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Urban Mass Transportation Administration

Madison Avenue Dual Exclusive Bus Lane Demonstration - New York City

Final Report
May 1984

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16. Abstract

In May 1981, the New York City Department of Transportation implemented a dual exclusive bus lane facility on Madison Avenue in midtown Manhattan, between 42nd and 59th Streets. The project was sponsored for one year as a demonstration by the Urban Mass Transportation Administration under the Service and Methods Demonstration Program, and has since been maintained locally as a permanent facility. The bus lane was implemented as a traffic management action to improve bus operations and reliability on this busy artery. During the evening peak period, the five northbound lanes of Madison Avenue accommodate over 1,400 vehicles per hour; during the 5-6 p.m. peak hour, over 200 of these vehicles are buses, which are forced to mix with other traffic result-resulting in major conflicts and inefficiency.

The dual bus lane facility was implemented in conjunction with a set of traffic management measures, including a stringent parking ban and right turn restrictions. Together, these measures produced a 42 percent decline in peak hour travel time for express bus travel on Madison, and a 34 percent decline in local bus travel time. Major impacts on non-bus traffic were not detected.

The Madison Avenue bus lane does not entail permanent physical barriers. It operates between 2 and 7 p.m. on weekdays, and is available for general use at all other times. Enforcement of the lane is accomplished through pavement striping; pavement, overhead, and "roll-out" signs; and patrol by a special squad of enforcement agents.

This report discusses the bus lane project in terms of its planning and development, including the public involvement and numerous alterations necessary to make the project viable. Impact analysis covers level of service effects, bus ridership, and costs.

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PREFACE

This report was prepared by COMSIS Corporation as the final product of an evaluation project performed under contract to the Transportation Systems Center (TSC) of the U.S. Department of Transportation. The report details the results of a demonstration of priority bus treatment in midtown Manhattan. The demonstration was conducted by the New York City Department of Transportation under a grant from the Urban Mass Transportation Administration (UMTA), in conjunction with the Service and Methods Demonstration program.

The author of the report is J. Richard Kuzmyak, who served as evaluation manager for COMSIS. Joseph Goodman, the UMTA project manager and Jesse Jacobson, the evaluation manager for TSC, are acknowledged for their assistance in the evaluation and in the review of the final report. Robert Casey and Carla Heaton of TSC also assisted in review of the report. Our gratitude is extended to the staff of the New York City DOT for their support of the evaluation and for serving as an information resource during the development of the report. We are particularly grateful to Charles Louie, NYC DOT project manager, and Raymond Amoruso of NYC DOT for their continuing assistance in responding to data requests and answering questions throughout the development of the report.

METRIC CONVERSION FACTORS

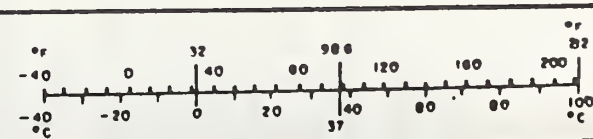
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (CONT.)

LIST OF TABLES

EXECUTIVE SUMMARY

PROJECT DESCRIPTION

In May 1981, the New York City Department of Transportation (NYC DOT) implemented a dual exclusive bus lane facility on Madison Avenue in the heart of midtown Manhattan. The project was sponsored by the Urban Mass Transportation Administration of the U.S. Department of Transportation for 1 year as a demonstration under the Service and Methods Demonstration Program. Between 2 and 7 p.m. on weekdays, the segment of Madison Avenue covered by the bus lane is travelled by over 700 buses; volumes exceed 200 buses per hour during the 5-6 p.m. peak hour. The bus lane and a body of related traffic engineering modifications have combined to reduce bus travel time on the 17-block segment of Madison by as much as 42 percent (6 minutes) during the 5-6 p.m. peak hour, and significantly improved the operating environment for buses with apparently modest effect on other traffic activity. The City of New York has been sufficiently impressed with the operation and performance of the lane that it is supporting the continued operation of the lane after the demonstration period, and plans to extend the concept to other streets as well.

The dual bus lane extends from 42nd Street to 59th Street (see Figure E-1), occupying the two easternmost traffic lanes on Madison. Madison Avenue is a five-lane, one-way northbound facility over this segment. The lane operates between 2 p.m. and 7 p.m. only on regular weekdays. Because it is not in operation 24 hours a day, the lane is not separated from regular traffic by a physical barrier. Rather, preservation of the lane as an exclusive bus facility is accomplished through signing, striping, and a program of active enforcement. The signing and striping system is shown schematically in Figure E-2. Photographs of these media as installed are shown in Figure E-3. A special squad of enforcement agents are stationed at critical locations along the lane when it is in operation, with the power to issue citations to violators (see Figure E-4). The violation rate is

FIGURE E-1. LOCATION OF MADISON AVENUE DUAL-WIDTH BUS LANE IN MIDTOWN MANHATTAN

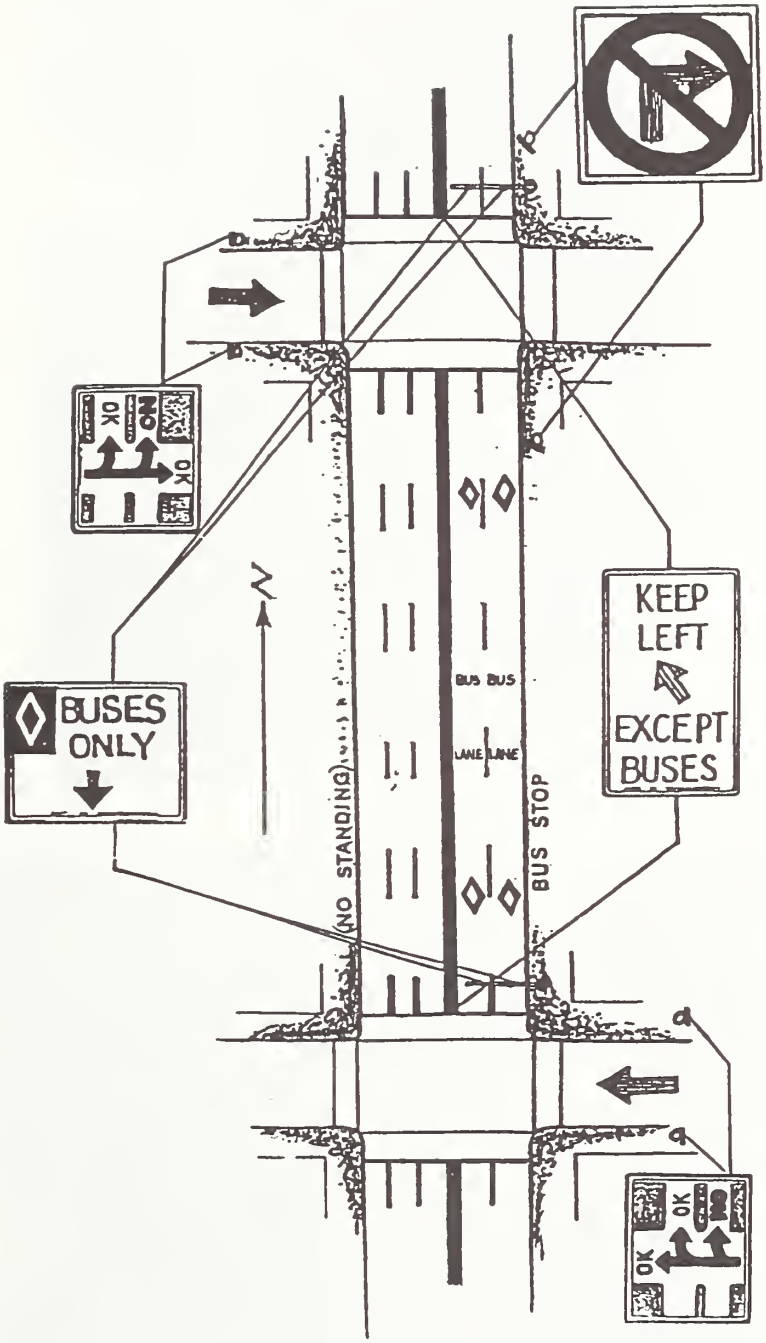


FIGURE E-2. MADISON AVENUE DUAL BUS LANE PLAN

Roll-out Sign

Overhead Signs

FIGURE E-3. BUS LANE SIGNING

Bus Lane Striping

Bus Lane Markers

FIGURE E-3. BUS LANE SIGNING (CONT.)

FIGURE E-4. ENFORCEMENT AGENT PATROLLING BUS LANE modest, however, as the lane has achieved a level of acceptance from the community and the traveling public.

Several other major traffic engineering actions were instituted along with the bus lane to ensure smooth overall operation and acceptance. To maximize performance of the bus lane, right turns by general traffic off Madison at eastbound cross-street intersections were eliminated. These turning maneuvers were formerly a major source of congestion and delay for Madison Avenue buses, whose passenger loading activity was oriented to the east curb, and contributed to pedestrian conflicts as well (see Figure E-5). Then, since the dual bus lane and turn restrictions constituted potentially harsh penalties to general traffic on Madison, a ban was levied against parking along the western curb. This parking ban was sufficiently effective in enhancing the capacity of Madison Avenue that general traffic volumes and travel speeds actually increased slightly on Madison after all improvements were in place. There were no changes made in traffic signalization as part of the demonstration.

OBJECTIVES AND SCOPE

New York City's travel network and traffic conditions are probably unparalleled in terms of complexity and intensity than in any other city in the United States. At the core of New York City is Manhattan island, a major employment, commercial and entertainment center, as well as a significant residential location. The many activities create an intense competition for the available space, not just for location, but for the high volume of travel that these activities generate. Roughly 2.8 million people and 615,000 vehicles enter Manhattan from the surrounding boroughs during an average 24-hour period.

Rates of transit use in New York are also unparalleled. The famous subways move immense volumes of people each day, more than the transit systems of most other large cities combined. However, buses and taxis also move large numbers of people. As the subways have grown older, their capacity has been taxed and many travelers, for reasons of reliability or accessibility, have

Pedestrian Conflicts with Vehicle Turning Maneuvers at Intersection

Board Safety and Efficiency Effects of East Curb Crowding

FIGURE E-5. BEFORE-PROJECT OPERATIONAL AND PEDESTRIAN CONFLICTS elected to use the other modes of public transportation. Significant numbers of commuters access Manhattan via a long bus ride, and many travelers within Manhattan use the extensive local bus network. These buses add significantly to the volumes on Manhattan streets.

The New York City DOT bears the responsibility for managing the diverse transportation activities in Manhattan. Against volumes and competition such as this, standard traffic control remedies have little impact, and total breakdown of the system, resulting in the dreaded "gridlock," has often been threatened. To DOT also goes the difficult problem of balancing treatment among the various interest groups--commuters vs. local residents, passengers vs. freight, public vs. private transportation. These are not easy choices, and virtually any proposed action is likely to be greeted with a host of dissenting opinions.

Largely because of its people-carrying efficiency, DOT has tried to assist public transit in either improving operations or holding its own in Manhattan. The congestion and conflict between buses and other traffic on the midtown segment of Madison Avenue was perhaps one of the worst bottlenecks in Manhattan. DOT had zoned the east curb for bus pickup and dropoff only, but the restriction was routinely ignored by taxis, trucks, and private autos who chose to conduct their business on that side of Madison Avenue. The opposite curb of Madison also has parking restrictions, but that lane and even the adjacent lane were routinely filled with parked vehicles. During the 4-7 p.m. evening peak period, when over 500 buses would pass through this segment of Madison, conditions would often reach a standstill. Buses would be forced to board passengers from one of the center lanes, or try to cross 2 or 3 lanes in order to clear an obstruction, and in the process block several lanes and create even worse obstacles. DOT felt that if it could just separate these two activities--bus and general traffic--it could significantly improve flow conditions on Madison, not only for bus but perhaps for other traffic as well.

The dual priority bus lane was the recommended action from several studied alternatives. Given the characteristics of the transit routes operating on Madison and their markets, DOT did not expect or project significant bus ridership changes to result from the action. Rather, it simply hoped to restore some equity in terms of travel time to bus as a high-occupancy mode, and make the entire transportation system function more smoothly. As a result, bus users were expected to realize time savings and bus operators greater reliability and potentially cost savings. These efficiency goals were the principal reasons for establishing the dual bus lane and related traffic engineering changes on Madison Avenue.

PROJECT IMPACTS

The dual bus lane and supporting traffic engineering actions resulted in the following major impacts:

Bus Travel Time Impacts

- As shown in Figure E-6, average express bus travel times on Madison Avenue declined from 15.3 to 8.9 minutes (41.8%) during the 5 to 6 p.m. peak hour , from 13.6 to 8.0 minutes (41.2%) during the 4 to 7 p.m. peak period, and from 10.6 to 6.2 minutes (41.5%) during the 2 to 4 p.m. off-peak.
- Average local bus travel times on Madison declined from 16.1 to 10.7 minutes (33.5%) during the 5 to 6 p.m. peak hour, from 14.3 to 10.2 minutes (28.7%) during the 4 to 7 p.m. peak period, and from 13.1 to 9.4 minutes (28.2%) during the 2 to 4 p.m. off-peak.
- After 7 months of operation, DOT reduced its enforcement squad on the lane from full staff (16 agents) to half (8 agents), which will be the long run operating plan. Under the half enforcement plan, illegal lane use by general traffic increased, with a small negative effect on bus speeds. These changes affected only the peak period, not the off-peak where travel times actually declined somewhat. Following the change in enforcement, average 5 to 6 p.m. peak hour travel time for express bus increased to 11.5 minutes, making the effective reduction in travel time due to the lane 3.8 minutes, or 24.8%, compared to 6.4 minutes (41.8%) before the change in enforcement. For local bus, travel time during the 5 to 6 p.m. peak increased to 11.1 minutes, making the effective project reduction 5.0 minutes or 31.1% compared to 5.4 minutes or 33.5% before the change in enforcement.

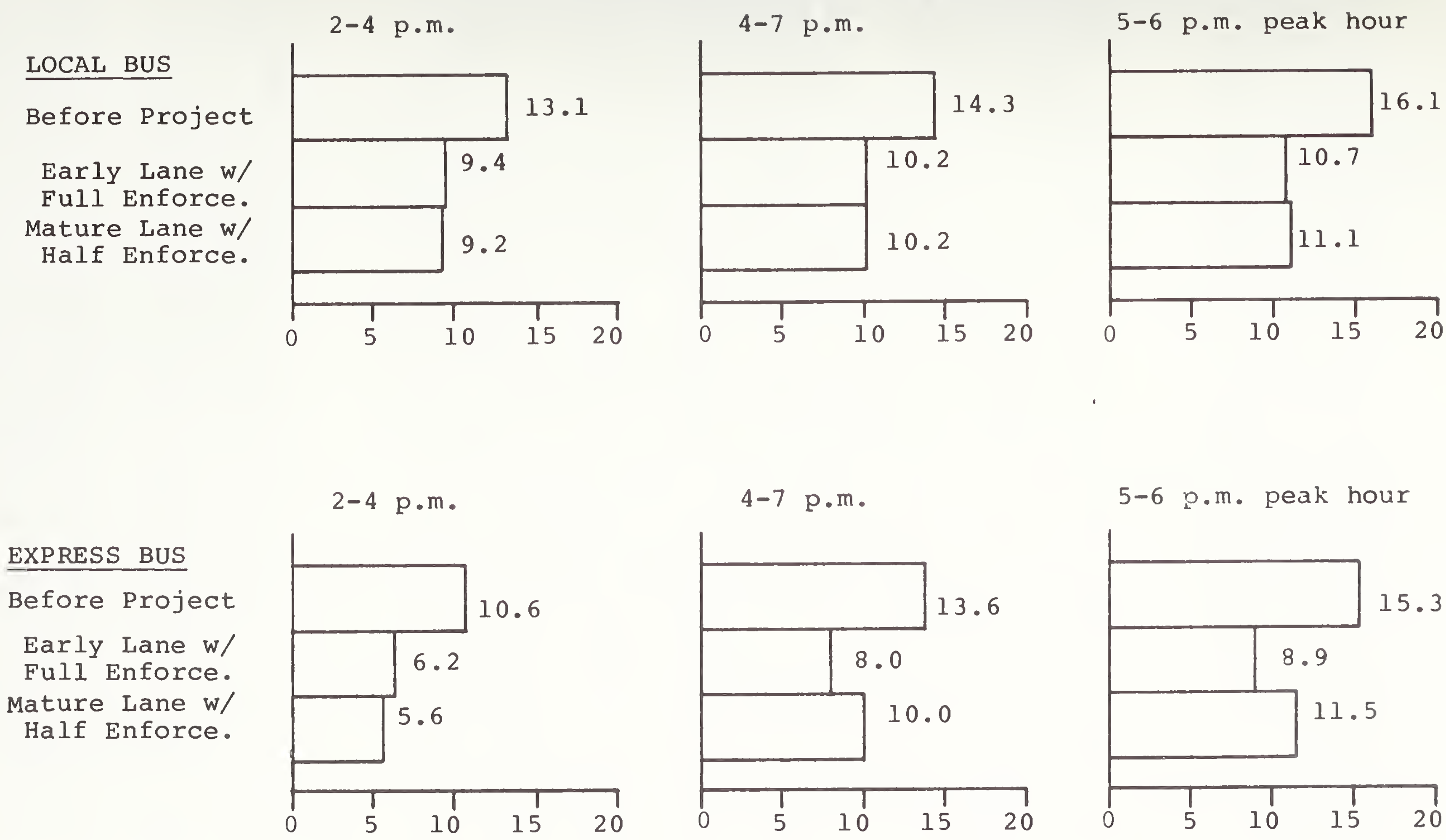


FIGURE E-6. BUS TRAVEL TIME COMPARISONS
MADISON AVENUE--42ND TO 59TH STREETS
(TRAVEL TIME IN MINUTES)

Bus Reliability

- Bus reliability, expressed as the variability in travel time (standard deviation as a percent of mean travel time) also improved as a result of the project: from 40.4% to 26.9% for express bus in the peak (4-7 p.m.), and 26.4% to 14.1% in the off-peak (2-4 p.m.); and from 39.8% to 16.4% for local bus in the peak (4-7 p.m.).

Bus Ridership

- Bus ridership gains were greatest for local bus. Average weekday ridership for MTA local bus routes M-1,2,3,4 and 32 increased from 9,450 to 12,385, or 31.1%, within 17 months following project implementation. About 17% of all local bus riders indicated that they started using buses on Madison Avenue because of the bus lane, and almost half of these switched from other transit service. About 62% felt that their trip was consistently faster because of the bus lane.

- Express bus ridership gains were modest in comparison to local bus, though the travel time savings on Madison were slightly greater. Express bus average daily ridership increased only 6.2%, from 14,614 to 15,524, during the same 17-month reference period. The reasons for this are believed twofold: (1) the express bus time savings of about 5 minutes on Madison are small in proportion to total trip times of approximately an hour; (2) travelers to the areas served by the express operators lacked prior alternatives, so there was little or no mode shifting as with local bus. Virtually all express bus riders were traveling for the purpose of work and traveled on a daily basis. It is not known how many of these riders were new as a result of the bus lane, or what their previous mode of travel had been. About 75% felt that their trip was consistently faster due to the project improvements.

Impacts On Transit Productivity

- The travel time savings coupled with the ridership gains caused the MTA to attempt changes in its local service routes M-1 and M-2 on Madison in January 1982, 8 months after implementation of the bus lane. However, the proposed changes were deemed unacceptable by the drivers' union.

- The express bus operators acknowledged travel time savings due to the bus lane. However, given the length of these routes and the fact that they are peak period services, the bus lane savings were not enough to realize additional trips from the same vehicle during the same peak period. Moreover, ridership gains were not sufficient to increase the number of vehicles in service. The operators conceded that all travel time gains were seen in terms of improved reliability. No operator realized any operating cost savings.

- The volume of buses on Madison Avenue fluctuated during the demonstration period. While the number of daily express buses stayed uniform at about 440 bus per day, the number of local buses varied between 246 and 299, due to reliability problems with the MTA's new Grumman\ buses and not the demonstration project.

Project Administration And Cost

- The cost to implement and operate the Madison Avenue bus lane project for one year was $788,300.
- The major project cost was labor, particularly the cost of lane enforcement. Labor costs related to enforcement accounted for approximately 74% of all expenditures, or about $581,500. This cost includes 7 months of high level enforcement, requiring an enforcement crew of 24 agents and 5 supervisors (annualized cost of $728,560), and 5 months of reduced enforcement, involving 16 agents and 4 supervisors (annualized cost of $448,293). DOT estimates that long term enforcement can be accomplished with as few as 8 agents, at a cost of $120,000 per year.
- Because of the enforcement squad, DOT administration requirements were limited to surveillance. Final planning, implementation, and monitoring of the lane required a half-time supervisor and 2 full-time assistant planners. Planning and administration costs accounted for only 12% of the project budget, although much of the planning activity was performed before receipt of the demonstration grant, and no estimate of these costs is available. Construction and material costs were minimal, accounting for only 10% of total project costs.

Impacts On Non-Transit Activities

With a change in the transportation system as large as that represented by the dual bus lane, significant impact on other transportation activity in midtown might have been expected. Anticipated impacts were the reductions of capacity and level of service on Madison, with the effect of diverting traffic to adjacent facilities and creating more widespread congestion problems. It was also a concern that the right turn restriction on Madison would precipitate circuitous and inefficient travel patterns for motorists needing to travel east of Madison.

It appears that these negative impacts were averted. The reason for this is due largely to the stringent parking ban imposed on Madison concurrent with the bus lane, which gave 3 usable lanes to non-bus traffic and may actually have improved overall travel conditions. The data on these secondary effects are much more limited in terms of sample size than the data obtained to explore the primary effects, i.e., the improvements in bus performance. Therefore, many of the changes suggested by the data cannot be statistically validated. Moreover, inspection of the variations in these data between the different points in time in which they were collected suggests that conditions change quite radically on their own. Considerably more information would be necessary to properly evaluate these secondary effects than it was feasible to obtain in this project.

Review of the available data suggests the following effects:

- Travel times for general traffic declined on Madison Avenue during the 4-7 p.m. peak period by about 5 minutes (33%), and declined in similar proportions on all other avenues within the project area except Fifth Avenue (the complementary southbound avenue adjacent to Madison), where travel times doubled, and on Sixth (up 6%).

- In reverse fashion, off-peak (2-4 p.m.) travel times on Madison increased by 29%, while falling on Sixth Avenue by 21%. Fifth Avenue again showed a doubling of travel time.

- Using data for periods comparable to the above, peak period traffic volumes on Madison increased by 13%; off-peak volumes increased by 5%. The two avenues west of Madison, Fifth and Sixth, projected to experience diversions from Madison due to the right turn ban, did show major increases. Peak period volumes increased by 23% on Sixth and 19% on Fifth, while off-peak volumes increased by 32% and 9%, respectively. Volume declined on avenues east of Madison.

- A sample intersection system was set up at Madison and 53rd and 52nd and Fifth to further investigate this potential shift in travel patterns. Turning movement counts showed that the number of left turns off Madison west onto 53rd Street may have increased by 44%, while turns east on 52nd Street from Fifth Avenue may have increased by about 20%.

- Travel times on the east-west cross streets in the project area generally increased. This increase was on the order of 10% to 15% in the peak and about 17% to 22% in the off-peak.
- Trends in traffic volumes on the cross street segments between Madison and Fifth could not be detected.
- The impacts on taxi usage, freight delivery, and commercial activity were not investigated as part of this study.

Institutional Impacts

Perhaps the largest single impact of the demonstration has been the success of DOT in implementing a transit priority system at all. Considering the similar efforts elsewhere in the past which have failed, and the intensity of travel in New York City, implementing and preserving an exclusive bus lane in midtown Manhattan must be viewed as a major planning and administrative achievement, totally apart from the issues of cost, benefit, and equity.

New York's success in implementation was aided by (1) strong political backing from the Mayor's Office, (2) careful planning and consideration of impacts, and (3) intensive liaison with and involvement of the public during the development. DOT made an extensive study of the potential impacts which could surface as rallying points or centers of action against the lane. Many interests were heard and accommodations made to maximize the lane's chances for support and survival. Important negotiations transpired between the powerful taxi industry and major commercial interests, particularly hotels in the vicinity of the project. The restriction of the lane to a part-day facility, the institution of a parking ban, and the freedom granted taxis to share the bus lane in the first 4-block segment are examples of important concessions which made the bus lane institutionally and politically viable.

CONCLUSIONS

The Madison Avenue bus lane has been a successful demonstration of the appropriate physical and administrative actions necessary to implement a transit priority solution within a difficult institutional environment.

The bus lane project was successful in its primary goal of improving transit operations on Madison Avenue. Not only have bus travel times and reliability improved, but overall utilization of the facility (in terms of vehicle throughput) has been increased. While the equivalent of Manhattan midtown, and Madison Avenue in particular, are not likely to be found in the same intensity in other American cities, the development, implementation, and successful operation of the bus lane constitute important findings. Transit is more attractive to travelers as its travel time and reliability improve relative to the automobile. Priority lanes improve transit performance, and in travel markets where there exist choice riders (unlike New York), priority lanes can increase transit market share. Many cities have choice markets and facilities where transit and auto compete, and priority lanes are important alternatives to these areas. Improved transit operating conditions can also improve productivity, and, depending on the operation, can cut costs or help stretch transit service.

It is important to note that transit priority measures are not without their cost. Where facilities are limited, granting priority to transit occurs at the expense of other travel and economic activity. As with Madison Avenue, a proper assessment would necessarily consider these other impacts. Measures of effectiveness should be developed which consider these multiple, and often conflicting, management objectives.

Political and institutional acceptance are extremely important factors in being able to implement any priority scheme. The conditions which provided the impetus and support in New York are not likely to occur in exactly the same form in other areas. New York had favorable circumstances in many respects: the poor traffic conditions on Madison; a Federal mandate to consider priority treatments; and a strong pro-transit support from the incumbent administration. However, it combined these support factors with practical planning and design considerations to ensure that the project would be implemented professionally and respected as a result of its appearance and operation. The enforcement strategy used was undoubtedly central to the success of the project--the enforcement impressed upon the public the seriousness of the effort and ensured that the performance of the lane would continue to justify its existence.

1. INTRODUCTION

The Madison Avenue exclusive bus lane experiment has been a demonstration of the use of priority lanes as a strategy for improving transit performance and reliability in a dense downtown setting. The priority treatment allocates two with-flow traffic lanes along Madison Avenue in midtown New York City over the segment between 42nd and 59th Streets. Madison is a five-lane (54 foot width), one-way northbound facility through this segment. The lane operates only from 2 p.m. to 7 p.m. on weekdays. Physical barriers are not used; separation of traffic is realized through striping, signs, and special enforcement agents. Several complementary traffic engineering actions, including parking and right turn restrictions, were implemented along with the bus lane to help ensure its effective performance. The lane was implemented on May 26, 1981, and operated as a demonstration for a full year. This initial operation was sufficiently successful that the City of New York has continued operation of the lane after the demonstration grant terminated in May 1982.

1.1 PROJECT BACKGROUND

A number of factors contributed to New York City's interest in exclusive bus lanes, and in the particular choice of Madison Avenue as the site for the dual reserved lane demonstration. A brief review of these factors is presented below.

Given New York's well-publicized history of traffic problems attributable to its size and level of activity, transportation and political officials in New York City have continually searched for effective transportation management strategies. Priority treatments for transit buses have been high on the list of strategies of the city's transportation planners for some time, but the problem of finding suitable locations for such facilities with the necessary political support has been difficult. Exclusive transit facilities typically take limited travel space away from some other interest group, and, given the political power of these interest groups, the changes have been difficult to implement on a lasting basis.

Aided by a U.S. Court order in 1977 requiring broader consideration of priority bus lanes and mayoral encouragement for transit improvements following the 1980 transit strike, the city's planners found the support they needed to begin developing priority facility plans.

A logical place to try to locate such a facility was in midtown Manhattan, where some of the city's worst traffic problems occurred. And in midtown, the leading candidate for improvement among major facilities was Madison Avenue. Madison was a key north-south artery, and carried the highest volume of buses, with the poorest bus speeds, of any avenue. Average bus speeds on Madison fell below 5 m.p.h. during the evening rush hour (5-6 p.m.).

1.2 OBJECTIVES

Apart from its 1977 court order to institute priority bus lane treatments, the New York City DOT's development of the Madison Avenue priority bus lane project corresponded to several objectives:

- o improvement of bus speeds and travel time
- o improvement of bus reliability
- o improved pedestrian environment
- o improved air quality
- o energy conservation.

The exceptionally low bus travel speeds on Madison Avenue were principally congestion-related. Buses spent a significant portion of their time stuck in traffic delays, amounting to 25% to 45% of their total travel time on the facility. It was hoped that implementation of the dual bus lane would significantly reduce this "stopped delay" component of travel time.

An even greater benefit was anticipated in the reliability of bus travel time. Occasional severe delays resulted in trip times on Madison of 30 minutes or more. The dual exclusive lanes were expected to hold this travel time to a consistent 10 minutes.

One aspect of the planned exclusive lane implementation involved elimination of right turn traffic off Madison onto eastbound cross streets. These turning maneuvers were not only a significant impediment to bus flow, but contributed also to crosstown traffic tie-ups and vehicle-pedestrian conflicts. Elimination of right turns was expected to increase pedestrian safety and improve pedestrian circulation.

