMENT**

### **Relevant Traffic and Parking Codes**

The traffic and parking violations from the Seoul “Road & Traffic Regulation” are summarized on the Driver’s License Agency Web site, although not all code sections are specified on that site.<sup>269</sup> Bus lane moving violations are documented in Section 60, part 1.

### **Penalties**

The Driver’s License Agency Web site summary of violations and penalties indicates that driving a private passenger vehicle in a “bus designated/high occupancy vehicle lane” (such as the curbside bus lanes during restricted hours) incurs a penalty of up to 60,000 won (US\$52) and 30 points against the driver’s license.<sup>270</sup> Driving a private passenger vehicle in a bus only lane incurs a penalty of up to 40,000 won (US\$34) and 10 points against the driver’s license.<sup>271</sup> Taxis and larger vehicles (such as delivery trucks) incur a greater penalty. Note that a driver’s license may be suspended after accumulation of 100 points.

The Driver's License Agency Web site page does not specifically mention bus lane parking violations. However, in general, illegally parking a passenger vehicle incurs a \$40,000 won (US\$34) penalty.<sup>272</sup> Again, taxis and larger vehicles incur a greater penalty.

A citation may be confirmed, paid, or appealed via an internet portal, which manages all types of traffic violations.<sup>273</sup> Fines can be paid also by email or cell phone with a credit card.

### **Patrol-based Enforcement**

According to interviewees, bus lane violations, including illegal parking, are cited and enforced by Seoul Metropolitan Government and local district (Gu) offices, not police officers. Gu civil service agents usually cite and track violations.

### **Camera-based Enforcement**

The Seoul Metropolitan Government utilizes two different types of cameras to enforce bus lane regulations: manual (manned) and automatic (unmanned). Most of the automatic cameras are attached to street poles. The automatic camera system, with cameras mounted on street poles along bus lanes, is operated by both the City Transportation Headquarters and local district offices. These cameras can capture the overall scene of violations, as well as the license plate of violating vehicles. In addition, civil service agents from local district (Gu) offices use small camcorder-like cameras for manual enforcement.

When either a camera or an enforcement officer cites a vehicle for illegal use of a bus lane, the vehicle's owner is mailed a notice. The owner has 10 days to acknowledge receipt of the citation and an additional 30 days to appeal.

Automated curbside bus lane camera-based enforcement began in 1995. The Transport Operation and Information Service (TOPIS) is presently running 42 bus lane surveillance cameras.<sup>274</sup> In addition, in May 2010, TOPIS began testing bus-mounted cameras on three major corridors through the city. Images from bus-mounted cameras are transferred to TOPIS in real-time. During the first month bus-mounted cameras imaged 806 parking violators and 36 instances of autos cutting into bus lanes. The Seoul municipal government has decided to increase the number of cameras to 16 until the end of this year. It is believed that bus-mounted cameras could be more effective than the fixed-cameras over the long run, as the effectiveness of the fixed cameras tend to decrease dramatically 2 to 3 months after the installation.<sup>275</sup>

## **PERFORMANCE**

Seoul's public transportation reforms of 2004 are considered an unqualified success. In just over a four-month period, the number of public transportation users and citizen satisfaction level increased, while bus-related accidents decreased.<sup>276</sup> An article assessing the reforms described "dramatic" increases in bus speeds on the BRT corridors, explaining:

Between June 2004 and December 2004, average bus speeds doubled in the Dobong-Mia BRT corridor (from 11 to 22 km/hr. (6.8 to 13.7 mph)) and increased by 64 percent and 33

percent in the other two BRT corridors. Even more impressive, average bus speeds are now only slightly lower than average car speeds. Car speeds have also increased in BRT corridors, since the removal of buses from the general traffic has reduced the disruption caused by buses zigzagging across lanes to and from the curbs to pick up and drop off passengers. The greatest improvement in speed, however, has been for buses, and on average, each BRT median lane now carries six times more passengers than other lanes in the same corridor.<sup>277</sup>

Over the intervening years, these improvements have continued. Table 30 shows that in 2009 the median bus lanes were about 2-3 km/h faster than both the ordinary lanes and curbside bus lanes. Speeds on the all-traffic lanes have continued to rise gradually, although it should be noted that since the median bus lanes prevent left turns in many locations, some motorists must use less indirect routes, which increases their overall travel times.

Speeds on the curbside lanes have declined slightly. This could be due to changes in enforcement, or shifts in the overall sample of curb bus lanes to include the more difficult-to-manage routes on narrower rights of way.

**Table 30. Lane Speed (km/h) (Seoul)**

	2001	2002	2003	2004	2005	2006	2007	2008	2009
All-traffic lane	17.8	18.9	16.7	17.7	17.0	17.3	18.4	18.3	18.9
Curbside bus lane	21.6	19.0	18.1	18.9	18.4	18.7	18.4	18.5	18.1
Median bus lane	-	-	-	22.0	21.3	21.1	22.3	22.2	21.1

Source: Seoul Metropolitan Government, *2009 Annual Speed Report* (2010), 19.

The authors of this report were unable to find data on the level of bus lane violations and the extent of the problem such violations pose. According to our interviewees, the Transportation Headquarters tracks data for their own enforcement programs, though the agency does not keep track of the citation data from local district offices. Violation data are collected on a monthly basis, but no formal studies have been published on bus lane violations or profiles of violating vehicles.



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## APPENDIX G: SYDNEY CASE STUDY

### INTRODUCTION

As Australia's largest metropolis, the Greater Sydney region is considered Australia's gateway to the global economy. To a greater extent than other cities studied in this report, the transportation system of Greater Sydney is designed, constructed, and managed at a state level. State agencies have implemented numerous innovations to establish an extensive bus lane network that runs both on highways and urban arterials, enforced by a fully automated digital camera system.

Greater Sydney is home to 4.6 million persons (see Table 31).<sup>278</sup> Unlike the other cities described in this study, Greater Sydney lacks a large, consolidated municipality at its center. The "City of Sydney" itself is quite small – it is one of 38 local government areas (LGAs) in the region, with only 177,000 residents and only 26 km<sup>2</sup> (10 sq. mi.) in area.<sup>279</sup> At its heart lies the Sydney Central Business District (CBD). Approximately 385,000 persons are employed within City of Sydney, with 300,000 of those workers employed within the CBD.

For the purposes of comparison with other cities in this study, the Sydney urban core is defined here as the "Sydney Inner Region," which consists of the City of Sydney LGA and 20 nearby LGAs that comprise its inner suburbs.<sup>280</sup> The Sydney Inner Region has a population of 1.45 million people and extends across 355 km<sup>2</sup> (137 sq. mi.).

