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Transportation Systems Management: Implementation and Impacts

March 1982

Final Report

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Transportation Systems Management: Implementation and Impacts

Final Report
March 1982

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Prepared for
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SOURCES AND ACKNOWLEDGEMENTS

The research and writing by Urbitran Assocites for the San Mateo, Seattle, and Connecticut Case Studies of this report were primarily done by Richard Leyshon. The research and writing for the Cambridge, New York, Minneapolis, Lehigh Valley, Concord, Portland, and Los Angeles Case Studies were primarily by Michael Cunneen. Overall direction and technical guidance were by Richard Steinmann of Urban Mass Transportation Administration and Dr. Robert B. Lee, P.E., Dr. John Falcocchio, and Nicholas Bellizzi. Graphics were primarily composed by Steve Jobson and Michael Cunneen.

Acknowledgements to individuals who provided information and material for this study as well as footnoted references and case study bibliographies are shown in Technical Appendix -- The TSM Case Studies, which are detailed evaluations of the case studies.

I. INTRODUCTION

A. Purpose and Scope of Study

Transportation System Management (TSM) is the name given to the concept of more efficiently using existing transportation systems by means other than large-scale new construction. TSM embraces a host of measures, all with the purpose of seeking to achieve better results from existing facilities rather than by creating new highways and transit systems. These measures tend to be subtle, low cost, and many are rapidly implementable compared to new capital construction. All tend to have minimal or no right-of-way space required as they are fitted into or on existing systems or are simply policies applied to whole areas.

The main purpose of this study was to evaluate and analyze a group of local TSM projects in an attempt to learn what factors or combination of factors facilitated or hindered project implementation. The insights gained from this project analysis will provide planners with guidance on how to better effect TSM project implementation.

A second goal of this study was to analyze the impacts of a sample of implemented TSM projects. Using criteria developed jointly by the contractor and UMTA, the study evaluated a set of projects to determine their success in facilitating the goals of TSM. The criteria jointly agreed upon were based on already completed research including, but not limited to, the North Central Texas Council of Governments TSM Prototype Study (Alan M. Voorhees and Associates)[1] and the FHWA Project 2K (Metropolitan Multimodal Traffic Management)[2] study of TSM measures of effectiveness. Information gained from this part of the research effort is designed to give planners across the nation better information about the expected impacts of various TSM strategies so that they might better choose among various TSM projects in their own areas.

Transportation Systems Management (TSM) was first introduced in the joint Urban Mass Transportation Administration (UMTA)/Federal Highway Administration (FHWA) planning regulations of 1975.

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[1] Handbook for Transportation System Management Planning Volume 2: Handbook for the Evaluation of Individual Transit Related TSM Actions, prepared for the North Central Texas Council of Governments by Alan M. Voorhees & Associates. August 1977.

[2] Measures of Effectiveness for Multimodal Urban Traffic Management, prepared for FHWA by JHK & Associates/Peat, Marwick, Mitchell & Co., February 1979.

This change was proposed to attempt to shift the national focus from high-capital approaches to meet transportation needs to a greater consideration of low-capital-intensive solutions to such needs. The TSM concept calls upon local agencies to consider, in the spirit of cooperative decision making, a wide range of actions with low-capital investment requirements that can improve transportation service in the short term. The concept reflects a growing consensus that steeply rising costs, environmental concerns, and intense competition for available resources make it imperative that better and more efficient uses for existing investments in the transportation infrastructure be found before additional investments are made in costly new facilities. Hence, a major objective of the TSM concept is to make more efficient use of the highways and transit systems already in place, thus reducing the need for new capital investments and for operating assistance.

During the past four and one-half years, TSM has evolved in a number of ways, reflective of the variety of local circumstances in which it has occurred. There is no one planning organization or organizational arrangement that fits the diversity of metropolitan areas in the United States. No institutional arrangement for effective TSM can be prescribed since the most effective arrangement will vary from locality to locality.

The function of TSM planning is to foster the use of the combination of modes that best represents an area's desired balance between the goals of efficient mobility, environmental attractiveness, and social equity in the operation of its urban transportation system. However, the full promise of TSM is a long way from being realized. Translating the concept of TSM into a regional planning framework and into systemwide TSM strategies has proven difficult. Often, TSM implementation has focused upon a single mode and narrowly defined site-specific problems.

Consequently, a regionally based, intermodal, goal oriented TSM approach has been difficult to develop and implement. This failure of TSM to reach its full potential has created the need to closely examine local TSM projects in an attempt to learn what factors, or combination of factors facilitated or hindered project implementation. By determining what factors influence the success or failure of TSM implementation the federal government will be better able to provide accurate up-to-date technical guidance in TSM planning and implementation to local areas.

In addition there exists a need to examine the impact of implemented TSM projects. Information gathered with respect to implemented TSM projects will give transportation planners better information concerning the expected impacts of various TSM projects. This information will lead to a better understanding of the area-specific and regionwide impacts of specific TSM strategies so that they might better choose among various TSM projects in their own areas.

The objective of this study was to inventory TSM projects in the United States, analyze ten in great detail, and report from these findings on the problems and performance of different TSM strategies. To accomplish this task case studies selection criteria were developed relevant to study objectives. These criteria, discussed fully in Part III, were objective measurements of TSM strategy performance - Measures of Effectiveness (MOEs). Wherever possible data was obtained and analyzed to produce a quantitative MOE analysis of each TSM strategy, enabling comparative analysis of TSM strategies and providing a range of anticipated cost and benefit figures.

B. Overview of Approach

The approach of this study was as follows:

1. Identify and inventory TSM projects across the United States,

2. Develop evaluation criteria (MOEs) to apply to these projects,

3. Select ten TSM projects for which the greatest statistical data and historical information was available to portray various TSM strategies in different parts of the United States,

4. Develop a history and analysis of each of the ten selected TSM projects, and

5. Prepare a summary analysis of the TSM strategies considered.

The identification and inventory step involved a literature review as well as numerous telephone interviews to verify available information from a variety of sources and to ascertain additional information on TSM strategies implemented by local governments. The jurisdictions contacted were also asked to provide reports, ordinances, and related materials describing their TSM strategies and the history leading to implementation. Once the inventory was complete, measures of effectiveness were developed using a variety of sources. Ten jurisdictions which had well-documented "before" and "after" information on their TSM projects were the subject of on-site investigations by the project team. These communities were visited to obtain firsthand information on their TSM projects.

In the inventory phase, information on existing projects was collected from numerous TSM studies available at UMTA and FHWA, as well as from studies of projects implemented or considered for implementation by state agencies, MPOs, and local agencies throughout the country. Bibliographies and reference documents relating to TSM were reviewed including:

- Transportation System Management: A Bibliography of Technical Reports, UMTA/FHWA, May, 1976.
- A Selected Bibliography and Reference Document in Transportation System Management, prepared for FHWA by JHK & Associates, May, 1977.
- Urban Consortium Bibliography Updates.
- TSM Today: Conference on Transportation System Management, TRB/UMTA/FHWA, Arlington, Texas, November, 1979 (Workshops 1 through 5).
- Transportation System Management: State of the Art, Interplan Corp., Contract No. UMTA RI-06-008, February, 1977.
- TSM Seminar: Policy, Procedure and Practices, ASCE/ITE, New York, May 15, 1978 (proceedings).
- Transportation System Management, Air Quality and Energy Conservation, Urban Consortium, September, 1980.
- TSM: An Assessment of Impacts, F.A. Wagner and K. Gilbert, Alan M. Voorhees, Inc., November, 1978.

The case studies of individual TSM projects included development of a description of site conditions before implementation and site conditions subsequent to implementation. Evaluations of the appropriateness of the chosen strategy were made. Impact assessments relied on secondary data sources to quantify impacts. The impact of each TSM project on travel behavior is the key element of the assessments. The impacts analysis also dealt with "secondary" impacts of the TSM projects such as energy use changes, air pollution effects, visual impacts, and land use.

The case studies chronologically document the process leading up to TSM project implementation. The planning, programming, implementation, operations, and monitoring/feedback stages are analyzed in detail in order to draw conclusions pertaining to those factors that facilitated or hindered TSM project implementation. Strategies considered or implemented are categorized by the various spatial types applicable, be it CBD, non-central high-activity center, corridor, or residential areas of urban, suburban, or rural density. All the available primary documentation necessary for complete understanding of the technical, financial, political, social, and economic factors affecting implementation was compiled and documented. Where interacting strategies yield benefits not attributable to any single strategy they were identified as such. Implementation cost data, where available, was documented, as well as any quantifiable user-benefits and disbenefits, and cost-effectiveness or cost-benefit analysis.

C. Organization of Report

This report is divided into six parts: 1) the introduction (Section I), 2) a discussion of the national inventory of TSM projects (Section II), 3) a discussion of TSM case study selection criteria (Section III), 4) a summary of reports of the ten TSM case studies and their strategies (Section IV), 5) a summary and conclusions regarding these TSM strategies (Section V), and 6) two technical appendices: the nationwide inventory of TSM projects and the ten TSM case studies themselves. These appendices have been published as separate volumes. Volume 2 of this series is the Case Studies and Volume 3 is the National Inventory.

II. TSM PROJECT INVENTORY

A major part of this study was the production of a Technical Appendix, a National Inventory of TSM Projects, organized geographically by UMTA region. The Inventory lists 185 TSM projects, briefly summarizing the project's status, the sponsoring agency, its TSM category, objectives, history, results of project, evaluation procedures (MOEs) used, and contact person. A sample Inventory listing for a project is shown in Figure II-1 - that of the Minneapolis Second and Marquette Avenue Contra-Flow Bus Lanes. This project is also described in detail in this report. Information contained in this Inventory was obtained from available federal, state and MPO reports, and by phoning and writing MPOs, state departments of transportation and bus transit operating agencies. An exhaustive compilation of all TSM projects would be impossible and was not attempted. Instead, the inventory sought to assemble and categorize TSM projects involving transit and traffic improvements which were of major scope, were applicable to other areas, and reflected well-planned or innovative application of the strategy concerned. The National Inventory may be found as Volume 3 of this series.

Location: Mpls. - St. Paul	**Federal TSM Category:** Preferential Lanes for HOVs	**Area of Application:** Corridor
Responsible Agency: Metro. Council	**Description of Project:** Marquette and Second Avenue Preferential Lanes (exclusive contra-flow lanes)	**Type of Strategy:** ☐ Traffic ☒ Transit ☐ Combined
Status: Implemented		

Project Objectives, Methods, And History	Problems Encountered, and Resolved	Evaluation Procedures Used	Results of Implementation (Include Monitoring & fine tuning)
-Improve transit service to CBD. Exclusive contra flow lanes for buses have been extended to 2 streets parallel to Nicollet Mall in order to continue preferential treatment for buses from I-35W bus lane. Helps express buses to cut travel time after leaving the freeway. Non-express buses also use the lane. These lanes have a potential for a 30% increase in bus volume, which is expected by 1980.		Measured bus travel times before and after project.	Bus travel times on Marquette Avenue and Second Avenue segments are 20% less than when they operated in mixed traffic.

Source(s) of Information
Metro. Council (Mpls. - St. Paul)

Data Availability: Yes ☐ No ☐ Partial ☒

If Yes: Has Data Been Received
Yes ☐ No ☐ Partial

Contact Person(s) & Organization — Phone No.
Stephen Alderson Metro. Council 612-291-6337

Figure II-1

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III. TSM CASE STUDY SELECTION CRITERIA

In the process of selecting for detailed study, ten projects from the hundreds of TSM projects in the country, selection criteria had to be established to narrow down the choices. These criteria included:

- o Having a variety of geographical locations and urban forms (i.e. compact, older eastern cities vs. more spread-out, auto-oriented newer cities).
- o Willingness of local agencies to participate in this study.
- o Type of application (areawide, corridor, CBD, or suburb).
- o Strategies implemented singly, and those implemented jointly with other strategies.
- o Availability of data base (before and after the project).
- o Interesting attributes of potential case study and applicability of case study to other areas.
- o Availability of individuals involved in the planning and implementation of the case study.
- o Having a variety of TSM strategies represented in the report of strategies which are not already well covered in other UMTA studies (for this reason Service and Methods Demonstration projects were not studied and certain TSM strategies such as freeway HOV lanes were not included as there is already exhaustive literature on the subject).
- o Mix of modes - automobiles, buses, rail and combinations of these and other modes.
- o Different funding sources and levels of funding.
- o Geographical convenience, prior contacts, or other reasons enabling the consultant to limit the costs of site visits.

A number of TSM projects were investigated as possible case studies but were not used because sufficient "before" and "after" background information and data was not available. These included the following projects.

1. San Antonio, Texas Alamo Plaza Contra-Flow Bus Lane. As this project dated back to 1968, it was difficult to find the individuals involved or relevant data to help evaluate the project's effectiveness. The lane, which runs by The Alamo along a commercial plaza, has subsequently been landscaped and tied in to a retail district mall.

2. Rockland County, New York Timed Transfer Bus Study. This was a small scale project involving two County and three Town bus routes which met at a regional shopping center in a sprawling and fast-growing Northeastern suburban area. The system was interesting because both standard size County and mini-sized Town buses were involved and because it occured at a major node where commuter buses and a large regional shopping center and parking lot are located. The study was not pursued because the principal figures involved in implementing the timed transfer system in 1976 - the heads of the County and Town transit systems - were no longer with those agencies and precise data was not available.

3. Port Authority of Alleghany County (Pittsburgh), PA Park and Ride Program. This large-scale park and ride program started in the late 1960s and was evaluated by a consultant in September 1975. Although current lot utilization and bus service information was available, much of the other data needed to evaluate program impact (i.e., average length of trips diverted, vehicle occupancy, share of trips using the system), was not.

4. Hartford Downtown Council, Hartford, CT, "Instant Repay" Program. The "instant repay" program, sponsored by the Hartford Downtown Council, is intended to encourage shopping in downtown Hartford and improve utilization of parking facilities outside of the immediate downtown area. Based on the value of items purchased, participating downtown merchants give shoppers tokens which are good for reduced parking rates at certain lots on the outskirts of the downtown area. The major objective of the program is to encourage use of underutilized parking facilities outside of the immediate CBD/retail core area and to reduce parking related traffic congestion. Unfortunately, data on the extent of program operations (the number of merchants participating and the value of discounts) and program's impact could not be ascertained.

5. San Diego Transit Co., San Diego, CA, Marketing Program. San Diego Transit carried on an ambitious marketing program during 1978-80, making specific

efforts to attract certain user groups (e.g. students and the elderly) during off-peak hours. Since an existing evaluation of the marketing program found inconclusive (and somewhat disappointing) results, no case study was attempted.

6. "Wheels" Norwalk Transit District, Norwalk, CT, Timed Transfer Bus Operations. Norwalk Transit District has coordinated bus schedules to allow riders on many routes to make transfers to other routes at a central location, with minimal waiting. This mode of operation dates from the initiation of service in 1977-78; hence there was no "before" case for comparison.

7. Regional Transportation Authority, Chicago, IL, Suburban Bus Productivity Study. The goal of this program was to use performance indicators (such as passengers/vehicle-hour) to identify the least productive suburban bus routes, and to recommend service changes to increase system productivity. However, although RTA analyzed and rated the performance of most of the suburban routes, only a few carriers had acted on the report's recommendations. Unfortunately, due to the continuing financial problems of RTA and the transit system in Chicago generally, none of the suburban bus services were able to provide the data needed. A case study was completed of a similar program at the Lehigh & Northampton Transit Authority (LANTA) in Allentown, PA.

8. Metropolitan Atlanta Rapid Transit Authority (MARTA), Atlanta, GA, Bus Route Restructuring Program. Since October, 1979 MARTA had restructured its bus operations in downtown Atlanta and in the East Line to provide feeder service to and from rail stations. Since an exhaustive impact study on the entire MARTA system (the Transit Impact Monitoring Program or TIMP), including the bus route restructuring is currently being conducted by the Atlanta Regional Commission (ARC), and because most of the needed data was not be collected until late 1981, a case study was not undertaken.

IV. SUMMARY OF TSM CASE STUDY FINDINGS

After applying the aforementioned analysis criteria, the study narrowed its focus to ten case studies (see Figure IV-1 and IV-2) dealing with six project types: a) exclusive bus lanes, b) park-and-ride lots, c) residential parking permit programs, d) transit management techniques, e) innovative transit subsidy techniques, and f) bus signal priority systems. The study focused on the ten cases because they provided ample information on the process and effects of the six project types.