Improved bus and overall traffic flow conditions were also expected to have a positive effect on air quality and energy consumption. Net improvements in both of these areas were expected in spite of shifts in overall traffic levels, and flow diversions to surrounding streets.

1.3 EVALUATION OVERVIEW

The primary evaluation interest in the Madison Avenue bus lane is its effect on improving bus flow and operations on Madison Avenue. This "improved flow" is translated as fewer delays, improved level of service, and perhaps increased productivity. These are all direct, positive, and measurable impacts that have earned the primary attention of the evaluation.

Other impacts are secondary results of the lane, and from the outset it was expected that these effects might not be uniformly positive. These include the impedance or rerouting of non-bus traffic within the project area, measured in elongated trips or travel times, and the possible shifting of congestion difficulties to adjacent facilities. Other secondary effects include impacts on pedestrian environment, safety, goods movement, and other retail and commercial activity.

The project evaluation has been structured to monitor, obtain data on and analyze these various impacts, such that the primary impacts are given the greatest emphasis. Impacts are categorized into three areas:

- level of service
- travel demand
- productivity and economics

An overview of the scope and general approach of the evaluation in each of these areas is provided below, along with a fourth rather separate area--planning and implementation.

1.3.1 Transportation Level of Service

The major issue in this evaluation is whether the priority lane package of improvements worked as intended in improving bus traffic flow along Madison Avenue. Adequate concern existed before the implementation as to whether the separation of traffic and confinement of bus traffic to two lanes would in fact improve bus flow, so physical operations were themselves closely monitored and recorded. With regard to lane impacts on bus travel time and reliability, intensive data collections were staged to obtain reliable estimates of bus travel time and also its breakdown by delay component. These included both large-sample net travel time measurements from street level using license plate matching techniques, as well as on-board travel time measurement.

Measurement of travel times for Madison Avenue buses for that portion of the route beyond the exclusive lane segment was initially considered but not done because of the perception that characteristics of the trip would not change significantly off Madison. Performance of buses on avenues parallel to Madison, as they may have been affected by project-related traffic diversions, were also considered but not done because it was perceived that the effects would be small relative to the cost of using the project's data collection resources for the measurement.

Perhaps the most important secondary impact was the presumed effect of the bus lane and related modifications on non-bus traffic. Pre-implementation calculations estimated that the transit improvements might reduce the daily volume of traffic on Madison by as much as 40%, with the majority being diverted to 3rd, Park and 6th Avenues as well as an appreciable increase in volumes on the cross-streets. These diverted trips, consisting mostly of taxi and multi-destination delivery trips, were expected to encounter longer trip lengths and travel times.

Several types of evaluation activities were attempted in order to measure the character and magnitude of these diversions. The most ambitious effort consisted of an attempted before-and-after driver postcard survey in which motorists, entering the zone at selected sampling points, were asked to indicate their destination and travel path on an enclosed map of the immediate street system. Large samples of these records were to be studied to determine patterns of diversion and aggregate changes in trip length. However, the pilot test results did not demonstrate an adequate level and quality of response, and the effort was abandoned.

As an alternative to the above, more conventional traffic engineering measures were used. Diversion effects were measured through traffic volume counts obtained at key locations in the street grid, and through travel speeds by time of day, obtained using floating car methods. Volume counts were supplemented by vehicle classification surveys to track changes in the composition of traffic, and turning movement surveys to try to measure circuity of travel paths. Street-corner tabulations of turning movements were obtained at representative locations in the grid. In one instance, counts were obtained for a four-corner system simultaneously, supplemented by license plate matching techniques to trace the movements of a sample of individual vehicles. Another approach involved interviews of travellers whose trips terminated in the first cross street block east of Madison, who were potentially affected by the right turn restrictions on Madison.

The quantitative measures of level of service changes described above were supplemented by video tape and photographic records of system operation, including traffic flow, conflicts and bottlenecks on Madison and at important cross-street intersections, and impacts on freight delivery operations and pedestrian environment. Data on traffic violations related to the bus lane were also maintained throughout the demonstration period.

1.3.2 Demand Impacts

It was not anticipated that the changes in bus service brought about by the priority lanes would significantly affect bus ridership. For express bus, in particular, it was assumed that commuters who could use transit to and from Manhattan were already traveling by transit. Therefore, it was assumed that the effect of the bus lane would simply be a shift of some travelers to Madison Avenue buses from other forms of transit (notably subway) and accrual of travel time savings to existing riders. Similar changes were expected for local bus, i.e., travel time savings and diversion of riders from other transit services.

Because major ridership gains were not anticipated, detailed measurements of ridership were not obtained. Cursory estimates of ridership for both local and express bus were developed based on street-level estimates of bus occupancy rates obtained at maximum load points. For express bus these measurements were supplemented by monthly ridership data from the individual operators. History of new bus riders on Madison and information on attitudes toward the service improvements were obtained from a post-implementation on-board survey.

1.3.3 Transit Productivity and Economics

It was expected that transit productivity gains would be realized as a result of the flow improvements on Madison Avenue. If buses can complete their routes in significantly less time, either more runs can be made or equipment can be removed from service on that route and either eliminated entirely or used elsewhere. Short of this level of achievement, productivity improvements would simply impart greater efficiency and reliability to bus travel on Madison. This prospect was monitored through periodic contacts with the operators.

Ideally, the cost-effectiveness of the lane project would be assessed by comparing the costs of implementation and operation with the travel time savings for users (or potential losses for non-users). Direct project-related cost data have been acquired. However, the data on benefits or losses for the different travel groups are weak, with the result that a general cost-effectiveness assessment has not been attempted.

1.3.4 Planning and Implementation

An important product of the Madison Avenue demonstration is the knowledge and experience acquired in the course of planning and implementing the bus lane. This aspect of the project was given careful attention by the evaluation, covering the following major topics:

- o how alternatives were identified and analyzed;
- o design considerations and integration within the overall traffic system;
- o public response and image building;
- o negotiations with businesses and operators, and consequent impact or results;
- o political support;
- o method of enforcement: cost and effectiveness;
- o post-implementation modifications and improvements, as well as their causes and effects.

Each of these elements has been documented by the evaluation, in terms of its role in or effect on the development and refinement of the bus lane. This implementation summary, whose information was derived from direct contact with the project, newspaper accounts, or grantee reports and file records, is the subject of Chapter 3 of this report.

1.4 ORGANIZATIONAL ROLES

The following parties have played key roles in this demonstration project:

1.4.1 New York City Department of Transportation

The New York City DOT, demonstration grant recipient, has served as the planning and implementing agency for the bus lane project. DOT staff have also had the principal responsibility for collection of performance and evaluation data on the project.

1.4.2 Urban Mass Transportation Administration

The Urban Mass Transportation Administration (UMTA) of the U.S. Department of Transportation has sponsored the demonstration under its Service and Methods Demonstration (SMD) Program. UMTA has the overall supervisory and management responsibility for its SMD projects.

1.4.3 Transportation Systems Center

The Transportation Systems Center (TSC) is the research arm of the U.S. Department of Transportation, and is responsible for the evaluation of all SMD projects.

1.4.4 COMSIS Corporation

Under contract to TSC, COMSIS has been assigned the responsibility for the evaluation of the Madison Avenue demonstration. As part of this responsibility, COMSIS developed the methodological plan for the evaluation, designed the various data collections, conducted the impact analysis, and prepared the project report.

1.5 FUNDING

The Madison Avenue Dual Exclusive Bus Lane Demonstration was funded by an UMTA Service and Methods Demonstration grant (Section 6). Total demonstration funding was in the amount of $788,300, which covered planning and administrative costs, construction costs, and enforcement.

1.6 ORGANIZATION OF THE REPORT

The remainder of this report is organized as follows:

- Chapter 2 provides a description of the project site, including demographics, transportation system characteristics, and travel patterns.
- Chapter 3 describes the planning and implementation process.

- Chapter 4 summarizes the project impacts, organized into categories of level of service impacts, impacts on travel demand, and impacts on productivity and economics.
- Chapter 5 provides the overall summary and conclusions.

Various supporting data are included in a technical appendix.

2. SITE DESCRIPTION

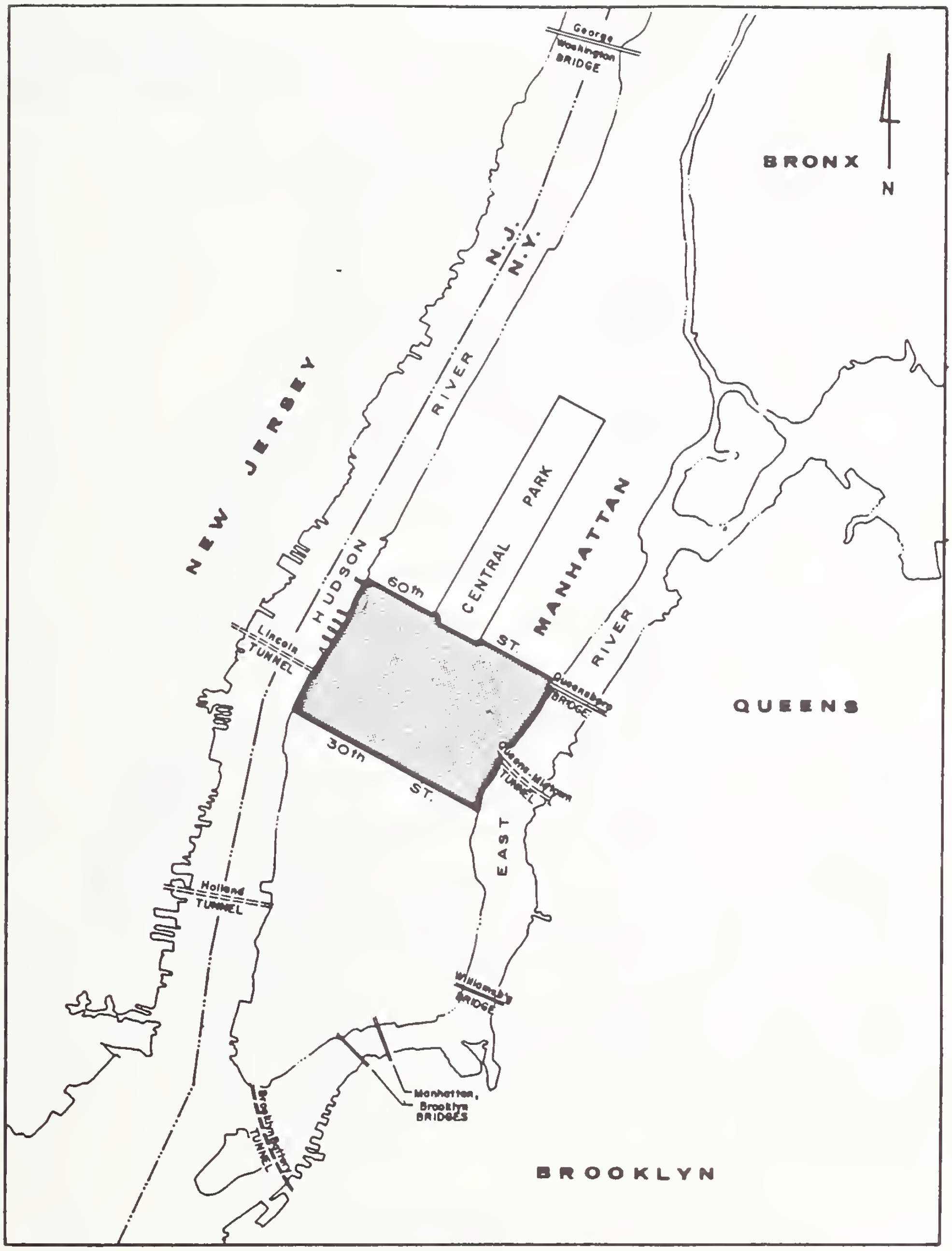
2.1 OVERVIEW

The study area for the Madison Avenue exclusive bus lane project is midtown Manhattan, in the heart of New York City. As shown in Figure 2-1, midtown is generally regarded as that area bounded by 60th Street and Central Park to the North, 30th Street to the south, and the East River and the Hudson River on the east and west, respectively. In addition to being the commercial center of the region, it is world-renowned for its entertainment, tourist, and cultural attractions. Midtown also serves as the major transportation hub for the region, including such facilities as Pennsylvania Station, Grand Central Station, the Port Authority Bus Terminal, and the East Side Airlines Terminal. Both the Lincoln Tunnel (to New Jersey) and the Queensborough Bridge and Queens Midtown Tunnel (to Queens and Long Island) enter Manhattan in midtown. While the area covers only 4.3 square miles, it houses a population of approximately 115,000, and is the employment location for 1.2 million workers. Some 2.85 million person trips are made into the Manhattan CBD (all of Manhattan south of 60th St.) on an average weekday, approximately 70 percent of which are made by public transportation.

2.2 LAND USE, POPULATION, AND EMPLOYMENT

As shown by the map in Figure 2-2, land use in midtown consists of light industry on the west, entertainment in the central zone, retail and office activity in the area between Lexington and 6th Avenues, and housing, both on the near west side and between Lexington and the East River on the east side. Madison Avenue itself is in the center of the Lexington/6th Avenue office/retail corridor, perhaps the largest concentration of this type of activity in the City.

Employment in midtown has grown almost continuously, from the earliest records through 1971, when it peaked at about 1.1 million employees. As of 1977, however, total employment had



Source: "Midtown Transportation Factbook," Edwards and Kelcey, 1978.

FIGURE 2-1. MIDTOWN MANHATTAN STUDY AREA

Source: "Midtown Transportation Factbook," Edwards and Kelcey, 1978.

FIGURE 2-2. MIDTOWN MANHATTAN LAND USE MAP declined to less than 900,000, although non-residential floor space had continued to increase. From 1971 to 1977, non-residential floor space increased from about 268 million to 285 million square feet. Much of this growth in new facility construction has occurred in the Madison Avenue corridor. The area between 6th and Park Avenues (from 30th to 59th Streets) alone accounts for 455,000 employees, or about half of all of midtown's employment.

Midtown's resident population is overshadowed by its employment population. The number of people who reside in midtown was relatively stable at about 170,000 through 1940, after which it began a slow decline to about 115,000 as of 1970. This imbalance between resident and employment populations explains the orientation of midtown's transportation to non-resident travelers.

2.3 TRAVEL PATTERNS

The most recent data regarding travel characteristics in midtown available at the time of preparation of this report were compiled in 1976. These data describe travel to the "Manhattan CBD," which is the entire area south of 60th Street. However, this larger area and the midtown study area are believed to have very similar travel characteristics.[1] Where available, exclusive data on midtown are utilized.

In 1976, approximately 2.85 million person trips and 615,000 motor vehicle trips were made into the Manhattan CBD in a typical weekday. Approximately 700,000 of these person trips (and 46,000 of the vehicle trips) occurred during the 8-9 a.m. period. The origin of these trips by sector is shown in Figure 2-3. The largest share of person trips, about 40%, comes from the north, across the 60th Street cordon, followed by the Brooklyn and Queens sectors at 26% and 22%, respectively. Similar proportions characterize motor vehicle travel into the CBD.

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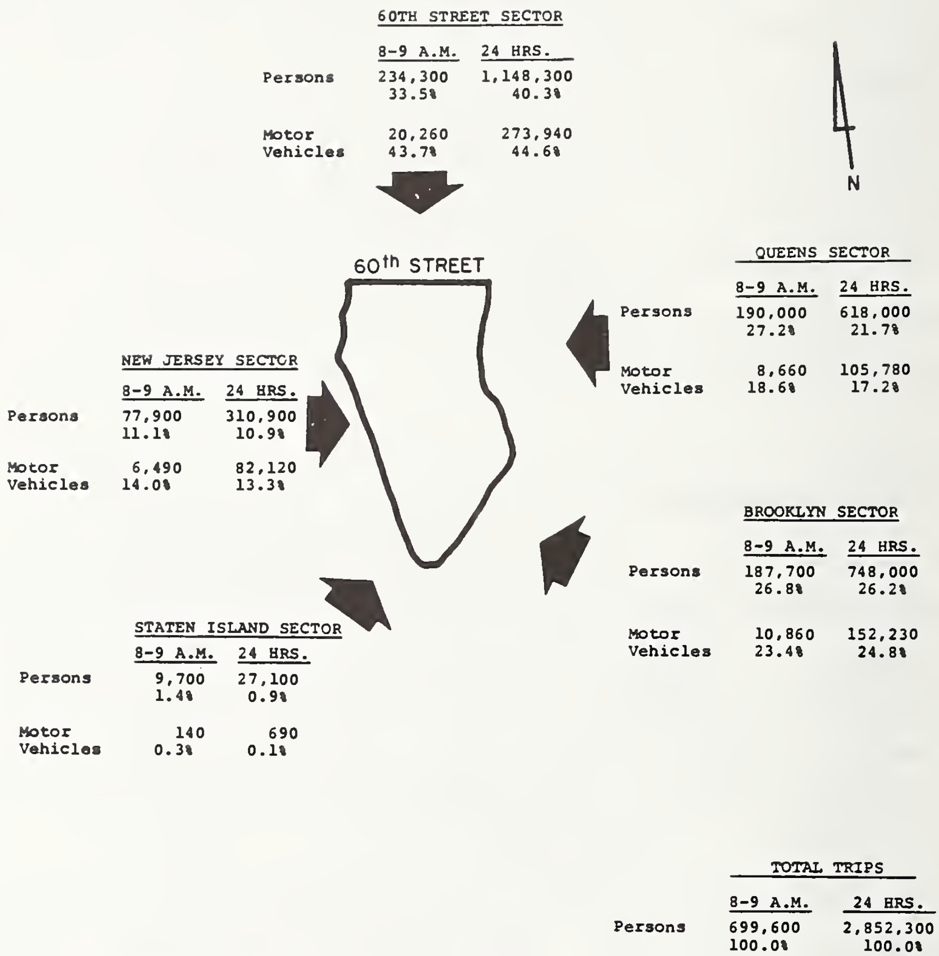
[1] **Midtown Circulation and Surface Transit--Midtown Transportation Factbook**, Edwards and Kelcey with URS/Madigan, Praeger, Inc., November 1978.



Source: Hub-Bound Travel
Tri-State Regional Planning Commission, 1978
1976 Data (Typical Weekday)

FIGURE 2-3. PERSON AND VEHICLE TRAVEL TO THE MANHATTAN CBD BY SECTOR

Of these 2.85 million person trips, nearly 70 percent were made by public transportation, while the remaining 30% were made by auto, taxi or truck. Of the 700,000 a.m. peak period trips, 90% were made by public transportation. Travelers from north of 60th Street, and from the Brooklyn and Queens corridors primarily utilize the subway, both during the rush hour and over the 24-hour day. Travelers from the New Jersey sector primarily utilize bus and subway during the peak periods, and auto, taxi, or truck during the remainder of the day.

In conjunction with the suburbanization trends following World War II, person travel to the Manhattan CBD declined from a high of 3.7 million daily trips in 1948 to the present 2.85 million. From 1948 through about 1963, the proportion of trips made by public transportation also declined. However, between 1963 and the present, the proportion of trips served by public transportation began to increase, even though the total number of transit trips continued to decline. Meanwhile, the number of person trips made by auto, taxi and truck from 1924 through the present has shown a relatively steady increase, with a slight decline following the 1973 energy crisis.

In 1977 a survey was conducted of automobile travelers to midtown, which revealed the following major characteristics:[1]

- About half of all auto trips into midtown originate within the 5 boroughs, led by Manhattan (17.2%), followed by Queens (14.7%), Brooklyn (9.6%), the Bronx (6.6%) and Staten Island (1.8%).
- Most auto trips into midtown are made for business; 39% of all such trips are for going to work, 22% to make a business call, and 10% to deliver passengers or goods. Most of the remaining 30% are for personal business or entertainment.
- Average occupancy of all vehicles destined to or passing through midtown on a weekday is 1.65 persons. The highest occupancies occur in the a.m. peak, the lowest in the mid-day. Shopping, package/person delivery, and personal business have the highest occupancies, journey-to-work and business calls the lowest.

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[1]**Hub-Bound Travel**, Tri-State Regional Planning Commission, 1978. Even-numbered streets serve eastbound traffic and odd-numbered serve westbound;

- During the 7 a.m. to 8 p.m. period on a typical weekday, approximately 77% of all trips entering midtown terminated in midtown, while the majority of the remaining 23% which were passing through crossed the 30th Street Corridor into downtown New York City.

2.4 TRANSPORTATION SYSTEM CHARACTERISTICS--STREET NETWORK

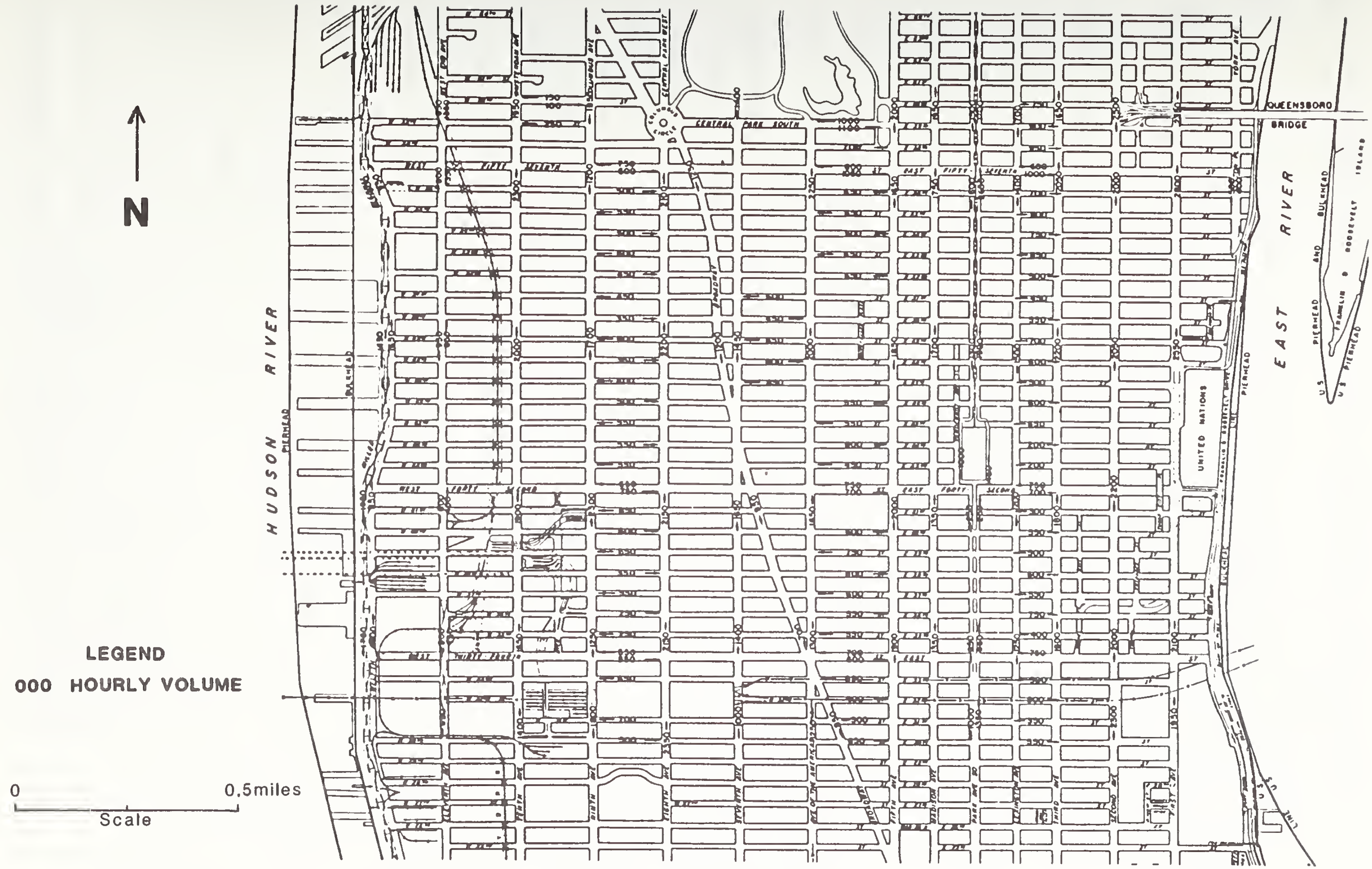
New York, and midtown Manhattan in particular, are well served with both highway and transit facilities.

The midtown street network is a grid comprised of primarily one-directional streets and avenues. In general, even-numbered northbound and southbound avenues cannot be similarly categorized, as seen in Figure 2-4. Madison Avenue is a northbound facility, as are 3rd Avenue and 6th Avenue in the vicinity of the project development. Conversely, 5th Avenue and Lexington Avenue are southbound streets, while Park Avenue, with its unique median divider, operates in both directions. What this means is that the heaviest traffic volumes on the northbound streets tend to occur during the evening peak period, while the southbound streets are heaviest during the morning peak.

Avenues are typically 60 or 70 feet wide, except for Lexington, Madison and Fifth, which vary from 51 to 55 feet. Madison itself is a 5-lane, 54-foot roadway with 13-foot sidewalks north of 42nd Street and a 45-foot roadway with 15-foot sidewalks south of 42nd Street. Widths of the major crosstown streets (like 39th, 42nd, and 57th) vary from 53 to 60 feet, while all other crosstown streets are 30 to 34 feet wide.

Virtually all of the 500 intersections in midtown are controlled by traffic signals, consisting primarily of non-interconnected, single-dial, synchronous-motor controllers operated on a 90-second cycle. Although the allocation of green time varies between intersections, the average split is 50% for the avenue, 40% for the cross street, and 10% for clearance intervals.

Traffic restrictions on Madison Avenue include prohibition of left turns from and onto Madison at several locations:



Source: "Midtown Transportation Factbook," Edwards and Kelcey, 1978.

FIGURE 2-4. MIDTOWN STREET NETWORK AND TRAFFIC VOLUMES DURING 4-7P.M. PEAK PERIOD

- **Madison and 34th**--from Madison (except buses) between 8 a.m. and 7 p.m. daily, or onto Madison from 34th at any time.
- **Madison and 42nd**--from Madison between 8 a.m. and 7 p.m., except Sunday, or from 42nd onto Madison during same period.
- **Madison and 57th**--from 57th onto Madison (except buses) daily except Sunday between 8 a.m. and 7 p.m.

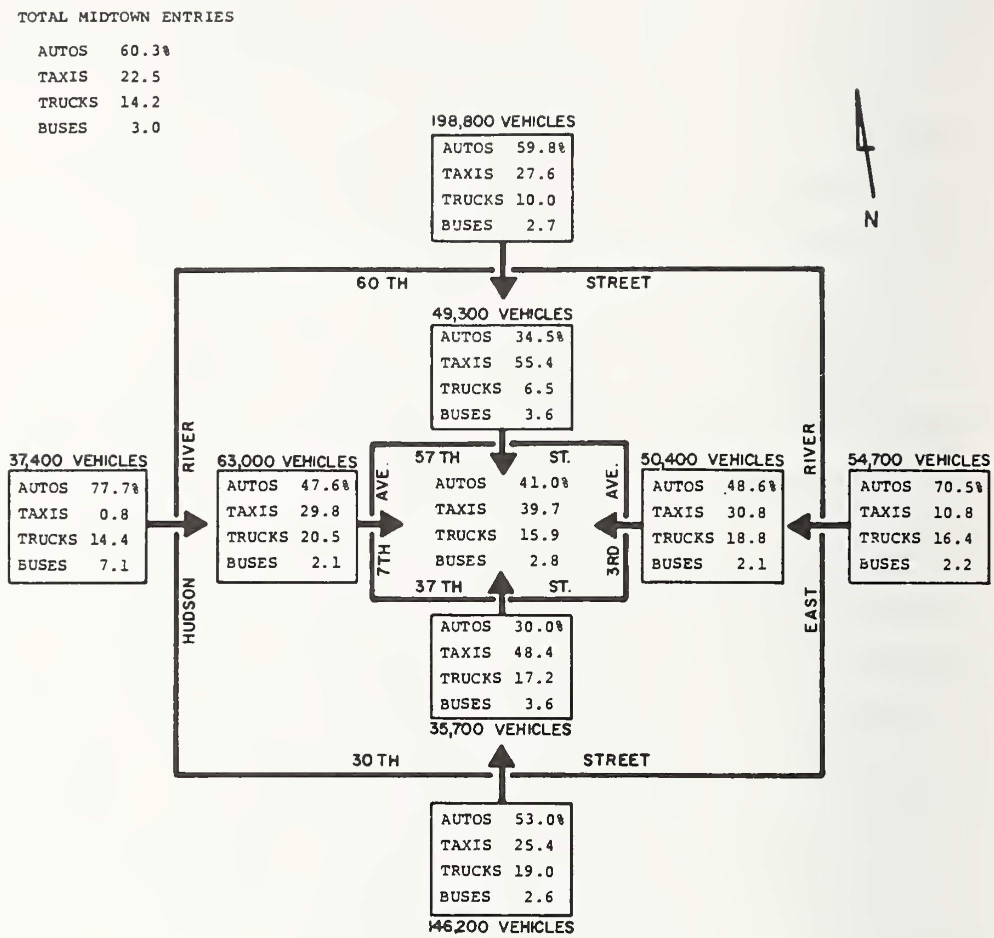
As stated previously, the street grid network is directly linked to neighboring New Jersey via the Lincoln Tunnel and to Queens and Long Island via the Queensborough (59th Street) Bridge and the Queens-Midtown Tunnel. An express highway, FDR Drive, borders midtown on the east. The West Side Highway previously performed a similar function on the west, but is has been out of service since about 1980 due to its poor condition. A replacement facility, the Westway, has been stalled due to a variety of political and financial problems.