The Sydney Inner Region is served by a dense network of bus services. It has nearly 120 bus routes, operated by Sydney Buses and a variety of other major bus lines that serve commuter markets in Greater Sydney, as well as another 20 or more express, limited, and prepay routes, and a free CBD shuttle. The greater Sydney region is also served by an extensive rail system, CityRail, which serves commuters as well as a large number of trips internal to the Sydney Inner Region. It also has a well-developed ferry system, a monorail circulator, and a light rail transit line. However, buses remain the area's dominant transit mode, serving about 59 percent of public transit trips in the Inner Region.<sup>281</sup>

**Table 31. Metropolitan Profile (Sydney)**

<b>City population<sup>a</sup></b>	1.5 million	Sydney Inner Region
<b>Metropolitan population<sup>b</sup></b>	4.6 million	Sydney Statistical Division
<b>Annual unlinked urban transit trips<sup>c</sup></b>	326.3 million	
Heavy/commuter rail (CityRail) <sup>c</sup>	111.9 million	34% of urban transit trips
Light rail, monorail <sup>d</sup>	8.0 million	2% of urban transit trips
Bus (Sydney buses only) <sup>e</sup>	191.9 million	59% of urban transit trips
Ferry <sup>f</sup>	14.5 million	4% of urban transit trips
<b>Ratios calculated from data above</b>		
Urban transit trips per city resident	225 annual trips per capita	
Urban bus trips per city resident	132 annual trips per capita	
Urban transit trips per metro resident	71 annual trips per capita	
Urban bus trips per metro resident	42 annual trips per capita	

*Sources:*

- <sup>a</sup> Australian Bureau of Statistics, "Population Estimates by Local Government Area, 2001-2010," <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3218.02009-10> (accessed December 9, 2011).
- <sup>b</sup> Definition of the Sydney Inner Region is from NSW Division of Local Government, "Suburb Search," [http://www.dlg.nsw.gov.au/dlg/dlghome/dlg\\_regions.asp?mi=0&ml=8&regiontype=1&region=SI](http://www.dlg.nsw.gov.au/dlg/dlghome/dlg_regions.asp?mi=0&ml=8&regiontype=1&region=SI) (accessed August 24, 2010).
- <sup>c</sup> Rail Corporation NSW, Annual Report 2010-11, 22, [http://www.railcorp.info/publications/annual\\_reports](http://www.railcorp.info/publications/annual_reports) (accessed February 17, 2011). Total 294.5 million CityRail passenger journeys times authors' estimate of 38% of CityRail trips are by residents of the Sydney Inner Region.
- <sup>d</sup> Veolia Transdev, "Light Rail & Monorail in Sydney," <http://www.veoliatransdev.com.au/business-activity/our-operations/light-rail-monorail-in-sydney/index.html> (accessed December 9, 2011).
- <sup>e</sup> State Transit Authority of New South Wales, Annual Report 2010/11 (2011), 156-157, [http://www.statetransit.info/publications/STA Annual Report 2010-11.pdf](http://www.statetransit.info/publications/STA%20Annual%20Report%202010-11.pdf) (accessed February 17, 2011).
- <sup>f</sup> Sydney Ferries, Annual Report 2010-2011 (2011), 8, [http://www.sydneyferries.info/uploads/library/about/SFAnnualReport2010-11\\_lores.pdf](http://www.sydneyferries.info/uploads/library/about/SFAnnualReport2010-11_lores.pdf) (accessed February 17, 2011).

Bus lanes in New South Wales come in several varieties:<sup>282</sup>

1. Bus lanes are the most common form found in the City of Sydney. These lanes run on city streets, and provide priority use for buses during designated hours. Even during the hours these lanes are in effect, they allow limited use by certain other vehicles (such as taxis or vehicles making a turn).
2. Bus only lanes appear in short segments in the city, such as queue-jumper lanes at key intersections.
3. Transit lanes are analogous to high occupancy vehicle lanes in the United States. Any vehicle may use the lane if it meets the minimum designated occupancy (e.g. two or more people in the vehicle for a "T2" lane). Such lanes are typically located outside the CBD on the region's strategic bus corridors, and can provide a less restrictive means for facilitating bus service than the other options.
4. The region also has several Transitway or "T-way" corridors, which provide bus rapid transit services. These are more restrictive than conventional bus lanes, and generally prohibit any use by private passenger vehicles. The two key T-way facilities are

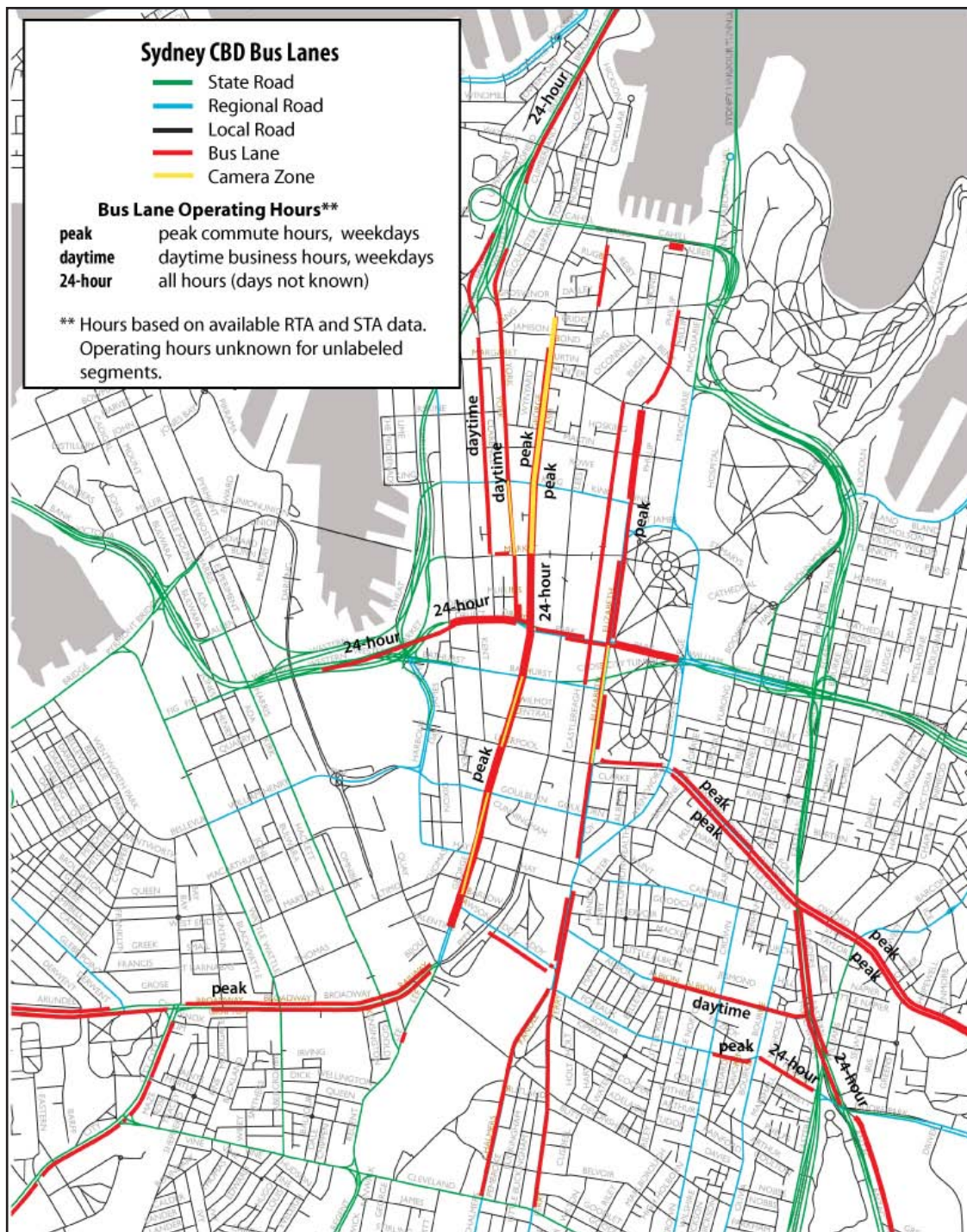
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the 31-km Liverpool-Parramatta Transitway (opened in 2003) and the 24-km North-West Transitway (2007). These lanes include both designated lanes on street or highway facilities, or dedicated busways that do not operate alongside mixed traffic.