A. Project Types Included

1. Exclusive Bus Lanes

One TSM method which has been applied in many cities to facilitate transit use has been exclusive bus lanes on which automobiles and other non-bus traffic are banned. Exclusive bus lanes are intended to free buses from traffic congestion and give them a travel time advantage over private vehicles.

Four examples of exclusive bus lanes are studied in this report. In three cases the bus lanes are contra-flow, where buses (and in some cases other specially exempted classes of vehicles) have exclusive use of a curb lane to move against the one-way traffic. In all three of these cases (New York City's Second Avenue, Minneapolis' Second and Marquette Avenues, and Los Angeles' Spring Street) the contra-flow bus lanes are located in Central Business Districts (CBDs) and the primary purpose of the bus lanes is to speed the outbound evening movement of express suburban buses. The fourth case studied involves a median reversible bus lane along a suburban arterial route approaching the CBD of Portland, Oregon (the Barbur Boulevard Bus Lane). The purpose of the Barbur Boulevard lane was to provide morning and evening peak period suburban express buses with an exclusive lane so as to avoid any traffic congestion.

2. Park and Ride Lots (Commuter Parking Lots - Carpool and Express Bus)

Many states and metropolitan area transit agencies have constructed commuter parking lots to encourage carpooling and, in some cases, park-and-ride bus service to these lots has also been provided. Commuter parking lots are intended to increase vehicle occupancy by facilitating carpooling and vanpooling, and to increase the appeal of express bus services in order to limit the need for downtown parking and reduce auto trips into congested central business districts.

	CONTRA-FLOW BUS LANES	MEDIAN BUS LANES	TRANSIT MANAGEMENT	PARK & RIDE	TRANSIT SUBSIDY	BUS PRIORITY	RESIDENTIAL PERMIT PARKING PROGRAM
CAMBRIDGE, MA							●
NEW YORK, NY	●						
LEHIGH VALLEY, PA			●				
CONNECTICUT				●			
MINNEAPOLIS, MN	●						
LOS ANGELES, CA	●						
CONCORD, CA						●	◐
SAN MATEO, CA					●		
PORTLAND, OR		●					
SEATTLE, WA			●				

Figure IV-1 THE 10 TSM CASE STUDIES

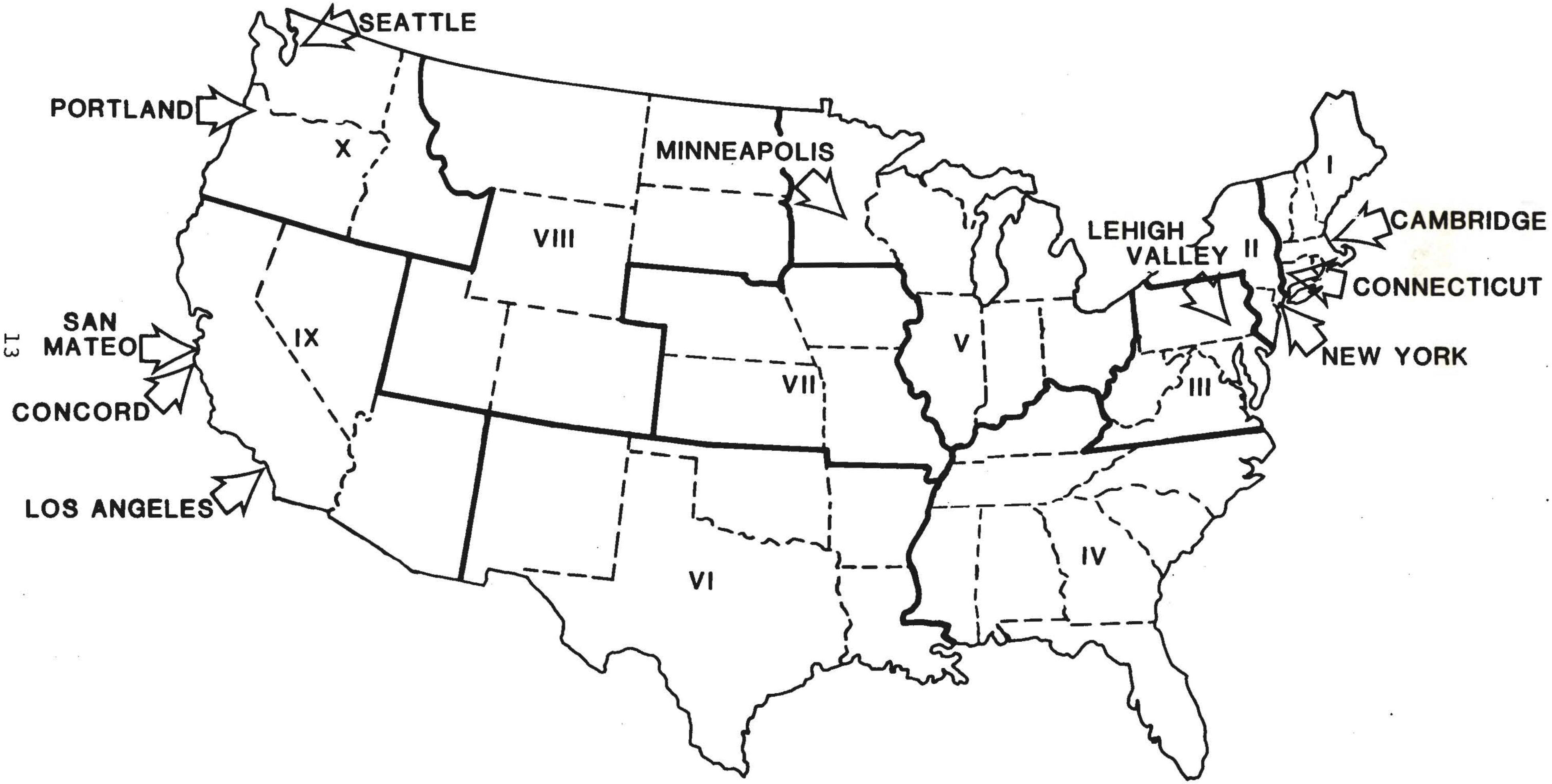


Figure IV-2: DISTRIBUTION OF TSM CASE STUDIES BY UMTA REGION

A statewide program of commuter parking lots (for both carpool and express bus users) sponsored by the State Department of Transportation in Connecticut was studied and evaluated. While the lots are scattered around the state, most are located on or near major travel corridors in the Hartford and New Haven metropolitan areas. Both remote lots (over 20 miles from the destination, and used primarily for carpooling) and fringe lots (under 10 miles from the destination and usually served by express bus) have been developed. The objectives of the commuter lot program in Connecticut, which began in 1969 and now includes approximately 140 lots, are to facilitate carpooling and increase the use of express bus services, to reduce downtown parking needs, to alleviate rush hour traffic congestion, and to reduce vehicle-miles travelled (VMT) and associated adverse environmental impacts.

3. Residential Parking Permit Programs (RPPPs)

Residential Parking Permit Programs are TSM measures designed to prohibit parking by automobiles which do not belong to the residents of an area. In many urban neighborhoods residents lack driveways or parking garages and may need on-street parking space for their own or their visitors' vehicles. When such residential neighborhods are located near major employers, transit stations, colleges, or other major trip attractors, they may find that on-street parking space is taken up by nonresidential users including out-of-town commuters. RPPPs usually consist of issuing special stickers for residents' vehicles which can legally be parked along streets in the designated neighborhood.

This report analyzes in detail the RPPP in Cambridge, Massachusetts. To a lesser extent, another RPPP (in a subarea of Concord, California) is analyzed under the section dealing with Bus Signal Priority systems.

4. Transit Management Improvements

Reducing the escalation of transit unit costs is an increasing concern of transit systems across the country in this era of Federal cutbacks. Two case studies of transit system management techniques were analyzed. The first is the use of part-time split shift bus drivers in Seattle, Washington. The second is the service retrenchment program in the Lehigh Valley industrial metropolitan area of Pennsylvania, which involved the elimination of duplicative routes and service cutbacks on underused routes.

Seattle Metro's part-time driver program commenced in 1978 after lengthy and difficult negotiations with the driver's union, and is now one of the largest part-time transit labor programs in the United States. The purpose of the program was to reduce transit labor costs and allow expanded peak-hour service by assigning short, rush-hour bus runs to part-time drivers, who do not receive the eight-hour guarantee and spread time payments that full-time drivers are promised under contract.

The service retrenchment program by LANTA (Lehigh and Northampton Transportation Authority) in the Lehigh Valley of Pennsylvania in 1977-78, involved the elimination of duplicative routes and the cutting back of service frequencies.

5. Innovative Transit Subsidy Techniques

Innovative transit subsidy programs, including fare-free transit and user-side subsidies, have attempted to increase transit use by specific user groups (e.g., the transit dependent) or by the population in general by reducing transit fares. These programs, which are usually marketed intensively, have been both temporary and long term, attempting to develop an expanding base of transit users by making it easy for people to use transit and by emphasizing its low cost.

The innovative transit subsidy plan studied was the Southern Pacific Fare Stabilization Plan, which was sponsored by the San Mateo County (California) Transit District during 1978-80. The purpose of this program, which offered a 30 percent discount on commuter tickets to County residents, was to stabilize and increase ridership on the Southern Pacific commuter rail service after a fare increase in 1977. By attracting new riders and reversing the declining ridership trend, it was hoped that the program would lead to a long-term purchase of service agreement with the railroad, guaranteeing the preservation of rail service and the provision of public funds for needed service improvements.

6. Bus Signal Priority Systems

An important TSM tactic with the same basic objective as exclusive bus lanes is a traffic signal priority or preemption system for buses. These are electronic systems attached to traffic signals which pick up light beams emitted from special devices on board the buses which cause the normal sequence of traffic light signals to be altered to favor bus movements. Under a signal preemption system, the approach of a bus will automatically signal the lights to turn green for the oncoming bus.

The bus signal priority system analyzed was in operation in Concord, California 1978-1980 on the Willow Pass corridor, a suburban arterial system serving several shopping centers. The purpose of the system was to speed up the movement of buses otherwise caught up in automobile congestion.

B. Exclusive Bus Lane Strategies

Barbur Boulevard Reversible Bus Lane, Portland, Oregon

1. Strategy Objectives

The objectives of creating the Barbur Boulevard Reversible Bus Lane were:

a. to reduce automobile use by inducing auto drivers to switch to mass transit,

b. to support City policies to preserve Portland's downtown as a thriving concentrated commercial center, the lane being part of an overall city plan to influence land use development in the Portland area, and

c. to reduce congestion in the Southwestern Corridor.

2. Approaches to Implementation

a. Planning & Historical Background

In response to the mandates of the Federal 1970 Clean Air Act, the City of Portland sought to reduce air pollution in its downtown and other inner city areas. Enhancing mass transit and imposing restrictions on automobile travel and parking availability have been the main focus of the Transportation Control Strategy (TCS).

The TCS was developed with the Oregon Department of Environmental Quality (DEQ) and the Tri-County Metropolitan Transit District (Tri-Met) in compliance with Federal clean air standards. Part of the TCS was to: "Develop exclusive bus lanes where feasible. Consider using reverse flow lanes at peak hours on such arterials as Barbur Boulevard, Sandy Boulevard, and Interstate Avenue." A High Occupancy Vehicle (HOV) Lane for buses and carpools has been in operation successfully on the Banfield Freeway in eastern Portland since December, 1975. The Barbur Boulevard Bus Lane has been the second major bus priority radial route created in Portland, in large part to fulfill the TCS.

Planning for the Barbur Boulevard Bus Lane was geared toward providing congestion-free access to the Portland CBD from the Southwestern Corridor (I-5 and Barbur). The major questions addressed in the planning stages dealt with the length of the project and the functions and relationships of the major elements of the project - a bus lane, a transit station, and a park-and-ride lot.

Planning involved three agencies: The Oregon Department of Transportation (ODOT), the City of Portland Planning Bureau, and Tri-Met. In 1973, concurrent with adoption of the 1990 Plan, Portland Mayor Neil Goldschmidt formed a Technical Advisory Committee (TAC) on transit-oriented park-and-ride and bus lane projects. The TAC gave top priority to the Barbur Boulevard project. Because of the small staff of Tri-Met and the City Bureau of Planning, the ODOT assumed most of the work and responsibility for the project. This included: the formulation of the Federal grant application, the Environmental Impact Statement (EIS), and project engineering. Barbur Boulevard from Front Avenue south is a state highway.

The key factors in the decision to implement the exclusive bus lane on Barbur Boulevard were traffic projections. The 1990 Plan projected Barbur with a peak vehicular demand volume of 2,430 by 1990 while its capacity at the intersection with Hamilton Street was only 1,700. The other major southwest roadway, Interstate 5, was already considered near capacity at its existing ramps. These traffic projections were based in large part on the 100 percent population growth projected for suburban/exurban Washington County, to the west of Portland. Barbur Boulevard, which carries seven of the fourteen routes linking Washington County to the Portland CBD, was envisioned as a major conduit between new outlying residences and the CBD. The Barbur Bus Lane was therefore perceived as a way to increase the people carrying capacity of this corridor.

b. Participating Agencies, Organizations and Groups

The interest groups participating in this project included: community associations, the City Planning Bureau, Tri-Met, the Oregon State Department of Transportation, and the Mayor's Technical Advisory Committee.

c. Institutional Roles & Jurisdictions

As most of Barbur Boulevard is a state highway (99W) and as the Oregon Department of Transportation had the personnel and expertise, ODOT was the principal agent in the implementation of this project. However, there was considerable coordination and involvement between ODOT and the Portland City DPW, responsible for the northern end of Barbur Boulevard and side streets, the Portland City Bureau of Planning, and the public transit operator, the Tri-County Metropolitan Transit District (Tri-Met). Many public meetings preceded the project and as Federal funds were used, an Environmental Impact Statement (EIS) was prepared for the project.

d. Funding

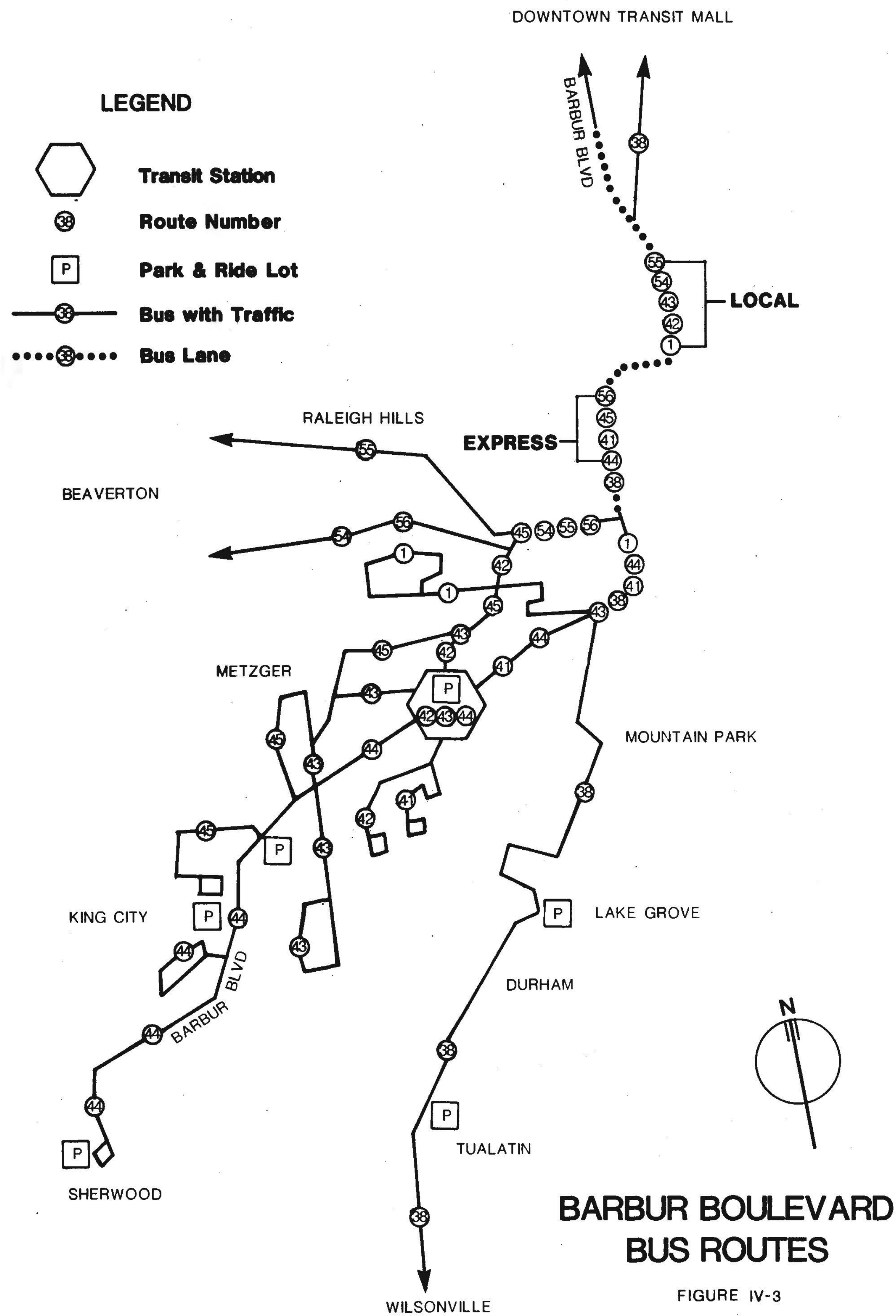
Development of the 1.8-mile median bus lane cost $608,000 (1978 dollars), 86 percent paid for out of Federal Interstate funds by trading in the Mount Hood Freeway project. The local share was paid for out of State and Tri-Met funds. Another $2,244,137 (1976 dollars) was spent on an ancillary park-and-ride lot/transit station and other features.