Midtown offers both on and off-street parking facilities. There are approximately 61,000 off-street spaces available within 412 facilities. About 75% of these facilities are situated in garages, while the rest are located in surface lots. Of the off-street spaces, 17,739 are to be found in the midtown core, or the area north of 42nd Street between 8th and 3rd Avenues. On-street parking is more ubiquitous and difficult to classify. On-street parking is controlled by four categories of regulations: no stopping; no standing; no parking; and parking allowed with restrictions (including metered parking). Special exceptions to the latter three categories apply to freight delivery, taxis, and authorized vehicles. At a minimum, the hierarchy of restrictions is complex and heavily protested by the parking interests, making it difficult to effect changes or to enforce restrictions. On-street parking is prohibited throughout the midtown core on weekdays between 8 a.m. and 6 p.m., exclusive of authorized vehicles, such as those belonging to diplomats and government officials. Curbside space during the period of restriction is zoned as "No Standing" or "No Standing Except Trucks." Enforcement, however, is difficult, and generally overtaxes the limited force of approximately 30 Traffic Control Agents. Roughly 8,000 parking summons were issued during a typical week in midtown in 1977; an average of 245 illegally parked vehicles per day were fined in Manhattan during the same period.

On-street parking regulations that applied to Madison Avenue before the bus lane project included prohibition of parking along the west curb except for authorized vehicles (e.g., diplomats, officials) at several locations; nineteen of the thirty west curb blockfaces on Madison provided a total of 54 parking spaces for use by these vehicles. The curb lane along the east side of Madison was designated as a bus zone and signed "No Standing, Bus Zone."

The percentage of total traffic by mode varies by district within midtown. As a result of midtown land use and its role as a focal point for business, entertainment, and tourist activity, taxis comprise a significant portion of all vehicles in midtown. Taxi traffic is concentrated in the central section of midtown, comprising approximately 45 to 80 percent of all morning traffic within the midtown core. Trucks, on the other hand, utilize peripheral avenues to a greater extent than those passing through the center of midtown. Trucks having an overall length of 33 feet or more are prohibited from all midtown roadways except 1st and 2nd Avenues, 9th through 12th Avenues, and 34th and 57th Streets between 1st and 12th Avenues. Vehicle classification by mode and sector of entry to the total midtown study area and to a central area within midtown is illustrated in Figure 2-5. On the typical avenue within the midtown core between 7 a.m. and 7 p.m., autos account for 41% of traffic volumes, taxis 39.7%, trucks 15.9%, and buses 2.8%.

Automobile travel speeds by avenue are summarized in Table 2-1. Midtown avenue speeds range from 5 to 24 miles per hour, while crosstown speeds, excluding 59th and 60th Streets, range from 3 to 9 miles per hour. Auto travel speeds on the avenues are generally slowest during the a.m. period for southbound flow and during the p.m. period for northbound flow. Travel speeds along Madison average 9 mph during the a.m. peak, 7 mph during the midday peak, and 5 mph during the p.m. peak. The p.m. peak



Source: "Midtown Auto Driver Study," Prepared for New York Department of City Planning by Crossley Surveys, Inc., 1977, 1977 Data.

Data Provided by the New York City Department of Transportation-Bureau of Traffic Operations, 1971-1977 Data.

FIGURE 2-5. VEHICLE CLASSIFICATION BY MODE: 7 A.M. - 7 P.M.

TABLE 2-1. AUTOMOBILE TRAVEL SPEEDS BY AVENUE*

Avenue	8-9 a.m.	12-1 p.m.	5-6 p.m.	8 a.m.-6 p.m.
1st	13.8	13.7	9.5	11.9
2nd	7.7	8.1	10.1	8.0
3rd	12.5	7.9	6.7	8.6
Lexington	8.4	8.1	9.1	7.8
Park NB	9.8	10.0	5.5	8.9
Park SB	5.6	7.5	8.6	6.8
Madison	9.5	7.0	4.8	6.5
5th	7.4	6.4	5.9	6.1
6th	13.5	11.0	6.6	9.3
7th**	9.6	7.2	10.6	8.2
Broadway**	8.7	7.0	9.1	9.1
8th	12.0	8.9	6.1	8.7

*Between 30th and 66th Streets.

**Speeds reported correspond to Broadway north of 42nd Street and 7th Avenue south of 42nd Street where the two avenues cross.

Source: New York City Department of Transportation - Bureau of Operations, 1978 data.

travel time on Madison is the lowest of all avenues between 1st and 8th Avenues in midtown.

Another important form of travel in Manhattan is walking. Pedestrian volumes along midtown streets are quite high (see Table 2-2), particularly along the major shopping and entertainment corridors, and in the vicinity of the transportation terminals. Madison Avenue is characterized by significant pedestrian volumes during the midday and evening hours. During the midday period, Madison Avenue between 47th and 48th Streets is traveled by approximately 11,000 pedestrians per hour (both east and west sidewalks); p.m. peak pedestrian volumes average 10,000 persons. Madison possesses a narrower sidewalk than all other midtown avenues with the exception of Lexington.

The attempted coexistence of large volumes of vehicles and pedestrians in a confined space produces right-of-way conflicts and accidents. In 1977, Madison Avenue intersections between 30th and 59th Streets were the scenes of 265 accidents involving 52 pedestrians. Despite this record, Madison had a higher level of safety than any other midtown avenue.

2.5 TRANSPORTATION SYSTEM CHARACTERISTICS--TRANSIT SYSTEM

Public transportation to and from midtown has many forms, including subway, commuter rail, local and express bus, and even a tramway. Taxi must also be considered a major form of public transportation in New York. New York City subway routes and stations within midtown are illustrated in Figure 2-6. Bus routes, both public and private, are delineated in Figures 2-7a and 2-7b. Figure 2-7a illustrates local bus routes, while 2-7b illustrates express bus routes.

Madison Avenue itself, in the area of the demonstration project, is flanked by subway lines on Lexington, 6th and 7th Avenues, and supports the highest peak hour bus volumes of any midtown arterial, amounting to over 200 buses per hour during the p.m. peak hour. Between 8 a.m. and 6 p.m. on the average weekday, approximately 1,200 buses traverse Madison Avenue; 38% of these are local, 56% are express, and 6% are deadheading. All of

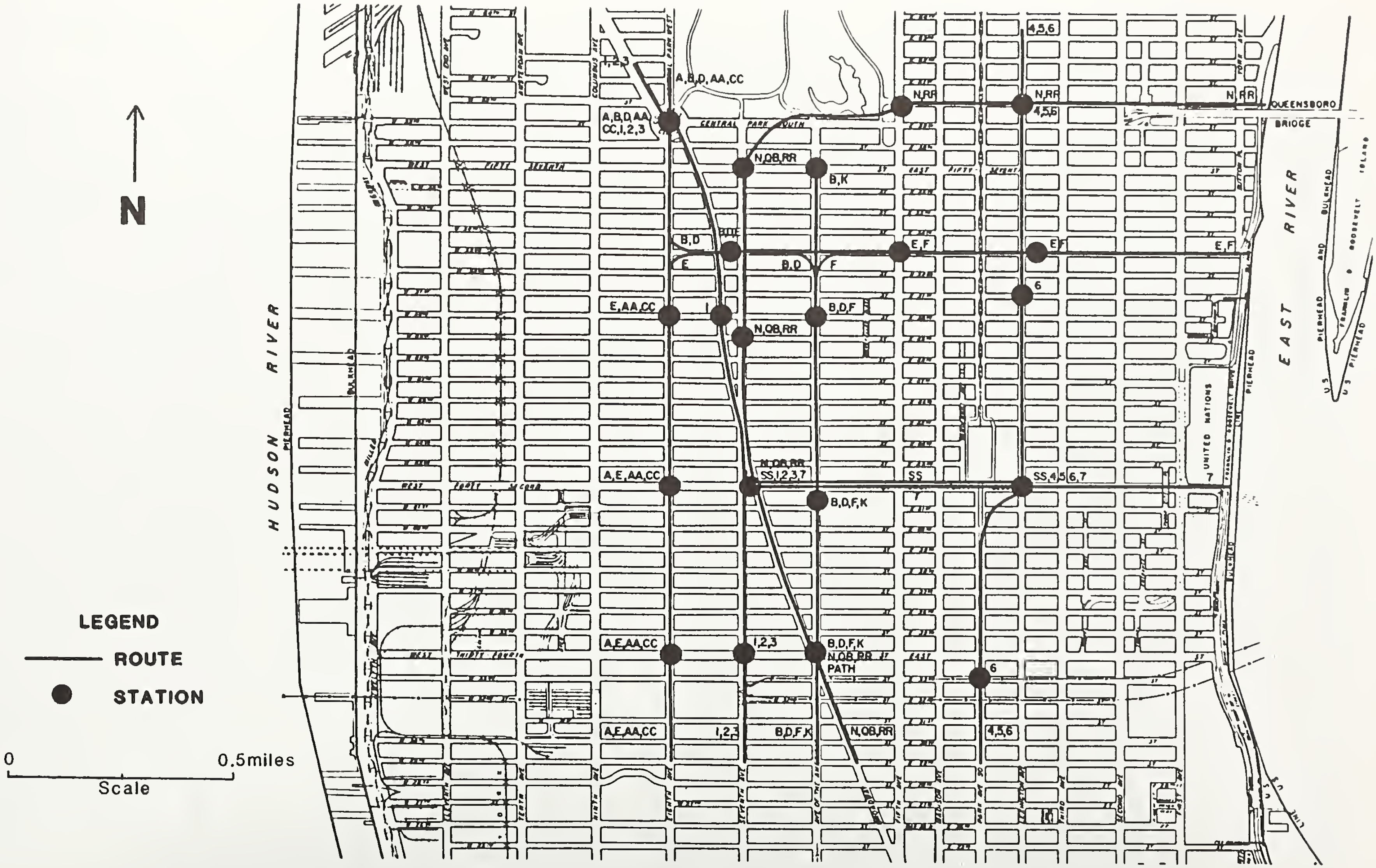
TABLE 2-2. PEDESTRIAN VOLUMES ON MIDTOWN AVENUES

	Hourly Volumes			
	Midday Peak		P.M. Peak	
Avenue	Between 47th & 48th Streets	Between 57th & 58th Streets	Between 47th & 48th Streets	Between 57th & 58th Streets
8th	1,500/1,600*	1,200/1,300	2,500/1,600	1,700/2,500
Broadway	3,300/1,500	**/3,400	3,500/1,500	1,700/1,700
7th	2,300/4,000	1,500/1,300	2,000/5,300	1,600/1,600
6th	2,500/5,000	2,100/3,300	2,000/3,600	2,000/2,400
5th	12,000/8,500	5,600/3,700	4,900/4,900	3,300/2,400
Madison	6,200/4,800	3,100/5,000	5,000/5,000	2,500/2,200
Park	3,600/3,500	2,000/3,200	3,200/4,800	2,200/2,300
Lexington	6,200/3,700	4,000/5,600	2,500/2,400	4,200/4,800
3rd	3,300/1,600	2,000/3,100	2,400/2,700	2,500/3,400
2nd	1,700/**	1,500/**	**	1,600/2,000

*Hourly volume on west sidewalk/hourly volume on east sidewalk.

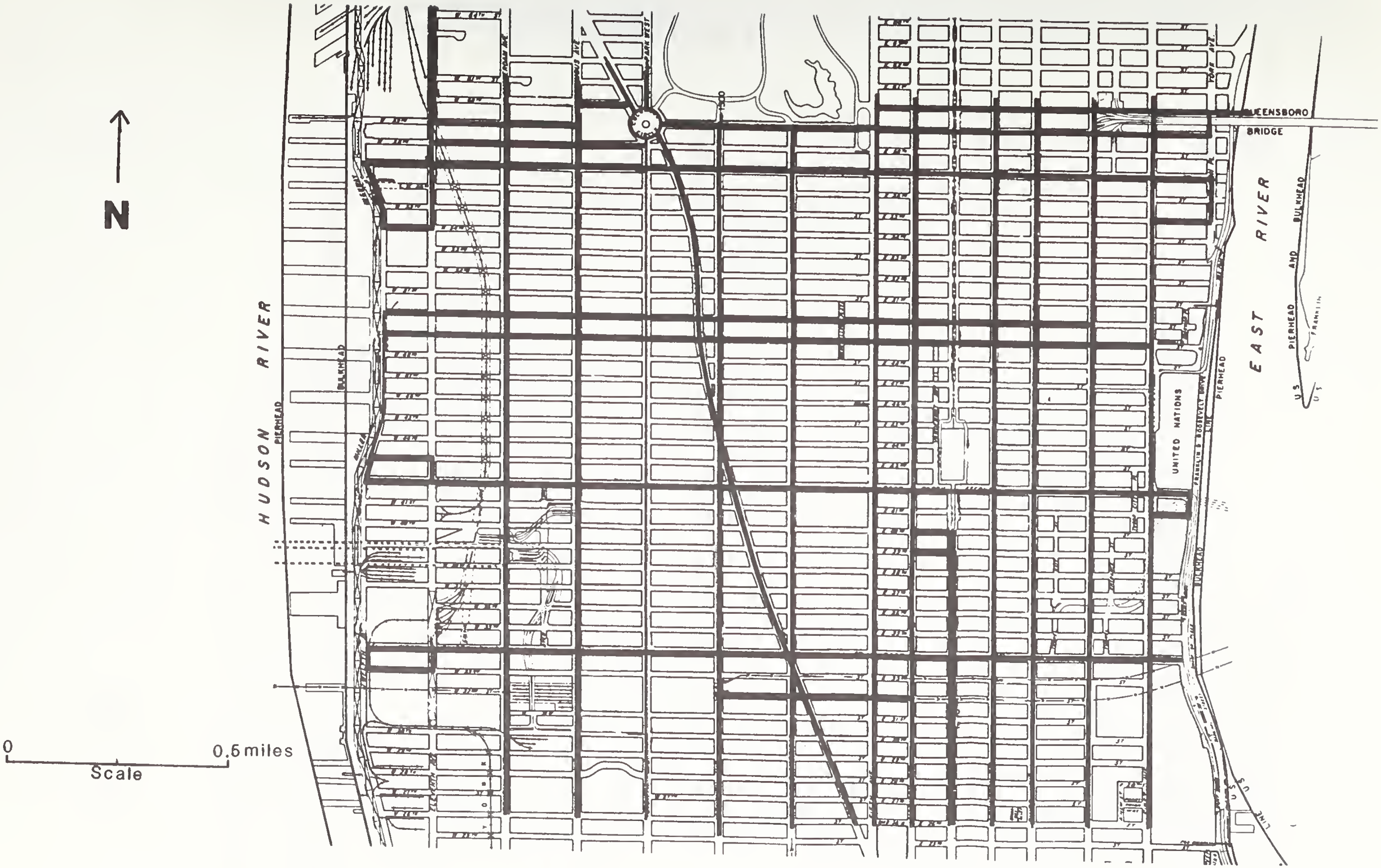
**Hourly volume is less than 1,000.

Source: Data provided by Regional Plan Association.



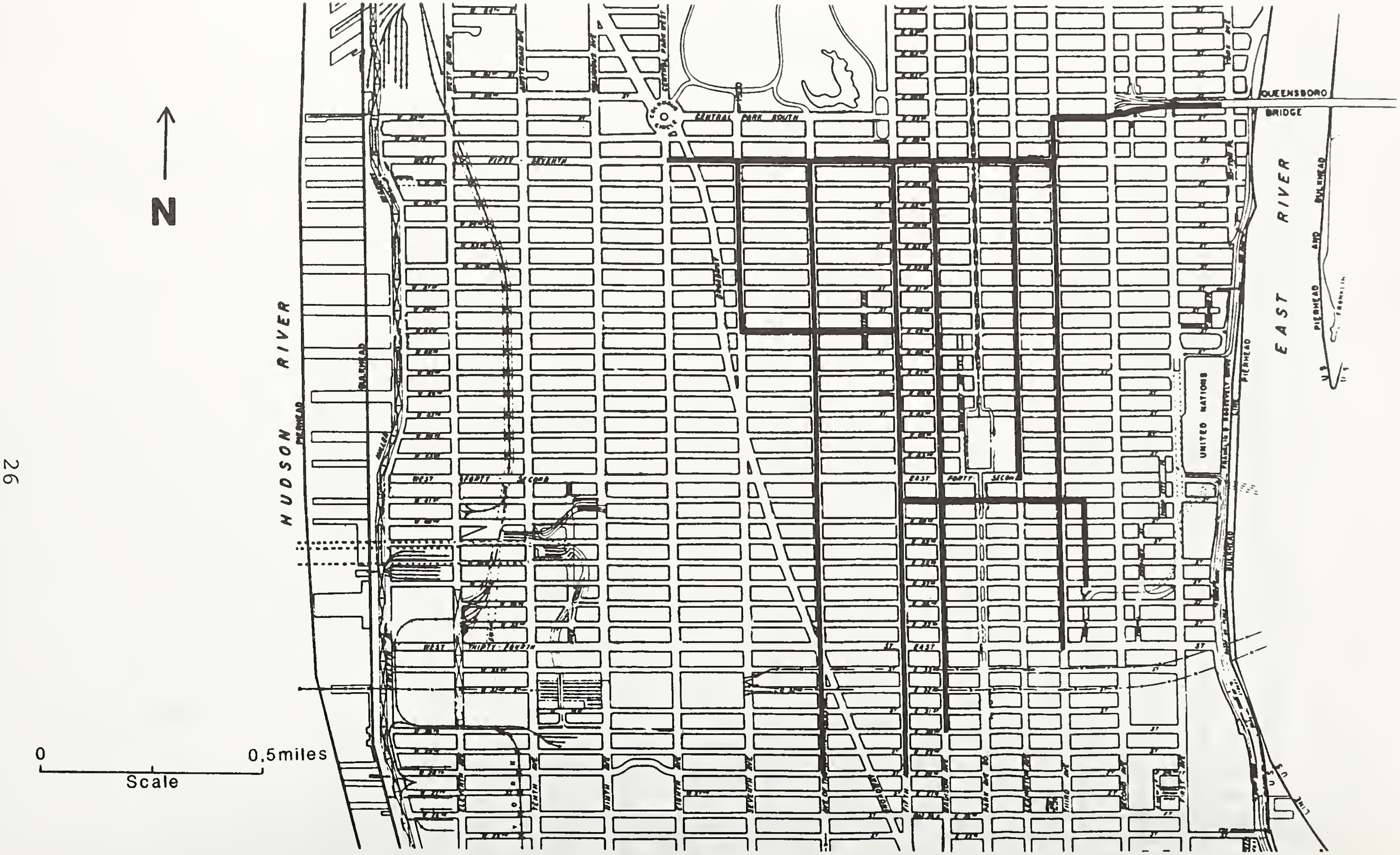
Source: "Midtown Transportation Factbook," Edwards and Kelcey, 1978.

FIGURE 2-6. SUBWAY ROUTES AND STATIONS IN MIDTOWN



Source: "Midtown Transportation Factbook," Edwards and Kelcey, 1978.

FIGURE 2-7a. LOCATION OF LOCAL BUS ROUTES IN MIDTOWN



Source: "Midtown Transportation Factbook," Edwards and Kelcey, 1978.

FIGURE 2-7b. LOCATION OF EXPRESS BUS ROUTES IN MIDTOWN the local buses (5 routes) are operated by the New York City Transit Authority, as are 41% of the express (11 routes). The remaining express services (16 routes) are operated by three private companies (New York Bus, Liberty Lines, and Jamaica). Of the 27 express routes, 8 serve the Bronx, 7 serve Brooklyn, 2 serve Queens, and 11 serve Staten Island. Most of the areas served are difficult or impossible to reach by subway.

Scheduled local bus headways by route range from 2-4 minutes, 5-6 minutes, and 3-6 minutes in the a.m., midday, and p.m. peaks, respectively. Combined local bus headways average less than one minute during the a.m. peak and approximately one minute during the midday and p.m. peaks. Express buses are dispatched according to a set schedule, which varies by line.

Bus travel speeds in midtown are generally two-thirds of those speeds attained by automobiles on streets and avenues where both operate, and do not vary as much as auto travel speeds by time of day. Local bus travel speeds for midtown avenues and major cross streets are shown in Table 2-3. Madison Avenue local bus travel speeds were the lowest recorded of all avenues between 1st and 7th Avenues in midtown. Local bus travel speeds along Madison are typically 4 to 5 mph during the a.m. and midday peaks, and 2 1/2 to 4 mph during the p.m. peak. An analysis of the components of bus travel speed indicated that buses on Madison spent only 40% to 50% of their time actually running, 15% to 25% of their time for passenger service, 25% to 45% for stop delay, and 20% to 30% for signal delay.

TABLE 2-3. LOCAL BUS TRAVEL SPEEDS*

	Travel Speeds in Miles/Hour			
Corridor	8-9 a.m.	12-1 p.m.	5-6 p.m.	8 a.m.-6 p.m.
1st Avenue	8.7	7.8	5.8	7.5
2nd Avenue	4.9	4.9	5.2	5.3
3rd Avenue	9.0	6.0	6.0	6.5
Lexington Ave.	4.9	4.4	5.3	4.8
Madison Avenue	7.9	4.2	4.2	5.0
5th Avenue	6.3	4.5	4.9	4.9
6th Avenue	5.6	4.9	4.2	4.9
7th Avenue	8.3	5.9	5.5	6.5
34th St. EB	4.8	3.5	4.7	3.8
34th St. WB	3.8	2.7	3.6	3.5
42nd St. EB	5.1	5.2	5.5	5.3
42nd St. WB	5.8	4.8	5.1	5.0
49th St. WB	4.0	2.9	4.6	4.0
50th St. EB	3.7	2.6	4.6	3.7
57th St. EB	5.6	5.1	4.9	5.1
57th St. WB	5.1	4.1	4.7	4.4

*Avenue speeds generally between 30th and 66th Streets; Street speeds generally between 1st and 10th Avenues.

Source: New York City Department of Transportation - Bureau of Traffic Operations, 1978 data.

3. PLANNING AND IMPLEMENTATION

3.1 IMPETUS FOR BUS PRIORITY TREATMENT

In September 1977, the United States District Court ordered the City of New York to implement certain strategies in order to meet Federal air quality standards. One section of this order, 76 Civ. 837, directed the New York City Department of Transportation to institute priority bus lane treatments. The City used this order to add weight to its own long-standing interest in promoting transit priority projects. A number of such treatments had been attempted over the preceding 10-year period, including short bus lane segments on existing facilities, bus exemptions from general traffic turning restrictions, and various arterial and areawide transportation improvement programs. While some of these efforts involved bus lane segments on downtown streets, generally they were hastily conceived and poorly executed. As a result, lane boundaries were constantly violated by other traffic, the facilities never worked as intended, and the plans were short-lived.

The New York City DOT had a strong interest in developing a priority lane facility somewhere in midtown Manhattan, where some of New York's most severe traffic problems occur. In 1977-78, a private consulting firm was hired by the DOT to conduct an inventory and analysis of existing travel facilities and their usage in mid-town.[1] This study concluded strongly that bus transit performance was severely limited by virtue of its forced operation in mixed traffic. This was regarded as a disequity in that buses comprised only 3% of all motor vehicles in the CBD during the a.m. peak hour, while they transported about 48% of all motor vehicle travelers. The DOT believed that significant improvements could and should be made in bus performance through judicious use of low-capital priority treatments in the midtown area.

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[1] **Midtown Circulation and Surface Transit--Midtown Transportation Factbook,** Edwards and Kelcey with URS/Madigan, Praeger, Inc., November 1978.

The DOT was also convinced that if a priority lane were to be successful, it would need careful design and implementation, stringent enforcement, and strong political support. Each of these preconditions was realized. On the heels of the 1980 transit strike, Mayor Edward Koch strongly endorsed a citywide program of transit service improvements, including the use of exclusive lanes. This gave the DOT's plans much-needed credibility and clout. The concern over adequate attention to design and enforcement was subsequently addressed through the receipt of a Section 6 Service and Methods Demonstration Grant from UMTA.

3.2 SELECTION OF MADISON AVENUE AS DEMONSTRATION SITE

Several locations were considered as bus lane implementation sites, but Madison Avenue readily emerged as the leading candidate for bus priority measures. Major factors which favored Madison included:

- its role as midtown's major office/retail corridor.
- the highest bus volumes of any midtown arterial--approximately 200 buses during the p.m. peak hour.
- the lowest bus travel speeds on any midtown avenue during the midday and p.m. peak periods--approximately 4 mph.

In addition to the above, spatial factors favored Madison. Since Madison Avenue's southern terminus is at 23rd Street, there are only a limited number of points at which traffic can enter onto the Avenue south of midtown. In the view of the DOT, this increased the potential of implementing a successful priority system since overall traffic volumes on Madison were less than on other midtown avenues.

3.3 DEVELOPMENT OF ALTERNATIVES

Once it was determined that Madison would be the bus lane demonstration site, several alternative schemes were developed and analyzed by the DOT planning staff. An early decision was made to direct any improvement plan for Madison at the segment of the Avenue between 42nd and 59th Streets. The primary reason for this was that Madison widens from 45 feet (4 lanes) to 54 feet (5 lanes) north of 42nd Street, allowing more adequate spacing for the lane. Secondly, virtually all express bus traffic using Madison is oriented to destinations east and north of Manhattan, largely Brooklyn, Queens and the Bronx. Most of this traffic departs Madison at 59th Street to cross the Queensborough (59th Street) Bridge.

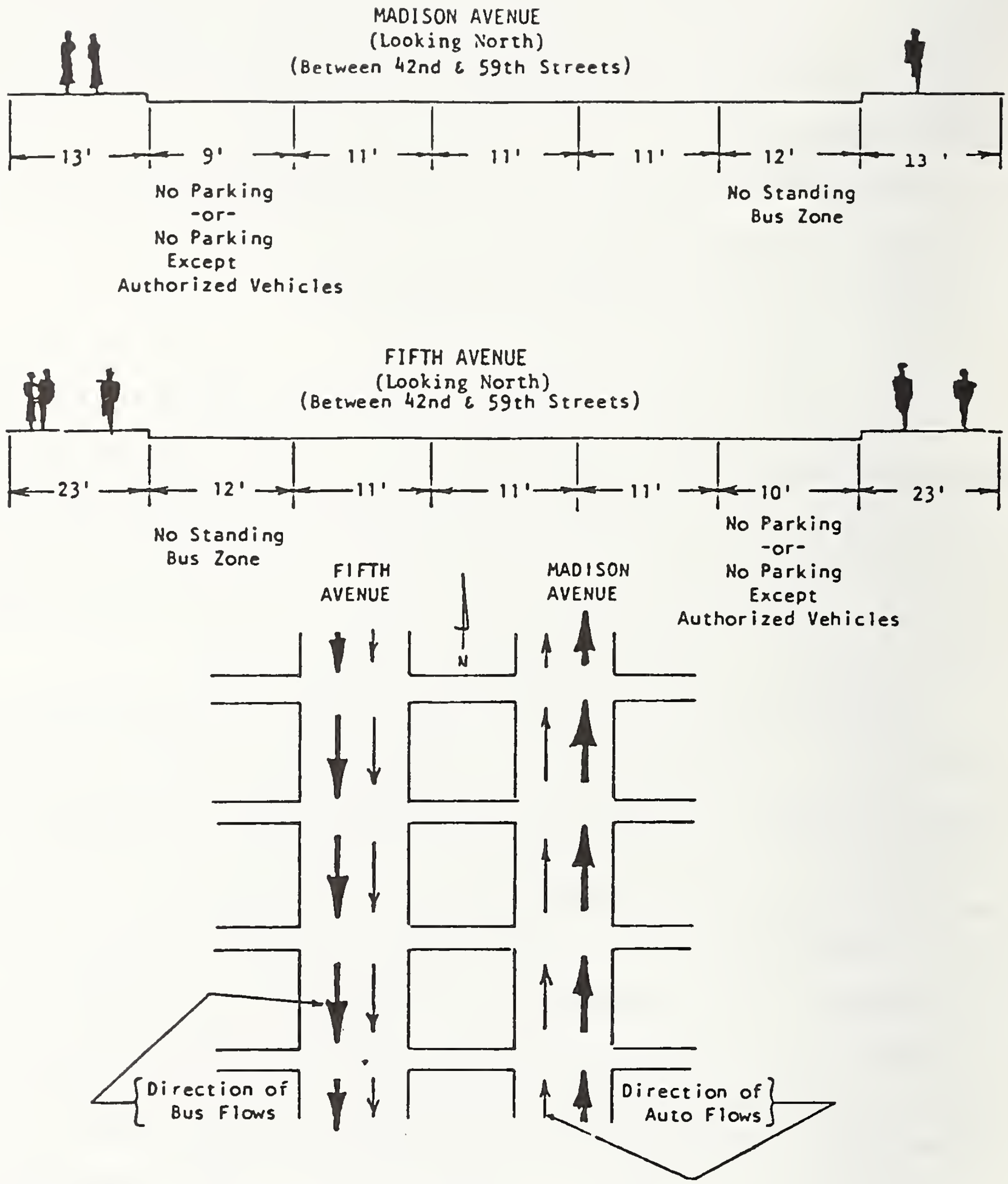
Five alternative priority treatment schemes were considered:

- a dual bus lane
- a contraflow bus lane
- a dual contraflow bus lane
- a transit street
- relocation of selected bus routes onto other streets.