This case study is primarily concerned with on-street bus lanes in the Sydney Inner Region. The term “bus lanes” in this case study refers generally to any bus priority lanes operating on local streets. Since the Transitway corridors are located outside Inner Sydney, they are not discussed extensively here.<sup>283</sup>

In 2009, there were approximately 126 km (78 mi.) of bus lanes throughout New South Wales, of which 23 km (14 mi.) were located in the City of Sydney LGA.<sup>284</sup>

At the heart of the Sydney CBD are a series of north-south bus lanes. These are connected at the southern end of the CBD and south of the CBD by a series of bus lanes providing east-west connectivity (see map in Figure 33 below, and a list of lanes in Table 32 at the end of this case study).



**Figure 33. City Bus Lane Network Map (Central Sydney)**

Source: Authors' adaption of map from: Roads and Traffic Authority, "Bus Lane Maintenance in Sydney CBD; April/ May 2009," [http://www.rta.nsw.gov.au/constructionmaintenance/downloads/buspriorityprogram/bu\\_lane\\_map1.pdf](http://www.rta.nsw.gov.au/constructionmaintenance/downloads/buspriorityprogram/bu_lane_map1.pdf) (accessed March 10, 2010).

## HISTORICAL DEVELOPMENT

The State of New South Wales (NSW) began a Greater Sydney bus lane management program in the mid-1970s to improve the efficiency of major routes across the region. The

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program established transit lanes for high occupancy vehicles, including buses, taxis, and private automobiles with two (or in some cases three) occupants.

In 1988, the Central Sydney Strategy, produced jointly by the NSW Department of Planning and Sydney City Council, recommended the introduction of dedicated bus lanes in the CBD.<sup>285</sup> That same year, New South Wales established the Roads and Transit Authority (RTA), and gave it broad powers over traffic planning, management, and safety regulation.<sup>286</sup>

Sydney's first lane dedicated for bus travel was established in 1992 across the Sydney Harbour Bridge. It was adopted upon the opening of the Sydney Harbour Tunnel, which significantly increased motor vehicle capacity into the CBD.<sup>287</sup> The bus lane was credited with boosting peak-hour bus ridership into the city by 30 percent.<sup>288</sup>

In 1999, the RTA gained the power to deploy camera-based strategies for bus lane enforcement.<sup>289</sup> The organization's focus on managing traffic flow had prevented it from strict enforcement of bus lanes, since traffic stops can often disrupt traffic more severely than the violations that triggered them. Camera-based enforcement provided an alternative that was consistent with maintaining the smooth flow of traffic.

In 2003, the NSW government convened an independent panel chaired by Barrie Unsworth to review the current state of the regional bus system and to recommend future expansion and improvements. The Unsworth Report identified the lack of coordinated planning for bus priority routes as a key constraint limiting the bus system's potential, proposed a new emphasis on the establishment of strategic bus priority corridors, and described an illustrative network consisting of 43 of these corridors.<sup>290</sup> The report also called for a consolidation of the region's many bus services contracts, and highlighted a number of other bus priority measures, including traffic signal preemption technologies, expansion and standardization of bus lane hours (particularly in the CBDs), implementation of bus signals (such as queue-jumping phases), and expansion of electronic bus lane enforcement.<sup>291</sup>

Beginning in 2005, New South Wales undertook a comprehensive planning effort that adopted many of the bus priority network improvements recommended by the Unsworth report. This effort culminated in the New South Wales Government's 2005 Metropolitan Strategy report, *City of Cities: A Plan for Sydney's Future*,<sup>292</sup> committed capital funds to development of a bus priority network in the 2006 State Infrastructure Strategy,<sup>293</sup> and developed implementation details in the 2006 Urban Transport Statement<sup>294</sup> and the 2008 Sydney City Subregional Strategy.<sup>295</sup> This latest document continued to advance the concept of 43 bus priority corridors across the greater region, with a target bus speed of 25 kilometers per hour on each corridor. Strategies cited in the document included dedicated bus lanes, short bus bypass lanes and queue-jumper signals ('B' signals), and conversion of unrestricted traffic lanes to "Transit" or "No Stopping" lanes. The Strategy also emphasized GPS-based technology for managing traffic signal priority for late-running buses.<sup>296</sup>

As of 2010, 31 of the strategic bus corridors have been complete or partially implemented.<sup>297</sup> As NSW begins a major plan update with a 2036 planning horizon, the state is continuing to emphasize bus priority. An early document in this planning effort called for consolidation

of NSW's many planning agencies (this has since been accomplished with the creation of Transport NSW), greater integration of transportation and land use plans, and increased housing densities along strategic transit corridors.<sup>298</sup>

However, the City of Sydney may seek to push street management policy in a different direction. The Sustainable Sydney 2030 plan argues that "Key bus routes are at capacity and need urgent conversion to higher volume and less polluting mass transit modes." The plan emphasizes creating a more inviting street environment for bicycles and pedestrians, and replacing congested bus lanes with light rail in the city center.<sup>299</sup>

## **INSTITUTIONAL ARRANGEMENTS**

Australia is a federalist system with two sovereign levels of governance: the Commonwealth Government, and the State governments.

The government of NSW manages the region's buses and the region's road network. The state also has primary responsibility for traffic enforcement and most transportation planning functions. As of July 2010, the state's various transportation functions are situated within a new superagency, Transport NSW.

As discussed below, a few transportation-related powers are held by LGAs. Parking policies and enforcement responsibilities in NSW are now delegated to the LGAs. LGAs can also play an advisory role on certain other transportation matters of local concern.