3. Characteristics of the Project

The Barbur Boulevard Bus Lane is the center lane of Barbur Boulevard (State Highway 99W). It runs approximately 1.8 miles linking the southern outskirts of the Portland CBD to low- density suburban areas to the southwest (see Figure IV-3). Twelve feet in width, the lane is median-reversible. The Lane is identified by double yellow lines with occasional diamonds and signs. The Bus Lane provides an exclusive 1.8 mile right-of-way for about 35 buses running express in morning and evening peak periods. The Bus Lane runs less than half way between the edge of the CBD and the Barbur Boulevard Transit Station, six and a half miles south of the CBD.

The Barbur Boulevard Transit Station, originally known as the West Portland Park-and-Ride Station, is a large roofed bus station with several bus bays, a large passenger waiting area, secure bicycle parking, benches, lavatories, posted schedules and maps, and a 300-space commuter parking lot. A short loop road provides access for buses to the Station off Barbur Boulevard. Originally, it was intended that the Barbur Boulevard Bus Lane run all the way to the Transit Station, which is located along Barbur at its junction with the Capitol Highway and Interstate 5 (Baldock Freeway). Such an extension has been indefinitely postponed as it was found to be prohibitively costly. One of the five bus routes operating on the Bus Lane stops at the Transit Station as do three of the five local buses, operating with general traffic on the curbside lanes of Barbur Boulevard. The Transit Station acts as a bus transfer point and park-and-ride facility at the edge of Portland.

It was the intention of the sponsoring agencies that the median Bus Lane would function as an inbound morning express bus lane between 6:30 a.m. and 9:30 a.m. and an afternoon outbound Bus Lane between 3:30 p.m. and 6:30 p.m. No other vehicles were to be permitted on the median lane in peak periods even though express bus average headways would be only four minutes. During off-peak hours, 9:30 a.m. to 3:30 p.m. and 6:30 p.m. to 6:30 a.m., the median lane would be used as a continuous left-turn lane for both northbound and southbound motorists.



BARBUR BOULEVARD BUS ROUTES

FIGURE IV-3

4. Results of Implementation

The Barbur Boulevard Bus Lane opened September 5, 1978 and has been in continuous operation since then.

a. Bus Speed and Operations

The express buses operating on the Barbur Boulevard median Bus Lane move an average of a minute and a half faster than local buses operating on Barbur. However, this small time advantage is only partially due to the exclusive right-of-way. Most of the minute and a half delay experienced by local buses involves picking up or discharging passengers along the Boulevard - an activity with which the express buses do not have to contend. While the Tri-Met evaluation of the Bus Lane's performance noted the time differences between the express and local services, it did not measure how much time the locals were spending due to passenger collection/distribution service. Tri-Met observers believe the reserved lane per se has saved express buses little or no time compared to running with mixed traffic on typical days. The projected three or five minute time advantage did not materialize because traffic congestion has not yet reached the projected 1990 levels.

For this reason the Lane is viewed by some as a good idea whose time has not yet come. An evaluation of the Lane's performance however, tends to have limited utility because the Lane was intended to be a response to 1990 conditions and to be in place before the problem arose.

The December 11, 1974 City Council ordinance authorizing the Lane and the use of Federal Interstate funds on its behalf indicates that: "...the Council requests the Highway Division and Planning Commission (ODOT) to give high priority to the construction of an exclusive transit lane on Barbur Boulevard between West Portland and Slavin Road when it is warranted either by sufficiently high bus volumes or significant traffic congestion on that segment of the route..." (author's italics). Since neither the congestion nor the increase in bus volumes has yet materialized, the implementation of the Lane is premature as defined by its legal mandate.

b. Ridership

Ridership declined slightly on the express routes operating on the Barbur Boulevard Bus Lane in the first two years of operation while Tri-Met sytem ridership has increased.

c. The Accident Problem

The accident problem for buses on the Boulevard's median Bus Lane has been bad enough to cause Tri-Met to seriously consider abandoning the lane. Tri-Met reports it has had to sustain increased operating costs due to accidents which exceed the minor savings in fuel and reduction in mechanical attrition gained by use of the Lane.

However, it is too early to evaluate how serious this problem really is. Accidents declined considerably from the first year of operation to the second and no serious bus-related accidents are on ODOT's record for the first few months of the third year. Also, all the second year's accidents but one were confined to a single intersection, Barbur and Hamilton, so that the problem - and any solution - is concentrated at one location.

d. Energy Consumption

It is premature to judge the energy impact of this project as it was intended to serve the operating characteristics of the late 1980's and 1990's. So far it has clearly caused more fuel consumption than it has saved. This is mostly related to the amount of fuel involved in the construction of the Station, park-and-ride lot, and the widening and partial repaving of Barbur Boulevard. This capital investment of energy was intended to save energy in the long run. However, that lessened consumption has not yet begun. So far there is no evidence of a modal shift from automobiles to buses in this corridor. What is clear, besides the captial energy expenditure, is that the Lane system causes slightly more operating energy to be consumed. Automoblies wishing to cross Barbur during peak periods must use more fuel to execute circuitous turning maneuvers as left turns are banned. Energy is used to light and maintain the Station and the park-and-ride lot.

e. Neighborhood Impact

The Lane *per se* has had a minimal, though slightly unfavorable, neighborhood impact. With the peak period left-turn ban, local drivers are inconvenienced. This is a problem for access to the YMCA, the Veteran's Administration Hospital complex, and some schools. People who live along the Boulevard also lost most peak period bus service -- half the Barbur Boulevard routes don't stop there anymore, though headways are still quite short and off-peak service unchanged.

5. <u>Problem Identification</u>

Traffic projections in the early 1970's projected much congestion in the Southwestern sector of the Portland Metropolitan area by 1990. Also, public transportation agencies wanted to improve the speed performance of suburban commuter buses.

6. <u>Problem Resolution</u>

The solution selected was the median reversible bus lane. However, before this could be put into operation, additional construction of paved surface (to create a fifth lane) and to secure a rockslide area had to be undertaken and federal capital funding secured. The original plan to extend the lane further south to the Barbur Boulevard Transit Station, had to be dropped for cost reasons.

7. <u>Unresolved Problems</u>

It is not clear that the lane has improved bus travel time by more than a neglible amount. The slight travel time increase is credited to turning five routes into expresses for this portion of their route. The lane may grant buses travel time advantages in the future if traffic congestion worsens, as there is good reason to believe.

Two other unresolved problems have also persisted. First, the peak period lane operation and ban on left turns divides this segment of Portland and necessitates circuitous auto journeys, unless illegal maneuvers are made. Second, the lane, at least in its first year or two of operation, has had an unacceptably high number of bus-related accidents, in large part due to motorist confusion over the lane's regulations (it is a left-turn lane open to all traffic most of the day).

8. <u>Future Plans</u>

The bus operator, Tri-Met, has considered abandoning use of the lane by its buses because of accidents. many local residents would like to open the lane up to autos, especially to make left turns. For these reasons public agencies concerned with the lane in Portland generally feel either some way to make the lane safer has to be found (an alternative perceived to be expensive) or the exclusive lane dropped in favor of bus priority signal treatment. This would allow the median lane to be used as a continuous left-turn lane at all times or a peak period reversible lane for all traffic.

9. <u>Conclusions Applicable to Other Areas</u>

The project demonstrates the safety problems with median reversible lanes, which have had accident problems when instituted elsewhere. However, the project did achieve a useful widening of an arterial bound to have higher traffic volumes in the future. Like other bus lane projects, it demonstrates that exclusive right-of-way may not result in travel time savings.

Second Avenue Contra-flow Bus Lane, New York, New York

1. Stategy Objectives

The objectives of the Second Avenue Contra-Flow Bus Lane were:

a. to expedite express bus flow during the evening rush hours for buses using the Queensboro Bridge,

b. to reduce traffic congestion on the Manhattan side of the Queensboro Bridge approaches,

c. to encourage higher evening utilization of express buses heading to the outlying areas of Queens County, and

d. to improve efficiency of express bus service.

2. Approaches to Implementation

a. Planning & Historical Background

Evening outbound express bus runs from the Manhattan CBD to suburban Queens experienced significant delays compared to the morning inbound Queens to Manhattan runs because they used different routes. The evening Queens-bound trips were especially delayed at the approaches to the Queensboro Bridge.

Express bus ridership in the evening service was about 20 percent less than that carried in the morning peaks. Based in part on a study of express bus ridership completed in 1974, the City and express bus operators attributed much of this ridership differential to the longer travel time experienced by travelers in the evening return trips.

While Queens express buses make different collection and distribution runs, they all share a common route in traversing the East River - inbound in the morning via the Queens Midtown Tunnel and outbound in the evening via the 59th Street Queensboro Bridge. Buses go inbound (to Manhattan) in the morning via the Queens Midtown Tunnel because they can take advantage of a contra-flow bus lane approaching the Tunnel. For the evening return trips, however, such an outbound lane cannot be instituted. In addition, evening tunnel congestion and heavy congestion on its approaches preclude outbound use of the Tunnel.

Outbound express buses were hampered by two major factors in the Queensboro Bridge area:

1. Traffic increased 26 percent on the untolled Queensboro Bridge between 1970 and 1977. This increase was the result of traffic diverted from the toll facilities operated by the Tri-Boro Bridge and Tunnel Authority (TBBTA), as tolls were increased from $0.50 to $1.00 during this period.

2. The bridge's upper roadway was closed to buses in 1972 because it was deemed structurally too weak to accommodate them.

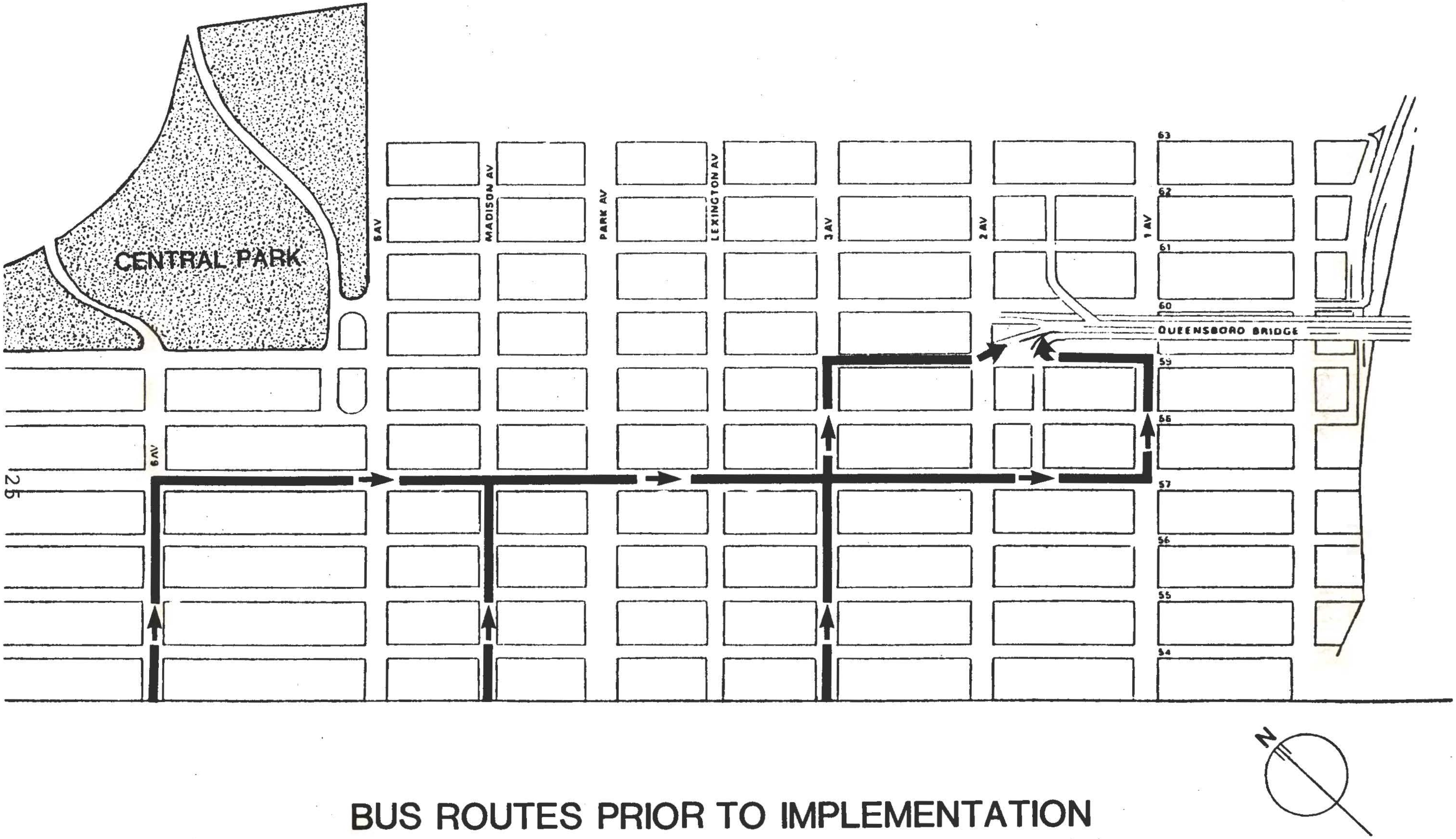
Prior to closure of the upper roadway, the express buses could all travel east on 57th Street from Third Avenue and left onto a ramp to the bridge from 57th Street between Second and First Avenues. With this ramp to the upper roadway no longer available, buses diverted one of two ways (see Figure IV-4):

1. north on Third Avenue from 57th to 59th Streets and then east on 59th Street to the bridge; or

2. east on 57th Street to First Avenue and north on First Avenue to 59th Street, then west on 59th Street to a ramp entering the lower bridge roadway.