Each alternative was assessed relative to its impacts on transit and traffic operations, curbside service, pedestrian circulation, and safety. In addition, the following were treated as variables in each basic design: physical separation barriers; uniform modal restrictions (e.g., no automobiles); temporal restrictions; and operational restrictions.

Considerable thought was given to the matter of traffic separation strategies, principally comparing the advantages and disadvantages of using physical barriers vs. other methods. Arguments for a physically-separated lane facility were not only to ease the problem of enforcement, thus ensuring unrestricted operation, but also to lend the appearance of permanence and political support for the particular facility, and as an endorsement for bus priority measures in general. Many disadvantages were seen in physical separation, however, including high construction costs and limited flexibility for alternative uses of the lane.

Diagrams of each of the major bus lane alternatives as well as the pre-existing situation are shown in Figures 3-1 through 3-5. It will be noted from Figure 3-1 that the Madison Avenue and Fifth Avenue corridors operate as a system for daily bus operations. Morning buses discharge incoming commuters on Fifth Avenue during the a.m. peak, while the same buses pick up returning passengers on Madison during the p.m. peak. Despite this daily sharing of bus operations, p.m. traffic conditions on Madison were considerably poorer than a.m. conditions on Fifth, further



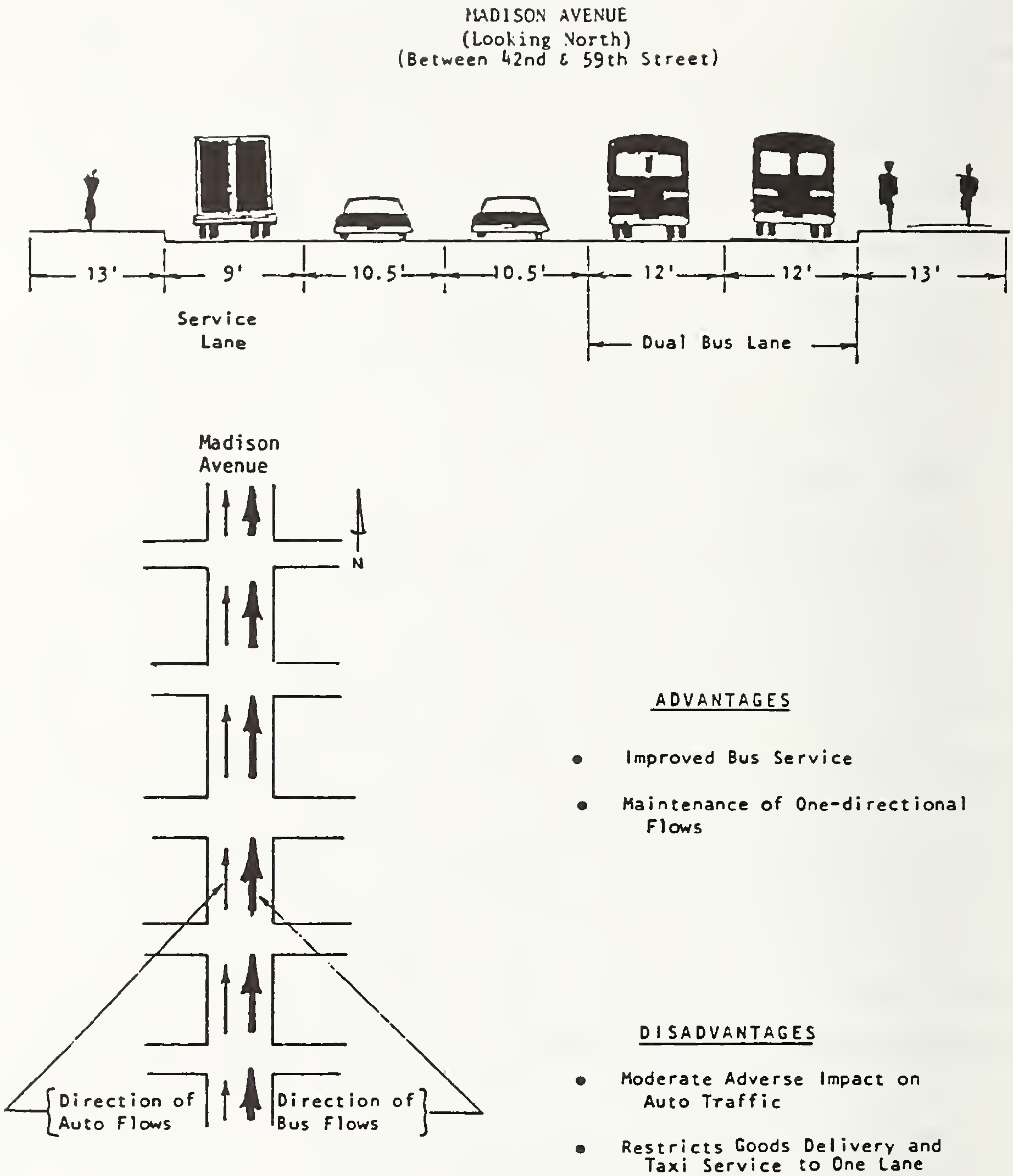
Source: Demonstration Grant Application, New York City Department of Transportation, May 1980.

FIGURE 3-1. PRE-LANE CONDITIONS ON MADISON AND FIFTH AVENUES

underscoring the importance of giving first consideration to Madison.

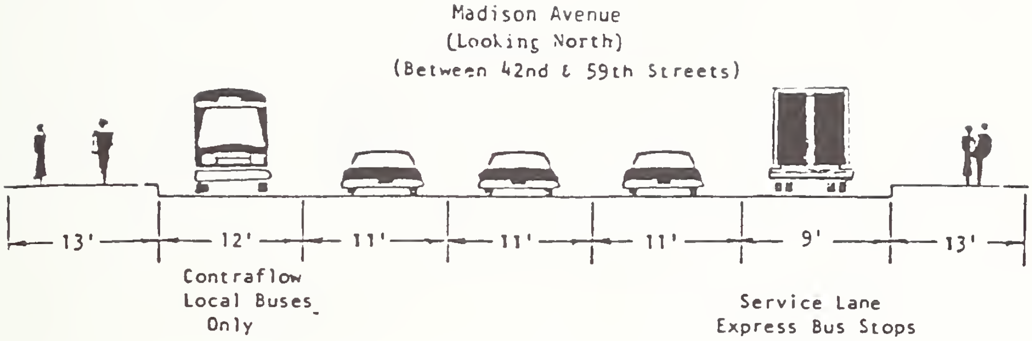
The first alternative suggested and studied was the dual bus lane scheme. As planned, this scheme, illustrated in Figure 3-2, would allocate two adjacent lanes to bus-only traffic along the east curb of Madison, firmly reserving the curb lane for bus use in servicing passengers, while providing a separate lane for moving buses to smoothly bypass stopped vehicles. The principal advantages of this alternative included the promise of much higher bus speed and smoother bus/passenger interfacing, as well as maintaining like direction of flow for bus and other traffic. The major disadvantages included reduction of roadway width to other traffic, restriction of goods delivery and taxi service to one lane only, and traffic flow difficulties for those right turn vehicles not permitted to use the bus lane.

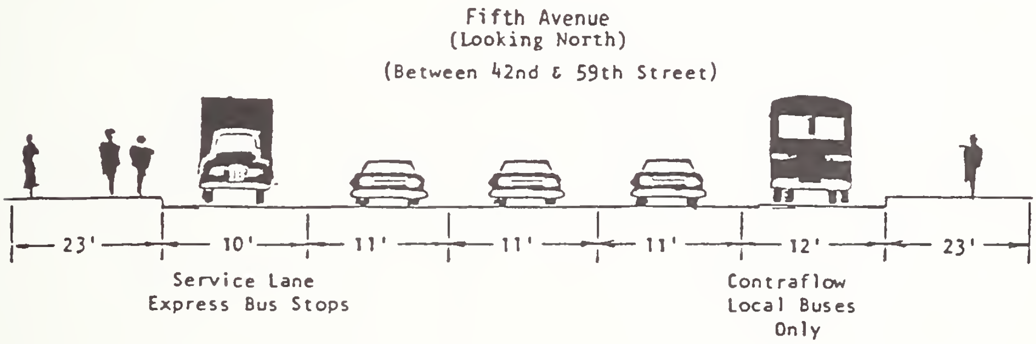
The second alternative, illustrated in Figure 3-3, featured provision of a single contraflow lane along the west curb of Madison and along the east curb of Fifth Avenue for local bus traffic, while maintaining existing conditions on the respective east and west curbs for express buses and taxi service. The system would allow for three moving traffic lanes at all times, plus a continuing service lane accessible to both taxi and freight users during the respective non-critical bus peak periods for the two facilities. The advantages of this alternative were the physical separation of local and express bus operations, immediate extension of the concept to Fifth Avenue in the Madison/Fifth Avenue system, and the self-enforcement aspect of the contraflow lane. Moreover, the single lane treatment posed the least impact to existing traffic flow conditions of any alternative. The disadvantages were principally the safety hazards, particularly in the beginning, to pedestrian and other vehicular traffic posed by buses moving in an unfamiliar direction at above-average rates of speed. The plan would also require major signal and sign modifications to accommodate two-directional flow, as well as provision of transitional zones, and a continued coexistence of non-bus service activities and local bus operations along the unaffected curb lane.

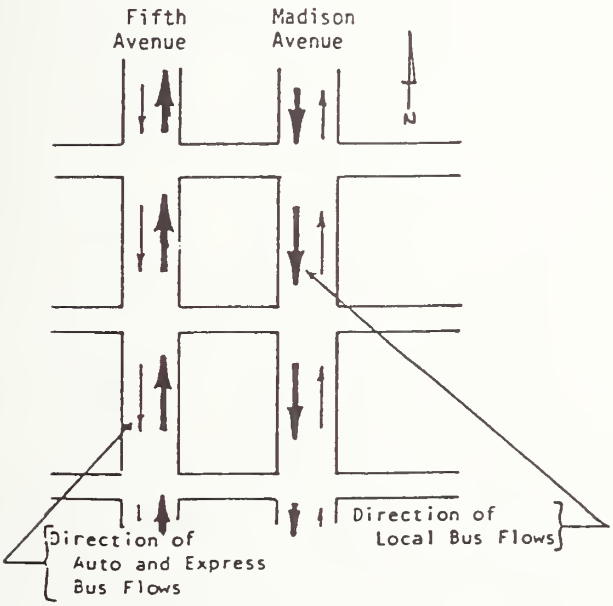


Source: Demonstration Grant Application, New York City Department of Transportation, May 1980.

FIGURE 3-2. DUAL BUS LANE ALTERNATIVE ON MADISON AVENUE







ADVANTAGES

- Improved Bus Service
- Self-enforcing
- Least Adverse Impact on Auto Traffic

DISADVANTAGES

- Two-directional Flow
  - Initial Pedestrian and Vehicular Safety Hazard
  - Re-education of Transit Patrons Required
- Restricts Goods Delivery and Taxi Service to Part of One Lane
- Two Avenues Affected
- Connections at Terminal Points

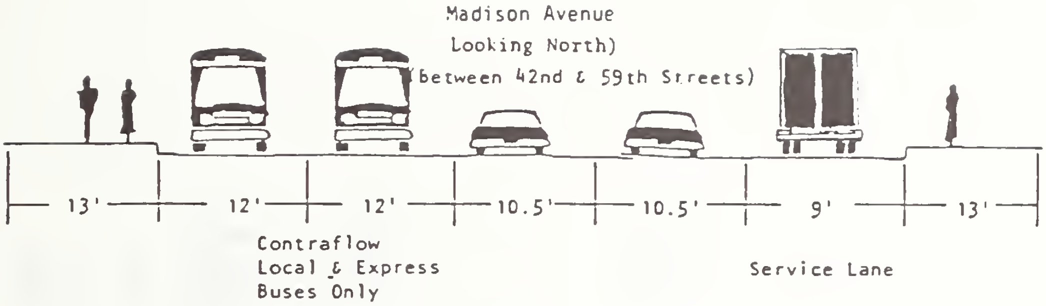
Source: Demonstration Grant Application, New York City Department of Transportation, May 1980.

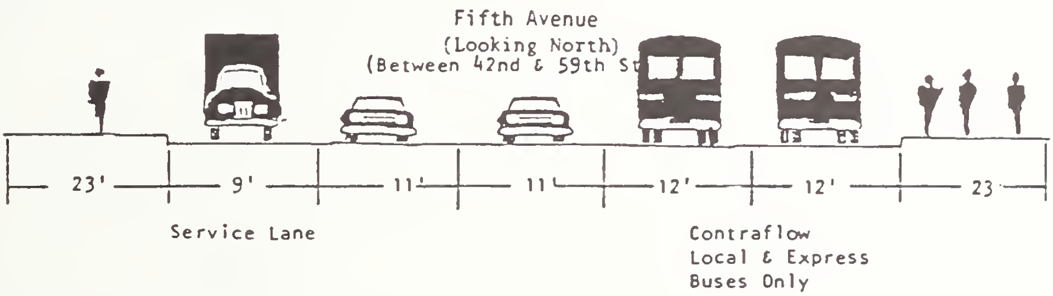
FIGURE 3-3. CONTRAFLOW BUS LANE ALTERNATIVE

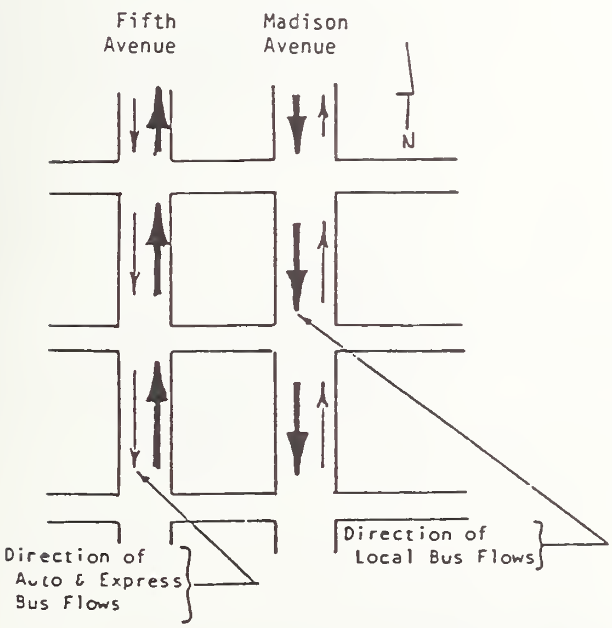
The third alternative was a dual contraflow lane system, pictured in Figure 3-4. This system placed a dual contraflow lane on both the west curb of Madison and the east curb of Fifth Avenue. Again, the major advantage of the contraflow alternative was self-enforcement, with the further advantage over the single-contraflow approach that both local and express buses could benefit from the self-enforcement. The dual lane would also allow buses to bypass each other without mixing with general traffic. The disadvantages again were in the safety concerns, traffic engineering modifications, and the permanent restriction of the contraflow lane and curb area to bus-only traffic.

The fourth alternative considered was the transformation of Madison into a transit street. Two variations on this basic theme were considered: prohibition of all vehicles except buses; and prohibition of private auto traffic (35% to 43% of all daily traffic), while permitting usage by buses, taxis and trucks (see Figure 3-5). The bus-only system alternative would have provided the greatest improvement in bus service of any alternative, as well as making dramatic improvements to the pedestrian environment (particularly if a lane were removed for additional sidewalk space). However, it also would have presented the most severe impacts on other traffic and commercial activity. The multi-user transit street was to incorporate a dual bus lane to facilitate passing maneuvers. Its principal disadvantage would have been its impact on private auto travel.

The fifth and final alternative involved no priority treatment, only the rerouting of selected bus operations. The most likely scheme involved rerouting express bus routes from Madison Avenue at some point between 42nd and 57th Streets, possibly via the existing 50th Street transit street, to an alternate northbound avenue. This scheme would merely redistribute bus traffic to a facility with less existing volume, with questionable impact on express bus travel times and user access, and adverse impacts on the facility to which the buses would be diverted.







ADVANTAGES

- Improved Bus Service
- Self-enforcing

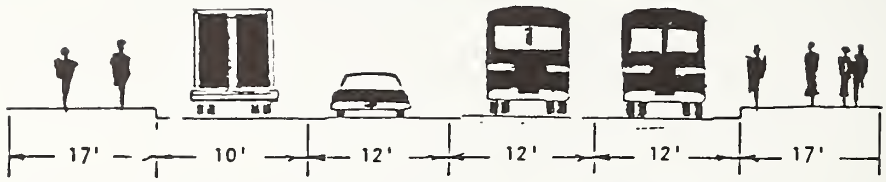
DISADVANTAGES

- Moderate Adverse Impact on Auto Traffic
- Two-directional Flow
  - Initial Pedestrian & Vehicular Safety Hazard
  - Re-education of Transit Patrons Required
- Restricts Goods Delivery & Taxi Service to One Lane
- Two Avenues Affected
- Connections at Terminal Points; Narrow Width of Avenue South of 42nd Street

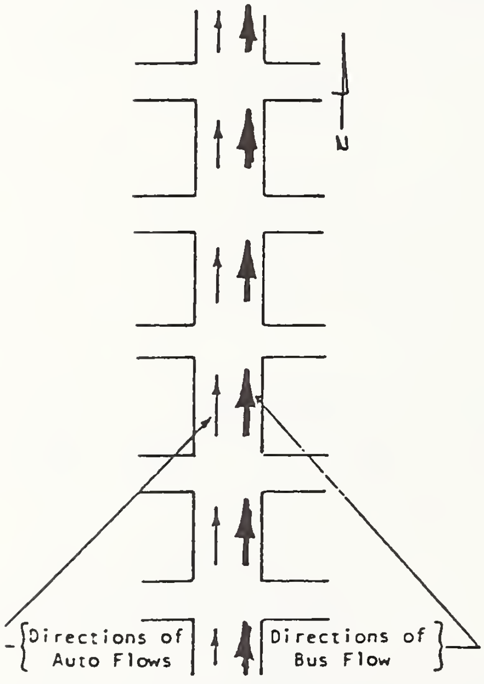
Source: Demonstration Grant Application, New York City Department of Transportation, May 1980.

FIGURE 3-4. DUAL CONTRAFLOW BUS LANE ALTERNATIVE

MADISON AVENUE
(Looking North)
(Between 42nd & 59th Streets)



Madison Avenue



ADVANTAGES

- Improved Bus Service
- Improved Pedestrian Circulation
- Maintenance of One-directional Flows

DISADVANTAGES

- Most Adverse Impact on Auto Traffic
- Restricts Goods Delivery and Taxi Service to One Lane

Source: Demonstration Grant Application, New York City Department of Transportation, May 1980.

FIGURE 3-5. TRANSIT STREET ALTERNATIVE (BUSES, TAXIS AND TRUCKS)

Alternatives were analyzed and compared relative to performance objectives and operational characteristics. The major objective was that of increasing overall bus travel speed and reliability. A secondary objective was to increase transit use in midtown, thereby reducing traffic volumes, improving traffic flow, and reducing vehicular pollution. Other objectives entered into the assessment included minimization of adverse impacts on traffic circulation, minimization of adverse impacts on taxi service and goods delivery, and minimization of construction and maintenance costs (including enforcement).

It was held that, in general, any improvement in bus operations would occur at the expense of traffic circulation, taxi service, and goods delivery, and that these were essential elements in maintaining the vitality of retail activities on and near Madison Avenue. Hence, the assessment of alternatives directly considered adverse impacts on these broader economic issues.

Impact analysis and selection was systematized through an Improvement Plan Selection Matrix, as shown in Table 3-1. Objectives were distilled into six impact areas:

- **transit operations**--increased bus speeds and reliability
- **traffic operations on Madison**--use of Madison by other modes, affecting trip lengths, travel times, deliveries
- **traffic operations on adjacent avenues and streets**--impacts on usage and level of service on adjacent facilities due to diversion from or circuity caused by the improvement
- **pedestrian environment**--pedestrian vs. right-turning vehicle conflicts, general congestion/pollution levels
- **curb access**--trucks and taxi freedom to make pickups and deliveries
- **ease of implementation/minimization of costs**--community acceptance, capital and operating costs.

3.4 SELECTION OF SCHEME AND DETAILED DESIGN

Based on the DOT's selection criteria, the dual with-flow alternative gained the highest cumulative score, and was selected

TABLE 3-1. IMPROVEMENT PLAN SELECTION MATRIX

Impact / Alternative	Transit Operations	Traffic Operations on Madison Avenue	Traffic Operations on Adjacent Avenues	Pedestrian Environment	Curb Access (Truck & Taxi)	Ease of Implementation/ Minimization of Costs	Total
Dual With-Flow Bus Lane	5	2	2	4	4	4	21
Single Contraflow Bus Lane	3	2	3	2	1	3	14
Dual Contraflow Bus Lane	5	2	2	2	4	3	18
Transit Street	4	2	1	4	4	2	17
Re-Routing	1	3	4	2	4	4	17

KEY:

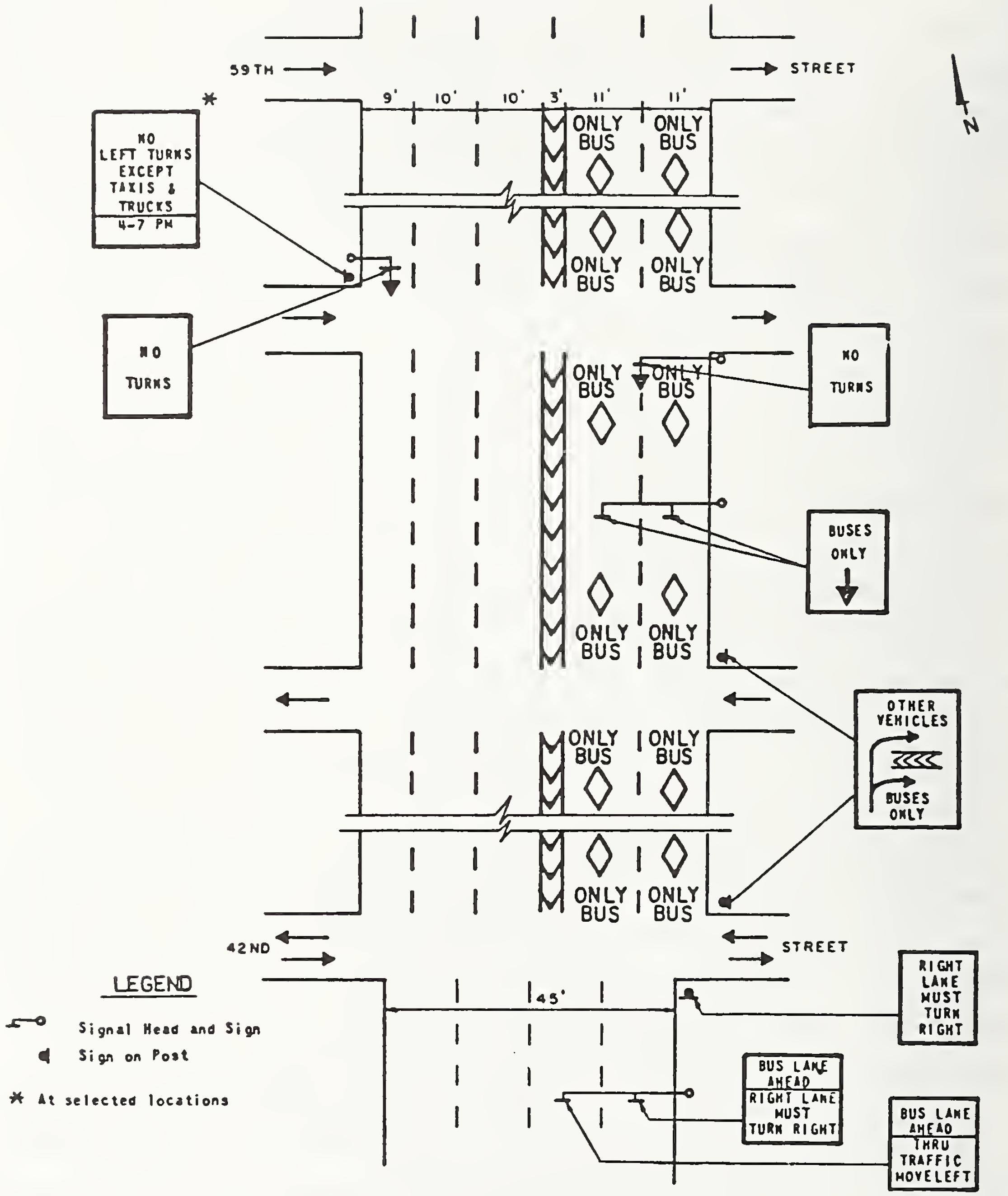
Numerical Value	Transit Operations	Traffic Operations on Madison Avenue	Traffic Operations on Adjacent Avenues	Pedestrian Environment	Curb Access (Truck & Taxi)	Ease of Implementation/ Minimization of Costs
5	Positive ↑	No Impact	No Impact	Positive ↑	No Impact	Low Cost
4						
3						
2						
1	No Impact	↓ Negative	↓ Negative	No Impact	↓ Negative	↓ High Cost

Source: Demonstration Grant Application, NYC Department of Transportation, May 1980 as the preferred alternative. The dual contraflow lane was second best, while the single contraflow lane earned the poorest rating overall.

Once selection of the primary alternative was completed, closer attention was given to design details related to operations. These included attention to right turn restrictions, hours of operation, separation devices, and enforcement needs.

For various reasons, the DOT decided not to separate the lane through use of a physical separation barrier (wall). The reasons included cost of installation, potential blockage under heavy bus traffic conditions, and inflexibility to change if plans or conditions were to be altered. As an alternative, a separation system was devised which relied on pavement markings and signing, as illustrated in Figure 3-6. The scheme involved separation of a 22-foot section of the 54-foot pavement through use of a 3-foot thermoplastic pavement strip, which further served as a buffer zone between moving traffic and the bus lanes. The 22-foot busway was deemed adequate in width to accommodate the maneuvers of buses pulling in and out from the curb and around stopped buses. The remaining 29 feet of pavement were apportioned into two 10-foot lanes for general traffic and a 9-foot service lane along the west curb. A new pavement mat was considered in order to provide a clean surface for the marking scheme, but eventually deemed unnecessary. The bus lanes themselves were marked with thermoplastic diamonds and the message "BUS ONLY." The lanes were to be further identified with overhead signs, both on Madison and on relevant cross streets, to apprise oncoming traffic of the restrictions.

A major impact on bus travel times along Madison was caused by the right turn movements of general traffic turning off Madison, which was then compounded by crosstown traffic delays in the same intersections. This difficulty inspired action on some type of right turn restriction plan. Four major schemes were considered: prohibition of right turns from the bus lane, with permission to turn from the middle lane; right turns from the bus lane at every other intersection with an eastbound street (every four blocks); right turns from the bus lane at all intersections;



Source: Demonstration Grant Application, New York City Department of Transportation, May 1980.

FIGURE 3-6. PROPOSED SIGNING AND PAVEMENT MARKINGS: MADISON AVENUE - 42ND TO 59TH STREETS and total prohibition of right turns from Madison over the length of the bus lane. After due consideration of the tradeoffs between circuity impacts on general traffic, impacts of turning movements on bus lane operation, and the cost and difficulty of additional signing and signalization, it was decided to uniformly prohibit all right turns over the length of the project. What this implied was that vehicles presently using Madison from origins south of 42nd Street and then turning right en route to crosstown destinations would be obliged to either travel northbound on 3rd, 6th, or Park Avenues, or to execute a left turn from Madison and circle the western block in order to access the area east of Madison. The DOT determined that approximately 10% of all vehicles making right turns off Madison had destinations on the blockface immediately accompanying the turn, and the right turn restrictions would mean that these vehicles would experience an increase of between 400 to 1,200 feet in trip length.

Although it was important to restrict the volume of right turn movements, the economic impact of such a restriction was clear. To ameliorate this impact, consideration was given to a compromise scheme which would allow taxis, as public passenger carriers, to also use the bus lane. However, given the small estimated percentage of taxi trips that would be affected when balanced against the impact that taxi volumes would have on the desired flow conditions of the lane (40% to 60% increase in V/C ratio), this proposal realized an early defeat.

Since the bus lane facility was to be closed to all but bus traffic, and because no physical separation barrier was to be used, enforcement of the lane space against violation by other traffic became a major concern. Demarcation of the lane was to be enhanced by signing measures and also concrete curbing segments at the start of each block. However, the DOT believed that the physical measures would do little to deter violations when conditions became cramped. They therefore built into the design a plan to use enforcement agents, who would be assigned exclusively to the bus lane and vested with the authority to issue citations to all travelers illegally driving in the bus lane or attempting to make right turns off Madison. For the initial period of operation of the lane, the DOT planned to field an enforcement squad of twice what it felt would be the "normal" operating size in order to facilitate the public's transition to the lane. This plan required a staff of 24 agents (and 5 supervisors) who were assigned to each Madison Avenue intersection between 42nd and 59th Streets. Agents would be on duty at all times when the lane was in operation.

A final design issue was the temporal operation of the lane, i.e., whether it would be a part-time or full-time facility. Without a permanent physical separation barrier, the lane area could be eligible for alternative uses. However, it was concluded that to make the lane less than a full-time facility would reduce its identification to the public and render it more difficult to enforce. Hence, a 7-day, 24-hour operating policy was adopted.