### **Transit Operations**

The State Transit Authority (STA), an agency under the state's Department of Transport and Infrastructure (and now under Transport for NSW), is responsible for transit operations throughout the state.<sup>300</sup>

Since 2005, bus services in the Greater Sydney region have been provided through 15 service area contracts. This represented a significant consolidation of services from 87 smaller service areas that existed before 2005. (The number of contract areas is due to drop again to eight in 2012.) Under the current arrangement, the four contracts serving much of the core of the Sydney metropolitan region are operated by Sydney Buses, a business unit of the STA. The other contracts are held by private firms. In addition to these contractual transit services, numerous other private companies offer bus services throughout the region.

In addition to Sydney Buses, the STA also operates Western Sydney Buses (which operates the T-way services), and Newcastle Buses and Ferries (serving an area approximately 100 mi. north of Sydney).<sup>301</sup>

### **Street Planning and Design**

The Roads and Traffic Authority (RTA) is responsible for planning, design, construction, and maintenance of the state's roadways, as well as transportation safety and vehicle and

driver registration.<sup>302</sup> The authority also provides funding and assistance to local governments for the construction and maintenance of regional and city roads. Reflecting its road operations and management orientation, maintenance of traffic flow is a key factor in the RTA's bus lane planning and management. RTA has also recently been incorporated into Transport for New South Wales.

LGAs like the City of Sydney have a limited role in street design and management. They can regulate parking, the placement of bus stops, curb cuts for private property access, and street closures for utility work and special events.<sup>303</sup> They also design and implement projects on local streets for pedestrian safety and access, public spaces, bicycle lanes, traffic calming, and other purposes.<sup>304</sup>

### **Traffic Enforcement**

The RTA is responsible for defining statewide traffic legislation and setting fines. Under the Road Transport (Safety and Traffic Management) Act of 1999, the RTA is also empowered to use cameras and automated image analysis in the enforcement of bus lanes.<sup>305</sup>

The NSW Police Force is responsible for enforcing moving offenses and most other traffic laws. However, under regulations adopted in 1999, parking enforcement in the City of Sydney, formerly handled by NSW Police, was delegated to the City of Sydney LGA.<sup>306</sup>

### **Coordination**

The City of Cities planning effort included the participation of multiple agencies in the designation of strategic bus corridors and the rationalization of bus operators' service areas. In partnership with the Ministry of Transport, the Department of Planning, and the Treasury, the RTA defined 43 strategic bus corridors on the system and then set up a Project Control group to look at how to meet the Ministry of Transport's goals on each corridor (20 to 25 km/h average operating speeds (12 to 16 mph) and overall transport reliability).<sup>307</sup>

However, although it is a government entity, STA was not included in this stage of the planning process. As a regulated contractor to the Ministry of Transport, it was treated similarly to the other private entities that provide bus services in parts of the region. Only after the high level network had been identified were the operators brought in to discuss operational and design approaches. Now, they are said to be closely involved with and supportive of the bus lane planning process.<sup>308</sup>

Because the RTA designs, manages, and enforces its bus lanes, and also sets general traffic regulations, the Sydney region has less need of interagency coordination in managing its bus lanes than do many other cities with entirely separate agencies taking the lead on traffic engineering and policing functions.

There is some operational coordination between the RTA and bus service providers. For example, STA and RTA have established mechanisms for bus drivers to report from the field about vehicles blocking bus lanes. Towing companies are then notified, and the vehicles are removed.

RTA also partners with bus operators on the deployment of a GPS-triggered traffic signal priority system for over 4,000 buses operated by nine bus companies. The system can respond intelligently to priority requests depending upon the overall traffic flow and bus headways. Because of RTA's mandate to improve overall traffic flow, it is implementing these signal priority systems only in corridors where the bus reliability improvements can be shown to offset that adverse impacts on other traffic.<sup>309</sup>

## PHYSICAL DESIGN AND SIGNAGE

### Lane Design

Bus lanes within the Sydney CBD are predominantly curbside lanes, with no curbside parking allowance for cars. Some bus lanes farther from the constraints of the core of the CBD do offer curbside parking and/or a curbside dedicated bicycle lane.

In specific locations, the alignment of the bus lanes may differ. The northern portion of the York Street bus lane, which receives the traffic from the bus lane that runs over the Sydney Harbour Bridge, runs along a central lane through much of the CBD, with other travel lanes on both sides of the bus lane. Buses must exit this lane to pick up or drop off passengers at the curb. Further south along York Street, the bus lane runs alongside a parking lane, with direct access to the curb available at bus stops.

The standard RTA-specified width for a bus lane is 3.0 m (9.8 ft.); this width is intended to accommodate a 2.5 m-wide (8.2 ft.) bus. However, some bus lanes are as narrow as 2.8 m (9.2 ft.) where the right-of-way is particularly narrow.<sup>310</sup>

Sydney's bus lanes are generally distinguished by a red lane color. The red is either an epoxy overlay over an existing surface or a 25mm (1 in.) asphalt seal on the road (see Figure 34). White lettering is used to label the lane's type ("BUS LANE" or "BUS ONLY") after intersections, and may indicate the time of use (for example, "AM BUS LANE") or may indicate specific users allowed in the lane (for example, a graphic of a bicycle or a turn arrow indicating that other traffic may use this lane to make a turn).<sup>311</sup>

Solid white paint lines demarcate the lane boundaries along the roadway. Dashed line lane boundaries are used at intersections to indicate that a vehicle may enter the lane to make a turn. No physical barriers are used to separate the bus lane from other traffic lanes.

Traditionally, state law permitted only signs to be used as a basis for traffic enforcement. But because of a concern that excess signage was leading to driver confusion, the law was changed to provide pavement markings the same legal effect as signs. Now New South Wales relies on both signs and pavement markings to designate bus lanes, and uses pavement markings exclusively to designate transit lanes.<sup>312</sup>

In places where bus lanes run along the curb, no special design treatments are generally added along the curbside of the lanes.



## Signage

Signage used for bus lanes is white with black lettering and outline. Each sign has a white “B” within a red, rounded block, an image of a bus, and wording indicating the type of lane and operating hours (see Figure 35 for RTA artwork examples).<sup>313</sup> Signage is placed at the beginning of each segment and at intersections. Signage may also be placed between intersections along longer stretches, to remind drivers that the lane has restricted usage.



**Figure 34. Curbside And Center-lane Bus Lanes (Sydney)**

*Notes:*

- a) No special curb treatment or lane barriers. Bicycle graphic indicating the shared-use lane.
- b) Bicycle sharing use of the bus lane. This lane is at the intersection of York Street and Erskine Street in City of Sydney CBD.

*Sources:*

- a) Eastbound lane on Oxford Street, at Liverpool Street and College Street intersection, City of Sydney CBD (2007), Cameron Gordon;
- b) Karl Fjellstrom, Institution for Transportation & Development Policy (ITDP), Photo Library (January 2007), <http://www.itdp-china.org/i-lib/db/photo.aspx?id=2078&c=Sydney> (accessed March 15, 2010).