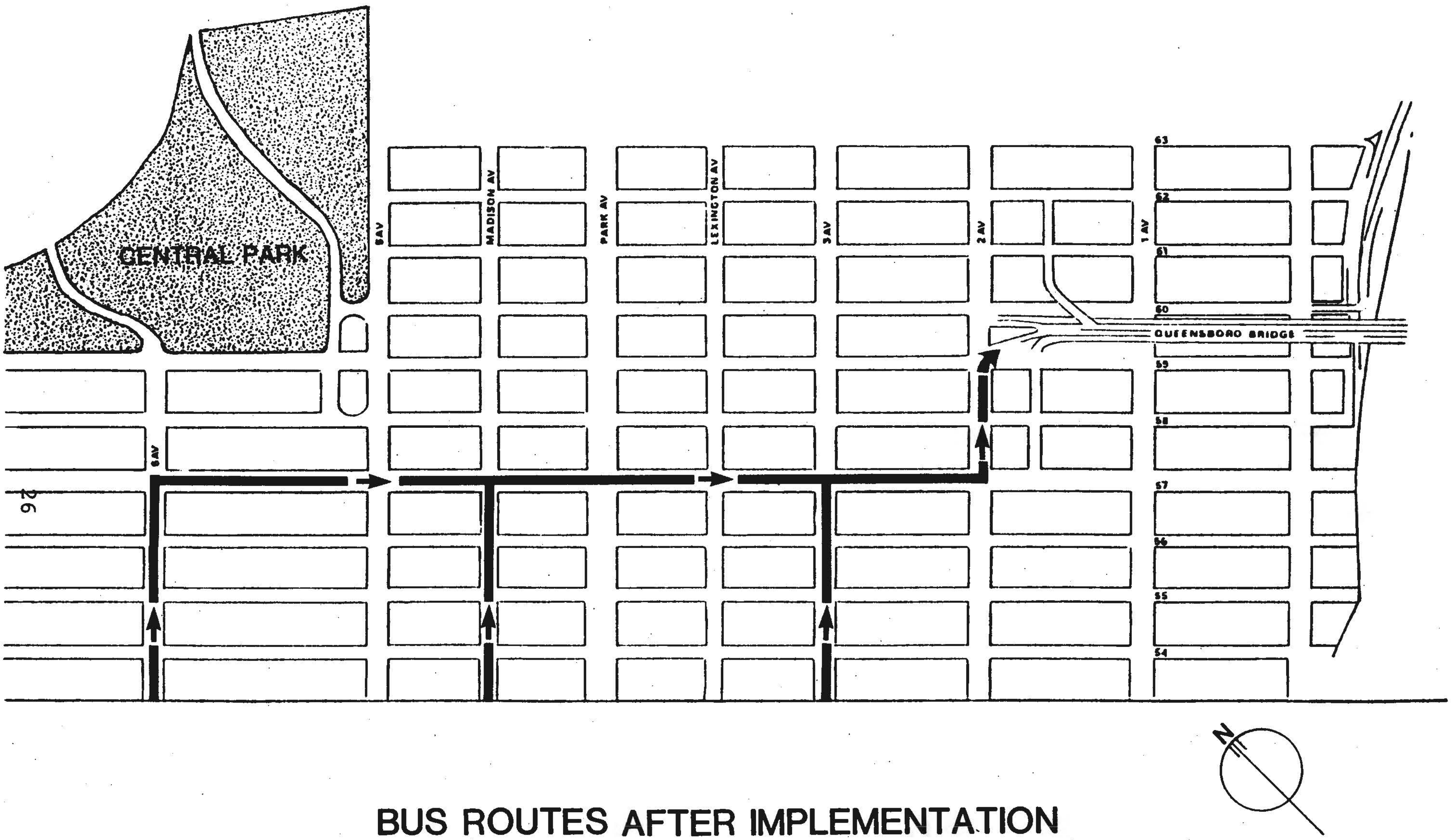
Both approach routes had problems. While the first was short, it involved traversing a badly congested area and making two turns; the second route involved much less friction with traffic and pedestrians but was longer and involved three turns, the last of which was virtually a U-turn within a narrow turning radius. This last turn is now prohibited to all traffic and that ramp entrance is blocked as its utility has been obviated by the contra-flow lane.

An analysis of these problem led to the eventual proposal for a bus contra-flow lane (see Figure IV-5). The purpose of this lane was to speed up the evening outbound express buses reaching the Queensboro Bridge. The need became increasingly more pronounced as it became clear that the lead time, high capital costs, and administrative complexity of new subway construction to serve the



BUS ROUTES PRIOR TO IMPLEMENTATION

FIGURE IV-4



BUS ROUTES AFTER IMPLEMENTATION

FIGURE IV-5

burgeoning east midtown area of Manhattan made these projects impossible to implement in the foreseeable future. The City was particularly interested in fostering express bus ridership in order to draw as many Manhattan-bound commuters as possible from using automobiles.

b. Participating Agencies, Organizations and Groups

The interest groups participating in this project included: New York City Department of Transportation; express bus operators; effected businesses; and the New York City Police Department.

3. Characteristics of the Project

Figure IV-6 shows the striping and lane configuration of Second Avenue with the contra-flow lane. A yellow double-striped line separates the 18' contra-flow from southbound lanes. Thirty (30) of the seventy (70) available feet of Second Avenue at this 600' stretch are reserved for buses as there is also a 12' with-flow southbound bus lane. The lane, which extends two blocks (three signalizaed intersections), is used by about 250 buses in the 4:00-6:00 p.m. peak period. The lane is inoperative except in the peak period. While the lane is along a curb, there are no passenger stops along it.

An important ancillary operation was instituted three months later. Fifty-ninth Street was made one-way between Second Avenue and the Bridge ramp; westbound 59th Street traffic could also get onto this Bridge ramp. If problems developed on Second Avenue, buses would use First Avenue and 59th Street westbound to reach the Bridge.

4. Results of Implementation

The contra-flow lane was instituted on October 30, 1978 and has been in operation since then.

a. Bus Operations

Buses save an average of one to two minutes per trip and up to seven minutes during the most congested periods with the contra-flow lane. Bus speeds from Third Avenue and 57th Street to the Bridge increased from six to eight m.p.h. Annual bus miles saved were estimated to be 5,200. The total passenger time savings amounted to 43,000 passenger hours per year. The 5,200 bus miles saved annually are equivalent to roughly 1,730 gallons of diesel fuel (assuming 3 m.p.g., New York City peak period estimate). The actual advantages to buses are slightly understated as some charter and school buses are also using the lane.

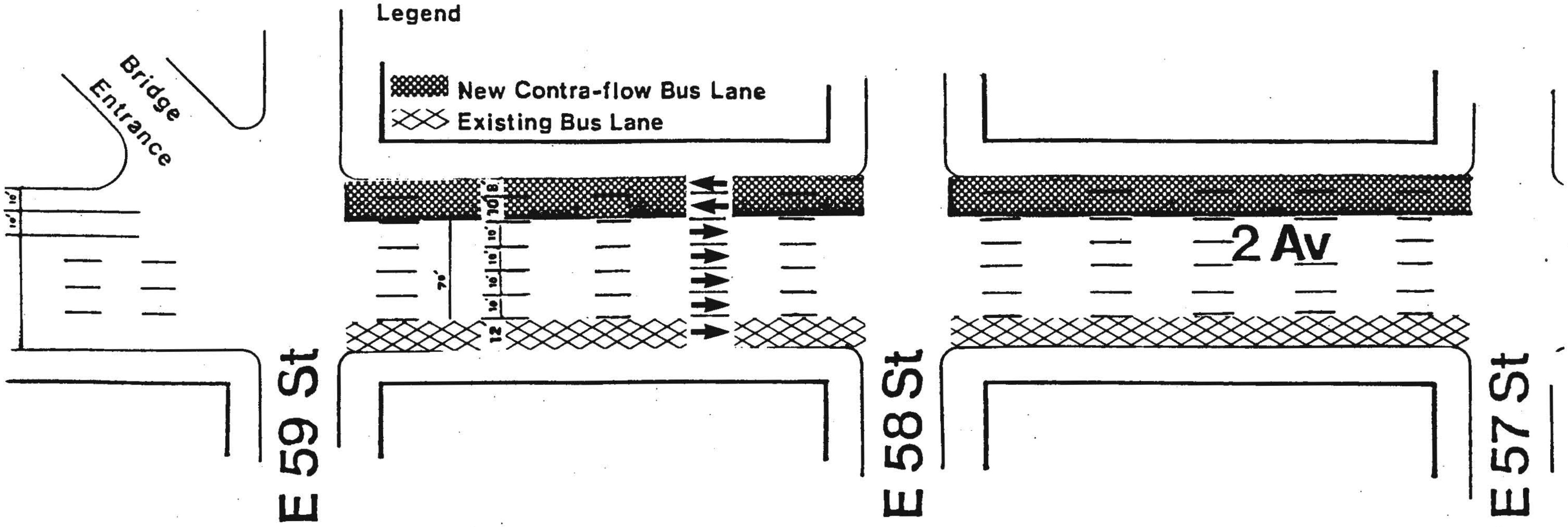


DIAGRAM OF CONTRA-FLOW OPERATION

FIGURE IV-6

b. Bus Ridership

Ridership on these express bus routes has also grown. Annual ridership on all Queens express buses went from 5,355,000 (1977) to 5,538,000 (1978) to 6,772,000 (1979) despite a long 1979 strike against Green Bus Lines, which operates three of the sixteen routes and held 5 percent of the 1978 ridership. Daily passengers grew from 8,176 (October, 1977) on 194 buses to 8,373 (October, 1978) on 233 buses to 10,780 (October, 1979) on 210 buses (decrease due to Green Lines strike).

c. Safety

In its first sixteen months of operation, no pedestrian or traffic accidents could be directly attributed to the bus contra-flow lane. It should be noted that midtown Manhattan pedestrians are not accustomed to two-way avenues nor contra-flow operations.

d. Traffic

As southbound Second Avenue traffic lost one lane, travel speed dropped from 11.2 to 8.2 m.p.h.; some of this speed reduction may be attributed to an increase in southbound traffic after the project's implementation as noted by the New York City Department of Transportation. With some buses removed from First and Third Avenues, traffic speeds on these thoroughfares increased from 8.6 to 9.7 and 5.7 to 5.8 m.p.h., respectively.

e. Air Quality

Six months after the lane's opening, estimates were made of the pollutant emissions reduced because of the reduced bus VMT. These were estimated to be 32 percent less hydrocarbons, 33 percent less carbon monoxide and 32 percent less nitrous oxide. However, as southbound traffic increased and became more congested, it correspondingly gave off more pollutants. No air quality monitoring was undertaken by the City to measure this. However, using the U.S.E.P.A.'s MOBILE 1: MOBILE Source Emissions Model (EPA-400/9-78-005-007) the changes in emission levels of the traffic (southbound and contra-flow northbound) can be estimated for both before the implementation of the contra-flow lane and afterwards. Those estimates for the 600' two-block area with 2,050 vehicles an hour are shown below.

	BEFORE Daily Grams/Mile	BEFORE Tons/Year	AFTER Daily Grams/Mile	AFTER Tons/Year
Hydrocarbons (HC)	8.84	0.131	11.33	0.176
Carbon Monoxide (CO)	96.81	1.435	126.95	1.972
Nitrous Oxides (NOX)	3.36	0.050	4.67	0.073

The reason for the increase in emission levels is that the southbound speed has been reduced as southbound vehicles are squeezed into less width. The higher emissions levels from southbound traffic on these two blocks do not represent the net air quality impact. The removal of buses from First and Third Avenues tends to raise speed there and hence contribute to lower emission levels.

f. Project Costs

The New York City Department of Transportation has made no dollar estimate of the costs involved. Capital costs included only expenses for signs, re-striping, chains, and new northbound signal faces. Operational costs are the labor costs for the five to six traffic control agents assigned to the project between the hours of 3:00 and 7:00 p.m., Monday through Friday, except holidays.

g. Extension of Project

It has been proposed by the New York City Department of Transportation that the two-block contra-flow bus lane be extended to ten blocks, going south to 49th Street to connect with the Crosstown Public Transportation Corridor at 49th/50th Streets from which through automobile traffic is currently prohibited midday between the hours of 11 a.m. and 4 p.m. This Crosstown Corridor is currently under study by the City to explore the feasibility of expanding its impact area and time of operation.

5. Problem Identification

As express bus service grew and faced increasing traffic congestion at the approaches to the Queensboro Bridge, the New York City Department of Transportation sought some means to free express buses from congestion and improve their outbound travel time.

6. Problem Resolution

The institution of the contra-flow lane was the solution instituted. There were no institutional or fiscal problems in instituting the lane as if was all handled as a City matter, using City funds and personnel on a City avenue.

7. Unresolved Problems

The lane solved the problem as much as was feasible. The City subsequently instituted other bus priority measures, including with-flow bus lanes, bans on turns and curbside parking, and restrictions on peak period auto traffic, to supplement the two-block contra-flow lane. The cumulative result of these measures is to reduce bus delay substantially. The only major unresolved problem is the labor-instensive nature of the bus lane operation, which is not on a permanent footing.

8. Future Plans

There are plans to extend the two-block contra-flow lane to ten blocks, further south on Second Avenue to the 49th Street transit corridor. There have long been plans to open a new subway line between the Manhatan CBD and outlying Queens suburbs, serving much the same market as the present express bus system.

9. Conclusions Applicable to Other Areas

Much the same conclusions drawn from other bus lanes can be drawn from this New York one. The Second Avenue contra-flow lane demonstrates at least three qualities successful bus lane projects should ideally have: 1) sufficient width for bus passing, and 2) sufficient traffic congestion to warrant exclusive treatment and gain significant travel time advantages.

Second and Marquette Avenue Contra-flow Bus Lane, Minneapolis, Minnesota

1. Strategy Objectives

The objectives of the Second and Marquette Avenue Contra-flow Bus Lane were:

a. to increase bus transit accessibility to the Minneapolis CBD for the purpose of reducing automobile use,

b. to create a better pedestrian environment downtown, and

c. to expand the downtown bus preferential treatment program which began with the Nicollet Mall Transitway, in 1967.

2. Approaches to Implementation

a. Planning & Historical Background

The City of Minneapolis had generally sought to reduce automobile use in its CBD and create a better pedestrian environment. Bus and taxi service were recognized as ancillary to these ends. The Nicollet Mall and the contra-flow lanes on Marquette and Second Avenues are examples of this policy. Second floor enclosed pedestrian bridges, or "skyways", link major offices, department stores, banks, and hotels in the CBD, providing an exclusive pedestrian right-of-way.

The conditions which led to the institution of the Marquette and Second Avenue contra-flow lanes were:

1. increased bus volume, especially suburban express bus movement into and within the Minneapolis CBD;

2. a governmental consensus in the Twin Cities area to enchance downtown Minneapolis mass transit access; and

3. a large increase in express buses on I-35W from suburbs south of Minneapolis as part of the I-35W Urban Corridor Demonstration Project - a ramp metering and bus prioritization project begun in the fall of 1972.

The proposal for the Marquette and Second Avenue bus lanes was first introduced to the Minneapolis City Council in 1973 by the city traffic engineering office, which had analyzed many options to facilitate CBD bus movement in cooperation with the Metropolitan Transit Commission (MTC). The case for a contra-flow, as opposed to a with-flow lane, was reinforced by Minneapolis' unsuccessful experience with a with-flow bus lane on Hennepin Avenue in 1954. That lane was dropped largely because of the conflict with right-turning vehicles.

b. Participating Agencies, Organizations and Groups

The interest groups participating in this project included: the Metropolitan Transit Commission, the Minneapolis Department of Public Work's Division of Traffic Engineering, the Minneapolis Police Department; the Downtown Council, the local business community, and the Minneapolis City Council.

3. Characteristics of the Project

The Marquette and Second Avenue contra-flow lanes have been in operation since 1974 with minor modification. For both avenues, the lanes are 18'-20' wide, allowing buses and taxis to pass one another (see Figures IV-7 and IV-8). The reverse flow lanes are separated from the three oncoming traffic lanes by a one foot high mountable curb with three feet high orange highway cones on top. Bus priority devices at traffic signals were installed as part of the CBD computerized signalization system in 1978. The system has not yet been implemented. Prior to the one foot mountable barrier, the lanes were divided from other traffic by double yellow pavement lines and highway cones. Some of the bus lane system's elements are discussed below.

a. Double Laning And Directional Divider

To allow bus passing, it was decided that 18-20' of contra-flow lane width must be provided, a MTC prerequisite.