3.5 COMMUNITY INVOLVEMENT

In addition to the technical planning and design activity, a central aspect in the development of the priority lane was the community interfacing and public relations program. DOT project staff actively gathered data from travelers and business establishments during the entire planning and design phase to evaluate the impacts of the different lane strategies on existing travel patterns. As the project developed, interested community and professional groups were brought into the planning process. By the time of implementation, 64 separate organizations had been exposed to or had participated in the project design. Important negotiations took place between the DOT and bus and taxi operators, commercial interests, and other institutions in order to formulate an adequate design that would capture public support.

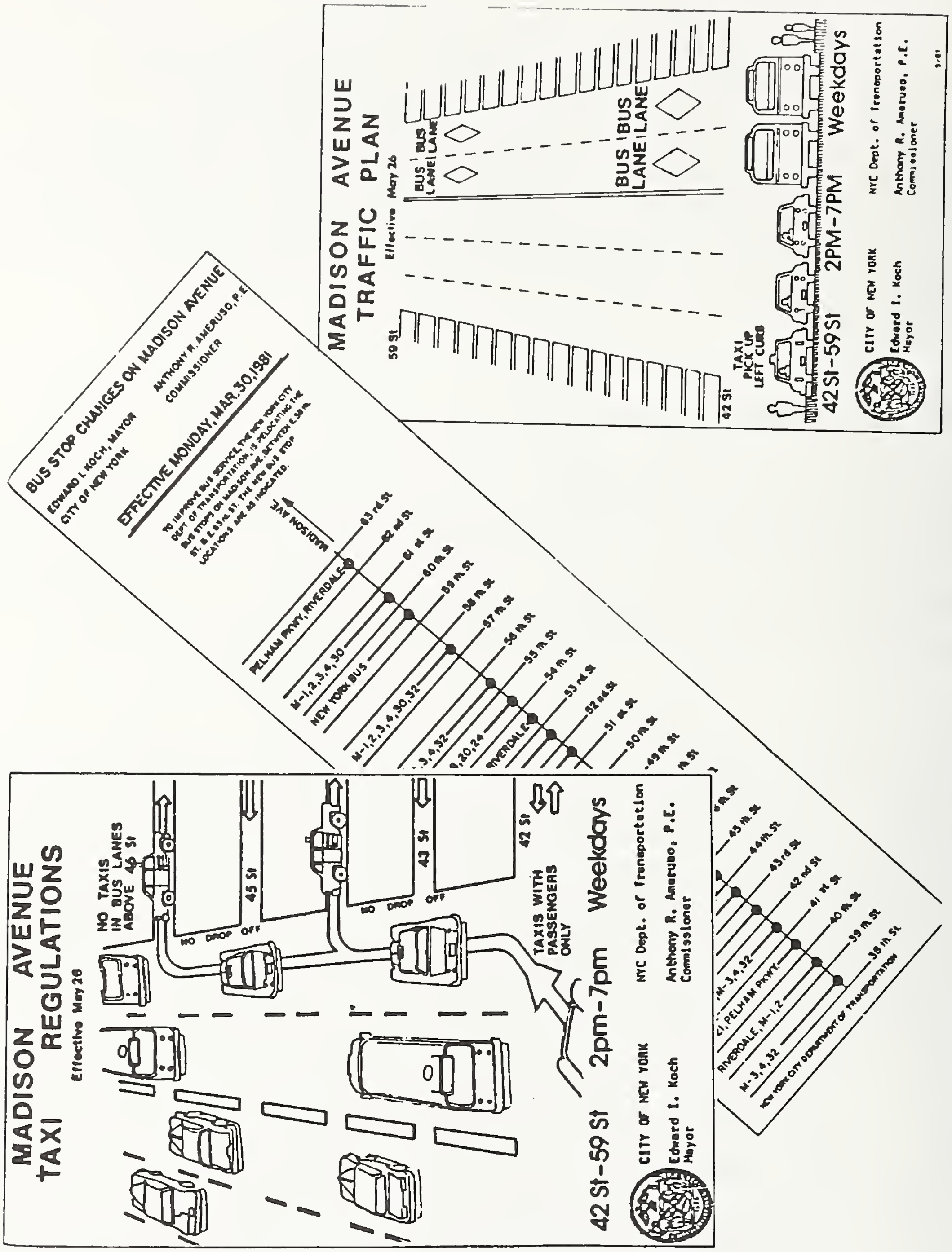
Major project developments also received regular media attention. A public information campaign was conducted in conjunction with each project element, primarily through the distribution of fliers and direct contact with affected individuals and groups. Sample public information fliers are shown in Figure 3-7.

It was also necessary to monitor and coordinate with the construction of four major buildings on Madison, as well as street openings by utilities to insure smooth implementation of the project on schedule. Special meetings were held with involved parties, and rules established which forbade activity during the hours of lane operation, except for verified emergencies.

3.6 PRE-IMPLEMENTATION DESIGN MODIFICATION

As a result of the community interaction process and two eventual postponements in the project startup date (due to uncontrollable events), additional time for planning and reflection was realized, causing a number of modifications to be worked into the design before the actual implementation occurred on May 26, 1981.

One of the major changes was a reduction in the period of operation of the lane. Questions arose within the DOT regarding whether bus volumes throughout the day could justify a full-time exclusive facility. If not, imposing a full-time restriction would impose economic hardship on and carry equity implications for other traffic, and potentially undermine the lane's chances for permanent acceptance and support. Based on a review of available traffic data, the lane hours were first cut back to include only the midday and p.m. peak periods, i.e., from 10 a.m. to 7 p.m. However, before the scheduled April 21st implementation, additional questions were raised concerning the choice of hours, and it was decided to acquire new data and reevaluate the plan. The start date was subsequently rescheduled to May 26, during which time new data were collected on traffic volumes and its lane distribution by time of day on Madison. From this data it was concluded that the most justifiable plan was a facility which operated between the weekday hours of 2 p.m. and 7 p.m. This necessitated a last-minute change in sign lettering, and



Source: Demonstration Grant Application, New York City Department of Transportation, May 1980.

FIGURE 3-7. PUBLIC INFORMATION FLIERS

also a decision to replace the curbing segments (traffic separators) at the beginning of each block with temporary roll-out signs. This revised scheme is pictured in Figure 3-8.

Because the dual bus lane would be taking away one of the three center lanes on Madison, which is where most traffic was concentrated, an important element of the plan was to limit parking along the west curb of Madison to allow that curb lane to function as a flow lane. This meant institution of a general parking ban along Madison, consisting of both rezoning and increased enforcement. Authorized parking was relocated to various cross streets, and taxi stands were eliminated. Replacing these were two regulations: "No Standing Except Trucks Loading and Unloading, 7 a.m. to 1 p.m., Except Sunday"; and "No Standing, 1 p.m. to 7 p.m., Except Sunday." This was to allow vehicles to turn left from the curb lane during hours of bus lane operation and to change the second-from-left lane from a turning lane to a through lane. This change in restrictions led to a stepped-up program of enforcement against parking violators. Parking enforcement in midtown was stepped-up generally, but special efforts were directed at Madison Avenue during the period preceding implementation of the lane through the first month of operation. The existing corps of Manhattan parking agents was condensed for this "blitz" period and trained onto the midtown area. They were specifically drilled on the swift administration of citations to offenders in order to effectively demonstrate the serious intent of the ban. The revised parking restrictions and the "blitz" went into effect on May 5, 1981.

Also during the delay period between the originally-planned fall 1980 implementation and the actual spring 1981 implementation, two other changes in the preliminary design occurred: repositioning of bus stops along Madison, and the granting of selective use of the lane to taxicabs. Under strong pressure from business and the taxi industry, the DOT consented to allow taxis to use the lane and to make right turns within the 42nd-to-46th Street segment of Madison. This was largely to maintain access to Grand Central Station and several major hotels in that area, and only taxis carrying passengers upon entry were to be

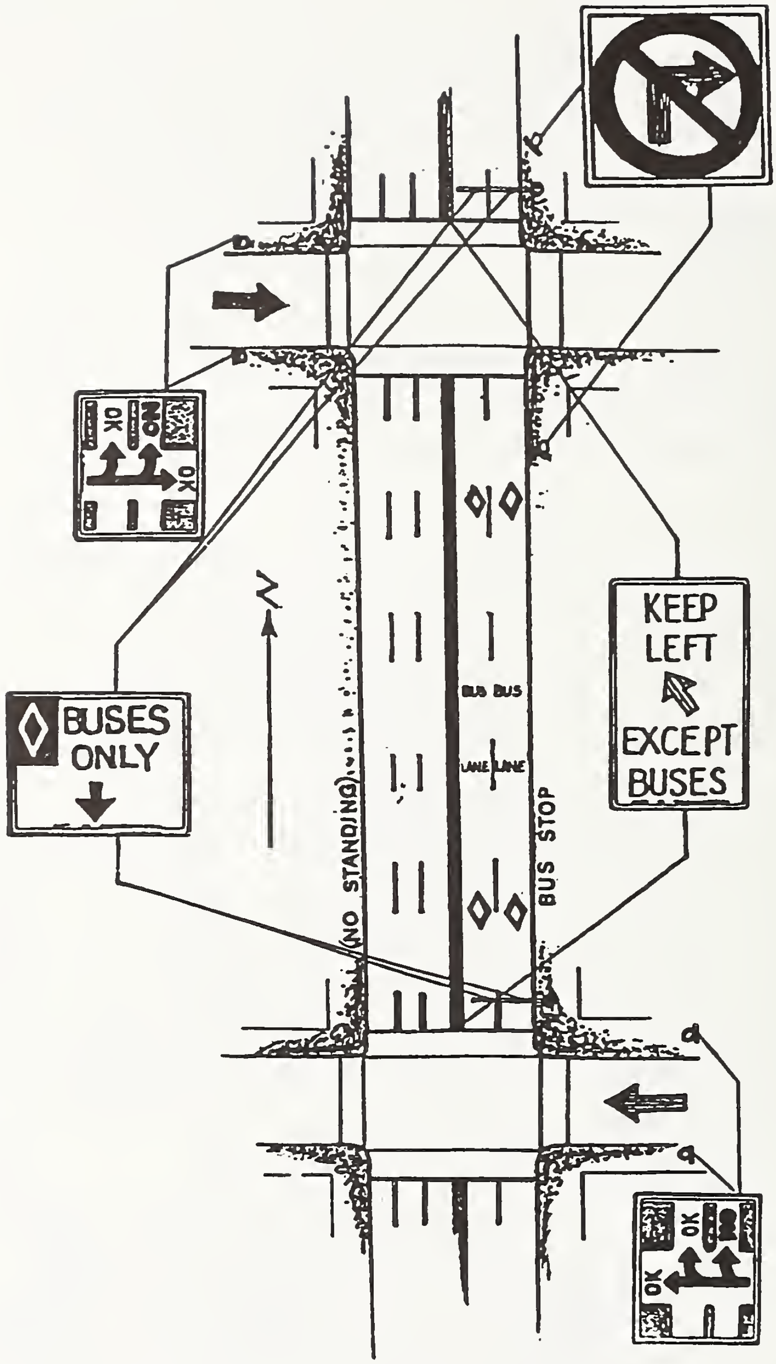


FIGURE 3-8. MADISON AVENUE DUAL BUS LANE PLAN

permitted to use the bus lane. The second action, the respacing of the bus stops, occurred in conjunction with the New York City Transit Authority's broader "Guide-a-Ride" program. This program was designed to optimize bus stop frequency relative to travel time, congestion, and demand, as well as distinguishing local bus service from express. Stops for local buses between 38th and 63rd Streets on Madison were changed from every other block on average (about 500 feet) to every third block (about 750 feet). The distance between express bus stops was changed from an average of every 5 blocks (about 1,250 feet) to every 7 blocks (about 1,750 feet). In general, the stops were removed from critical block faces, e.g., at 42nd Street where the bus lane would begin, approaching 46th Street where heavy turning volumes of taxis were expected, at 57th Street where several of the routes turn east, and approaching 59th Street where the bus lane would end and most express bus traffic would turn right. The stop changes went into effect on March 30, 1981.

3.7 IMPLEMENTATION

The Madison Avenue dual bus lane was formally implemented on May 26, 1981. Improvements in bus operations and travel time were immediately evident, as shown by the before and after photos in Figures 3-9, 3-10, and 3-11. Bus speeds virtually doubled during the first few days of operation, and even during the high-volume evening peak period there was a dramatic improvement in bus operations. Difficulties in maneuvering in and out of the curb lane were largely eliminated. At the same time, general traffic flow experienced no major degradation in level of service, due largely to the simultaneous parking and right turn restrictions. Lane violations were relatively modest due to the high level of enforcement; most were misunderstandings of the formality of the lane, and were resolved by the enforcement agents through diplomacy rather than by punitive action. All of these initial successes helped sell the lane to the public, the press, and local officials, giving it support during its first crucial weeks of testing and acceptance. Political support and

FIGURE 3-9. MADISON AVENUE DURING P.M. PEAK BEFORE BUS LANE

FIGURE 3-10. MADISON AVENUE BEFORE BUS LANE ILLUSTRATING RIGHT TURN/PEDESTRIAN CONFLICTS

FIGURE 3-11. MADISON AVENUE DURING P.M. PEAK WITH PRIORITY LANE

public acceptance has been favorable over the course of the demonstration, and since May 26, 1982 the lane has been operated by the City of New York as a regular feature of its public transportation network.

3.8 ENFORCEMENT

As previously discussed, a major factor in the successful operation of the Madison Avenue bus lane is enforcement, particularly since permanent physical barriers have not been used to separate the lane from general traffic. As any visitor to New York knows, Manhattan streets are a study in facility utilization. Traffic volumes are dense, and vehicle operators competitive and single-purposed in completing their travels in the most expedient fashion. Traffic violations are frequent and routine, as would be expected when resources are stretched to their maximum.

For this reason, the NYC DOT was understandably concerned about whether the bus lane boundaries would be respected, and devoted considerable attention to the matter of enforcement. In fact, enforcement emerged as the single largest expense item in the project budget, comprising 75% of total resources. It became apparent to the DOT that for the City to accept both the lane as a permanent feature of the midtown transportation system and the long term financial responsibility for its operation, cost-effective alternatives to the initial program of full enforcement would have to be found.

In November and December 1981, and again in March 1982, the DOT conducted experiments of various alternative enforcement schemes. The alternative enforcement plans tested different combinations of three basic enforcement actions--traffic agents, traffic cones, and rollout signs (prohibition signs cemented into a drum base and "rolled" out onto the separation barrier during periods of lane operation as shown in Figure 3-12). Strategies were operated for a period of one to several days each and were evaluated for effectiveness by the DOT using video-tape records. Measures used for evaluation consisted of violation rates (lane

FIGURE 3-12. ROLL-OUT SIGNS

violation, turn violations, and total), volumes (bus and other), and speeds (local and express bus). The results of these tests are summarized in Table 3-2.

Using violation rates as a basis, the test results seem to confirm the obvious, i.e., that there is no immediate substitute for the physical presence of enforcement agents. Four of the top five plans all incorporated agents. However, the use of traffic cones also seems to have been an effective deterrent to lane violation. In fact, plan A, which uses only half the regular agent force along with cone separators, proved to be more effective than plan B with the full agent force without cones (enforcement plan for the first 7 months of operation). It should be noted, however, that the "half-enforcement" plan uses 16 agents and 4 supervisors rather than the 24 agents and 5 supervisors under the full enforcement plan, so it is somewhat more than half. Plan D, which used no agents at all but relied solely on cones and rollout signs, was almost comparable to plan C with a half-strength agent force and rollouts, and was almost twice as effective as the scheme with half-strength agent force and no rollouts or cones. If the cones have a weakness, it appears to be in the discouragement of right turns, which is where the traffic agents are most effective. Cones seem to be the most effective deterrent for lane violations, however, even more than simply the agents. Rollout signs also appear to be of value, though not nearly as much as the first two actions. As seen in the difference between plans F and G, the signs do have some impact.

From these experiments the NYC DOT concluded that plan C, which used the half-strength agent force and rollout signs, was the most effective alternative for long-run operation. While during the test, plan D, which used the rollouts and cones, appeared as effective as plan C, the DOT felt that plan C was superior for both cost and performance reasons. In terms of performance, the DOT believed that the physical presence of the agents would have a more lasting impact on the public's respect for the lane, while the cones might be more easily violated. The DOT also felt that plan C could be less costly. It estimated that the agent force could ultimately be reduced to as few as 8, which it felt would cost the City about $120,000 a year ($15,000 per agent). In comparison, it felt that the distribution and collection of cones on a daily basis would require a full-time team of four workmen plus a supervisor, a driver, and a truck, totaling about $150,000 per year. These cost estimates are subject to some question; in particular the project's experiment with a reduced agent force, as explored in Section 4.4.2 on Cost Impacts, cost closer to $364,000 a year. The plan D system, meanwhile, assumes no alternative use of the cone placement crew beyond the 1-hour placement task at the beginning and end of the bus lane operating period; hence, the $150,000 cost estimate is probably pessimistic. In review, it appears that the enforcement plan which employs the traffic agents is favored because of the presence of authority, which may very well be essential to the lane's long term operational viability. However, it is not clearly the least cost alternative.

No attempt has been made by this evaluation to assess the enforcement strategies from the standpoint of traffic volumes or bus speeds. The speed/volume data in Table 3-2 generally represent one-time measures, and hence are not regarded as statistically reliable.

TABLE 3-2. ALTERNATIVE ENFORCEMENT STRATEGY EXPERIMENT

Case	Enforcement Plan			Violations			Volumes		Bus Speeds	
	Agents	Rollouts	Cones	Lane	Turns	Total	Cars	Buses	Local	Express
A	1/2	Yes	Yes	17	13	30	948	98	7.8	10.4 mph
B	Full	Yes	No	34	8	42	1168	128	5.1	13.4
C	1/2	Yes	No	28	22	50	1044	117	6.4	13.7
D	No	Yes	Yes	27	24	51	991	96	6.4	9.5
E	1/2	No	No	52	17	69	1171	85	7.9	15.7
F	No	Yes	No	37	45	82	1064	90	7.0	7.5
G	No	No	No	96	40	136	1077	95	7.9	8.1

4. PROJECT IMPACTS

4.1 INTRODUCTION

This section describes the impacts of the Madison Avenue dual exclusive bus lane project in the general categories of level of service changes, demand and mobility impacts, and productivity and economics. The emphasis of the evaluation is on level of service changes, particularly for buses, but also to other street traffic as a consequence of the bus priority treatment. Improvements in bus speed due to the project changes have been considerable, while impacts on other traffic apparently have been minimized. Major bus ridership gains were not expected to result from the lane, and indeed they have not. Similarly, the productivity of bus operations on Madison Avenue has improved to the extent that schedule adherence and reliability have been enhanced; however, the gains in travel time have not been sufficient to alter operations.

Numerous data have been collected to evaluate the impacts of the Madison Avenue bus lane. These data were collected at various points in time, as summarized in Figure 4-1, representing conditions prior to implementation, conditions just following implementation, conditions just prior to a major change in lane enforcement policy, and conditions just prior to the end of the demonstration. Some before-project data were collected in the spring and fall of 1980, when it was assumed that the lane would be implemented in the fall of 1980. Additional before data were subsequently obtained in the spring of 1981, after it was decided to delay implementation until May 1981.

Post-implementation data were collected at three points in time: immediately after implementation (summer 1981), before the changes in lane enforcement procedures (fall 1981), and just before termination of the demonstration period (spring 1982).

Type Data	Pre-Implementation	Post-Implementation
Bus Travel Times (License Match)	*November 1980 April 1981	May/June 1981 +November 1981 March 1982
Bus On-Board Travel Times (COMSIS)	April 1981	Nov 1981 March 1982
Auto Travel Times	October 1980 Feb-April 1981	May/June 1981 Oct/Nov 1981
Traffic Volume Counts	October 1980 May 1981	May/June 1981
Vehicle Classification	April 1980 July 1980 May 1981	May/June 1981 March 1982
Lane Distribution	April 1981	May/June 1981
Turning Movements	Jan/Feb/Mar 1981 May 1981	May/June 1981 March 1982
Bus Occupancy	April 1981	June 1981
Bus Ridership	Jan-May 1981 (express) April 1981 (local)	June-Dec 1981 (express) May/June 1981 (local)
Bus On-Board Rider Surveys		March 1982
Lane Violation Rates		Nov/Dec 1981 March 1982
Curb Usage Surveys/ Right Turn Prohibition		+Nov/Dec 1981 +March 1982

*Data rejected by evaluation because of accuracy

+Data rejected by NYC DOT because of collection problems

FIGURE 4-1. SUMMARY OF DATA COLLECTIONS

4.2 LEVEL OF SERVICE

The level of service analysis concentrates on lane impacts on transit performance, such as bus speed and reliability, and impacts on other traffic activity in the vicinity of the project, such as travel speeds and volumes, turning movements, and vehicle mix.

4.2.1 Impacts on Transit Performance

This analysis measures transit performance in terms of bus travel time and reliability. Two types of travel time measurements were made in conjunction with the exclusive bus lane: total time to travel the length of the project improvement, measured by street-level observers using license plate matching techniques; and on-board measurement of travel time by delay component, i.e. running time, passenger service time, and signal/traffic delay time. Reliability, as defined by the study, simply measures the standard deviation in travel time along Madison Avenue, and does not consider schedule adherence, per se.

4.2.1.1 Bus Travel Times (License Match Data) - Bus travel times on Madison Avenue have been reduced considerably due to the exclusive bus lane project. It should be pointed out, however, that it is this "body of improvements", and not the bus lane alone, that accounts for the improved performance. These various changes included elimination of parking (and double parking) from the west curb area, elimination of right turns off Madison, and respacing of the bus stops on Madison. These changes improved overall traffic flow, and bus operations as a result. Changes in the method of lane enforcement have also had an effect on bus performance.

Traffic flow difficulties on Madison Avenue before the bus lane were the result of several interrelated problems. Bus operations had to vie with all other forms of traffic in use of the eastern curb (location of the bus lane), even though that curb lane was signed for buses only. Also, right turn traffic significantly mixed with and impeded bus flow. However, Madison Avenue before the demonstration project was also a very crowded and inefficient facility, particularly with regard to the western curb lanes. Parking violations were very common along the west curb, rendering that lane useless for moving traffic. Moreover, the adjacent lane was also frequently congested with double-parked vehicles, which significantly reduced the serviceability of that lane. To have simply instituted the dual bus lane without attending to these other conditions may have produced a better environment for buses, but would probably have produced unacceptable travel impacts on the facility as a whole.

Bus travel times before and after implementation of the bus lane are illustrated in Figure 4-2 and summarized in Table 4-1. The data used for these comparisons were derived from license plate matching techniques. This method consists of recording, by observers stationed at the beginning and end of the bus lane segment, the license number of randomly passing vehicles simultaneous with clock time to the nearest second. Subsequently, vehicles were matched by license number and their travel times computed.

License match data were obtained on three separate occasions:

- In April 1981, preceding implementation of the bus lane but following the bus stop respacing.
- In late May and June 1981, immediately following lane implementation and reflecting conditions under "full" enforcement;
- In March 1982, preceding the end of the demonstration and reflecting stable operating conditions and "half" enforcement.

These travel time data suggest that the bus lane and related changes had a considerable effect on bus operations on Madison Avenue. Travel time reductions range from 33 percent to almost 50 percent. However, not all of these changes can be statistically validated. Traffic conditions in midtown Manhattan are highly variable, because facilities are so often pushed to capacity. Traffic speeds and volumes can vary by as much as 100% from season to season and even from day to day. Thus, even though the number of license plate observations was quite large, in some cases the background variation overwhelms the ability of

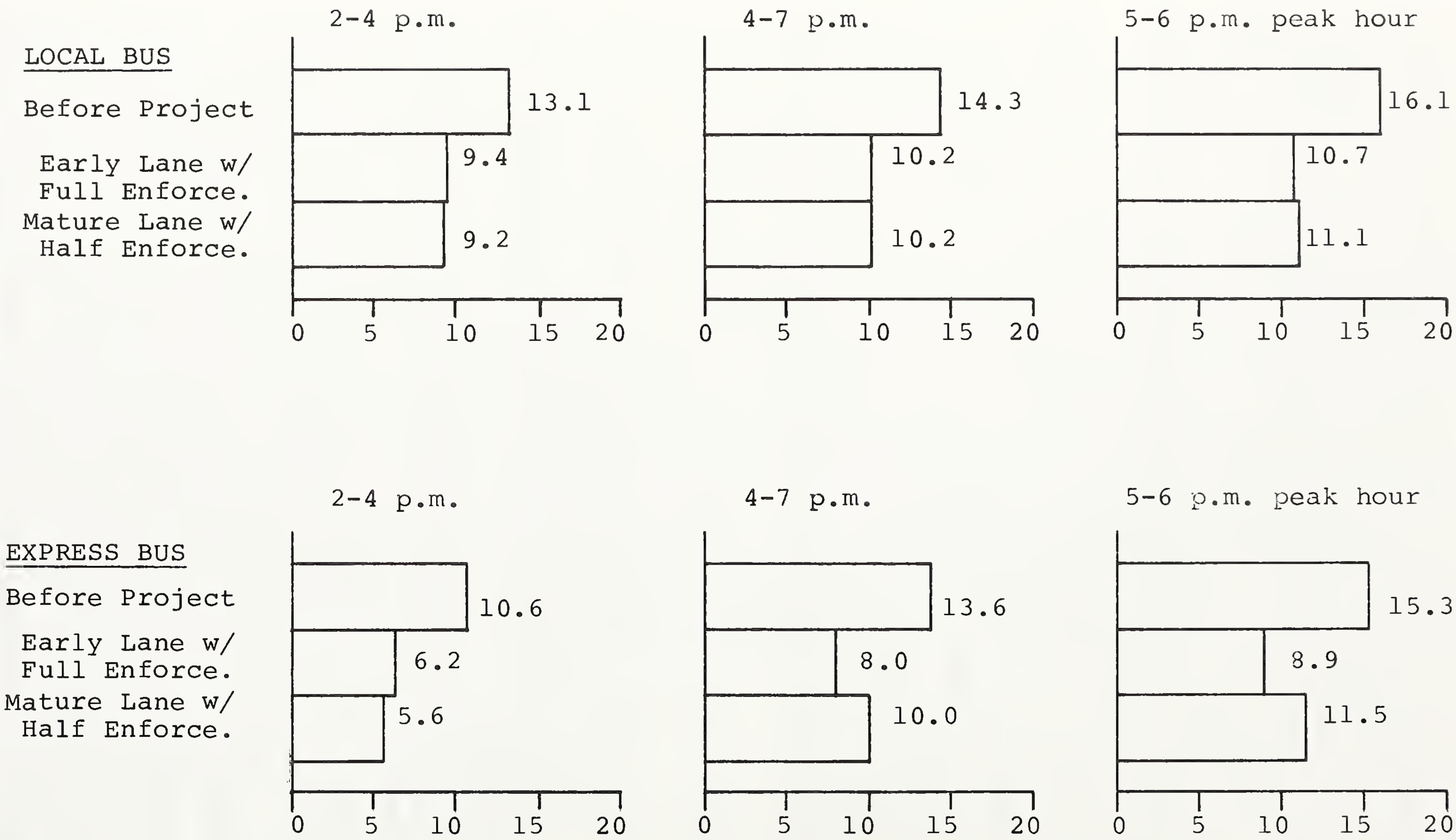


FIGURE 4-2. BUS TRAVEL TIME COMPARISONS:
MADISON AVENUE--42ND TO 59TH STREETS
(TRAVEL TIME IN MINUTES)

TABLE 4-1. ANALYSIS OF BUS TRAVEL TIME CHANGES: MADISON AVENUE--42ND TO 59TH STREETS (LICENSE PLATE MATCH DATA)

(Travel Time in Minutes)

Conditions	2 - 4 p.m. Local	2 - 4 p.m. Express	4 - 7 p.m. Local	4 - 7 p.m. Express	5 - 6 p.m. Local	5 - 6 p.m. Express
Pre-Lane (Apr '81) vs. Lane w/Full Enforcement (June '81)	13.1 (I) 9.4	10.6 (I) 6.2	14.3 (I) 10.2	13.6 (I) 8.0	16.1 * 10.7	15.3 * 8.9
Pre-Lane (Apr '81) vs. Lane w/Half Enforcement (March '82)	13.1 (I) 9.2	10.6 * 5.6	14.3 * 10.2	13.6 * 10.0	16.1 * 11.1	15.3 * 11.5
Lane w/Full Enf. (June '81) vs. Lane w/Half Enforcement (March '82)	9.4 (I) 9.2	6.2 (I) 5.6	10.2 (I) 10.2	8.0 (I) 10.0	10.7 11.1	8.9 * 11.5

* - Travel time difference significant at 95% confidence level.

(I) - Insufficient data for analysis.

For Sample Size and Standard Deviation, see Table A-1 in Appendix.

the data to demonstrate what appear to be large changes with statistical confidence.

What can be shown with confidence (Table 4-1) is that bus travel time declined significantly for both express and local buses during the evening peak period for that portion of the route affected by the bus lane, i.e., from 42nd to 59th Streets on Madison. The most dramatic change occurred during the 5-6 p.m. peak hour, where local bus travel times declined from 16.1 to 10.7 minutes (33.5%) for the 42nd to 49th Street Madison Avenue segment of the trip, and from 15.3 to 8.9 minutes (41.8%) for express bus. These changes were significant at the 95% confidence level. During the entire 4 to 7 p.m. peak period, reductions appeared to be of about the same magnitude: from 14.3 to 10.2 minutes (28.7%) for local bus and from 13.6 to 8.0 minutes (41.2%) for express. Unfortunately, the June 1981 data are insufficient to determine whether these changes or those occurring in the off-peak (2-4 p.m.) are significant.