**Figure 35. Example Bus Lane and Bus-only Lane Signage (Sydney)**

Sources: Roads and Traffic Authority, New South Wales, Australia, "Using Bus Lanes" (no date), <http://www.rta.nsw.gov.au/usingroads/buses/buslanes/index.html> (accessed March 9, 2010); Government of New South Wales, Australia, *Road Rules*, "Part II Division 6 Rule 154 Bus lanes" (August 2008), <http://www.legislation.nsw.gov.au/> (search for "Road Rules") (accessed March 9, 2010).

## ACCESS POLICIES

### Hours of Operation

Operating hours for bus lanes in the City of Sydney CBD vary (see Figure 33), but generally fit into one of three categories:<sup>314</sup>

- Peak-period: in effect during peak commute hours, 6 a.m. – 10 a.m. and/or 3 p.m. – 8 p.m., weekdays.
- Daytime: in effect during business hours, 6 a.m. – 8 p.m., weekdays; or 9:30 a.m. – 8 p.m., weekdays.
- 24-hour: in effect all hours of the day.

Approximately 70 percent of the bus lane miles operation on the peak schedule, 18 percent on the daytime schedule, and the remaining 12 percent run on the 24-hour schedule.

Outside of their designated hours, the bus lanes may be used by all classes of vehicles.

## Users Permitted

Unless otherwise specified, buses, taxis, coaches, for-hire cars, emergency vehicles, motorcycles, and bicycles are allowed in a bus lane at any time. In addition, special use vehicles and RTA-directed vehicles may use the lane.<sup>315</sup> As the name indicates, bus-only lanes are for the exclusive use of buses (as well as emergency and designated “special purpose” vehicles).

Private vehicles may use a “bus lane” in the last 100 m (328 ft.) before an intersection or driveway to make a turn, to turn into or out of a driveway along the block, or to pass a stopped vehicle or other obstruction.<sup>316</sup> Private vehicles must not stop to pick up or drop off passengers in a bus lane. Deliveries are prohibited.

## ENFORCEMENT

Bus lane enforcement is provided by a combination of NSW Police patrol (for moving offenses), local parking officer patrol (for stopping or parking offences in the City of Sydney LGA), and RTA-managed automated camera-based bus lane enforcement (for illegal travel in a bus lane). In addition, the RTA patrols for and tows illegally parked vehicles.

## Relevant Traffic and Parking Codes

The RTA governs all traffic and parking regulations statewide. Regulations are documented in the RTA-published Road Rules.<sup>317</sup> The spirit of these rules is described in the Access section of this document. Applicable sections of the Road Rules include:<sup>318</sup>

- Part 11 – Division 6 – Rule 154 describes vehicle use restrictions in a bus lane or bus-only lane. Attention to signage is discussed.
- Part 11 – Division 6 – Rule 158 describes normal exceptions, that is, when a vehicle may enter or use a bus lane. Included is a discussion of when vehicles may enter a bus lane to avoid an obstruction or to overtake another vehicle.
- Part 11 – Division 6 – Rule 158 – Subrule 4 describes permitted use of a bus lane by all vehicles to make a turn or to enter/exit a driveway. This references the 100 m (328 ft.) limit for allowable travel in the lane.
- Part 11 – Division 6 – Rule 165 describes allowance for emergency stops in a specialized lane.

## Penalties

Bus lane related moving violation fines begin at AU\$253 (US\$223) within the City of Sydney CBD<sup>319</sup> and AU\$243 (US\$214) in other areas.<sup>320</sup> Moving violations also incur three demerit points that are recorded against the driver’s license.

Parking and standing violations do not incur demerit points but do carry a fine of AU\$193 (US\$173).<sup>321</sup> The citation is written against the owner of the vehicle. If an illegally parked vehicle is towed, the vehicle owner is responsible for any towing fees.

### **Patrol-based Enforcement**

Within the City of Sydney LGA, patrol-based enforcement of moving-traffic laws is the sole responsibility of the NSW Police Force Traffic Services division (state police).<sup>322</sup> Parking laws are enforced by City of Sydney parking patrol officers.<sup>323</sup> RTA and City of Sydney parking officers maintain a system of patrolling for and towing illegally parked vehicles along bus lane routes. This is done on random street segments on a rolling basis during peak hours and also on an on-call basis (e.g. from STA bus drivers). Contract tow companies handle the work, and vehicles are towed from the bus lane to the nearest legal spot. The local council typically levies a parking fee to the vehicle owner and the RTA bills for the towing, but there is no ticket (e.g. a penalty that can be adjudicated at a traffic court).<sup>324</sup>

Patrol-based enforcement of illegal driving in a bus lane use is considered problematic because city streets with curbside bus lanes do not provide police with adequate space to stop a vehicle to issue a citation. Given the narrow streets in the Sydney CBD, pulling over a vehicle that is violating a bus lane can cause traffic to back up, increasing travel times for drivers and bus passengers alike.<sup>325</sup>

### **Camera-based Enforcement**

The RTA is responsible for all aspects of a stationary camera-based bus lane enforcement system, including site selection, installation, maintenance, and administration (including issuing of citations through the postal service). Site selection guidelines consider such criteria as frequency of bus service, level and impact of illegal use, and level other available enforcement.<sup>326</sup>

In 2001, the RTA installed the first bus lane cameras in the City of Sydney CBD.<sup>327</sup> A subsequent 2002 RTA survey of statewide bus lanes and transit lanes revealed an ongoing 35 percent average illegal use of these restricted lanes. In an effort to reduce this illegal usage, legislation introduced in 2004 allowed expansion of the camera-based enforcement. As of the end of 2009, the CBD had 34 active bus lane cameras.<sup>328</sup> This system now covers approximately 1.9 mi. of bus lanes along 1.3 mi. of roadway (see the yellow-marked lanes in Figure 33), or about 25 percent of the CBD-core bus lanes.<sup>329</sup> To keep commuters informed, the camera-based enforcement sites are published on the RTA's website.<sup>330</sup>

Sydney's bus lane enforcement cameras are fully automated. Stationary cameras are placed at least 200 m (656 ft.) apart along the bus lane. Variable-focus lenses allow a clear digital image to be recorded, and Optical Character Recognition software is used to identify license plate characters. If two consecutive cameras detect the same license plate, then a vehicle has remained in the bus lane for more than the allowed 100 meters, and the system automatically mails a citation to the vehicle owner. Automated digital analysis (rather than human analysis) and a record-naming system that is not based on the vehicle's license or owner information assure anonymity. All images include location information

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and a date-time stamp. The system automatically excludes valid vehicles (such as buses) using the lane.

Payments and citation challenges must be made through the state's Debt Recovery Office. The Debt Recovery Office website includes a section devoted to camera-based offence information, including the ability to view digital images on-line (according to citation-based secure code numbers).<sup>331</sup>

The system is termed "owner onus," meaning that the registered owner of the vehicle is responsible for identifying the actual operator of the vehicle at the time of infraction, should the owner wish to challenge the citation.<sup>332</sup> If the owner successfully proves that another person was operating the vehicle at the time of violation, the fine against the vehicle owner is dropped. However, the points remain on the vehicle owner's record. Too many points result in temporary license suspension.