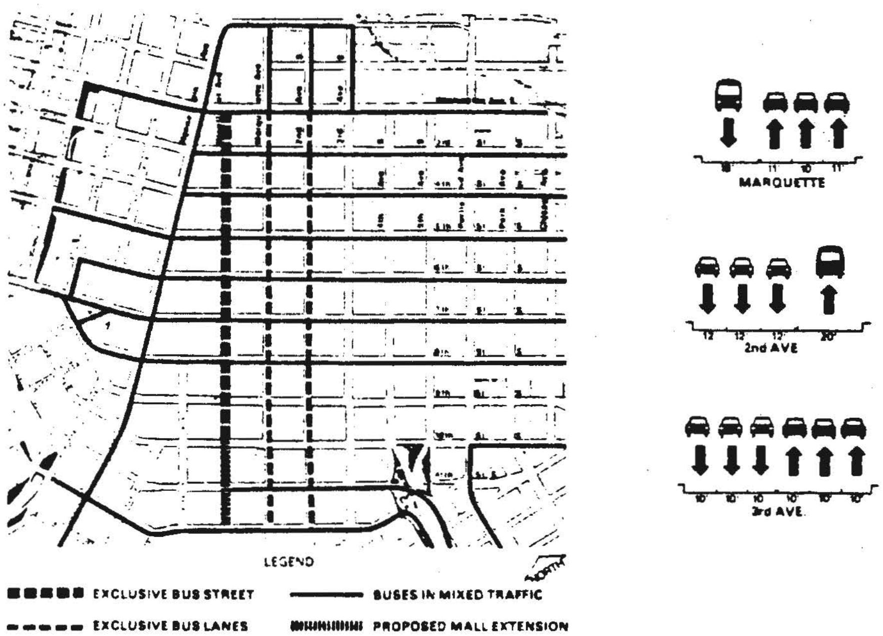
Originally, the DPW had felt that a 6' concrete median would be necessary to divide with- and contra-flow lanes on a permanent basis. Access from the contra-flow sides of the avenues would be maintained by providing gaps in this concrete median in front of driveway openings. However, when the City decided that only a double contra-flow lane of 18-20' would work, it was realized that the width was not available for both a 6' median and three with-flow lanes. Therefore, it was decided that a one-foot mountable barrier would suffice as a permanent median. In the experimental stage the contra-flow lane would be divided from other lanes by double yellow lines and orange highway cones.

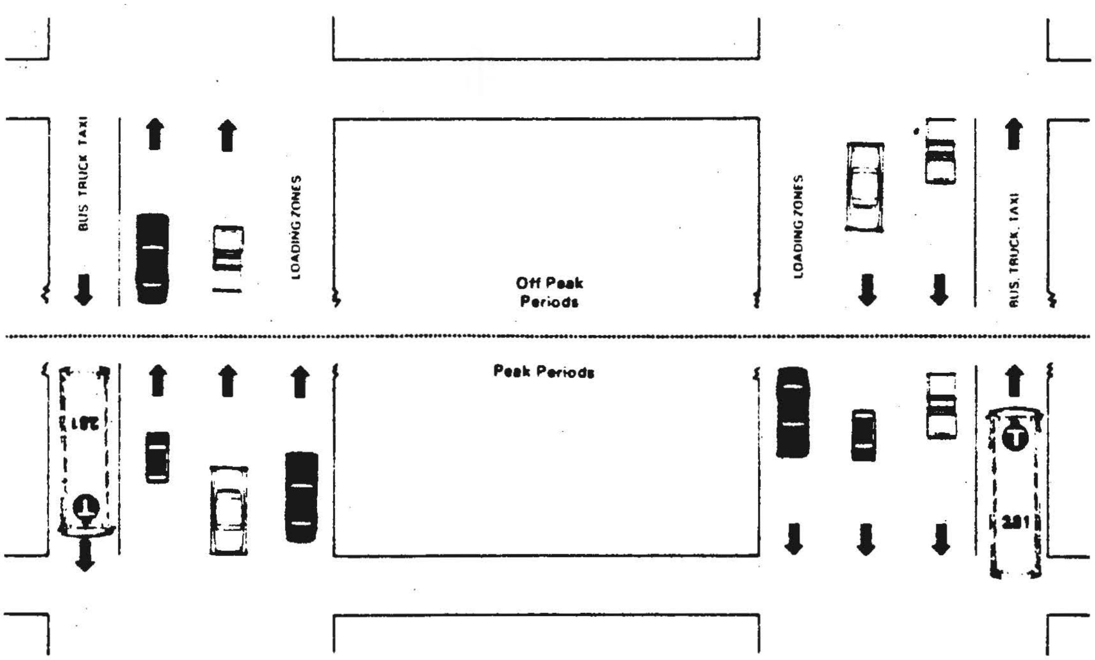
b. Taxi and Truck Use of Contra-Flow Lanes

It was decided to allow taxis at all times. Commercial vehicles were allowed to use the lanes for local delivery and pick-up at all times other than peak periods (7:00-9:00 a.m. and 4:00-6:00 p.m.). With the elimination of all automobile curbside parking and standing, delivery vehicles were aided by the institution of the contra-flow lanes.

No parking was permitted at any time on either curbside (right hand) or median (left hand) of the with-flow portions of Marquette and Second Avenues. No standing was permitted on the with-flow median sides at any time nor on either with- or contra-flow curbsides 7:00-8:30 a.m. or 3:00-6:00 p.m. However, truck pickup and delivery was

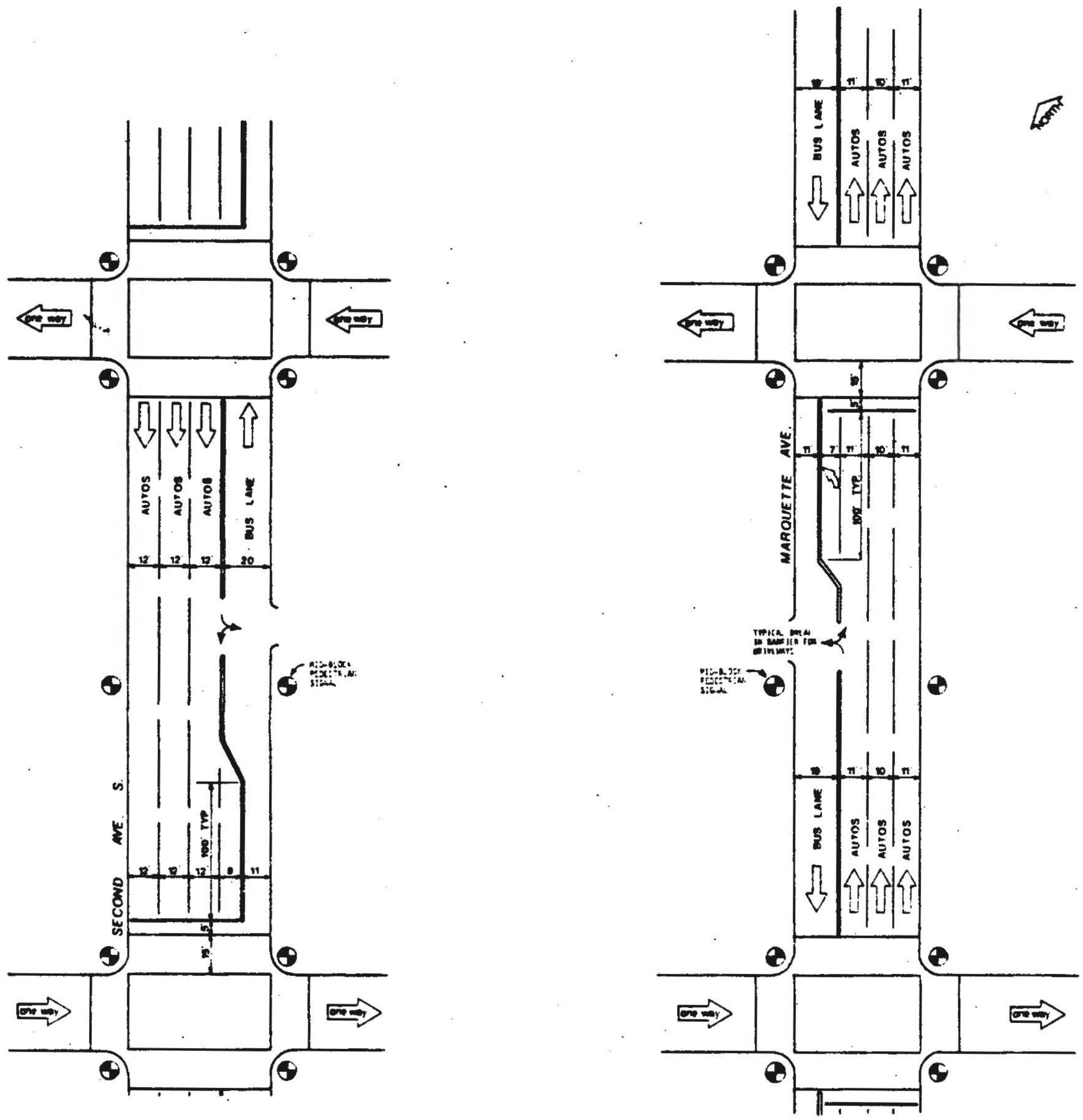
Figure IV-7 : CONTRA FLOW LANE ARRANGEMENT, MARQUETTE AND SECOND AVENUES, MINNEAPOLIS





From : Downtown Minneapolis Bus Lanes Alternatives Study, Barton-Aschman, Associates, 1976.

Figure IV-8 : DIAGRAM OF CONTRA FLOW LANES



Barton-Aschman Associates

permitted on both with- and contra-flow curbside lanes on both avenues in nonpeak hours. These concessions granted to commercial vehicles were included in the plan after CBD business and labor participation through the Downtown Council and Building Owners and Managers Association.

4. Results of Implementation

The contra-flow lanes were instituted on September 9, 1974 on a 90-day experimental basis. That period was extended for two years before a semi-permanent lane divider was installed. The following evaluation is based on a "before" and "after" analysis conducted by the City DPW late in 1976.

a. Bus Operations

It was anticipated that a 50 percent decrease in bus travel time on Marquette and Second Avenues, during the peak periods, could be achieved by use of the contra-flow lanes. The figure realized was roughly 20 percent, or a little over one minute saved per bus trip. This was not sufficient to change any bus schedules or reduce operating expenses by more than a negligible amount. However, the lanes have made it easier for buses to keep to their schedules, protecting them from occasional long traffic delays which they might otherwise encounter.

The number of buses operating on these lanes has been increasing and is projected to continue to grow. In 1975, there were 49 peak hour buses on 2nd Avenue and 153 on Marquette; MTC projects that by 1985 there will be 87-101 on 2nd and 154-175 on Marquette. By October 1975, 50 percent of those leaving the Minneapolis CBD were doing so by bus.

b. Bus Ridership

The Marquette Avenue contra-flow lane currently carries more than five thousand people in the peak hour, a situation the MTC feels approaches capacity. The contra-flow lanes have worked well for buses and bus passengers --too well in the view of those who see "wall-to-wall" buses at rush hour on these lanes and the pedestrian crowding on the sidewalks. A MTC survey found bus riders favoring the contra-flow scheme by 63 percent to 17 percent.

c. Traffic

An important objective of the project was to avoid worsening traffic congestion and to hold any reduction in vehicular flow to a minimum. It was hoped that many motorists would shift to buses or drive on other avenues. According to observations of the City's Traffic Engineering Division, this objective was largely met. Apparently, about 10 percent of the traffic diverted to Hennepin and 3rd Avenues, which have sufficient capacity. P.M. peak traffic volumes decreased 9.3 percent on Marquette and 15.4 percent on Second Avenue. City Traffic observations detected a less than 5 percent increase in automobile travel time on these segments. There are some traffic problems at midday, when right-hand curbside freight activity reduces the number of moving lanes down to two. The large number of left turns, first witnessed most profoundly during the pre-Christmas shopping season in 1974, prompted the City to institute left-turn pockets.

d. Safety

There is no pattern indicating any change in pedestrian accidents because of the lanes. MTC officials say that the occassional intrusion of buses over the barrier into with-flow traffic has not caused accidents despite the obvious head-on conflict.

e. Taxi and Truck Operations

While taxi and truck operations were only incidental to the contra-flow lane project, and were not originally part of it, they were the modes which benefitted the most from it. Taxi and truck CBD circulation became easier because they were exempted from the one-way traffic system and had to traverse fewer links. Trucks and taxis retained the right of access to buildings on both sides of Marquette and 2nd Avenues, yet did not have to compete with automobiles for parking and standing places along these curbs. Observations before and after the project was implemented noted an increase in off-peak truck use of the reverse-lane curb, and a 50 percent decrease in such use for the peak hours. (U.S. Postal Service vehicles were subsequently exempted from the peak period truck ban.) There was a 30 percent decrease in vehicle pick up and delivery of passengers along the contra-flow lane curb during this period. Commercial vehicles have more than enough room on the lane to load, unload, stand, or move.

5. Problem Identification and Resolution

In the course of the initial 90-day experimental period of the lanes' operations, several problems with the system were identified and adjustments made.

a. Left-turns

During the Christmas shopping season, which came soon after the establismment of the lanes, heavy left-turning traffic necessitated the creation of left-turn lanes at some intersections. Left-turn bays were also established within the contra-flow way at some intersections. The institution of these left-turn bays reduced contra-flow lane width to 10' in places.

b. Right-of-way Problems

Later, City and MTC observers concluded that at 10' the lanes were too narrow. At this width, buses tended to pound the sewer grates and to roll over the median in passing maneuvers. The new Hennepin Avenue contra-flow lane in Minneapolis is never less than 14' wide.

c. Building Access

To compensate for the loss of curbside access to buildings on the left-hand side of Marquette and Second Avenues, new side street loading and parking zones had to be created. Given the lower traffic volumes at night and the desire for convenient curbside access for night workers, the "NO PARKING ANYTIME" right-hand curb regulation was changed in November 1974 to "NO PARKING 6 A.M. - 6 P.M."

d. Lane Length

The largest operational change involved reverting to normal two-way traffic operation on the northernmost two blocks of both the Marquette and Second Avenue contra-flow lanes from First to Washington Streets. This action was needed to provide access to the Towers Apartments. This change had little effect on bus travel time or operations.

e. Median Barrier

The one-foot median barrier constructed two years after the lanes were first introduced does present a problem for snow ploughing and street cleaning--either ploughs or brushes must be partially raised or they must avoid the barrier.

f. Mid-Block Pedestrian Signals

These were dropped from being implemented as part of the original plan because it was observed that pedestrians ignored these devices on the Nicollet Mall and because additional signals would only complicate the lanes movement patterns.

6. Unresolved Problems

a. Building Access

The only unresolved problem is the difficulty of automobile access to many buildings along the contra-flow lanes. For the northernmost two blocks of the corridor this problem was solved by allowing all traffic, without restriction, into a widened contra-flow lane (normal, two-way traffic). However, complaints are still heard from garage operators who regard the contra-flow lane as a barrier to direct automobile access to garages. This problem is difficult to resolve. If the contra-flow lane is opened to automobiles seeking access, enforcement would be required to ensure that auto through movement and parking does not take place. Given the unrestricted taxi access to these buildings and the ability of automobiles to pull up to discharge or pick-up passengers at the median and on side streets, the access problem is not generally viewed as significant.

b. Lane Capacity

The Marquette Avenue contra-flow lane is presently nearing capacity. Capacity, with 50 percent "green" time has been estimated at 150 buses an hour. The MTC has estimated its 1985 bus volume on Marquette as 178 buses/hour; it was 115 in 1975. The MTC's estimates for increases in downtown bus volumes between 1975 and 1985 on the other major CBD avenues are: Hennepin, 73 to 110; Second, 49 to 74; and Nicollet Mall, 83 to 124.

c. Project Costs

The initial cost of creating the Marquette and 2nd Avenue contra-flow lanes on an experimental basis is given as $24,521 in the Minneapolis Department of Public Works' final report on the establishment of the lanes. The report further explained the expenses as: far side right and left signal indications for buses; additional signs to define the contra-flow lane and change "NO STOPPING 7:00 - 9:00 A.M." to "NO STOPPING 7:00 - 8:30 A.M."; removal of lane lines at dual turn locations on the avenues and cross streets; and new lane lines.

The above cost does not include the construction of the one-foot concrete median or routine maintenance of the lanes, medians, signs, lights, or enforcement of contra-flow lane regulations. Nor does it reflect the costs involved in any of the modifications to the lanes: left-turn lanes and bays, elimination of the northernmost two blocks from the lanes, side street parking and loading zone re-signing, installation of additional signs, movement of signs, or the costs of planning and communications related to the lanes.

The total capital cost of the permanent bus lanes is given by the Minneapolis DPW as $805,000, including $73,000 for restriping of lanes and walks, $118,000 for electrical loop detector and amplifier hook-up (for bus traffic signal priority), and $614,000 for construction of the medians. Funding was obtained solely from the City.