The second set of post-implementation data, obtained in March 1982, are sufficient for analyses. These data, when compared to the pre-implementation conditions, show a statistically significant reduction in travel time for both local and express bus for all time periods (except the 2-4 p.m. off-peak for local bus, where the data are insufficient). Moreover, a change was demonstrated despite the suggestion from the data that bus travel times were higher in March 1982 than in June 1981 due to the change in enforcement policy, from full enforcement to half-enforcement. From the data, it appears that travel time went back up slightly for express bus in the 5-6 p.m. peak hour, increasing by 2.6 minutes, diminishing the reduction relative to the before case to 33 percent. Local bus does not appear to have been affected at all by the change in enforcement policy.

4.2.1.2 Travel Time Reliability - In addition to reducing average total travel time for Madison Avenue buses, the bus lane and related improvements also had the effect of reducing the variation in travel time, which will be used here as a measure of reliability. The specific measure used is the standard deviation in travel time relative to mean travel time as measured during the April 1981 pre-implementation period. Table 4-2 shows how reliability (according to this measure) was affected by the various improvements.

Table 4-2 indicates that the improvements generally caused a reduction in travel time variability. In all cases, the variability in express bus travel time seems to exceed that of local bus, though improvements due to the project were of a comparable level. Where there are data available (5-6 p.m. peak hour), it appears that variability was less under full enforcement than with half enforcement. Comparing pre-project with March 1982 (half enforcement) data, it appears that local bus travel time variability fell from 39.8 percent to 16.4 percent in the p.m. peak (4-7 p.m.) and from 26.1 percent to 13.6 percent in the 5-6 p.m. peak hour. No data are available to compare the off-peak. In comparison, express bus realized improved reliability in the p.m. peak (4-7 p.m.) from 40.4 percent to 26.9 percent, and from 41.8 percent to 24.0 percent in the p.m. peak hour.

4.2.1.3 Bus Travel Time By Component (On-Board Measurement) - In addition to measuring bus travel time with the license plate match approach, on-board measurements were also taken. The purpose of the on-board readings were twofold:

- o to serve as overall checks on the license match travel time
- o to determine from what component of operations the travel time savings are derived.

On-board travel time observers recorded three elements of travel time: (1) boarding time, or the time required to pick up and discharge passengers; (2) signal delay time, or the time during which the vehicle is at rest in a signal queue; and (3) running time, or the residual time when the vehicle is either in motion or at rest due to non-signal or non-passenger delays.

Table 4-2. BUS RELIABILITY

Comparison of Variation in Travel Time
(Standard Deviation as Percent of Mean Travel Time[1])

Conditions	2-4 p.m. Local	2-4 p.m. Express	4-7 p.m. Local	4-7 p.m. Express	5-6 p.m. Local	5-6 p.m. Express
Before Project (April 81)	NA	26.4	39.8	40.4	26.1	41.8
Bus Lane with Full Enforcement (June 81)	NA	NA	NA	NA	11.8	18.2
Bus Lane with Partial Enforcement (March 82)	13.2	14.1	16.4	26.9	13.6	24.0

For sample size and standard deviation, See Table A-1 in Appendix.

[1]Mean travel time represents April 1981 base period.

These travel time estimates by component for peak and off-peak conditions are summarized in Table 4-3. Data were obtained at three points in time for three different bus services. The collection intervals were: April 1981, the period following the bus stop respacing but prior to the bus lane and parking ban; November 1981, a period 6 months after implementation of the bus lane and just before full enforcement was ended; and March 1982, the period just before the end of the demonstration which reflects the partial enforcement conditions. April 1981 and March 1982 are coincident with the license match travel time measurements. November 1981 stands alone, however, since the license match times for this period were disregarded as faulty by NYC DOT.

The data also reflect three different types of services: express and two different locals. The locals are split into two groups: the route M-1 through M-4 group, which travels the entire length of the project (42nd to 59th Street); and the M32 group, which turns off Madison at 56th Street. It will be noted that the M32 group buses have slightly lower times to reflect this shorter distance. The express bus group comprises three different operators--Liberty Lines, New York Bus, and Jamaica Lines--in approximately equal proportions in the sample. Sample size and standard deviations keyed to the data in Table 4-3 may be found in supplementary Table A-2 in the Appendix.

The measures of total travel time in Table 4-3 reasonably support, within 1 MPH, those estimates from the license match survey in Table 4-1. Tests of significance were performed on the changes in total time and running time only, since there does not appear to be a pattern in the boarding and signal delay components--the conclusion being that the improvements in travel time are concentrated in the actual "time in motion."

The data in Table 4-3 permit an analysis not possible in Table 4-1, namely an assessment of the travel time changes between April 1981 and the lane under full enforcement, where the license match data are inadequate. These analyses indicate a significant reduction in run time and total time for local bus M32 and express bus in the peak (4-7 p.m.), but not for local bus

TABLE 4-3. BUS TRAVEL TIME BY COMPONENT*
(ON-BOARD TRAVEL TIME MEASUREMENT)

Time Period	Travel Time Component	Local Bus (M 32)[1] Apr 81	Nov 81	Mar 82	Local Bus (M-1,2,3,4)[2] Apr 81	Nov 81	Mar 82	Express[2] Apr 81	Nov 81	Mar 82
2-4 p.m.	Running Time	7.8	5.6^{N}	4.8^{S}	7.8	5.9^{S}	5.1^{S}			
	Boarding Time	2.3	2.0	2.2	2.7	3.6	2.9		NOT	
	Signal Delay	1.8	2.1	1.9	2.8	1.5	2.0		MEASURED	
	Total Time	11.9	9.7^{N}	8.9^{S}	13.3	11.1^{N}	10.0^{N}			
4-7 p.m.	Running Time	9.3	6.0^{S}	6.3^{N}	7.3	6.9^{N}	6.2^{N}	7.7	4.6^{S}	5.4^{S}
	Boarding Time	1.6	2.3	2.2	2.8	2.7	3.5	1.6	1.7	2.0
	Signal Delay	3.3	1.5	3.1	2.5	2.3	2.5	3.2	1.7	2.2
	Total Time	14.2	9.8^{S}	11.6^{N}	13.2	11.7^{N}	12.2^{N}	12.5	8.0^{S}	9.4^{S}

[1] Travel Segment: 42nd St. to 56th St.

[2] Travel Segment: 42nd St. to 59th St.

*Sample size and standard deviation information may be found in Appendix Table A-2.

S or N indicates significant or not significant relative to base (April 81) at the 95 percent confidence level. Boarding time and signal delay time differences were not evaluated statistically.

M-1,2,3,4. Local bus M-1,2,3,4 shows a significant improvement in running time only in the off-peak (2-4 p.m.), whereas M32 does not. With regard to the change between April 1981 (pre-lane) and March 1982 (the lane with partial enforcement), the only significant improvements are in running time for local bus (all) off-peak, local bus M32 only in total travel time off-peak, and express bus peak run time and total time. Where the categories are comparable, the conclusions reached in Table 4-3 are generally consistent with those in Table 4-1.

4.2.2 General Traffic Impacts

Implementation of the dual priority bus lane on Madison Avenue, with its complement of traffic engineering modifications, constituted a major change in operating conditions for both bus and non-bus traffic. This section reviews the impact of the project on level-of-service for general traffic in an "area of influence" arbitrarily defined as Seventh Avenue to Third Avenue, and 42nd to 59th Streets.* Subsequent discussions will refer to this area of influence alternatively as the midtown grid.

Impacts on general traffic are traced through several measures, including changes in traffic volumes and travel times, change in traffic mix (classification), and potential increases in circuity and length of travel path.

4.2.2.1 Bus Volumes - As shown in Table 4-4, bus volumes on Madison Avenue, particularly the number of local buses, changed during the course of the demonstration project, but not as a result of the bus lane. A total of 683 buses per day traveled Madison Avenue (246 local and 437 express) before the bus lane was implemented, and remained at 678 shortly after implementation (241 local and 437 express). However, by March 1982 the number

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*Designation of this zone where impacts were likely to be experienced was based on a review of traffic flow characteristics and the experience of the NYC DOT staff. Motorist maneuvers to compensate for the turn restrictions, parking restrictions and congestion levels resulting from the lane were expected to take place largely within this portion of the midtown grid.

TABLE 4-4. MADISON AVENUE BUS VOLUMES

	Time Period (p.m.)	Before Lane	After Lane (July 1981)	After Lane (March 1982)
	2-3	80	78	92
	3-4	82	83	110
SUBTOTAL	**2-4**	**162**	**161**	**202**
	4-5	160	174	183
	5-6	221	218	226
	6-7	140	125	128
SUBTOTAL	**4-7**	**521**	**517**	**537**
TOTAL		**683**	**678**	**739**
Local*		246	241	299
Express		437	437	440

*The variation in the number of local buses in service is due to the difficulties experienced with the new Grumman® buses beginning in December 1980. The MTA operation was supplemented by "loaner" buses from Washington, D.C. during this period. As the Grummans® were repaired and returned to service, the loaner buses were returned and a fleet of new GM® buses also began to come on line. These variations in vehicle availability and supply account for the fluctuations during the period of observation.

of local buses on Madison had increased by about 20 percent, from 241 per day to 299, while the number of express buses held steady at 440, bringing the total to 739.

The reason for the variations in the number of local buses operating on Madison had to do with the MTA's much-publicized difficulties with its new Grumman® buses beginning in December of 1980. Through the early operation of the project, the number of buses in service was fluctuating widely. The MTA resorted to loaning buses from other areas during the trouble period to try to maintain service levels. By the fall of 1981 the situation began to stabilize. Most of the Grummans® were returned to service, supplemented by a fleet of new GM® buses beginning in September 1981.

4.2.2.2 Auto Travel Times - Auto travel times in the midtown grid were estimated using "floating car" techniques. These data are summarized in Table 4-5 in separate displays for the (north-south) avenues and the (east-west) cross streets, each of which is further broken down by peak (4-7 p.m.) and off-peak (2-4 p.m.).

Before-project travel time data were collected in October 1980, and again in February and April 1981. The post-implementation or "after" data were obtained in late May and early June 1981, immediately after implementation of the bus lane, and again in October/November 1981, presumably reflecting stable post-implementation operating conditions.

Several characteristics of the auto travel time data affect the analysis that has been conducted, and these features should be briefly mentioned here. The before data for the (north-south) avenues, in particular, cannot be used for statistical analyses. The October 1980 "before" data were averaged into a single measure before their receipt, hence neither the degrees of freedom nor the variance can be determined, and the before-and-after travel time changes on the avenues (including Madison) cannot be tested and verified statistically. While additional data for the avenues was obtained in February and April of 1981, these data could not be used because they represented a different segment

TABLE 4-5. AUTO TRAVEL TIMES

	AVENUES (4-7 p.m.)					
	PRE-LANE (Minutes)			POST-LANE (Minutes)		
FACILITY	Oct 80	Feb-Apr 81	ALL	May/June 81	Oct/Nov 81	ALL
Northbound Avenues, 42nd to 59th Streets						
Madison	16.6	DATA NOT USABLE	16.6	11.2	10.3	11.1
Sixth	7.9		7.9	8.8	7.4	8.4
Park (N)	11.2		11.2	8.7	9.0	8.7
Third	14.2		14.2	7.9	14.6	9.3
Southbound Avenues, 59th to 42nd Streets						
Seventh	8.3	DATA NOT USABLE	8.3	4.4	4.4	4.4
Fifth	4.2		4.2	8.9	6.3	8.6
Park (S)	6.7		6.7	4.2	7.7	4.9
Lexington	8.0		8.0	5.0	5.1	5.0

Note: Sample size and standard deviation are shown in Appendix Table A-3.

TABLE 4-5. AUTO TRAVEL TIMES (CONT.)

	AVENUES (2-4 p.m.)					
	PRE-LANE (Minutes)			POST-LANE (Minutes)		
FACILITY	Oct 80	Feb-Apr 81	ALL	May/June 81	Oct/Nov 81	ALL
Northbound Avenues, 42nd to 59th						
Madison	9.3	DATA NOT USABLE	9.3	12.2	11.0	12.0
Sixth	8.2		8.2	7.1	4.7	6.5
Park (N)	6.1		6.1	6.4	10.7	7.2
Third	10.3		10.3	7.0	14.2	7.3
Southbound Avenues, 59th to 42nd						
Seventh	7.2	DATA NOT USABLE	7.2	5.6	5.4	5.6
Fifth	5.9		5.9	11.9	8.4	11.5
Park (S)	6.7		6.7	6.9	8.6	7.3
Lexington	6.0		6.0	5.5	5.0	5.4

Note: Sample size and standard deviation are shown in Appendix Table A-3.

TABLE 4-5. AUTO TRAVEL TIMES (CONT.)

FACILITY	CROSS STREETS (4-7 p.m.)					
	PRE-LANE (Minutes)			POST-LANE (Minutes)		
	Oct 80	Feb-Apr 81	ALL	May/June 81	Oct/Nov 81	ALL
Eastbound Streets, 7th to 3rd Aves.						
42nd (E)	8.0	5.5	6.3	6.5	7.8	6.9
46th	13.4	7.4	9.4	11.0	10.0	10.7
48th						
50th	13.9	9.1	10.1	10.5	11.9	10.9
54th		8.3	8.3	9.1	10.2	9.4
57th		10.3	10.3	10.4	7.6	9.4
59th	12.5	7.2	9.0	11.5	8.5	10.5
Westbound Streets, 3rd to 7th Aves.						
42nd (W)	11.6	6.3	8.0	7.3	8.6	7.6
45th	12.7	7.6	9.3	10.3	8.1	9.2
47th				11.2		11.2
49th	10.6	7.9	8.4	13.9	9.7	10.6
53rd		8.9	8.9	11.2	10.9	11.1
55th				8.8		8.8
57th		5.7	5.7	6.3	7.3	6.6

Note: Sample size and standard deviation are shown in Appendix Table A-3.

TABLE 4-5. AUTO TRAVEL TIMES (CONT.)

FACILITY	CROSS STREETS (2-4 p.m.) PRE-LANE (Minutes) Oct 80	Feb-Apr 81	ALL	POST-LANE (Minutes) May/June 81	Oct/Nov 81	ALL
Eastbound Streets, 7th to 3rd Aves.						
42nd (E)	11.9	5.4	8.6	8.1	11.5	8.0
46th		9.1	9.1	11.6	10.7	11.3
48th				11.7		11.7
50th	10.7	7.9	8.4	10.8	8.6	10.1
54th				15.1	14.7	15.0
57th		8.5	8.5	16.3	9.0	13.9
59th	14.3	10.0	11.4	12.2	14.6	12.9
Westbound Streets, 3rd to 7th Aves.						
42nd (W)	8.1	7.0	7.3	10.3	13.6	11.1
45th		10.5	10.5	16.7	12.7	14.7
47th				12.6		12.6
49th	10.6	10.0	10.1	10.3	7.8	9.5
53rd		10.9	10.9	13.7	10.6	12.7
55th				16.4		16.4
57th		10.3	10.3	9.0	10.9	9.6

Note: Sample size and standard deviation are shown in Appendix Table A-3.

(30th to 62nd Street rather than 42nd to 59th Street) than the travel time data for the other periods. This means that the "before" period is different for the auto travel time (October 1980) as compared to the bus travel time (spring 1981).

Using the travel time data for the avenues as descriptive statistics only, the data suggest that in most cases auto travel time declined following implementation of the project. During the 4-7 p.m. peak period, travel time appears to have declined on all avenues except Sixth and Fifth, which are part of the Madison "loop" system.* Madison Avenue travel times appear to have declined by about 5 minutes between 42nd and 59th Streets, almost a third. This is almost the same magnitude of improvement experienced by buses as a result of the bus lane. In the off-peak, the number of travel time decreases are evenly matched by increases. Off-peak travel times seem to have increased on Madison, Park (both directions), and Fifth, while declining on Sixth, Third, Seventh and Lexington. Madison and Fifth showed the steepest increases, 29 percent and 95 percent, respectively. Again, none of these changes can be verified statistically.

The data were somewhat better for the cross streets. Once again, the initial before data (October 1980) had been previously averaged. However, the February/April 1981 before data were for comparable segments, and could be merged. Nevertheless, as can be seen in Appendix Table A-3, the number of observations was small for statistical analysis purposes--in most cases the mean travel time was estimated from three observations or less. Using the indicated travel times as descriptive statistics (because they cannot be statistically verified), it appears that auto peak-period (4-7 p.m.) travel time generally increased following implementation of the project. This increase has been relatively small during the peak period (4-7 p.m.), averaging less than a minute against a base of 6 to 10 minutes in most cases, or about 10 to 15 percent. Westbound streets do not appear to have been

*In order to access destinations east of Madison with the right turn ban, it was presumed that motorists on Madison would circle the nearest block west of Madison to complete the maneuver.

affected any more than the eastbound. During the off-peak (2-4 p.m.), travel times also generally increased, but to a somewhat greater extent: about 2 minutes on a base of 9 to 11 minutes, or about 17 to 22 percent. Again, none of these changes can be verified statistically.

4.2.2.3 Traffic Volumes - Traffic volumes on key facilities in the project area were obtained through use of standard mechanical tube counters. These data were collected by the Bureau of Traffic Operations under request from the NYC DOT; availability of counters and internal priorities of the Bureau greatly influenced control over the location and characteristics of the data sample. Figure 4-3 illustrates the location of the sampling sites.

Traffic counts were obtained on four occasions--two before and two after the bus lane was implemented. The volume count data are summarized in Table 4-6. As with the travel time data, the volume data are presented in separate displays for avenues and cross streets, and for peak and off-peak travel periods. Information on sample size and standard deviation for the volume count data are supplied in Appendix Table A-4.

For reasons related to data, analysis of volume changes on the avenues has been focused on that portion of the sample identified by the boxes in the first two pages of Table 4-6. This subsample compares volumes for each of the major avenues along the Bureau's 52nd/53rd Street screenline, where the data samples are the largest. The subsample also establishes October 1980 as the relevant before-project reference, while using the combined May-June 1981 and March 1982 data as the post-implementation measure. There are two reasons for using only October 1980 as the before-project measure. It can be noted that a significant difference exists between the October 1980 and March 1981 before-project measures in Table 4-6. In fact, in most cases, the two before-project measures "bracket" the volumes following implementation. Combining the two measures provides a single measure of doubtful meaning. Hence, it was decided to drop one of the measures; since before-project auto travel time

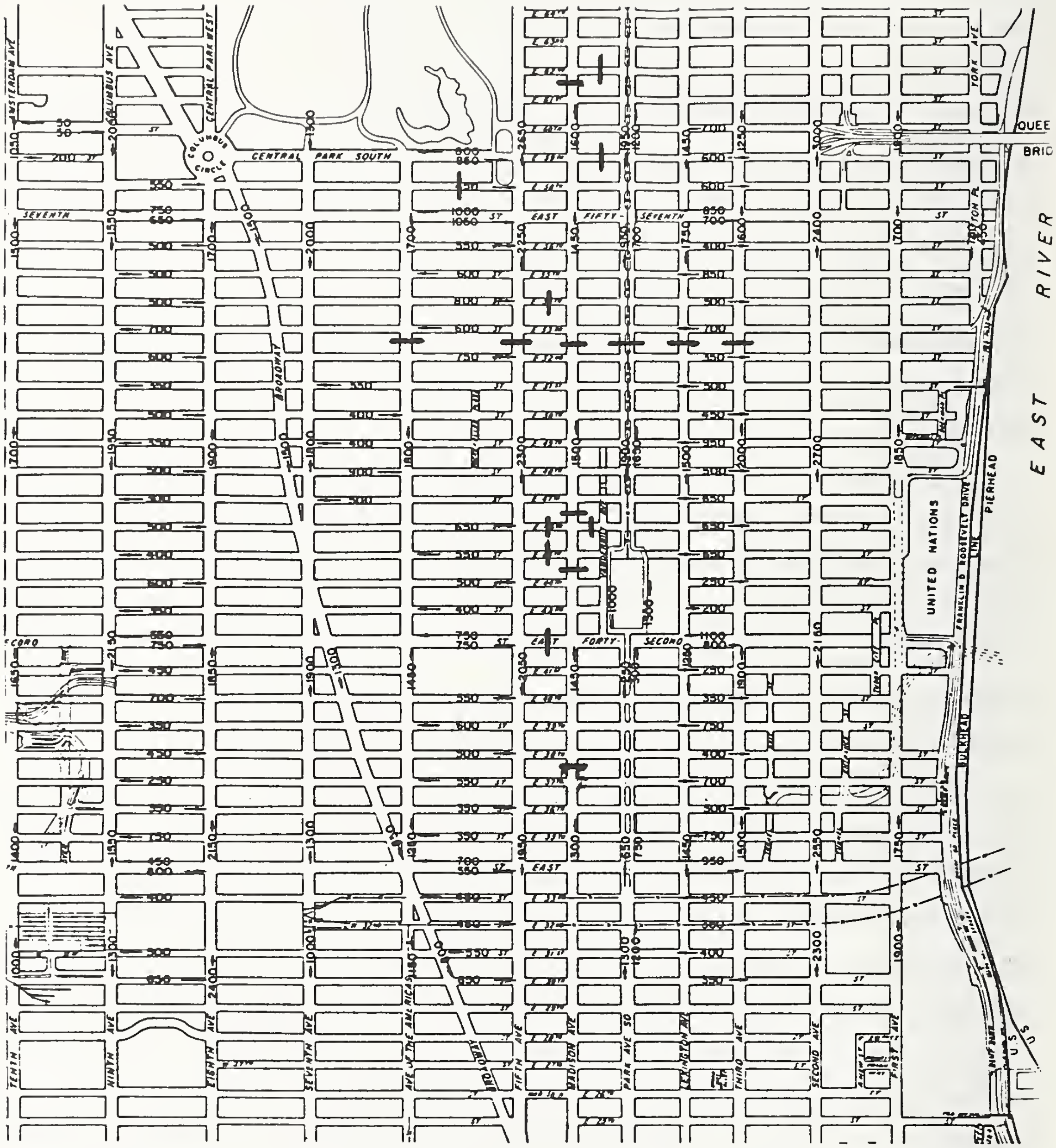


FIGURE 4-3. TRAFFIC VOLUME SAMPLING SITES

TABLE 4-6. TRAFFIC VOLUME COUNTS

AVENUES
(4-7 p.m.)

Sampling Location	PRE-IMPLEMENTATION (Avg. Veh. per Hour) Oct 80	May 81	ALL	POST-IMPLEMENTATION (Avg. Veh. per Hour) May/ June 81	Mar 82	ALL
Madison bet. 52nd & 53rd	1195[1]*	1583	1416	1340	1354	1350[1]*
Sixth bet. 52nd & 53rd	1728	2358	1908	2232	2087	2120
Fifth bet. 52nd & 53rd	1364	1667	1440[2]	1649	1608	1619[2]
Park (S) bet. 52nd & 53rd	1288	1189	1271	1185	1392	1331
Park (N) bet. 52nd & 53rd	1883	1588	1856[3]	1562	1529	1537[3]
Lexington bet. 52nd & 53rd	1359	1249	1343	1147	1248	1228
Third bet. 52nd & 53rd	2134	1760	2072	2064	1856	1916
Madison bet. 37th & 38th		2180	2180	2063		2063
Madison bet. 44th & 45th		1368	1368[4]	1050		1050[4]
Madison bet. 46th & 47th		1431	1431	1361		1361
Madison bet. 61st & 62nd		1430	1430	1673		1673

*Indicated pairs (1-1, 2-2, etc.) significantly different at 95% level of confidence.

Note: See Appendix Table A-4 for information on standard deviation and sample size.

TABLE 4-6. TRAFFIC VOLUME COUNTS (CONT.)

AVENUES
(2-4 p.m.)

Sampling Location	PRE-IMPLEMENTATION (Avg. Veh. per Hour)			POST-IMPLEMENTATION (Avg. Veh. per Hour)		
	Oct 80	May 81	ALL	May/ June 81	Mar 82	ALL
Madison bet. 52nd & 53rd	1176	1792[1*]	1528	1280	1218	1235[1*]
Sixth bet. 52nd & 53rd	1613	2091	1749	2266	2093	2133
Fifth bet. 52nd & 53rd	1407	1629	1463	1673	1481	1532
Park (S) bet. 52nd & 53rd	1538	1325	1503	1331	1546	1482
Park (N) bet. 52nd & 53rd	1845	1383	1803[2]	1378	1319	1334[2]
Lexington bet. 52nd & 53rd	1275	1345	1285	1213	1286	1271
Third bet. 52nd & 53rd	2139	1775	2078	1922	1989	1970
Madison bet. 37th & 38th		2055	2055	1974		1974
Madison bet. 44th & 45th		1423	1423[3]	923		923[3]
Madison bet. 46th & 47th		1259	1259	1157		1157
Madison bet. 61st & 62nd		1294	1294	1494		1494

*Indicated pairs (1-1, 2-2, etc.) significantly different at 95% level of confidence.

Note: See Appendix Table A-4 for information on standard deviation and sample size.

TABLE 4-6. TRAFFIC VOLUME COUNTS (CONT.)

CROSS STREETS
(4-7 p.m.)

Sampling Location	PRE-IMPLEMENTATION (Avg. Veh. per Hour)			POST-IMPLEMENTATION (Avg. Veh. per Hour)		
	Oct 80	May 81	ALL	May/ June 81	Mar 82	ALL
42nd bet. Madison & Fifth		637	637	631		631
45th (W) bet. Mad & Fifth		491	491	573		573
45th (W) bet. Lex & Third		677	677	626		626
46th (E) bet. Mad & Vand.		753	753	633		633
46th (E) bet. Mad & Fifth		576	576	558		558
54th (E) bet. Mad & Fifth		566	566	582		582
58th (W) bet. Fifth & Sixth		692	692	812		812
59th bet. Park & Madison		603	603	507		507
62nd (W) bet. Park & Mad		678	678	824	600	645

TABLE 4-6. TRAFFIC VOLUME COUNTS (CONT.)

CROSS STREETS
(2-4 p.m.)

Sampling Location	PRE-IMPLEMENTATION (Avg. Veh. per Hour)			POST-IMPLEMENTATION (Avg. Veh. per Hour)		
	Oct 80	May 81	ALL	May/ June 81	Mar 82	ALL
42nd bet. Madison & Fifth		611	611	706		706
45th (W) bet. Mad & Fifth		562	562	541		541
45th (W) bet. Lex & Third		705	705	635		635
46th (E) bet. Mad & Vand.		832	832	666		666
46th (E) bet. Mad & Fifth		611	611	585		585
54th (E) bet. Mad & Fifth		487	487	544		544
58th (W) bet. Fifth & Sixth		733	733	770		770
59th bet. Park & Madison		650	650	547		547
62nd (W) bet. Park & Mad		645	645	789	629	661

measures existed only for October 1980 (Table 4-5), for consistency the same period was selected for the volume reference.

These data show conformance with the hypothesized diversions in travel patterns. Madison Avenue showed minor increases after the project was implemented, in both the peak (+13%) and off-peak (+5%). Meanwhile, volumes on Sixth Avenue were up 22.6 percent in the peak and 32 percent in the off-peak, while Fifth Avenue was up 18.7 percent in the peak and 8.8 percent in the off-peak. These meausres are presumed to show that traffic activity was greater west of Madison because of the right turn restrictions affecting movements east of Madison. For avenues east of Madison, volumes generally showed moderate declines, with the exception of Park Avenue northbound, where volumes declined by 22.5 percent in the peak and 38.3 percent in the off-peak. The reasons for such a sharp decline on Park are not obvious. It should be noted for all comparisons that, because of small sample sizes, most of the above changes cannot be statistically verified.

The volume data for the cross streets are limited by small sample size for statistical analysis. Unlike the avenues, volume counts on the cross streets were not obtained in October 1980 and March 1982. Clear-cut trends cannot be detected in the volume changes, most of which appear to have been minor.

4.2.2.4 Vehicle Type Distribution - An issue related to changes in traffic volume as affected by the bus lane is how that volume changes in character, i.e., whether there are patterns in the types of vehicles affected. This question was addressed through vehicle classification surveys. These surveys classified traffic volumes into four types of vehicles: autos (not taxis), taxis, trucks, and buses.

While classification data were obtained on numerous facilities, data compatability considerations have caused a restriction of the analysis to Madison Avenue. However, these data are not sufficient in terms of sample size to allow statistical analysis.

The data in Table 4-7 summarize conditions on Madison Avenue generally in the upper half of the project area, i.e., roughly

TABLE 4-7. TRAFFIC DISTRIBUTION BY VEHICLE TYPE ON MADISON

	Percent by Type				
	Auto	Taxi	Truck	Bus	Number Days Sampled
Before: April & July 1980[1]					
2-4 p.m.	31.8	45.1	15.6	7.5	5
4-7 p.m.	40.4	36.7	9.7	13.2	5
Before: April/May 1981[2]					
2-4 p.m.	33.7	44.4	15.4	6.5	2
4-7 p.m.	41.8	37.4	8.4	12.4	2
After: May/June 1981[1]					
2-4 p.m.	43.1	43.8	6.2	6.9	2
4-7 p.m.	50.1	36.6	5.6	7.8	2
After: March 1982[3]					
2-4 p.m.	33.0	44.6	12.1	10.3	2
4-7 p.m.	43.7	34.8	7.0	14.5	2

[1]Madison between 52nd and 53rd

[2]Madison @ 41st and @ 62nd (average of two sites)

[3]Madison between 49th and 50th

around 50th St. The data comprise two before periods (spring/ summer 1980 and spring 1981) and two after periods (summer 1981 and spring 1982).