The current camera enforcement technology restricts use of the system to stretches of street that run for at least 200 m (656 ft.) with no intervening intersections. However, the RTA is now enhancing the system, moving from digital photographs to digital video, which can be used for enforcement on shorter segments or blocks that contain side-streets and/or driveways.<sup>333</sup>

## PERFORMANCE

The RTA's goal has not been to maximize the performance of the bus lanes for buses, or even for the average road user. Instead, the RTA very explicitly seeks to make bus travel easier without worsening traffic speeds for other vehicles on the network. This rule limits the range of locations that are considered for bus lanes, the enforcement actions that are considered feasible, and even the aggressiveness of traffic signal priority treatments for transit vehicles. This approach may emerge as a point of conflict with the City of Sydney as it moves ahead with its CBD economic development and sustainability plans.

STA does not collect systematic data on the overall performance of the bus lanes, and has not studied their impacts post-implementation. Based on periodic focus groups and rider surveys, and STA has generally concluded that its customers value reductions in crowding and improvements in reliability. To the extent that bus lanes help the agency improve its operations to address crowding and reliability concerns, while reducing operating costs, bus lanes are considered beneficial for providing outcomes sought by their ridership.

The RTA, however, does measure the effectiveness of key segments of its bus priority system. It collects annually a set of performance measures that monitor illegal usage of bus lanes, travel speed benefit to the lane as compared to the adjoining lane, and overall traffic flow. The limitation of these measures is that they track only the performance of a discrete segment (i.e., just a facility in isolation), and not the overall route or network-wide impacts, and cannot always examine the effects of the bus lane in isolation from other factors.

**Table 32. Bus Priority Lanes on City Streets (Sydney)**

#	Street	Dir.	From	To	Length (mi.)	Days	Hours
1	York St.	SB	Grosvenor St.	Druitt St.	0.6	5	6a-8p
2	Clarence St.	NB	Market St.	Barrack St.	0.2	5	9:30a-8p
			Barrack St.	Jamison St.	0.3	5	6a-8p
3	Elizabeth St.	NB	Liverpool St.	Market St.	0.5	5	6a-10a; 3p-8p
4	Elizabeth St.	SB	Bathurst St.	Liverpool St.	0.2	5	6a-10a; 3p-8p
			Chalmers St.	Cleveland St.	0.5	5	6a-10a; 3p-8p
5	Castlereagh St.	SB	Hunter St.	Hay St.	1.0	5	6a-10a; 3p-8p
6	George St.	SB	Bridge St.	Market St.	0.5	7	6a-8p
			Park St.	Bathurst St.	0.1	5	6a-8p
			Bathurst St.	Valentine St.	0.6	5	6a-10a; 3p-8p
7	George St.	NB	Valentine St.	Goulburn St.	0.3	5	6a-10a; 3p-8p
			Liverpool St.	Bathurst St.	0.2	5	6a-10a; 3p-8p
			Druitt St.	Market St.	0.1	7	All times
			Market St.	Grosvenor St.	0.5	7	6a-8p
8	Park St.	EB	Elizabeth St.	College St.	0.2	7	All times
9	Druitt St.	EB	Sussex St.	George St.	0.2	7	All times
10	Liverpool St.	EB	Elizabeth St.	College St.	0.4	5	6a-10a; 3p-8p
11	Oxford St.	EB	College St.	Jersey Rd.	1.4	5	6a-10a; 3p-8p
			Jersey Rd.	College St.	1.4	5	6a-10a; 3p-8p
12	Chalmers St.	NB	Cleveland St.	Elizabeth St.	0.5	5	6a-10a; 3p-8p
13	Foveaux/Fitzroy Sts.	EB	S. Dowling St.	Bourke St.	0.1	5	6a-10a; 3p-8p
			Bourke St.	Crown St.	0.1	7	All times
14	Flinders St.	NB	Fitzroy St.	Oxford St.	0.4	7	All times
15	Flinders St.	SB	Oxford St.	Fitzroy St.	0.4	7	All times
16	Broadway	EB	Bay St.	Quay St.	0.6	5	6a-10a; 3p-8p
			Quay St.	Bay St.	0.6	5	6a-10a; 3p-8p

Source: Authors' estimates.

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## APPENDIX H: LIST OF INTERVIEWEES AND REVIEWERS

The authors wish to convey their sincere appreciation to the following individuals, who participated in interviews with the research team, responded to detailed questions by email, or reviewed drafts of the case studies. Their specific contributions to the study have not been noted in the text to maintain the confidentiality of these communications. Agency affiliations are noted for identification purposes only, and do not represent any agency review or endorsement of the findings and characterizations in this report. The authors take full responsibility for the accuracy of the report's contents.

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## Sydney

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- Craig J. Moran, New South Wales Roads and Traffic Authority
- Corinne Mulley, University of Sydney
- Roger Wilson, New South Wales State Transit Authority



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## ABBREVIATIONS AND ACRONYMS

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<b>3GBP</b>	Third Generation Bus Priority
<b>AC Transit</b>	Alameda-Contra Costa Transit District
<b>ASP</b>	Agents de Surveillance de Paris
<b>BART</b>	Bay Area Rapid Transit
<b>BRT</b>	Bus Rapid Transit
<b>CBD</b>	Central Business District
<b>CCTV</b>	Closed Circuit Television
<b>CERTU</b>	Centre d'Études sur les Reseaux, les Transports et l'Urbanisme
<b>CTCDC</b>	California Traffic Control Devices Committee
<b>CVC</b>	California Vehicle Code
<b>DPT</b>	Department of Parking and Traffic
<b>EPA</b>	Environmental Protection Agency
<b>FHWA</b>	Federal Highway Administration
<b>GLA</b>	Greater London Authority
<b>GLC</b>	Greater London Council
<b>INSEE</b>	Institut National de la Statistique et des Études Économiques (France)
<b>ITDP</b>	Institution for Transportation and Development Policy
<b>ITS</b>	Intelligent Transportation System
<b>LACMTA</b>	Los Angeles County Metropolitan Transport Authority
<b>LADOT</b>	City of Los Angeles Department of Transportation
<b>LAPD</b>	Los Angeles Police Department
<b>LASD</b>	Los Angeles Sherriff's Department
<b>LBI</b>	London Bus Initiative
<b>LBPN</b>	London Bus Priority Network
<b>LGA</b>	Local Government Area
<b>LUZ</b>	London Larger Urban Zone
<b>MPA</b>	Metropolitan Police Authority
<b>MPS</b>	Metropolitan Police Service
<b>MSA</b>	Metropolitan Statistical Area
<b>MTA</b>	Metropolitan Transit Authority
<b>MUNI or Muni</b>	San Francisco Municipal Railway
<b>MUTCD</b>	Manual on Uniform Traffic Control Devices
<b>NATO</b>	North Atlantic Treaty Organization.
<b>NEPA</b>	National Environmental Protection Act