8. Future Plans

A temporal spreading of demand may occur naturally as a response to intolerable sidewalk and bus crowding in the peak fifteen minutes. The demand on Marquette can also be lessened by shifting some bus routes to cross-streets. Given the spatial concentration of employment along 5th, 6th, and 8th Streets, and Marquette's space limitations, this is likely to occur. There are other ideas to increase capacity. One is to speed up passenger loading operations by opening rear doors and have payment when passengers alight from the bus, instead of payment when boarding. This procedure is already in effect on the I-35W express buses. Another is the use of higher capacity (articulated or double-decker) buses, which reduce dwell-time per passenger, as well as vehicle space requirements per passenger.

The building access problem is not viewed as serious enough to necessitate any change in lane operation.

9. Conclusions Applicable to Other Plans

The contra-flow lane planning in Minneapolis brought in all the key downtown elements--the bus operator, the police, the city traffic engineers, business, labor, and the City Council. The original plan was modified and in several ways improved. It was originally a plan only for bus movement, integrated with the establishment of a computerized signalization system. It developed into a comprehensive CBD plan to facilitate taxi and freight vehicle operations as well, with proper consideration to public utility underground work, pedestrian access, traffic flow, and a bus signal preemption system. The Minneapolis project was entirely sound from a traffic engineering viewpoint and was developed by the professional traffic engineers responsible to the City government. The nagging problem of automobile access to buildings along the contra-flow lanes was minimized. Freight access by commercial vehicles and direct passenger access by taxi or bus was provided.

Another aspect of this project reflects how much it underlines the value of TSM projects which can be modified easily and incrementally, based on need and operational experience. It was possible to operate the project on an "experimental" basis for two years with only $25,000 (1974 dollars) as capital investment and with no extra operating personnel. During those two years enough was learned to test the impacts of the lanes, make several modifications, and plan a final design which was efficiently integrated with an innovative CBD transportation system--the pedestrian skyway network--and computerized signalization. Minneapolis took over a year of planning and two years of actual operating experience before they finally invested $805,000 (1976 dollars) to put the project in final form.

Other conclusions, borne out by this and other bus lane studies, applicable elswhere are: 1) the marginal speed advantages gained by buses from the exclusive right-of-way, 2) the safety of contra-flow operation, 3) the need for adequate pedestian waiting area (sidewalks), and 4) the need for advance passenger knowledge of exactly where particular buses will stop.

Spring Street Contra-Flow Bus Lane, Los Angeles, California

1. Stategy Objectives

The objectives of the Spring Street Contra-Flow Bus Lane study were:

a. to expedite downtown express bus circulation,

b. to enhance the busway rapid transit service on the San Bernardino Freeway by reducing downtown bus delays for express buses, and

c. to encourage higher mass transit utilization for trips to downtown Los Angeles.

2. Approaches to Implementation

a. Planning & Historical Background

With the implementation of the San Bernardino Freeway Express Busway, the Southern California Rapid Transit District (SCRTD) saw the need to extend the exclusive bus right-of-way concept to downtown streets. Under the sponsorship of the SCRTD, a study was made which recommended contra-flow bus lanes on two one-way couplets (Hill/Olive and Spring/Main Streets). The City of Los Angeles was not willng to go along with these recommendations for several reasons, including Civic Center Mall construction on Main

Street. Spring Street was left as the only street left for contra-flow bus operations.

On May 19, 1974 the curbside exclusive bus lane was implemented , with contra-flow bus movement northbound against southbound Spring Street traffic and passenger pick-up and delivery along entire length of the bus lane.

While the SCRTD had thought that a Spring Street contra-flow bus lane would speed the movement of its express buses, the LADT had thought otherwise, in large part because the contra-flow buses would be moving against a new southbound signal synchronization. The LADT had found that 89 percent of the delay to buses was due to red lights or passenger stops, not traffic congestion. Subsequent to implementation, LADT surveys demonstrated that this had occurred and the LADT and some local business establishment, which lost curbside access becase of the lane, called for an end to the contra-flow lane. However, the City Council decided to allow the lane to continue. In 1978, the Los Angeles Department of Traffic was reorganized along with some other City agencies as the Los Angeles Department of Transportation (LADOT). Thereafter the new LADOT and the SCRTD collaborated to double the width of the most heavily used segment of the contra-flow lane, a move which increased bus speed and which permitted skip stopping at separate express and local bus stops there.

b. Participating Agencies, Organizations and Groups

The interest groups participating in this project included: the Los Angeles Department of Traffic (LADT), the Southern California Rapid Transit District (SCRTD), the Los Angeles City Council, the downtown businesses directly impacted by the contra-flow lane, and the Central City Association. The LADOT was the prime agent in the 1979 changes in the lane.

3. Characteristics of the Project

The Spring Street Contra-Flow Bus Lane was implemented in May 1974, to facilitate downtown movement for buses and to provide continuity of preferential right-of-way for buses using the San Bernardino Busway (see Figure IV-9). The contra-flow lane on Spring Street was first operated as a 13-foot lane from Ninth Street to Macy Street a length of 12 blocks (1.4 miles) through eleven signalized intersections (see Figure IV-10). Experience with this type of operation was evaluated by the LADT and the SCRTD. These independent evaluations reported the "before" and "after" comparisons for (1) bus speed, (2) traffic speed, (3) accidents, (4) ridership, and (5) business activity.

The LADT and SCRTD studies arrived at opposite conclusions: the SCRTD regarded the contra-flow lane as a positive action, the LADT regarded it as a negative one. These differences, however, were mainly due to the perceptions held by these agencies regarding the overall objectives of the contra-flow lane. LADT saw it as one option among other traffic engineering options to be considered in improving traffic and bus flows, while SCRTD was highly concerned with such issues as transit visibility or physical presence, and passengers' perceptions.

Supported by the City Council, the contra-flow lane survived in spite of the fact that bus operating speed was not improved, and traffic speed on Spring Street was reduced during the a.m. and p.m. periods.

The contra-flow lane had two basic operational problems which contrained its potential efficiency: (1) because of its narrow width buses could not pass each other and this produced delays in the system, and (2) the lack of space to handle the high number of buses stopping to serve passengers between First and Aliso Streets created much confusion for bus riders as they would not know the location of their bus stops on any given day. A number of modifications were implemented in November 1979 to resolve these problems for the contra-flow segment north of First Street.

The modifications (see Figures IV-11, IV-12 and IV-13), intended to speed bus movement and reduce the problems for waiting passengers, were: 1) doubling the width of the contra-flow lane between First and Arcadia Streets from 13' to 21-26' to allow bus passing on this segment, which had the highest bus volume; 2) alternating Busway and non-Busway bus stops on this segment to permit bus skip-stop operations and to reduce passenger confusion; and 3) the conversion of Spring Street's northward extension (New High Street) from one-way southbound, to two-way operation to allow a contra-flow continuum for Spring Street buses.

About 1,145 bus runs (1980) ran on the lane with 260 in the 4-6 p.m. peak period on the most heavily used segments.

4. Results of Implementation

a. 1974-1979 Period: 13-Foot Lane Width, Entire Length

Bus Operational Speed

Whether the contra-flow lane actually facilitated or hampered bus movement in and out of the CBD was the major issue in the planning and post-implementation analysis of the lane by the Los Angeles Traffic Department, the Rapid

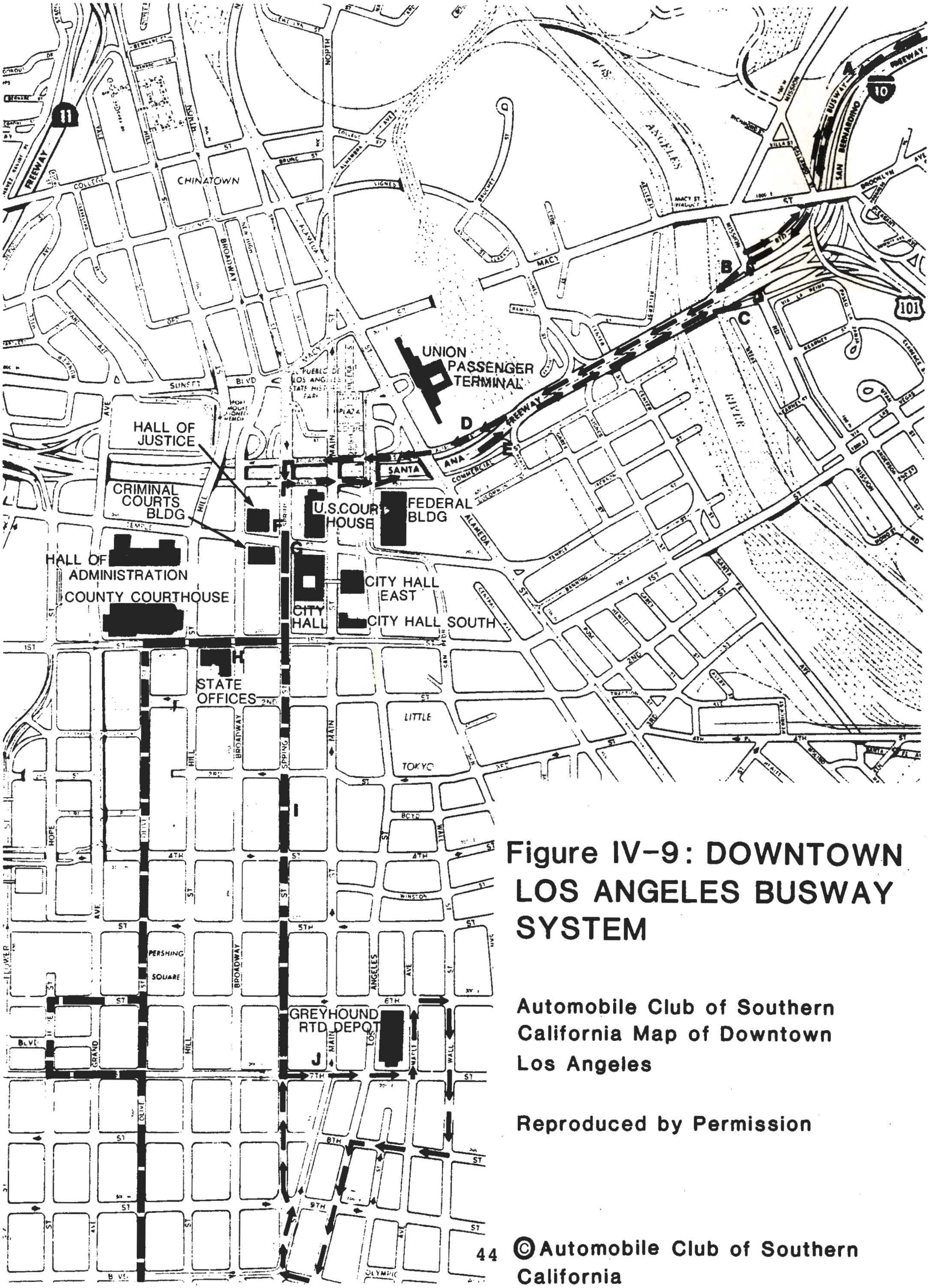


Figure IV-9: DOWNTOWN LOS ANGELES BUSWAY SYSTEM

Automobile Club of Southern California Map of Downtown Los Angeles

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EXPLANATION OF FIGURE IV-9

A. Buses move on exclusive Busway along north side of San Bernadino Freeway.

B. Inbound buses go straight onto ramp to Santa Ana Freeway.

C. Outbound buses exit off Santa Ana Freeway and turn north on Mission Road to reach Busway.

D. Inbound buses exit Freeway and reach Spring via Arcadia Street.

E. Outbound buses leave Spring contra-flow lane at Aliso Street, turning east.

F. Inbound (southbound) buses move with-flow on Spring Street.

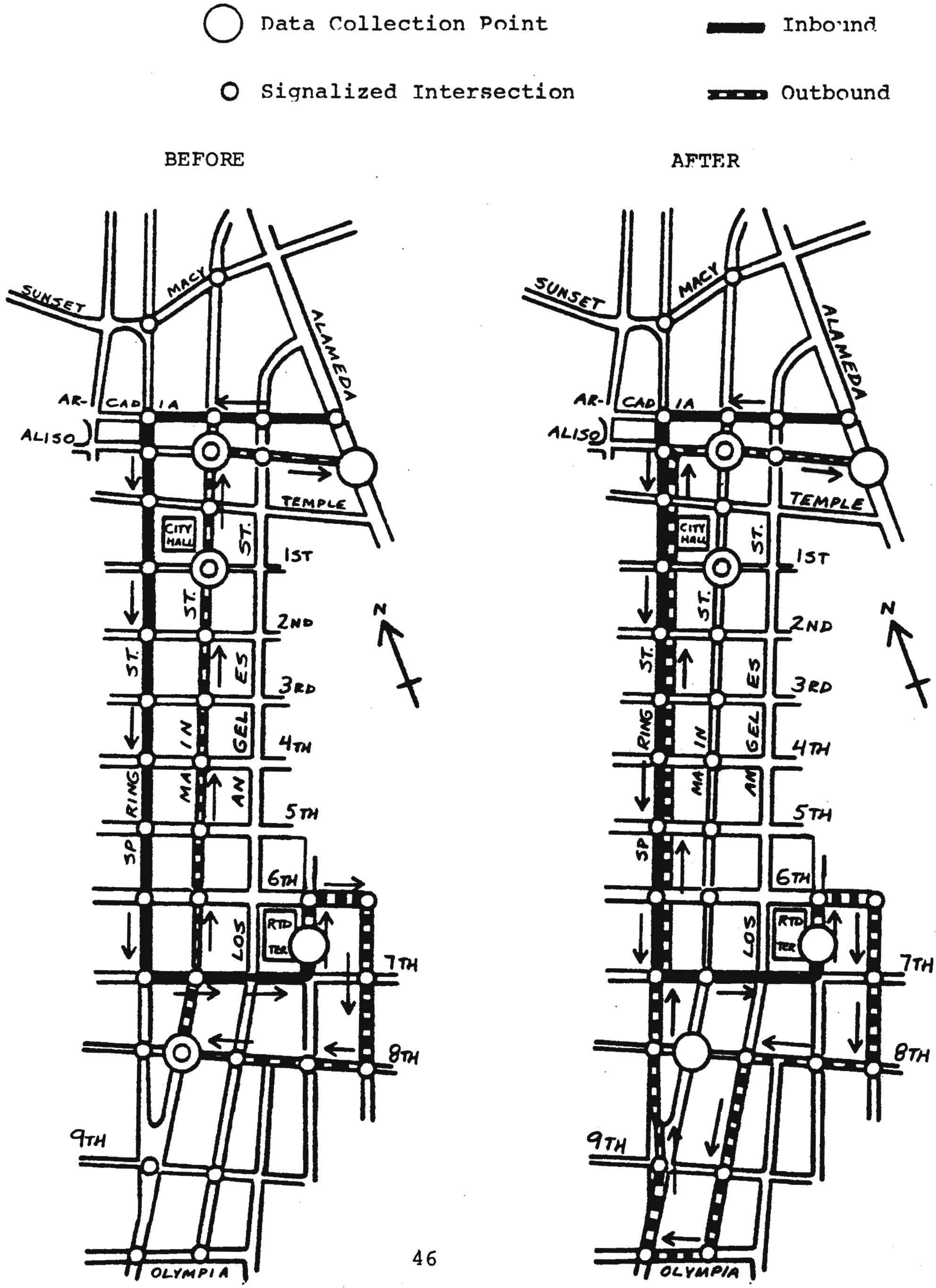
G. Outbound (northbound) buses move contra-flow on exclusive contra-flow bus lane, double-width north of First Street.