Only the sampling locations for two of the periods are identical, spring 1980 and summer 1981, both taken at Madison between 52nd and 53rd. The spring 1982 readings were taken between 49th and 50th Streets, and the April-May 1981 "before" estimates are an average of two readings, one at 41st and Madison and one at 62nd and Madison. The validity of this averaging may be questioned, although it is emphasized that the data is not being used for statistical inference.

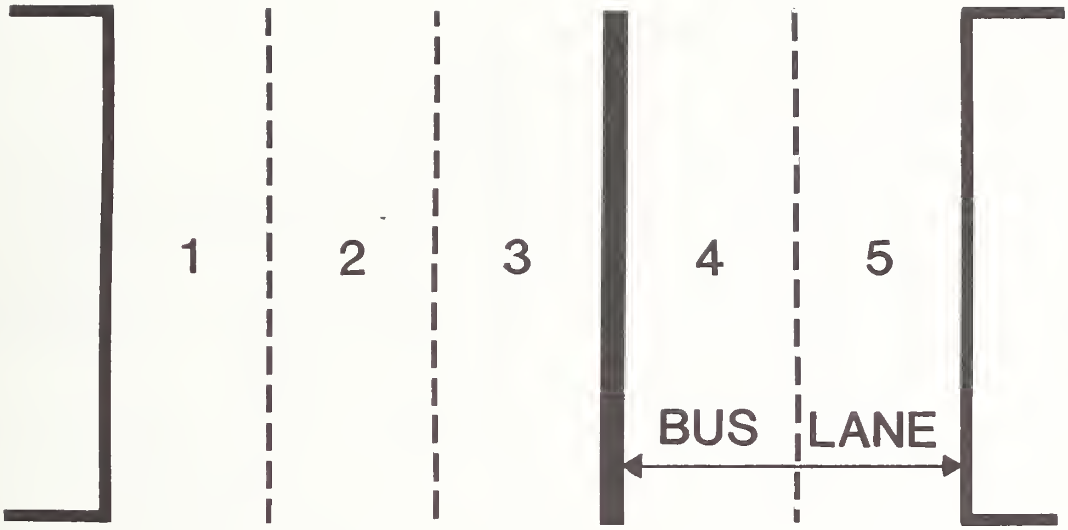
Comparing the two most comparable sets of measures--the April-June 1980 before data with the May-June 1981 after data--suggests changes mainly in the proportions of autos and trucks. Taxi, which vies with auto for being the largest vehicle share, showed the smallest variation in share before and after the lane. After the lane, taxi share remained close to its pre-lane 36.7 percent p.m. peak period share and its 45.1 percent off-peak share (36.6 percent and 43.8 percent, respectively). Principally, the share of truck vehicles declined, from 9.7 percent to 5.6 percent in the p.m. peak, and from 15.6 percent to 6.2 percent in the off peak. Meanwhile, the auto share grew, from 40.4 percent to 50.1 percent in the peak, and from 31.8 percent to 43.1 percent in the off-peak. Buses as a share of all traffic remained at about the same level in the off-peak (about 7%), but seemed to decline in share in the peak. This decline is not supported by the March 1982 "after" data, which suggests, if anything, a slight increase. It will be remembered that the MTA bus fleet was fluctuating in size during the project period, reaching a stable upper limit of 299 vehicles in March 1982, up 24 percent from the 241 total in July 1981. This increase is partially responsible for the change in bus share between June 1981 and March 1982 in Table 4-7.

4.2.2.5 Lane Distribution - As a result of the bus lane and related parking and turning restrictions, Madison Avenue traffic patterns were also reconfigured in terms of volume distribution by lane. These shifts can be seen through the traffic distribution-by-lane data in Figure 4-4. Before-and-after comparison data are available only for the 4-7 p.m. evening peak period. The before data were obtained in April 1, 1981, prior to the no-parking enforcement "blitz" along the western curb (lane 1). The after data were obtained in May and June of 1981, shortly following implementation of the bus lane. Thus, the data show the combined effect of the bus lane and the parking restrictions.

Implementation of the bus lane virtually eliminated non-bus traffic in the two easternmost lanes (lanes 4 and 5) of Madison. Lane 4 previously carried almost 40 percent of the Avenue's total traffic, which reflects the level of congestion experienced by buses trying to serve the east curb. Lane 4 volumes fell to only 7.8 percent after the bus lane. While lane 5, the actual curb lane, showed only a minor decline in traffic, from 3.7 percent to 3.3 percent, these data perhaps do not reflect the true nature of the congested situation along the east curb. Taxis regularly picked up and discharged passengers in lane 5, but because of the quick in-out curb access maneuver, the level of their presence in lane 5 was probably not captured by the steady-state volume count procedure. To compensate, buses frequently shifted into lanes 3 and 4 in order to keep moving under crowded conditions.

Elimination of parking and active enforcement along the west curb was a key element in maintaining traffic flow along Madison. As the data show, before the parking ban lanes 1 and 2 carried only 12 percent of all traffic. After the ban, over 42 percent of the traffic on Madison began to use lanes 1 and 2. The clearing of lanes 1 and 2 explains why major traffic volume and speed restrictions did not arise as a result of the bus lane project.

4.2.2.6 Turning Movements - Because of the right turn prohibition accompanying the bus lane, it was reasoned that non-transit vehicles might realize longer and more circuitous travel within the project area. Motorists who formerly traveled northbound on Madison and turned right between 42nd and 59th Streets to access



Time Period		1	2	3	4	5	Avg.Hourly Volume
		Percent by Lane					
4-7 p.m.	Before Lane	0	12.0	44.3	39.2	3.7	2638
	After Lane	5.2	37.4	45.0	7.8	3.3	2797
2-4 p.m.	Before Lane	NA	NA	NA	NA	NA	NA
	After Lane	4.9	39.3	49.1	3.8	2.9	2423

FIGURE 4-4. MADISON AVENUE TRAFFIC DISTRIBUTION BY LANE

destinations east of Madison faced two alternatives following deployment of the lane and the turn restrictions: they could travel Madison into the area of the project and then circle the block immediately to the west of Madison, after which they could cross Madison west-to-east; alternatively, they could make the right turn maneuver either before or after they would enter the project area.

Some assessment of these probable shifts in traffic patterns can be made through turning movement counts. A sample of intersections was identified for before-and-after measurement of turning movements prior to project implementation. Ultimately, data were compiled for nine pairs (before-and-after) of intersections. The location of this sample is shown in Figure 4-5.

The turning movement data are summarized in Table 4-8, which is presented in two parts. The first part illustrates turning movement patterns for the evening peak period, 4 to 7 p.m., and the second part summarizes the 2 to 4 p.m. off-peak period. As may be seen, the before data for the 2 to 4 p.m. off-peak period is limited to only 4 of the 9 intersections in the sample.

In most cases the data suggest a higher degree of turning activity after the project was implemented, consistent with the hypothesized corrective action (i.e., the 3-turn maneuver to the west). Samples are not large enough in any case to determine whether the changes are statistically significant, however.

The tendency of travelers within the area of the project (42nd to 59th Streets) to circle the western block to get to the east side of Madison has been measured by the intersection system of Madison Avenue and 53rd Street, and Fifth Avenue and 52nd Street. The p.m. peak data suggest an increase in the proportion of traffic entering each intersection which is engaged in a turning maneuver in the expected direction. Left turns off Madison west onto 53rd Street increased from 7.3 percent to 10.5 percent, while turns in the reverse direction, from Fifth Avenue east onto 52nd Street, increased from 12.6 percent to 15.1 percent. An equivalent comparison cannot be made for the off-peak.

The second alternative method for reaching destinations east of Madison is to turn east in the area south of 42nd Street,

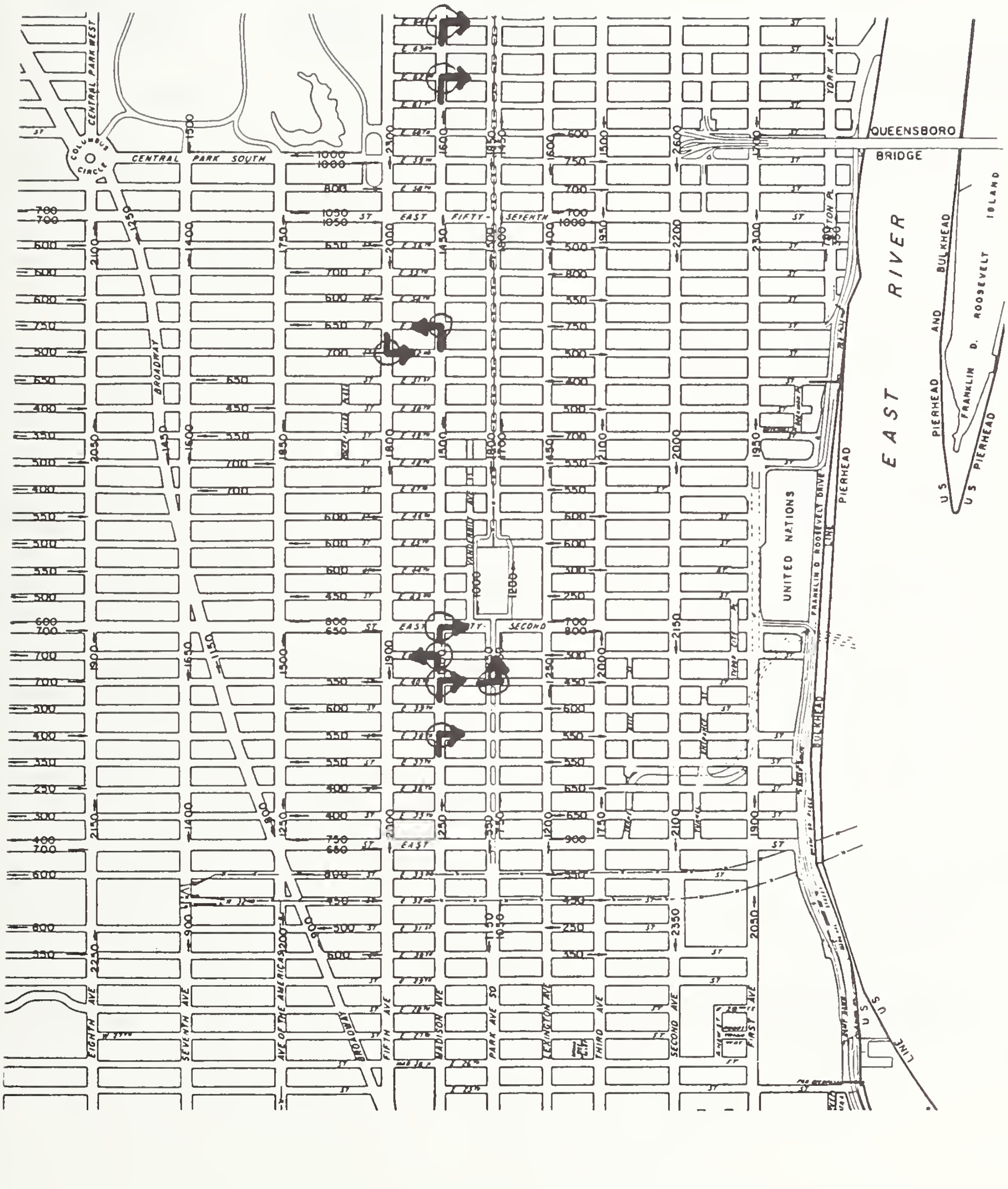


FIGURE 4-5. TURNING MOVEMENT RECORDING SITES

TABLE 4-8. VEHICLE TURNING MOVEMENTS

(4 P.M. to 7 P.M.)

Intersection Location	Before: Avg. Hourly Volume	Before: Percent Turning	After: Avg. Hourly Volume	After: Percent Turning
Within Project Area				
Madison & 53rd, left off Madison onto 53rd	1349	7.3	1158	10.5
Fifth & 52nd, left off Fifth onto 52nd	1080	12.6	1475	15.1
Before (South of) Project				
Madison & 42nd, right off Madison onto 42nd	977	5.1	1074	4.9
Madison & 41st, left off Madison onto 41st	1255	5.8	1079	6.4
Madison & 40th, right off Madison onto 40th	1110	10.9	1004	11.4
Park & 40th, left off 40th onto Park	315	14.3	380	21.6
Madison & 38th, right off Madison onto 38th	1145	9.4	936	10.6
After (North of) Project				
Madison & 62nd, right off Madison onto 62nd	1476	15.6	1633	25.1
Madison & 64th, right off Madison onto 64th	1424	10.3	1489	8.5

TABLE 4-8. VEHICLE TURNING MOVEMENTS (CONT.)

(2 P.M. to 4 P.M.)

Intersection Location	Before		After	
	Avg. Hourly Volume	Percent Turning	Avg. Hourly Volume	Percent Turning
Within Project Areas				
Madison & 53rd, left off Madison onto 53rd	NA	NA	935	18.0
Fifth & 52nd, left off Fifth onto 52nd	NA	NA	1522	13.6
Before (South of) Project				
Madison & 42nd, right off Madison onto 42nd	NA	NA	932	5.3
Madison & 41st, left off Madison onto 41st	NA	NA	1120	6.7
Madison & 40th, right off Madison onto 40th	1174	10.4	1003	8.6
Park & 40th, left off 40th onto Park	290	18.6	301	18.6
Madison & 38th, right off Madison onto 38th	938	10.2	930	9.6
After (North of) Project				
Madison & 62nd, right off Madison onto 62nd	NA	NA	1393	26.9
Madison & 64th, right off Madison onto 64th	1255	10.4	1327	14.8

before reaching the project area. The trends in trip path reshaping in this direction are slight. In the peak, slightly higher turning rates were noted at all sample intersections except Madison and 42nd, although subsequent left turns off 42nd north into the zone are not permitted anyway, so an increase in right turns at 42nd would not be expected. In the off-peak, where data exist to make the comparison, turning rates either held constant or declined.

The third alternative is to travel north of the project area to the first legal right turn, and then make two right turns followed by a drive south into the project area. The first Madison Avenue intersection where a right turn can be made is 62nd Street, and peak-period turning proportions increased from 15.6 percent to 25.1 percent after the lane. Right turns at the next usable intersection, 64th Street, showed no increase in the peak, but an increase from 10.4 percent to 14.8 percent in the off-peak.

4.3 TRAVEL DEMAND IMPACTS

Significant effects on travel demand, particularly a major increase in transit mode share, were not expected in this project. As a result, the emphasis of this evaluation has been placed on measuring the actual service improvements themselves, the effects on the transportation system, and the economic and institutional aspects of implementing the bus lane. Study of travel demand impacts has therefore been limited to Madison Avenue transit users only. These impacts are portrayed through data on overall ridership trends and traveler characteristics as determined from on-board surveys.

4.3.1 Impacts on Bus Travelers

4.3.1.1 Bus Ridership - Data on ridership for both the local and express bus routes affected by the Madison Avenue service improvements were difficult to obtain directly from the operators of those services. As a substitute, the NYC DOT estimated ridership using maximum load count techniques. Observers recorded ridership aboard buses at 59th Street, the point at which most buses traveling on Madison had reached their maximum load. An average hourly load was determined from the sample data and multiplied by the bus volume for the respective hour of operation to estimate total ridership. Estimates were made before the project in April 1981, and at two points following implementation--in May/June 1981 immediately following implementation, and more than a year later, in September 1982. These data are summarized in Table 4-9.

The data show increases in ridership for both express and local bus following implementation of the bus lane. The largest gains were with local bus, where ridership increased by 31.1 percent, or 2,935 daily riders over the before-project daily average of 9,450. Service changes were made to accommodate these additional riders. Express bus ridership, on the other hand, increased a modest 6.2 percent, or 910 daily riders over the before-project average of 14,614. This result was expected since the express bus market was believed by the operators to have been virtually saturated before the project. Service has also been kept the same; the same number of daily buses were in service in September 1982 as in April 1981.

4.3.2 Ridership Characteristics

In March and April of 1982, the DOT conducted surveys of Madison Avenue bus passengers. The purpose of these surveys was to determine the characteristics of patrons' trips, their perceptions regarding the bus lane, and to identify changes in travel behavior as a result of the project. Separate survey questionnaires were developed for express (Figure 4-6) and local (Figure 4-7) bus users. A total of 1,170 local bus users and 1,803 express bus users were surveyed. Results of the survey are summarized in Table 4-10.

TABLE 4-9. MADISON AVENUE BUS RIDERSHIP*
(Average Weekday Riders)

	Before (April 1981)		Early Post-Implementation (May/June 1981)		Late Post-Implementation (September 1982)	
Hour	Express	Local	Express	Local	Express	Local
2-3 p.m.	520	1,450	1,000	1,540	1,000	1,560
3-4 p.m.	792	1,700	1,008	1,665	1,372	1,891
Total Off-peak	**1,312**	**3,150**	**2,008**	**3,205**	**2,372**	**3,451**
4-5 p.m.	3,552	2,100	3,552	1,480	3,552	2,610
5-6 p.m.	5,967	2,900	5,814	3,763	6,120	3,906
6-7 p.m.	3,783	1,300	3,783	1,656	3,480	2,418
Total Peak	**13,302**	**6,300**	**13,149**	**6,899**	**13,152**	**8,934**
TOTAL	**14,614**	**9,450**	**15,157**	**10,104**	**15,524**	**12,385**

*Ridership data are estimates built up from maximum load count data and bus volumes by NYC DOT

MADISON AVENUE BUS LANE SURVEY

DEAR BUS RIDER:

The New York City Department of Transportation is conducting a study on the effects of the Madison Avenue Dual-Width Bus Lane which has been in operation since May, 1981.

We hope that you will answer this brief survey, because it will help us to evaluate and improve bus service on Madison Avenue and other avenues in the City.

1) What is the purpose of this trip? ____ Work ____ Shopping
____ School ____ Other

2) How often do you make this trip? ____ Daily ____ Several times a week
____ Once a week ____ Occasionally

3) Did you ride buses on Madison Avenue before the bus lane was installed?
____ Yes ____ No

4) Did you start using Madison Ave. buses because of the new bus lane?
____ Yes ____ No
If yes, did you switch from another line? ____ Yes ____ No
If yes, give route number ______

5) Has the trip been faster since the bus lane was installed?
____ Yes ____ No ____ Sometimes

(over)

6) You may have noticed that some bus stops were moved. Does this make catching your bus easier? ____ harder? ____ no change ____.

7) Has the environment (air quality, appearance, noisiness) on Madison Avenue improved since the bus lane was installed?
Better ____ Worse ____ No change ____

8) Would you like to see the same type of bus lanes on other streets? ____ Yes ____ No

9) Do you shop in Madison Avenue stores? ____ Yes ____ No

10) Have you changed your shopping pattern since the bus lanes started? ____ Shop more on Madison Avenue ____ Shop less on Madison Avenue ____ No change

11. Comments:

After completing this survey, please return to the surveyor.

THANK YOU VERY MUCH!

CITY OF NEW YORK
EDWARD I. KOCH
MAYOR

DEPARTMENT OF TRANSPORTATION
ANTHONY R. AMERUSO
COMMISSIONER

(over)

FIGURE 4-6. ON-BOARD BUS SURVEY QUESTIONNAIRE (LOCAL BUS)

MADISON AVENUE BUS LANE SURVEY

DEAR BUS RIDER:

The New York City Department of Transportation is conducting a study on the effects of the Madison Avenue Dual-width Bus Lane which has been in operation since May 1981.

We hope that you will answer this brief survey, because it will help us to evaluate and improve bus service on Madison Avenue and other avenues in the City.

1) What is the purpose of this trip? ____work ____school ____shopping
   ____home ____other

2) How often do you make this trip? ____daily ____several times a week
   ____once a week ____occasionally

3) Did you ride buses on Madison Ave. before the bus lane was installed?
   ____yes ____no

4) Did you start using Madison Ave. buses because of the new bus lane?
   ____yes ____no

5) Has the trip been faster since the bus lane was installed?
   ____yes ____no ____sometimes

6) You may have noticed that some bus stops were moved. Did this make it easier for you to catch your bus?
   ____yes ____no

7) Is there enough space for standing at bus stops? ____yes ____no

8) Has the environment (air quality, appearance, noisiness) on Madison Ave. improved since the bus lane was installed?
   ____yes ____no

9) Would you like to see the same type of bus lanes on other streets?
   ____yes ____no

9a) Do you shop in Madison Avenue stores? ____yes ____no

9b) Have you changed your shopping pattern since the bus lanes started?
   ____shop more on Madison Ave.
   ____shop less on Madison Ave. ____no change

10) Comments (Use the back of this sheet.)

After completing this survey, please drop it off with the driver of this bus.

THANK YOU VERY MUCH!

CITY OF NEW YORK

EDWARD I. KOCH
MAYOR

DEPARTMENT OF TRANSPORTATION

ANTHONY R. AMERUSO
COMMISSIONER

FIGURE 4-7. ON-BOARD BUS SURVEY QUESTIONNAIRE (EXPRESS BUS)

TABLE 4-10. RESULTS OF MADISON AVENUE BUS USE SURVEY

	Local Bus	Express Bus
1. Percent of riders traveling for:		
Work	60.2%	68.9%
School	2.8	2.4
Shopping	13.8	3.1
Other	23.2	2.7
Return Home	NA	22.9
	100.0%	100.0%
	(1,179)*	(1,803)
2. Frequency of making this trip:		
Daily	52.2%	85.0%
Several times a week	16.4	8.9
Once a week	5.2	1.6
Occasionally	26.2	4.5
	100.0%	100.0%
	(1,150)	(1,530)
3. Rode bus on Madison Avenue before bus lane:	78.9%	84.8%
	(1,125)	(1,525)
4. Start using Madison Avenue buses because of bus lane:	17.1%	1/
	(1,050)	
Percent of new starters switching from other transit service:	43.9%	1/
	(180)	
Percent of total riders surveyed who switched lines:	6.7%	1/
	(1,179)	
Previous Transit Service:	Indeterminate from responses as received	1/
Subway		
Local Bus off Mad.		
Express Bus off Mad.		
5. Favor installing lanes on other streets:	88.8%	93.0%
	(832)	(1,227)

*Number responding in parenthesis

1/These questions were not asked of express bus riders by the DOT because significant changes in ridership were not expected.

TABLE 4-10. RESULTS OF MADISON AVENUE BUS USE SURVEY (Continued)

	Local Bus	Express Bus
6. Trip faster:		
Yes	61.5%	75.1%
No	10.3	3.3
Sometimes	28.2	21.7
	100.0%	100.0%
	(992)*	(1,487)
7. Effect of moving bus stop location on ease of catching bus:		
Easier	12.5%	50.9%
More difficult	30.5	49.1
No change	57.0	Not asked
	100.0%	100.0%
	(893)	(1,423)
Enough space for standing: (percent answering in the affirmative)	NA	87.7%
		(1,498)
8. Effect on environment (air quality, noise, appearance):		
Better	34.1%	58.9%
Worse	10.6	41.1
No change	55.3	NA
	100.0%	100.0%
	(853)	(1,378)
9. Currently shop in Madison Avenue stores:	71.3%	55.5%
	(860)	(1,482)
10. Change in shopping since bus lane implemented:		
Shop more on Madison	9.9%	9.5%
Shop less on Madison	3.8	0.7
No change	86.3	89.9
	100.0%	100.0%
	(815)	(1,343)

*Number responding in parenthesis.

Most bus riders,* express or local, used the bus to travel to work. Over 60 percent of local bus riders and about 69 percent of express bus riders were travelling for the purpose of work. Because of peculiarities in the wording of the questionnaires, it is possible that the work travel share for express bus riders is even larger. The express bus is primarily a commuter service with regular patrons (85 percent ride "daily"). Those 22.9 percent who responded that they were "returning home" were probably completing work trips, hence the proportion of express trips made for the purpose of work may be in excess of 90 percent. Alternatively, local bus patrons were not given the option on the survey of answering "return home", hence, 23.2 percent of all trips were classified as "other". It is not as likely that the misclassed local riders are taking strictly worktrips, however.

The great majority of express bus riders, 85 percent, used the bus daily. However, only 52 percent of local bus riders rode as frequently as on a daily basis; 26 percent took the bus for that particular trip less than once a week.

Of the riders surveyed, 84.8 percent of express riders and 78.9 percent of local bus riders had ridden buses on Madison prior to the bus lane, although it is not known from the question as asked whether this usage was a recent or regular occurrence. Alternatively, this means that 15.2 percent and 21.1 percent, respectively, had not ridden Madison Avenue buses at all prior to the project. A total of 17.1 percent of the local bus riders not riding previously admitted that they started riding Madison Avenue buses because of the bus lane. Almost half (43.9 percent) of those who started riding buses on Madison after the bus lane, or 6.7 percent of all local bus riders surveyed, switched from another transit service. Riders who did switch transit services came mostly from parallel bus routes, and the remainder from the

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*Because the original survey results were not turned over to the evaluator, the distribution of bus **trips** by purpose cannot be estimated.

subway. A precise count or distribution of these prior alternatives is not available. It is also not known how many of the new riders were formerly taxi users.

The questions concerning switching of modes to Madison Avenue buses were not asked of express bus riders. This is because the DOT did not feel that there would be substantial shifts in express bus ridership as a result of the project.

Almost all riders surveyed believed that the bus lane was a good idea that should be expanded to other midtown streets; 89 percent of local bus riders and 93 percent of express riders were in favor of such an expansion. A surprising result, however, is that riders did not uniformly perceive a savings in travel time. Only 75.1 percent of express riders and 61.5 percent of local riders felt that their trip was consistently faster, in spite of evidence that bus travel times on Madison had been cut dramatically. Presumably, this means that the time savings on the Madison Avenue portion of the total trip is not sufficient to uniformly insure a shorter trip overall, at least in the perception of users.

The shift in bus stop locations as part of the overall improvement plan also did not receive uniform praise. Given the choice of responding that the change in stops made catching the bus easier or more difficult, express bus riders were essentially indifferent: half felt that catching the bus was easier thanks to the shift, and half felt that it was more difficult. Local bus riders were given the choice of also responding "no change," hence the local and express responses are not directly comparable. With this extra choice, 57 percent of local bus users felt there was no change in conditions; 30.5 percent felt that moving their stop was less satisfactory, while only 12.5 percent felt that it made access easier.

With regard to effects on the environment--air quality, noise and appearance--again local and express bus user responses cannot be compared side-by-side. Given a change to respond that there was no perceptive change in environment, 55.3 percent of local bus riders indicated that perception, while 34.1 percent felt that the environment had been improved, and 10.6 percent felt it had been made worse. Given only the option of indicating whether conditions had been improved or made worse by the bus lane, a surprising 41.1 percent of the express bus riders--almost half--actually believed that the environment had been made worse by the lane.

Effects of the lane on shopping activity in the Madison Avenue district appear to be slight. About 71 percent of local bus users and 55.5 percent of express bus users indicated that they currently shopped in Madison Avenue stores. However, only about 10 percent of riders in each group thought that they shopped more in the Madison Avenue area after the bus lane project. A smaller percent felt they shopped less: 3.8 percent of local riders and 0.7 percent of express riders.

4.4 IMPACTS ON PRODUCTIVITY AND ECONOMICS

4.4.1 Productivity

Both the public and private bus operators are quite pleased with the effects of the Madison Avenue bus lane project on bus operations. Both groups have experienced productivity gains, although the impacts of these gains on operations and costs have been mixed.

An interview with a representative of the MTA in March 1982 revealed that local buses running on Madison were realizing up to a 20 percent savings in their round trip time. However, with the existing route and schedule, the Authority could not squeeze a second trip out of the given vehicle during the same operating period. The savings accrued entirely to driver "recovery time", which increased from an average of 4 minutes to between 6 to 8 minutes. During its January 1982 "pick period" (a time for making driver and scheduling changes), the MTA attempted to act on the ridership and productivity improvements by revising its schedules and adding buses on the Madison Avenue M-1 and M-2 routes. However, the MTA could not get the bargaining unit to accept these changes, so they were not made. Nevertheless, the MTA hopes to accomplish these changes over the long run.

Representatives from two of the private express bus companies, Liberty and New York Bus, were interviewed during the same time period as the MTA. They both estimated travel time savings on the order of 10 to 15 minutes per run,* and were understandably pleased with the bus lane improvements. However, because of the characteristics of their operations, they have been unable to capitalize on the gains for anything other than to build welcome slack into their operations, which favorably impacts schedule adherence and potential for accidents. Both New York and Liberty are peak-period commuter services only (as regards Madison Avenue), and operate typically one-way service to fairly remote locations. Individual trips are so long, requiring an hour or more each way, that vehicles cannot return during the same period to make a second trip, even with the bus lane time savings. Because no bus trips were being spared, neither operator had realized any operating cost savings. Both companies would like to see additional priority facilities, particularly on Fifth Avenue during the morning peak period.

Exhibit A-1 in the appendix is a memo prepared by Liberty Lines which summarizes the benefits they have realized from the Madison Avenue Bus Lane.