<b>NCHRP</b>	National Cooperative Highway Research Program
<b>NCTRDP</b>	National Cooperative Transit Research and Development Project
<b>NSW</b>	New South Wales
<b>NYCDOT</b>	New York City Department of Transportation
<b>NYCTA</b>	New York City Transit Authority
<b>NYPD</b>	New York City Police Department
<b>ODP</b>	L'Observatoire des Déplacement à Paris
<b>PCN</b>	Penalty Charge Notice
<b>PCSO</b>	Police Community Support Officer
<b>PDUIF</b>	Plan de Déplacements Urbains d'Ile-de-France
<b>RATP</b>	Régie Autonome des Transports Parisiens
<b>RTA</b>	Roads and Transit Authority
<b>SFCTA</b>	San Francisco County Transportation Authority
<b>SFMTA</b>	San Francisco Municipal Transportation Authority
<b>SFPD</b>	San Francisco Police Department
<b>STA</b>	State Transit Authority
<b>STIF</b>	Syndicat des Transports d'Ile-de-France
<b>TfL</b>	Transport for London
<b>TLC</b>	Taxi and Limousine Commission
<b>TOPIS</b>	Transport Operation and Information Service
<b>TPS</b>	Transit Preferential Street
<b>TSM</b>	Transit Streets Management

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## ENDNOTES

1. Clay McShane, *Down the Asphalt Path* (New York: Columbia University Press, 1994), 185.
2. In 1939, Chicago introduced a contraflow lane that operated during peak hours on North Sheridan Road, which is sometimes cited as the earliest bus lane in the United States. When it was established, the northern terminus of the newly completed Lake Shore Drive was at W. Foster Ave., and north- and southbound traffic continued from there onto local streets. To accommodate this traffic, North Sheridan Road was established as a reversible street, with three lanes matching the dominant flow of traffic, and one contraflow lane serving buses and local traffic in the opposite direction. The lanes were marked by manually changeable traffic signs and orange-and-white lane lines. Even after Lake Shore Drive was extended in the 1950s, a truncated version of the reversible lanes continued to operate. While the contraflow lanes did not serve buses exclusively, it was created to facilitate bus operations. The lanes continued to operate into the 1970s, but have since been removed.
3. Herbert S. Levinson et al., *Bus Use of Highways: State of the Art, NCHRP Research Report 143* (Washington, D.C.: Highway Research Board, National Research Council, 1973), 26, 237.
4. Thomas Buck, "Subway Walks Suggested for State St. Area / Plan Advanced to Cut Loop Congestion," *Chicago Daily Tribune*, December 27, 1955, A2; Werner W. Schroeder, *Metropolitan Transit Research Study* (Chicago Transit Board, 1955, rev. 1956), <http://ntl.bts.gov/lib/12000/12200/12212/index.html> (accessed July 26, 2011).
5. Levinson et al., *NCHRP Report 143*, 41. The four streets that hosted the first bus lanes were Capitol Blvd., 4<sup>th</sup> Ave., 6<sup>th</sup> Ave., and Union Street. The bus lanes no longer exist today, and in some cases, the streets themselves have since been demapped.
6. "Cities Try Lanes Limited to Buses," *New York Times*, March 29, 1959, 59.
7. Thomas Buck, "Plan Special Traffic Lane for Bus Use," *Chicago Daily Tribune*, January 22, 1956, A7.
8. For more on Barnes' efforts to win greater latitude for traffic engineers, see Paul O'Neil, "Keep 'Em Rolling – To the Final Jam / How Henry Barnes, New York's traffic czar, fights the car population explosion," *Life*, 57, no. 20, November 13, 1964, 98 ff. For a description of the warrants used in the approval of Baltimore's bus lanes, see Levinson et al., *NCHRP Report 143*, 221-225.
9. "Cities Try Lanes Limited to Buses," *New York Times*, March 29, 1959, 59.
10. NATO Committee on the Challenges of Modern Society, *Bus Priority Systems; CCMS Report No. 45* (London: Transport and Road Research Laboratory, Department of the Environment, 1976), 1.

11. "Council Unit OK's Bus Lane Thru Loop on Washington," *Chicago Daily Tribune*, May 9, 1956, 5; Levinson et al., *NCHRP Report 143*.
12. Levinson et al., *NCHRP Report 143*, 219-221.
13. Levinson et al., *NCHRP Report 143*, 221-223. See also Adam Paul, "Signs and Signals: Bus Stops and Lanes of Old," *Monumental City* Web site (no date), <http://www.monumentalcity.net/signals/buslanes/> (accessed August 19, 2010).
14. Levinson et al., *NCHRP Report 143*.
15. Herbert S. Levinson, Crosby L. Adams and William F. Hoey, *Bus Use of Highways: Planning and Design Guidelines*, *NCHRP Research Report 155* (Washington, D.C.: Highway Research Board, National Research Council, 1975).
16. NATO, *Bus Priority Systems*.
17. Herbert Levinson et al. *Bus Rapid Transit: Volume 1: Case Studies in Bus Rapid Transit*, *TCRP Research Report 90* (Washington, D.C.: Transit Cooperative Research Program, Transportation Research Board, 2003); Alan R. Danaher, *Bus and Rail Transit Preferential Treatments in Mixed Traffic*, *TCRP Synthesis 83* (Washington, D.C.: Transit Cooperative Research Program, Transportation Research Board, 2010); Taotao Deng and John D. Nelson, "Recent Developments in Bus Rapid Transit: A Review of the Literature," *Transport Reviews* 31:1 (2010): 69-96.
18. Mark Miller and Stephen Buckley, "Bus Rapid Transit Institutional Issues: The Route from Research to Experience," *Transportation Research Record: Journal of the Transportation Research Board* 1760 (2001): 34-41; Naoko Matsumoto, "Analysis of Policy Processes to Introduce Bus Rapid Transit Systems in Asian Cities from the Perspective of Lesson-Drawing: Cases of Jakarta, Seoul, and Beijing," (presented at Better Air Quality Workshop, 2006, Yogyakarta, Indonesia).
19. See, e.g., Fraser McLeod and Nick Hounsell, "Bus Priority at Traffic Signals: Evaluating Strategy Options," *Journal of Public Transportation* 6, no. 3 (2003): 1-14; Amer Shalaby, Jinwoo Lee, John Greenough, Stanley Hung, and Michael D. Bowie, "Development, Evaluation, and Selection of Advanced Transit Signal Priority Concept Directions," *Journal of Public Transportation* 9, no. 5 (2006): 97-120.
20. Guangwei Zhou and Albert Gan, "Design of Transit Signal Priority at Signalized Intersections with Queue Jumper Lanes," *Journal of Public Transportation* 12, no. 4 (2009): 117-132.
21. This concept has been tested in Lisbon and Melbourne. See José Viegas and Baichuan Lu, "Widening the Scope for Bus Priority with Intermittent Bus Lanes," *Transportation Planning and Technology* 24 (2001): 87-110; Michael Eichler and Carlos F. Daganzo, "Bus Lanes with Intermittent Priority: Strategy Formulae and an Evaluation," *Transportation Research B* 40, no. 9 (November 2006): 731-744; José