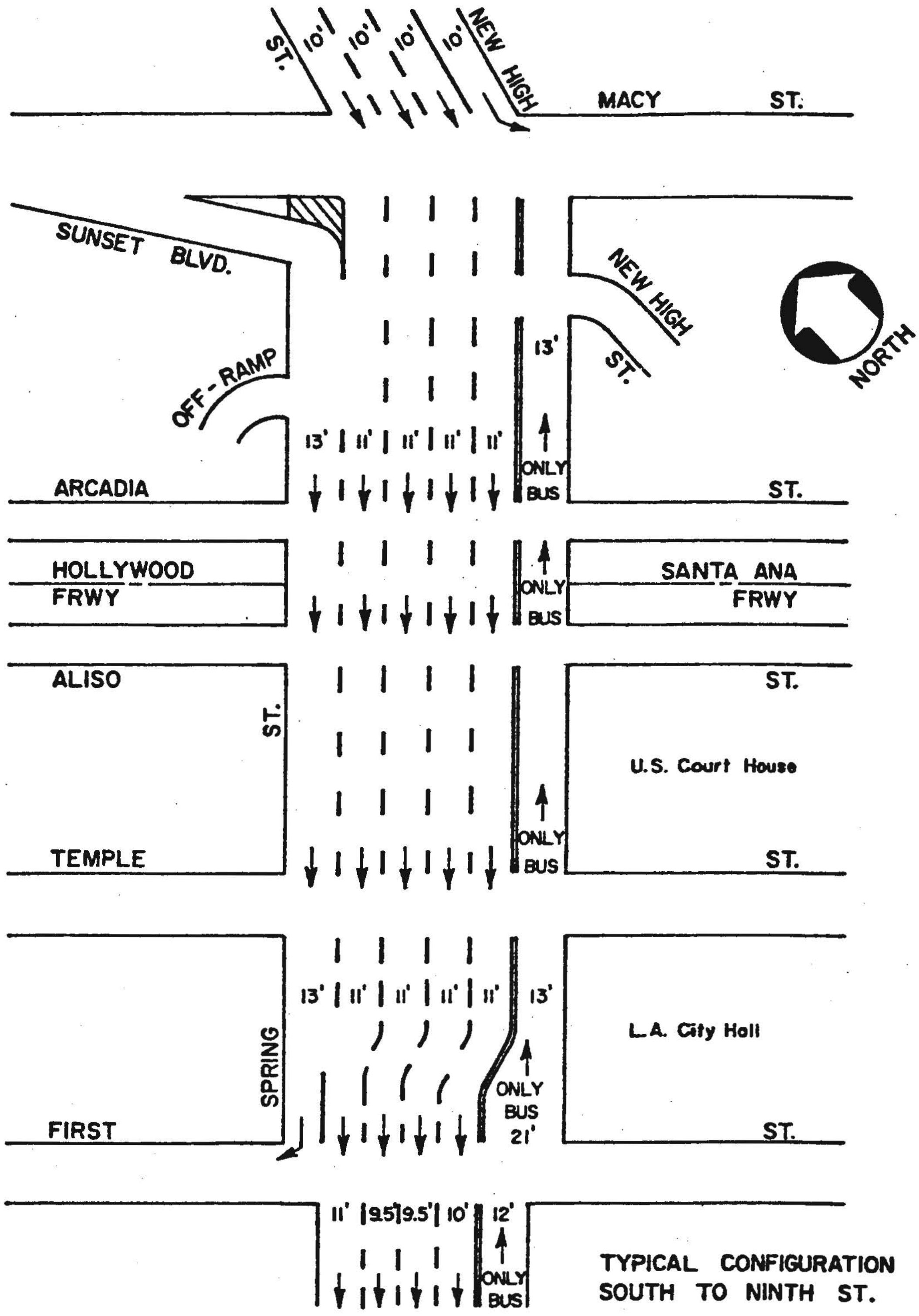
H. Most buses go west to Olive Street to provide west side commercial district service, running with-flow on First and Olive Streets - no contra-flow or other exclusive bus lanes.

I. Outbound (northbound) buses move contra-flow on exclusive 13' contra-flow bus lane.

J. Inbound buses access RTD Terminal and must make circuitous loop to enter northbound contra-flow bus lane to move outbound.

Figure IV-10: BUSWAY ROUTE NUMBER 60 DOWNTOWN ROUTE BEFORE AND AFTER SPRING STREET CONTRA FLOW LANE

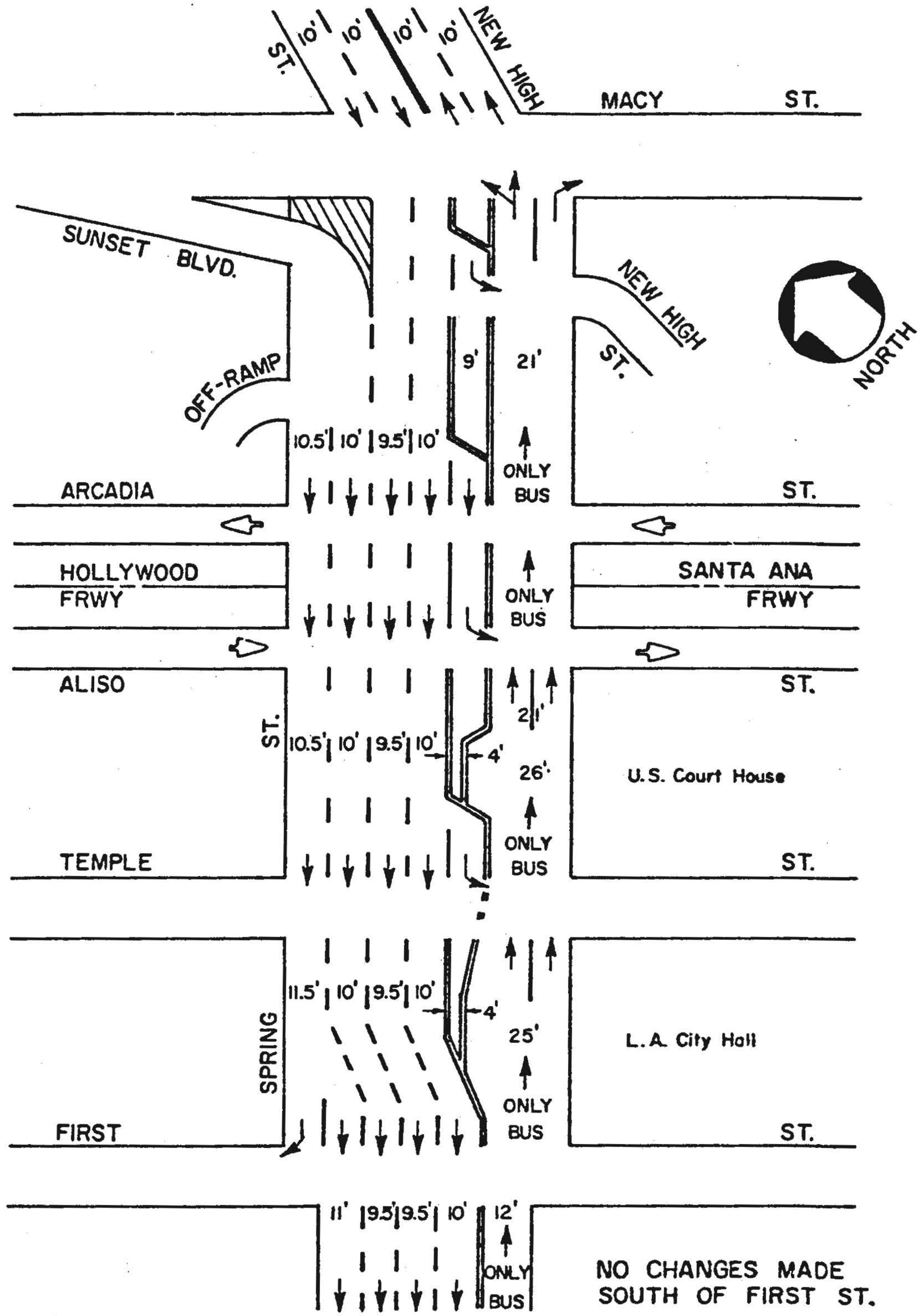




ORIGINAL SPRING ST. CONTRA-FLOW BUS LANE CONFIGURATION

FIGURE IV-11

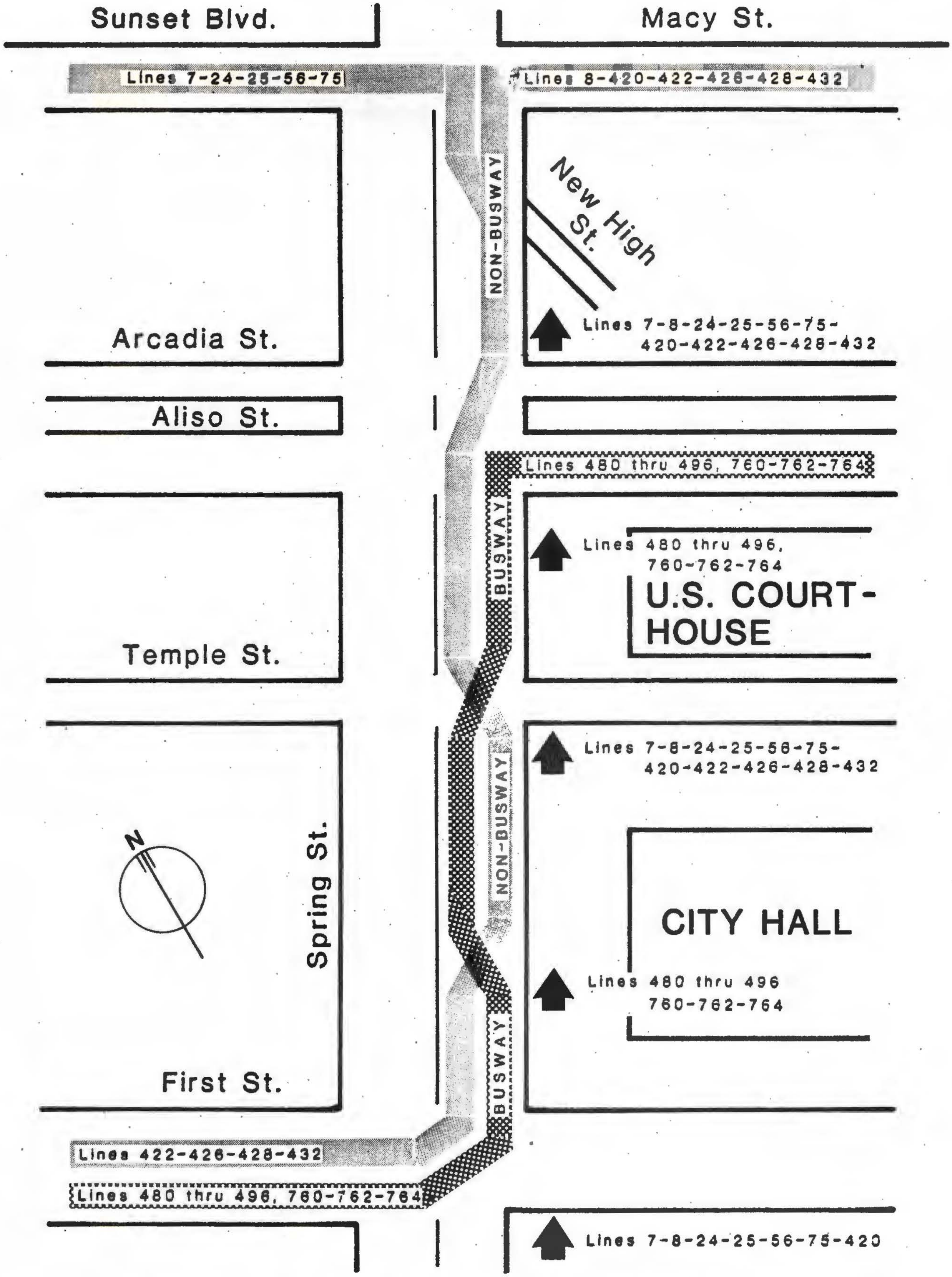
From Evaluation of the Spring Street Contra-Flow Bus Lane Widening and Re-routing of Buses on New High Street
LADOT and SCRTD, December, 1980.



REVISED SPRING ST. CONTRA-FLOW BUS LANE CONFIGURATION

FIGURE IV-12

From Evaluation of the Spring Street Contra-Flow Bus Lane Widening and Re-routing of Buses on New High Street LADOT and SCRTD, December, 1980.



SPRING STREET CONTRA-FLOW BY-PASS OPERATION

SOURCE: Southern California Rapid Transit District

FIGURE IV-13

Transit District and its consultants, and others. All studies by the LATD and four consultants found operational bus speeds on the Spring Street contra-flow lane to be slower than former bus speeds on Main Street.

The consultant for the Southern California Association of Governments (SCAG) found that an extra 1.2 minutes in the morning peak, and an extra 1.7 minutes in the evening peak had been added between 1st and 6th Streets to the travel times of Main Street buses which had been rerouted onto the Spring Street contra-flow lane. The consultant concluded that: "...contra-flow lanes in themselves do not save travel time if they are constructed without preferential traffic signaling...it appears that the contra-flow lane has not solved the basic problem of speeding downtown passenger distribution consistent with the greatly increased speed of the Busway."

The LADT cited the experience of other cities to substantiate its conclusion that exclusive bus lanes only result in significant bus travel time savings where traffic congestion is severe and that the establishment of contra-flow lanes may even lower bus operating speeds by having them run against the signal progressions without providing passing ability. The unsuccessful Louisville, Kentucky experiment with contra-flow bus lanes was cited in the LADT report because of its similarity to the problem on Spring Street "...extensive detours incurred in traveling from the CBD to the exclusive outbound bus lane...The bus, so to speak, had to go out of its way to utilize the PM exclusive bus lane and the resulting route deviation was very time consuming... the buses actually saved time using with-flow facilities."

It can be concluded that buses did not move faster with the contra-flow lane. However, the lane may have provided advantages not credited by the LATD, which was "...concerned only with the question of whether or not commuters are being moved more quickly through the Central Business District (CBD)." The advantages had to do with better <u>marketing</u>-- better delivery of the service to the market. The lane provided: 1) possibly better schedule reliability; 2) a constant visual reminder of the bus route and RTD system; 3) the relocation of riders to bus stops in a more acceptable environment away from Skid Row--a factor which influenced commuters' attitudes about waiting for the bus; and 4) bus service "... one block closer than the route previously used to most P.M. trip origins..." so that "... the total time from office to departure from the CBD probably is not increased." The 1,463 bus riders surveyed by SCRTD found Spring Street more convenient than Main Street by 71.7% to 10.3%. The lower walking time combined with shorter headways due to increased service probably cancelled out the slight loss in bus operating speed.

Traffic and Parking Impact

The LATD and RTD studies both established that on Spring Street the southbound traffic level of service declined, but still compared favorably with other downtown streets. The peak traffic crunch is also short; after 5:15 p.m. the downtown area clears out considerably.

While every block on the east side of Spring Street between 2nd and 10th Streets has an off-street parking lot and most have exits onto Spring Street, these lots have alternative access to cross streets and, in some cases, to Main Street. Vehicles can cross the bus lane perpendicularly from these lots. 389 Spring Street drivers responded to a roadside, mail-in questionnaire distributed by the RTD on June 9, 1975. Of these, 65.8% said they did not have any difficulties entering or exiting off-street parking facilities because of the contra-flow lane. Only 17.0% did. Over 83% of the responding drivers drove twice or more every week on Spring; 72.5% drove there daily. Eighty percent of the drivers also thought lane signing was adequate, 76% said they hadn't noticed any increased congestion on Spring Street, and 78% found it no "more undesirable" to drive on Spring Street than other downtown streets.

Modal Shift

According to the comprehensive cordon counts conducted by the Los Angeles Department of Transportation (formerly the Traffic Department), the proportion of passengers (all vehicular modes) entering the CBD by bus at the cordon line declined slightly from May 1974 (when the contraflow lane was implemented), to May 1978. Transit ridership data for these cordon counts was provided by the SCRTD and other bus operators; vehicle counts were made by machine. The bus share declined from 28.9% to 27.7% while the automobile share rose from 65.7% to 66.8%. The 27.7% 1978 transit share was still an increase over the 24.2% 1972 transit share, however, heavy subsidization and the institution of a flat fare had occurred in the intervening six years. These figures refer, however, to the cordon of the entire Los Angeles CBD. On the San Bernardino Busway Corridor, transit use increased, as Busway ridership rose about 50 percent in the year subsequent to bus lane implementation.

Accident Analysis

The LADT accident analysis found a substantial increase in bus accidents from an average of 4.3 in the three 42-week periods prior to implementation of the contra-flow lane to 17 in the 42-week period subsequent to contra-flow operation. This increase was twice the increase in the number of buses operating on Spring Street. Personal injuries grew from an average of two in the previous 42-week periods, to 17 (7 of them in the contra-flow lane) in the period after implementation (a 750% increase). Bus involvement in pedestrian accidents increased from an average of 0.67 in the three 42-week periods prior to implementation, to 6.0 in the 42 weeks after implementation; five of these accidents occurred in the contra-flow lane. Total traffic accidents on Spring Street have remained constant at 75 per year while traffic had decreased slightly.