4.4.2 Costs

NYC DOT received an UMTA Section 6 demonstration grant in the amount of $788,300. These funds were expended to implement and operate the bus lane for a period of 1 year. A summary of project expenses by major cost item is shown in Table 4-11. A detailed breakdown of costs may be seen in Appendix Table A-5.

Construction costs to prepare Madison Avenue for the bus lane project were a relatively small portion of total project costs. These expenses derived from street markings, reflectors, and signs. Construction and materials costs totaled $77,750, or about 10% of total project costs. Initial plans to

*Evaluation data indicates travel time savings on Madison of five to seven minutes.

TABLE 4-11. PROJECT COST BREAKDOWN

Construction and Materials		
Street Markings		$56,300
Reflectors		9,400
Signs		12,050
	Subtotal	$77,750
Labor (includes fringes and overhead)		
Enforcement		$581,478
Planning Staff		95,082
	Subtotal	$676,560
Miscellaneous		
Travel		$ 570
Other		33,420
	Subtotal	$33,990
	TOTAL PROJECT COST	**$788,300**

pave the facility before implementation of the bus lane were not completed; had the two bus lanes been repaved, the estimated additional cost would have been $53,500.

The major cost item in the project was labor, and in particular, the cost of enforcement. Enforcement costs, including fringes and overhead, totaled $581,478 over the 1 year demonstration, or 73.8% of total project costs. Enforcement costs are further analyzed in Table 4-12. During the first seven months of the demonstration, the project was managed under a "full enforcement" plan, where enforcement agents were stationed at every intersection along the length of the project. The enforcement squad necessary under this plan included 24 traffic control agents, 4 supervisors, and a captain (serving only 3/4-time). While the full enforcement plan required agents at only 16 locations, a team of 24 was retained to allow for absences and special duty. Through the last 5 months of the demonstration, the facility was managed by a reduced enforcement squad consisting of 16 agents, 3 supervisors, and a 3/4-time captain. Under the partial enforcement plan, agents were stationed at 12 locations, which meant that 4 agents were retained as backups.

The cost to enforce the bus lane during the 7-month full strength period was $391,318, which would total $670,830 if placed on an annual basis. The cost for the 5-month partial enforcement period was $151,861, which would total $364,466 if placed on an annual basis. Not included in either of these annual estimates is the cost of training, which in the project totaled $38,299, or approximately 6% of the equivalent annual cost.

NYC DOT's enforcement costs reflected both fringe (at 35%) and direct labor overhead (at 23%) attached to direct salary costs. Agent salaries averaged $12,029 per year, supervisors at $13,288, and a field captain at $15,272. In October 1981, the City of New York assumed the labor overhead cost for the enforcement staff, which was 23% of salaries and fringe. This reduced the DOT's enforcement cost somewhat. In particular, if the DOT had continued to realize the overhead cost, the annual cost of enforcement at full strength would have been $728,560, and the

TABLE 4-12. SUMMARY OF ENFORCEMENT COSTS

	STAFF			COSTS			
Period	Agents	Superv.	Captain	Salaries	Fringes at 35%	Overhead at 23%	Total
Training (Feb 1981 - May 25, 1981)	24	4	3/4	$23,044	$8,065	$7,190	$38,299
Full Strength (May 26, 1981 - Sept 1981)	24	4	3/4	$147,355	$51,574	$45,975	$244,904
Full Strength (Oct 1981 - Dec. 1981)	24	4	3/4	$108,454	$37,959	Assumed by City	$146,413
Reduced Strength (Jan 1982 - May 25, 1982)	16	3	3/4	$112,489	$39,371	Assumed by City	$151,860
TOTAL				$391,342	$136,969	$53,165	$581,476

annual cost of the partial strength plan would have been $448,293. The DOT has estimated that the continuing cost to the City to operate the lane with partial enforcement would be $120,000 per year. While the City's long-range enforcement plan employs only 8 agents and 2 supervisors, the annual cost of such a plan appears to be closer to $204,000.

NYC DOT planning and administration costs amounted to $95,082 (including fringes and overhead), or about 12% of total project costs. The project staff consisted of a project manager who worked roughly half time on the project, and two full-time planning assistants. There are two reasons why the planning and administrative costs are so small. First, the lane required very little administration once in operation. Second, a large portion of the planning effort was accomplished as part of the grant application process--hence, these costs would probably be larger for a project starting from scratch.

5. SUMMARY AND CONCLUSIONS

The Madison Avenue bus lane experiment has demonstrated two things:

- o That transit priority measures which are appropriately targeted, designed and executed can significantly improve transit performance, without necessarily causing major disruption to other travel markets.
- o That such measures can be successfully implemented amidst strong public opinions, diverse interest groups, institutional roadblocks, and political uncertainty.

Perhaps the second accomplishment is the more broad-reaching impact of this demonstration. Transit planners and operators have often been stymied when trying to innovate, because of both internal and external institutional constraints. Internally, innovation in service planning is restricted by many factors, chief among which are political mandates for service and agreements with organized labor. Externally, transit improvements are subject to the approval of the public, the press, the business community, and elected officials, each of which is extremely sensitive to and critical of changes in the status quo. Generally, conservatism rules. Recent history is rich with transit improvement initiatives that did not overcome these obstacles. In the area of transit priority treatment, the Santa Monica Freeway and the Boston Southeast Expressway Diamond Lane experiments are excellent examples of ideas that looked fine on paper, but lacked the necessary interfacing to gain public support and prosper. If the Madison Avenue dual exclusive bus lane is important, it is principally because it has demonstrated that a major transit improvement, which requires significant adaptation and compromising on the part of the public, can be successfully implemented with the proper technical and political expertise, even in the largest, most active city in the country.

The New York City Department of Transportation used two key events to legitimize and build support for its bus lane proposal. First, the DOT made it known that it was under order from the U.S. Environmental Protection Agency to specifically consider transit priority actions to address air quality problems.

Second, the DOT hoped to take advantage of a tide of public awareness and concern about transit following the crippling transit strike which occurred in the summer of 1980. The DOT was particularly fortunate in having the support of the Mayor's Office behind its transit improvement efforts as a further consequence of the strike.

The DOT had learned from earlier efforts with exclusive bus lanes, that the details of planning and execution were all-important. Plans that were implemented prematurely and in a semi-formal manner never achieved public respect and support, and in a short time were dismantled.

The Madison Avenue project profited from these earlier learning experiences. Alternatives were carefully developed and thoroughly investigated relative to their possible repercussions, as well as their technical effectiveness. The public and the business community were involved from the very beginning. Individual negotiations took place with merchants, hotel owners, and other resident entrepreneurs to ensure that the public pulse was known and that no major obstacle arose unforeseen. A major accomplishment was the liaison and negotiation with the taxi industry, representing perhaps the largest potential lobby against the lane. Myriad discussions, and probably even strategic concessions, transpired between the DOT and these external interests, forming the foundation for productive development of the lane. For reasons of protecting the DOT's future ability to negotiate with these same interest groups, this report is unable to discuss the specific details of the transactions related to Madison Avenue.

Flexibility is an important factor in implementing a project in such a dynamic environment. Even once it felt that the plans for the bus lane were complete and an implementation schedule had been set, the DOT faced still another round of challenges within the DOT, resulting in further plan modifications before implementation in May 1981. These were major changes: reduction of the lane from a full-time to a 2-to-7 p.m. weekday facility only; institution of a parking ban on Madison Avenue to try to minimize impacts on general traffic; and the decision to allow loaded taxicabs access to the bus lane between 42nd to 46th Street in order to minimize potentially serious repercussions from the business community. These modifications, rather than "water-down" the lane, demonstrated the agency's ability and willingness to adapt its proposal to the realities of the implementation environment and avoid potentially fatal conflicts on non-critical issues. The planning formula was evidently effective, as the lane has survived its test period and is now an accepted, permanent feature of the local transportation system.

Technically, the dual exclusive bus lane has fulfilled its operational objectives. Conditions on Madison Avenue have been transformed from a congested morass of vehicles and pedestrians, particularly during the evening rush period, to a surprisingly smooth and efficient operation. Buses can access their loading areas without creating traffic blockages and passenger safety hazards. The two lanes with buffer strip have proved more than adequate as a facility for buses to maneuver within. The lane works so well, in fact, that it became an early concern that buses might be moving too fast, for safety reasons.

While the bus lane has had a demonstrable effect on bus performance, it must be pointed out that the dual-exclusive lane was only one element in a package of integrated, complementary measures that were implemented almost concurrently. The right turn restrictions, for example, were a major factor in the performance of the bus lanes. Right turns off Madison by general traffic were a major source of bus delays before the project.

The parking ban on Madison Avenue was also a very essential feature of the project plan. Before the parking ban, the two westernmost of Madison's five lanes were virtually unused by moving traffic. These two lanes were substantially freed by the parking ban of parkers (legal and illegal) and double-parkers, perhaps more than making up for the loss of the two eastern lanes to the buses. If the parking ban had not been implemented, general traffic on Madison would have been left with perhaps one regularly usable lane. This would have been an unstable condition leading to strong community reaction, with violation and eventual failure of the bus lane. Following implementation, during the 4-7 p.m. evening peak traffic volumes (including buses, for which volume did not change) increased on Madison by 13 percent while average travel time between 42nd and 59th Streets declined by 33 percent, or about 5 minutes. Conditions in the off-peak did not improve: while volumes increased by 5 percent, travel times increased by 29 percent.

The qualitative effect that the project modifications had on traffic volumes on Madison was in composition. While taxis and buses stayed at about the same proportions of total volume before and after the modifications, about 37 percent peak/45 percent off-peak and 13 percent peak/7 percent off-peak, trucks as a share dropped from 10 percent to 6 percent in the peak and 16 percent to 6 percent in the off-peak. This may be due to the changes in parking restrictions for truck deliveries. Trucks now have unrestricted curb access between 7 a.m. and 1 p.m., which may mean that deliveries have been scheduled for other than the 2-7 p.m. observation period. The balance in volume yielded by trucks was made up for by an increase in personal autos.

While conditions for general traffic on Madison may not have deteriorated due to the project, it was proposed that significant trip diversion to adjacent facilities and circuitous travel paths would develop, particularly as a result of the right turn restrictions. It was believed that motorists would compensate for the bus lane by travelling on adjacent facilities, or, to reach destinations east of Madison Avenue, to execute special turning maneuvers using facilities west of Madison in order to circle around and cross Madison. These are difficult shifts to measure directly. Surrogate measures were used, consisting of volume counts and intersection turning counts. An intersection system was set up at Madison/53rd and 52nd/Fifth Avenue for monitoring, and the data obtained suggested an increase in turning movements during the p.m. peak from 7.3 percent to 10.5 percent of all traffic at 53rd/Madison, and from 12.6 percent to 15.1 percent at Fifth/52nd. Peak period volumes increased on Fifth and Sixth Avenues by 18.7 percent and 22.6 percent, respectively, and 8.8 percent and 32 percent, respectively, in the off-peak after implementation of the bus lane. Hence, it appears that some level of circuity is occurring as a result of the bus lane.

Bus ridership has increased during the period that the bus lane has been operating, but it is not clear whether the increase is permanent or has developed as a direct result of the bus lane. The private express bus operators show somewhat higher ridership numbers over a 1-year recording cycle, but feel that these changes are within the bounds of normal fluctuations. The MTA, who operates the local bus service, has shown about a 10 percent increase, which it feels is permanent. On-board rider survey data indicate that about 17 percent of local bus riders on Madison began riding because of the bus lane. Based on the survey responses, about 44 percent of these new riders switched from other transit service. Mode switching among express bus ridership was not investigated by the DOT because it was felt that these travelers had no alternatives.

Productivity gains have accrued to both the express and local operators, due both to travel time reductions and possibly increased ridership. For the express operator these improvements are welcomed, but have been inadequate to reduce the actual number of bus trips due to scheduling and trip length characteristics. Express bus trips are long (average 1 hour one-way trip time), and vehicles cannot be cycled for another run. The MTA has shorter trips and, based on a claimed 20 percent reduction in travel times and an increase in ridership, has indicated the potential to make scheduling changes. It attempted to make such changes in January of 1982, but could not get the initiative past the drivers' union bargaining unit.

Regarding costs, the most significant cost item in the bus lane project was enforcement. During the year of the demonstration $593,000, or about 75 percent of the $788,000 demonstration budget was consumed by enforcement costs. Because the lane was not implemented as a permanent, full-time facility, there are no physical barriers and the DOT relies on signing, striping, and enforcement agents to preserve the bus lane for buses. During the initial 7-month operating period, the lane was enforced by a staff of 24 agents, one stationed at each intersection with several in backup, and 5 supervisory personnel. The full complement of agents was effective, but considered too expensive for long-run operation, so alternatives were developed and tested. The two techniques which worked best were (1) traffic cone separators installed and removed daily, and (2) a reduced-strength (16-agent, 4 supervisor) enforcement squad with existing roll-out signs and markings. The DOT has recommended the second of these schemes (enforcement squad) to administer the lane after the end of the demonstration. While the enforcement squad approach appears to cost about twice as much as the traffic cone system, the DOT sees intangible benefits in the aspect of human enforcement. The revised enforcement plan implemented by the City after the demonstration uses 8 enforcement agents and 2 supervisors, and is estimated to cost about $204,000 per year.

The Madison Avenue bus lane project has successfully demonstrated the appropriate physical and administrative actions necessary to implement a transit priority solution within a difficult institutional environment. While New York City as a transportation system bears few, if any, direct parallels elsewhere in the country, there are nevertheless important transferable findings to this demonstration. These key findings are that:

- the concept must have high level political support throughout its planning and implementation.
- every effort must be made to identify and ameliorate negative impacts before implementation.
- the facility must function as designed during its early operation to gain public respect and support; enforcement is essential
- an active program of public liaison and strategic "deal-cutting" is a fundamental planning activity; technical planning competence must be accompanied by political and public relations skills; all major interest groups must be considered
- one-dimensional physical actions, e.g., a bus lane in isolation, may invite failure; an integrated program of actions which anticipates the impact on the different economic and travel sectors must be used to manage these different needs within a complex travel environment.

APPENDIX

TABLE A-1. BUS LICENSE MATCH TRAVEL TIME SURVEY
(Standard Deviations and Sample Size*)

Conditions	2 - 4 P.M.		4 - 7 P.M.		5 - 6 P.M.	
	Local	Express	Local	Express	Local	Express
Before Project (April 1981)	NA (127)	2.8 (102)	5.7 (294)	5.5 (676)	4.2 (147)	6.4 (341)
Bus Lane with Full Enforcement (June 1981)	NA (NA)	NA (NA)	NA (NA)	NA (NA)	1.9 (164)	2.8 (400)
Bus Lane with Half Enforcement (March 1982)	1.7 (138)	1.5 (98)	2.4 (218)	3.8 (336)	2.2 (101)	3.7 (180)

*Sample size in parentheses.

TABLE A-2. STANDARD DEVIATION AND SAMPLE SIZE DATA--ON-BOARD TRAVEL TIME MEASUREMENT

Time Period	Travel Time Component	Local Bus (M 32)[1]			Local Bus (M-1,2,3,4)[2]			Express[2]		
		Apr 81	Nov 81	Mar 82	Apr 81	Nov 81	Mar 82	Apr 81	Nov 81	Mar 82
2-4 PM	Running Time	1.93	.66	.79	1.95	1.33	1.24			
	Boarding Time	1.27	.57	.42	1.46	1.47	1.23		NOT MEASURED	
	Signal Delay	.84	.56	.76	1.19	.76	.90			
	Total Time	2.51 (4)	.87 (10)	1.32 (9)	4.15 (8)	2.13 (18)	2.08 (17)			
9-7 PM	Running Time	.84	.87	3.60	1.66	2.16	1.44	1.61	1.49	1.53
	Boarding Time	.17	.34	.26	1.39	1.21	1.32	.90	1.35	1.44
	Signal Delay	.50	.88	1.78	.49	1.12	.78	1.02	1.04	1.14
	Total Time	1.17 (2)	.96 (5)	5.24 (4)	2.01 (8)	3.66 (8)	2.62 (14)	2.84 (14)	2.36 (23)	3.19 (23)

*Sample Size in Parentheses

[1]Travel Segment 42nd Street to 56th Street.

[2]Travel Segment 42nd Street to 59th Street.

TABLE A-3. AUTO TRAVEL TIMES (In Minutes)

	Time Period (p.m.)	Before (Mar/Apr 81) Avg. Time	Std. Dev.	Num. Obs.	After 1 (Jun 81) Avg. Time	Std. Dev.	Num. Obs.	After 2 (Oct 81) Avg. Time	Std. Dev.	Num. Obs.	All After Avg. Time	Std. Dev.	Num. Obs.
Northbound Avenue													
Madison	2-4				12.2	1.4	8	11.0		1	12.0	1.4	9
	4-7				11.2	2.7	8	10.3		1	11.1	2.6	9
Sixth	2-4				7.1	2.0	3	4.7		1	6.5	2.0	4
	4-7				8.8	1.3	3	7.4		1	8.4	1.3	4
Park	2-4				6.4	1.3	4	10.7		1	7.2	2.3	5
	4-7				8.7	1.9	4	9.0		1	8.7	1.6	5
Third	2-4				7.0	2.3	4	14.2		1	7.3	4.5	5
	4-7				7.9	1.3	4	14.6		1	9.3	3.1	5
Southbound Avenue													
Seventh	2-4				5.6	0.6	3	5.4		1	5.6	0.5	4
	4-7				4.4	0.3	3	4.4		1	4.4	0.3	4
Fifth	2-4				11.9	2.2	8	8.4		1	11.5	2.3	9
	4-7				8.9	3.1	8	6.3		1	8.6	3.0	9
Park	2-4				6.9	1.1	4	8.6		1	7.3	1.2	5
	4-7				4.2	0.2	4	7.7		1	4.9	1.6	5
Lexington	2-4				5.5	0.5	3	5.0		1	5.4	0.5	4
	4-7				5.0	0.2	3	5.1		1	5.0	0.2	4
Eastbound Cross St.													
42nd	2-4	5.4		1	8.1	2.6	3	11.5		1	9.0	2.7	4
	4-7	5.5		2	6.5	0.7	3	7.8		1	6.9	0.9	4
46th	2-4	9.1		2	11.6		2	10.7		1	11.3	1.8	3
	4-7	7.4		2	11.0		2	10.0		1	10.7	1.1	3
48th	2-4				11.7		2				11.7		2
	4-7				11.1		2				11.1		2
50th	2-4	7.9	1.5	4	10.8		2	8.6		1	10.1	1.9	3
	4-7	9.1	2.4	4	10.5		2	11.9		1	10.9	1.3	3
54th	2-4				15.1		2	14.7		1	15.0	2.9	3
	4-7	8.3		1	9.1		2	10.2		1	9.4	2.1	3
57th	2-4	8.5		2	16.3		2	9.0		1	13.9	4.2	3
	4-7	10.3		2	10.4		2	7.6		1	9.4	2.8	3
59th	2-4	10.0		2	12.2		2	14.6		1	12.9	2.3	3
	4-7	7.2		2	11.5		2	8.5		1	10.5	1.8	3
Westbound Cross St.													
42nd	2-4	7.0		2	10.3	0.7	3	13.6		1	11.1	1.7	4
	4-7	6.3		2	7.3	0.5	3	8.6		1	7.6	0.8	4
45th	2-4	10.5		2	16.7		1	17.7		1	14.7		2
	4-7	7.6		2	10.3		1	8.1		1	9.2		2
47th	2-4				12.6		2				12.6		2
	4-7				11.2		2				11.2		2
49th	2-4	10.0	2.8	4	10.3		2	7.8		1	9.5	1.5	3
	4-7	7.9	2.9	4	13.9		2	9.7		1	10.6	2.2	3
53rd	2-4	10.9	3.1	4	13.7		2	10.6		1	12.7	3.0	3
	4-7	8.9	1.9	5	11.2		2	10.9		1	11.1	0.4	3
	4-7				8.8		2				8.8		2
57th	2-4	10.3		2	9.0		2	10.9		1	9.6	1.4	3
	4-7	5.7		2	6.3		2	7.3		1	6.6	0.9	3

TABLE A-4. TRAFFIC VOLUME COUNTS

Location	Time Period (p.m.)	Before 1 (Oct 80) Avg. Vol.	Before 1 Std. Dev.	Before 1 Num. Obs.	Before 2 (May 81) Avg. Vol.	Before 2 Std. Dev.	Before 2 Num. Obs.	All Before Avg. Vol.	All Before Std. Dev.	All Before Num. Obs.	After 1 (June 1981) Avg. Vol.	After 1 Std. Dev.	After 1 Num. Obs.	After 2 (March 82) Avg. Vol.	After 2 Std. Dev.	After 2 Num. Obs.	All After Avg. Vol.	All After Std. Dev.	All After Num. Obs.
Mad bet 37th & 38th	2-4				2055		2				1974		1						
	4-7				2180		2				2063		1						
Mad bet 44th & 45th	2-4				1423	105	3				923	120	5						
	4-7				1368	50	3				1050	81	5						
Mad bet 46th & 47th	2-4				1259		2				1157	42	4						
	4-7				1431		2				1361	105	4						
Mad bet 52nd & 53rd	2-4	1176	115	3	1792	418	4	1528	447	7	1280	222	4	1218	80	10	1235	129	14
	4-7	1195	78	3	1583	400	4	1416	354	7	1340	45	4	1354	99	10	1350	85	14
Mad bet 61st & 62nd	2-4				1294		2				1494	22	3						
	4-7				1430		2				1673	16	3						
5th Ave bet 52nd & 53rd	2-4	1407	164	3	1629		1	1463	174	4	1673	131	4	1481	167	11	1532	177	15
	4-7	1364	198	3	1667		1	1440	222	4	1649	90	4	1608	100	11	1619	96	15
Park (S) bet 52nd & 53rd	2-4	1538	100	10	1325		2	1503	123	12	1331	72	5	1546	167	12	1482	175	17
	4-7	1288	110	10	1189		2	1271	113	12	1185	68	5	1392	154	12	1331	164	17
Park (N) bet 52nd & 53rd	2-4	1845	390	10	1383		1	1803	395	11	1378	78	4	1319	285	12	1334	248	16
	4-7	1883	386	10	1588		1	1856	377	11	1562	163	4	1529	368	12	1537	324	16
6th Ave bet 52nd & 53rd	2-4	1613	138	5	2091		2	1749	260	7	2266	73	3	2093	174	10	2133	171	13
	4-7	1728	295	5	2358		2	1908	390	7	2232	89	3	2087	354	10	2120	316	13
Lex bet 52nd & 53rd	2-4	1275	445	6	1345		1	1285	407	7	1213	65	3	1286	120	12	1271	111	15
	4-7	1359	176	6	1249		1	1343	166	7	1147	66	3	1248	92	12	1228	91	15

TABLE A-4. TRAFFIC VOLUME COUNTS (CONT.)

Location	Time Period (p.m.)	Before 1 (Oct 80) Avg. Vol.	Before 1 (Oct 80) Std. Dev.	Before 1 (Oct 80) Num. Obs.	Before 2 (May 81) Avg. Vol.	Before 2 (May 81) Std. Dev.	Before 2 (May 81) Num. Obs.	All Before Avg. Vol.	All Before Std. Dev.	All Before Num. Obs.	After 1 (June 1981) Avg. Vol.	After 1 (June 1981) Std. Dev.	After 1 (June 1981) Num. Obs.	After 2 (March 82) Avg. Vol.	After 2 (March 82) Std. Dev.	After 2 (March 82) Num. Obs.	All After Avg. Vol.	All After Std. Dev.	All After Num. Obs.
3rd bet 52nd & 53rd	2-4	2139	77	5	1775		1	2078	163	6	1922	56	4	1989	269	10	1970	228	14
	4-7	2134	315	5	1760		1	2072	320	6	2064	53	4	1856	390	10	1916	340	14
42nd bet Mad & Fifth	2-4				611		1	611		1	706		2				706		2
	4-7				637		1	637		1	631		2				631		2
45th bet Mad & Fifth	2-4				562		1	562		1	541		2				541		2
	4-7				491		1	491		1	573		2				573		2
45th bet Lex & Third	2-4				705		1	705		1	635	48	3				635	48	3
	4-7				677		1	677		1	626	38	3				626	38	3
46th bet Mad & Vand.	2-4				832		1	832		1	666		2				666		2
	4-7				753		1	753		1	633		2				633		2
46th bet Mad & Fifth	2-4				611		1	611		1	585		2				585		2
	4-7				576		1	576		1	558		2				558		2
54th bet Mad & Fifth	2-4				487		1	487		1	544		2				544		2
	4-7				566		1	566		1	582		2				582		2
58th bet Fifth & Sixth	2-4				733		1	733		1	770	19	3				770	19	3
	4-7				692		1	692		1	812	53	3				812	53	3
59th bet Park & Madison	2-4				650		1	650		1	547	52	3				547	52	3
	4-7				603		1	603		1	507	5	3				507	5	3
62nd bet Park & Madison	2-4				645		1	645		1	789	27	3	600	81	12	661	91	15
	4-7				678		1	678		1	824	1	3	600	81	12	645	118	15

TABLE A-5. MADISON AVENUE BUS LANE PROJECT COST BREAKDOWN

Personnel

a) Enforcement

Salaries	$391,342
Fringes @ 35%	136,969
Overhead @ 23%*	53,165
Subtotal	$581,476

b) Professional Staff (Planning and Administration)

Salaries	$57,260
Fringes @ 35%	20,042
Overhead @ 23%	18,000
Subtotal	$95,082

Total personnel costs (salary, fringe and overhead) $676,560

Materials and Construction

a) Markings (Thermoplastic)

Striping --- $.55/ft. @ 4"
$30/diamond
$25/letter

200 foot block, 17 blocks

Cost for single block:
8" double line: 4 (200) (.55) = $440
16" inner stripes: (4) 10/block (7.5 feet) (.55) = $165
dash line: 15 feet (6/block) (.55) = $49.5

Striping cost for a single block = $654.5
Striping cost for 17 blocks = $654.5(17) = $11,127

Diamonds----4/block (17 blocks) = 68
(68) ($30) = $2,040

BUS ONLY----2/block (17 blocks) = 34
(34) ($175/message) = $5,950

*Overhead costs on agents after Sept. 1981 assumed by city. Salary & fringe base for overhead cost shown = $230,038. Salary & fringe not subject to overhead = $298,273.

TABLE A-5. (CONT.)

Crosswalk Marking:

across Madison Ave.---26 spaces--13 stripes
13 x 20 x 4.5 = 1,170 (2) + 54 feet (stop line)
= 2,340 + 54 = 2,394 feet/intersection
2,394 (17 intersections = 40,698 feet
40,698 (.55) = $22,384

across side street----16 spaces ---8 stripes
8 x 20 x 4.5 = 720 (2) + 34 feet (stop line)
= 1,440 + 34 feet = 1,474/intersection
1,474 feet (15 blocks) = 22,110 feet

across 42nd and 57th Street
2,394 (2) = 4,788 feet
cross street total = 22,110 feet + 4,778 feet = 26,898 feet
26,898 (.55) = $14,794

Total crosswalk marking cost = $37,180

Total marking cost = $56,300

b) Plowable Reflectors

200 foot block, placement at 20 foot interval
two rows: 340 reflectors @ $25 (mat. + instal.)
340 ($25) = $8,500
$8,500 + 10% (replacement) = $9,350

Total reflectors cost = $9,400

c) Signs

Bus signs and other regulatory signs = $12,050

Total cost of materials and construction	$ 77,750
Travel	$ 570
Other	$ 33,420
TOTAL PROJECT COST	**$788,300**

LIBERTY LINES

1010 Nepperhan Avenue
Yonkers, N.Y. 10703

(914) 969-6900
(212) 295-2032

Affiliated Companies
Airport Transportation Services, Inc
Liberty Coaches, Inc
Pelham Parkway Bus Service Inc
Resort Bus Lines, Inc
Riverdale Transit Corp
West Fordham Transportation Corp
Westchester Street Transportation Co., Inc
Westchester Tours Inc

March 5, 1982

MADISON AVENUE EXPRESS DUAL LANES

SCHEDULE CHANGES:

As a result of the Madison Avenue dual lanes, we have saved approximately 10 to 15 minutes of travel time between 42nd Street and 59th Street, however, these savings did not affect the savings in scheduled trips, primarily because of the time loss between 59th Street and 138th Street, Madison Avenue Bridge. The dual lanes have contributed to improving our overall performance.

PASSENGER REACTIONS:

Our passengers have expressed a favorable response towards the Madison Avenue dual lanes. The Express bus lanes have expedited the movement of equipment along Madison Avenue, thus allowing our passengers to benefit by the increased frequency of our service. Our Chauffeurs have also responded favorably. The Express lanes, which restricts private cars and cabs, have reduced the possibility of accidents.

SUGGESTIONS:

1. Extending the operating hours of the Express dual lanes from 7:00 p.m. to 8:00 p.m.

2. Extending Express lanes from 59th Street to 86th Street.

3. Implementing Express lanes on Fifth Avenue between 86th Street and 42nd Street between the hours of 7:00 a.m. to 10:00 a.m.

4. The traffic enforcement of restrictions to private cars has been relatively good, however, more traffic enforcement officers would be helpful in maintaining the effectiveness of this program.

5. We highly recommend that the Madison Avenue dual lane project be implemented along Sixth Avenue (Avenue of Americas) and Third Avenue.

RHP:cm

FIGURE A-1. MEMO FROM LIBERTY LINES (SUMMARY OF BENEFITS)

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