- M. Viegas, Ricardo Roque, Baichuan Lu, and João Vieira, "Intermittent Bus Lane System: Demonstration in Lisbon, Portugal" (presented at Transportation Research Board 86th Annual Meeting, Washington, D.C., 2007); Graham Currie and Herman Lai, "Intermittent and Dynamic Transit Lanes: Melbourne, Australia, Experience," *Transportation Research Record: Journal of the Transportation Research Board* 2072 (2008): 49-56.
22. For an overview of the literature, see Danaher, *TCRP Synthesis 83*, Chapter 3. Other key sources include Kevin R. St. Jacques and Herbert S. Levinson, *Operational Analysis of Bus Lanes on Arterials*, TCRP Report No. 26 (Washington, D.C.: Transit Cooperative Research Program, Transportation Research Board, 1997); City of Portland, Oregon, Office of Transportation, *Transit Preferential Streets Program: Final Report* (1997); Kevin R. St. Jacques and Herbert S. Levinson, *Operational Analysis of Bus Lanes on Arterials: Application and Refinement*, TCRP Research Results Digest No. 38 (Washington, D.C.: Transit Cooperative Research Program, Transportation Research Board, 2000); Herbert Levinson, Samuel Zimmerman, Jennifer Clinger, et al. *Bus Rapid Transit: Volume 2: Implementation Guidelines*, TCRP Research Report 90 (Washington, D.C.: Transit Cooperative Research Program, Transportation Research Board, 2003); Kittleson & Associates, *Transit Capacity and Quality of Service Manual, 2nd Edition*, TCRP Report 100 (Washington, D.C.: Transit Cooperative Research Program, Transportation Research Board, 2003); Graham Currie, "Bus Rapid Transit in Australasia: Performance, Lessons Learned and Futures," *Journal of Public Transportation* 9, no. 3 (2006): 1-22; Dimitrios Tsamboulas, "Ex-Ante Evaluation of Exclusive Bus Lanes Implementation," *Journal of Public Transportation* 9, no. 3 (2006): 201-217; Kittleson & Associates, Inc., *Bus Rapid Transit Practitioner's Guide*, TCRP Report 118 (Washington, D.C.: Transit Cooperative Research Program, Transportation Research Board, 2007); and Roderick B. Diaz and Dennis Hinebaugh, *Characteristics of Bus Rapid Transit for Decision-Making* (Tampa: National Bus Rapid Transit Institute, 2009). For an examination of impacts on communities, see Simon McDonnell, Susana Ferreira, and Frank Convery, "Impact of Bus Priority Attributes on Catchment Area Residents in Dublin, Ireland," *Journal of Public Transportation* 9, no. 3 (2006): 137-162.
23. See, for example, Project for Public Spaces, Inc., *Transit-Friendly Streets: Design and Traffic Management Strategies to Support Livable Communities*, TCRP Report No. 33 (Washington, D.C.: Transit Cooperative Research Program, Transportation Research Board, 1998).
24. "Urban transit" modes are scheduled transit services that primarily serve circulation within a city. Classic urban transit modes are subways and local bus services. For the purposes of this analysis, urban transit modes do not include commuter rail, commuter express buses, and other services that primarily provide access to the city from suburban areas, or provide intercity or inter-suburb connectivity, but contribute little to urban circulation. Of course, there are transit services that are not easily classified, like modern rail systems that provide both suburban access and intra-urban circulation. In these cases, the authors attempts to develop reasonable estimates of the urban share of travel on these systems.

25. In Greater London, New York City, San Francisco, and Seoul, the service areas of primary transit agencies coincide with the municipal political boundaries.
26. In all three U.S. cases, the Census Bureau's official metropolitan service area (MSA) designations are somewhat smaller than some popular metro area definitions. The U.S. Census Bureau also defines Combined Statistical Areas (CSA) that consist of groups of MSAs that are linked by commuting ties. However, the inclusion of suburb-to-suburb commuting in defining these areas produces CSA areas that are much larger than the popular metropolitan area definitions. In the judgment of the authors, the MSA definitions provide a better match for the metropolitan area definitions adopted for the non-U.S. cities. The London Larger Urban Zone and the Paris Aire Urbaine are based on the functional urban regions adopted by Eurostat for comparative purposes. The Seoul National Capital Area is a defined metropolitan political jurisdiction. And the Sydney Statistical Division is defined by the state of New South Wales for census purposes.
27. In most cases, private entities hold these contracts. However, in the central areas of Sydney, a government agency holds the contract to operate services.
28. Potential elements of coordinated interagency plans for bus lane operations and enforcement are outlined in Levinson et al., *NCHRP Report 155*; and John J. Roark, *Enforcement of Priority Treatment for Buses on Urban Streets, NCTRDP Synthesis of Transit Practice 2* (Washington, D.C.: National Cooperative Transit Research and Development Program, Transportation Research Board, 1982).
29. Danaher, *TCRP Synthesis 83*, 81.
30. Levinson et al., *TCRP Report 90, vol. 2*.
31. For research on combining goods delivery operations into a bus priority lane, see Fraser McLeod and Tom Cherrett, "Modelling the Impacts of Shared Freight-Public Transport Access Lanes in Urban Centres," *Proceedings of the Logistics Research Network Annual Conference* (Cardiff, UK, September 2009).
32. MTA New York City Transit, *Bus Lane Enforcement Project Evaluation*, unpublished report, 1995.
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  214. Transit priority treatments also appear on streets that carry light rail or cable car operations. On portions of Judah Street, West Portal Avenue, and Powell Street, motor vehicles are forbidden from entering designated "Transit-Only Areas" on the street.



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215. Temporary bus priority lanes established on Main, Folsom, Essex, and other streets during construction of the new Transbay Terminal have not been included in these totals. The bus lane descriptions and hours listed here are drawn from direct observations of bus lane alignments and signage based on site visits in 2007, confirmed and updated on Google Street View in November 2010. They reflect decisions made at the City's administrative discretion, and thus do not directly match the set of "Transit Only Areas" established by SFMTA Board Resolutions No. 08-151 (8/19/2008) and No. 09-172 (9/15/2009), as codified at City and County of San Francisco, *City and County of San Francisco Municipal Code: Transportation Code, Division II, Article 600, Section 601*, [http://search.municode.com/html/14143/level2/DII\\_A600.html#DII\\_A600\\_s601](http://search.municode.com/html/14143/level2/DII_A600.html#DII_A600_s601) (accessed April 1, 2010).
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