While this experience is hardly encouraging, its statistical significance is not clear. The LADT also found a tripling of bus-related accidents on Main Street, <u>after</u> half its buses had been shifted to the Spring Street contra-flow lane--six times the number of accidents per bus run.

The RTD accident analysis corroborated the LADT's finding of a significant increase in bus-related accidents in the contra-flow operation, more than twice the increase in bus mileage on the lane. They found 13.2 bus-related accidents per million bus miles on Spring Street southbound, and 11.2 per million bus miles on Main Street northbound before implementation of the contra-flow lane. After implementation they found bus-related accidents per million bus miles on Spring Street rose to 29.6.

However, the RTD study also noted the curious and much greater increase of bus-related accidents on Main Street from 11.2 per million bus miles to 49.3. This increase came after half the buses had been removed from Main Street and with no change in the with-flow operation there. The much greater increase in bus-related accidents on Main Street in the same period, recorded by both the LADT and the RTD's consultant, throw considerable doubt on the meaning of Spring Street's increase in bus-related accidents. Also only a handful of incidents and persons were involved in these accidents (there were only 1.6 bus accidents per month on Spring Street after implementation). The fact that bus accidents increased more on Main Street suggests that the contra-flow operation cannot be held as more dangerous than the with-flow operation it replaced.

The RTD analysis also compared the bus accident rate on Spring Street favorably with a national average city bus accident rate of 67 per million bus miles, and with contra-flow bus lanes in Madison, Wisconsin (205.0 accidents per million bus miles), Seattle (334.0), Indianapolis (69.0), and Louisville, Kentucky (67.0). They also felt that in time, with greater awareness of contra-flow operation, the accident rate would decrease.

<u>Economic and Social Impact</u>

The institution of the contra-flow lane created obvious problems for any commercial enterprise on the east side of Spring Street. Statements were made to the effect that the lane had a deleterious economic impact and it might be inferred that the contra-flow lane was partially responsible for Spring Street's decline. The local view is that "progressive blight" from the east is certainly more in evidence on Spring Street today than in 1974. One transportation official noted that a major reason for having buses use the contra-flow lane on Spring Street was that: "...the RTD wanted to have its riders wait for the bus on Spring Street, which was a much nicer street--only it's not so nice now."

According to business leaders, whatever negative impact the contra-flow lane had on commerce was negligible because it effected only a few small establishments. And any negative impact would also have to be traded off against the better transit marketing provided by the lane. Today the transit system is considered of prime importance to Los Angeles CBD commercial vitality by downtown business leaders and community planners.

b. <u>Post-1979 Period: Southern Segment Single Lane; Northern Segment Double Lane</u>

In 1979 the northern segment of the bus lane was widened from 13' to 21-26', permitting bus passing on this most heavily used segment. The following is a summary analysis of the lane after this changes.

<u>Contrast Between Northern and Southern Segments</u>

The northern and southern segments of the contra-flow lane provide different service levels after the 1979 changes.

The <u>southern</u> segment, from 9th to 1st Streets, consists of <u>one 13'</u> wide lane. This represents a bottleneck on which any halted bus blocks all buses behind it. This southern segment carries only a small fraction of Busway routes and hence has been of little utility to the Busway operation. It is on this segment of the contra-flow lane that commercial activities have been adversely effected. Because the southern segment of the contra-flow lane has been of marginal value to bus operations and has reduced the convenience to merchants, it may not be worth retaining. However, it should also be noted that when compared with Main Street, this segment provides the rider with a more secure and pleasant environment at bus stops.

The northern segment is quite a different story. It is effectively double-laned (1979) and hence does not act as a bottleneck. It does not interfere with commerce. It moves a much higher volume of buses than the southern segment. Subsequent to the 1979 lane widening, it has also been a faster route for buses than the former Main Street route--1.7 minutes for the First-Aliso stretch versus 2.0 minutes on the former Main Street route between First and Aliso . The northern segment of the contra-flow lane has the additional advantage of carrying a heavy volume of buses which otherwise would have to travel on First and Main Streets, which carry heavy peak period traffic. While the unit lane costs in the northern segment apparently were little higher than for the southern segment, it can be concluded that the northern segment has been far more cost-efficient, yielding real travel time benefits.

Costs

While precise information on the costs of implementing the contra-flow operation are not available, the only figure associated with 1974 planning and implementation of the project was $48,519.94. This was the figure given to the LADT by SCAG identifying all costs charged against the project between July 1, 1973 and May 24, 1975. In addition, the LADOT estimated an additional $4,000-4,500 was spent in widening the northern segment and changing New High Street to two-way operation. However, maintenance and enforcement costs are not included in these figures. The LAPD annual estimate ($314,000 in 1974) to enforce lane regulations could not be verified.

The SCRTD did not save money nor lose much under the new operational arrangement, which involved many of its buses putting on extra mileage. But no firm estimates can be made of: additional RTD revenue attributable to contra-flow operation, extra RTD operational (supervisory) costs, traffic enforcement costs, maintenance costs, and meaningful values which can be assigned to commercial loss, and to passenger and driver travel time.

Transportation Utility of Lane

The 1980 LADOT/SCRTD survey of the contra-flow lane found that about 9,000 people were carried between 4-6 p.m. in the northern segment of the contra-flow lane. Roughly half that number were being carried in the southern segment. This compares with 6,300 people[1] moving southbound with-flow on Spring in the same period.

Two bus routes suffered an operational speed loss and the addition of .6 mile of route with little compensation under the contra-flow arrangement.

No conclusions can be drawn from the accident data about the comparative safety or lack of it on the contra-flow bus lane.

The project highlights some of the problems of contra-flow bus operations and their limited utility--applicable where sufficient with-flow capacity remains, commercial operations are not seriously hampered, 18' or more is provided in width to allow for passing, and where a sufficient passenger volume warrants implementation.

Despite some problems, the northern segment of the contra-flow lane, from First to Macy Streets, works and seems to have demonstrable advantages in bus speed, reliability, and people movement over former with-flow operation. It is well situated where all Busway routes run, is sufficiently wide, has skip-stop operation, and carries a high volume of buses. However, it was not until five and a half years after the start of contra-flow operation that the necessary changes were made to make this segment work.

5. Problem Identification

The need for faster CBD bus movement became most pronounced with the introduction of bus rapid transit service in 1973 on the San Bernardino Freeway Express Busway, an 11-mile busway between the Los Angeles CBD and San Gabriel Valley suburbs. As the local transit district was prevented from constructing any rail rapid transit system with a CBD subway, it tried to obtain an exclusive CBD transit right-of-way in the form of the contra-flow bus lane to free buses from traffic congestion.

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[1] 2,000 autos/lane @ 1.4 persons per auto during the 4-6 p.m. period were estimated by LADOT, amount to 2,800 people. In addition about 3,500 were on southbound buses (175 buses x 20 passengers per bus) LATD 1974 estimate.

6. Problem Resolution

There was disagreement as to how much the contra-flow lane has solved the problem of CBD peak period bus speed. Generally, the conclusion was that the bus speed had not improved, though the 1979 lane widening in the key segment of the contra-flow lane did definitely improve bus speed for most Busway buses - but by only 20 seconds per trip on average.

7. Unresolved Problems

The bus lane had not worked out as well as planned and two unresolved problems remained after implementation in 1974: 1) improving CBD bus speed, and 2) the interference the bus lane was causing to Spring Street businesses. The first problem was partially solved by doubling the width of the contra-flow lane in its most heavily used portion in 1979.

8. Future Plans

A revival of business activity on the contra-flow lane's side of Spring Street could lead to pressure to end the southern segment of the lane. Another possibility, which has been a perennial issue in Los Angeles, would be to obviate the lane by construction a subway. The latest plan is to re-convert the San Bernardino Busway (originally an interurban trolley right-of-way) to light rail, with these vehicles running underground in the CBD.

9. Conclusions Applicable to Other Areas

CBD exclusive bus lanes may improve bus speed only marginally and may actually result in slower speeds if greater bus circuitry is caused by using contra-flow lanes.

A contra-flow lane wide enough for one bus at a time so that buses cannot pass the bus ahead of them is a potential bottleneck, especially if passenger stops are made along the lane. Speed is compromised. Also double-wide contra-flow lanes permit off-peak use of commercial vehicles as buses can pass trucks loading and unloading.

Bus lanes, especially contra-flow, must be coordinated with traffic signalization and may in general be less effective in moving buses than preferential signalization.

C. Park and Ride Lot Strategies

Connecticut Commuter Parking Lot Program

1. Strategy Objectives

The objectives of the Connecticut Commuter Parking Program were:

a. to provide parking lots at expressway interchanges in response to observed commuter parking activities at some of those locations;

b. to encourage carpooling and transit usage by commuters;

c. to reduce areawide traffic congestion and air pollution; and

d. to support the development of the State's comprehensive long-range transportation plans.

2. Approaches to Implementation

a. Planning & Historical Background

In the late 1960's it was noticed that many commuters were parking near expressway interchanges (notably on the Merritt Parkway and the Connecticut Turnpike) to form carpools to travel to their final destinations. These vehicles were often parked at locations that created traffic hazards.

In the summer of 1969 the Connecticut Department of Transportation's (ConnDOT) Division of Transportation Planning made a study of all expressway interchanges in the State to determine the location, the amount, and the characteristics of commuters and their parking activities.

Survey results indicated that although the origins of interchange parkers were dispersed throughout the State, their destinations were mainly at major employment centers such as Hartford, New Haven, and Stamford. The interchange locations which were studied were grouped into three catagories:

1. The "present usage" category included locations presently being used by commuters for parking near interchanges, and was further subdivided into sites requiring improvement of existing

parking areas, and sites requiring the construction of new lots.

2. The "no present usage" category, included existing interchanges considered as potential sites for parking facilities.

3. Parking lots which could be integrated into the design of new interchanges were identified as "future interchanges."

Four locations were selected as a "pilot" program for parking lot construction. Construction of these facilities utilzed State-owned right-of-way and was carried out by ConnDOT maintenance personnel in order to minimize costs. Construction activities of these initial lots included the placing of curbs and a bituminous concrete surface with pavement markings, in contrast to many gravel lots built later. Lighting was not provided initially, but in June 1975 ConnDOT adopted a policy that all existing paved lots, as well as all newly constructed paved lots, would be illuminated.

The Department recommended and began an intensive promotional effort before and during lot construction, including the following measures (most of which are still being used):

- o News releases explaining the interchange parking lot program and providing details about newly opened lots.
- o Opening of each lot by ConnDOT and local officials.
- o Installation of directional signs on appropriate roads to facilitate lot use.
- o Erection of signs at lot construction sites to identify locations of future free commuter parking lots.

The success of the four initial parking areas, as measured by the use of these lots by commuters, was the determining factor in the decision to continue developing commuter parking facilities in Connecticut. Subsequently, after noting popularity of the four pilot lots, ConnDOT adopted a commuter parking lot policy intended to encourage development and expansion of interchange parking lots for carpooling, and decided to expand the commuter parking lot construction program.

The Commuter Parking Program has grown substantially since 1975, both in development of new facilities and the upgrading and expansion of existing areas. As demand for commuter parking has grown, the State has built other lots at selected locations along State highways. In some places, where State land is not available or suitable for lot development, ConnDOT has rented parking spaces from shopping centers or churches. By March, 1980 there were 123 parking lots with a total capacity of about 10,420 spaces, and it was estimated that about 7,800 (75 percent) were occupied daily. This high rate of utilization is indicative of the program's growth and success since January, 1974, when only 540 of the 770 spaces were used daily. As of spring 1980, 37 of the 123 lots are served by commuter buses, and these bus lots account for nearly 48 percent of all vehicles parked in the lots each day.

b. Participating Agencies, Organizations and Groups

Those participating in the program included citizens, Connecticut's Planning Regions and Transit Districts, and ConnDOT's Bureaus of Public Transportation, Highways, Administration, and Planning and Research.

3. Characteristics of the Project

ConnDOT maintains a network of 123 park and ride lots located at or near expressway interchanges throughout the State. Most of these lots are built on State-owned land. Twenty-five percent of the spaces available were acquired through license agreements from shopping centers or church parking lots. As of May 1980, license agreement were in effect at 16 locations.

4. Results of Implementation

a. Lots Served by Express Bus

The average home-to-destination travel time for trips using the commuter parking lots is about 40 minutes: 6.23 minutes from home-to-lot and 33.39 minutes from lot-to-destination. Sixty percent of travlers drive to the lot alone; 12 percent ride to the lot in carpools; and 20 percent are driven there.

Table IV-1 presents a breakdown of how express bus users formerly made the trip. From 31 percent to 71 percent of the riders formerly drove alone, with a smaller percentage being diverted from local buses (2 to 13 percent), carpools (7 to 39 percent), and other autos (5 to 15 percent).

Tables IV-1, IV-2, and IV-3, summarize various characteristics of those using express bus services from commuter parking lots. Several characteristics are especially evident:

1. The vast majority of trips made by express bus (over 95 percent) are home-to-work trips.

2. On most routes, the majority of riders are female.

3. While there is not a clear cut usage trend according to age, certain routes are heavily patronized by persons under 35.

4. The majority of users reported annual income in excess of $15,000 per year (1977), indicating an income above State and national averages.

5. Most users have access to an auto (average household has 2.1 cars).

6. The reasons cited most often for using the express bus service were (in order of frequency): to reduce trip costs, to avoid having to drive in congested traffic, to avoid costly downtown parking, and to eliminate the inconvenience of finding a place to park downtown. Other reasons given less frequently included reducing travel time, saving wear and tear on cars, and access to only one auto or none at all.

The service has strong appeal for younger and female commuters, indicating that it is probably used extensively by clerical and staff workers, who tend to work set hours which allow them to take the express bus on a daily basis.

b. <u>Lots Not Served by Express Buses</u>

Based on the daily reduction of 109,705 VMT attributable to carpools using commuter lots, total emissions (hydrocarbons, carbon monoxide, and NO_x) were reduced by 2.04 tons per day, or 510 tons per year. This represents 52.7 percent of the total yearly emissions reduction of 967.5 tons for the entire commuter parking program, about .04 percent of total yearly emissions from motor vehicles (about 1,219,539 tons in 1977), and about .14 percent of emissions from work travel. An FHWA report in 1976 found that in Connecticut, the "carpool capture rate", or number of program-induced carpoolers as a percentage of all

TABLE IV-1

CONNECTICUT COMMUTER PARKING PROGRAM

Route	Date Service Initiated	Date of Survey	Means of Making Trip to Work Prior to Using Express Bus: Single Occupant Auto	Auto Passenger	Carpool	Local Bus	Did Not Make Trip	Total Responses	No Response or "Other"	Patronage Growth: Riders on First Day	Survey Date
Hartford Services											
Avon/Canton	07/16/73	10/25/77	53%	9%	11%	1%	26%	246	-	81	301
Corbins's Corner (W. Hartford)	01/17/72	08/04/77	31%	11%	9%	10%	34%	289	5%	-	-
Glastonbury (St. Dunstan's)	04/14/75	02/19/80	53%	-	19%	4%	17%	59	8%	18	68
Glastonbury (St. Paul's/ St. Augustine)	09/17/73	02/26/80	50%	4%	7%	12%	24%	159	3%	-	196
Burr Corners (Manchester)	07/10/72	05/08/80	34%	8%	13%	13%	32%	436	-	76	525
Old Saybrook (to Hartford)	10/24/77	05/18/78	38%	7%	10%	4%	40%	76	1%	64	77
Vernon	07/11/77	05/06/80	35%	7%	17%	9%	27%	262	5%	216	300
Colchester/ Marlborough	06/28/76	06/01/77	41%	15%	28%	6%	3%	61	7%	77	107
Enfield	01/21/74	08/25/77	33%	8%	19%	1%	28%	380	11%	176	531
Bristol	04/04/77	08/09/77	33%	10%	16%	18%	20%	137	3%	204	281
Willimantic	02/23/76	12/15/77	33%	-	39%	3%	25%	81	-	86	170
New Haven Services											
Branford	07/16/73	11/02/78	44%	9%	7%	10%	30%	241	-	98	700
Milford	09/23/74	12/20/79	53%	-	13%	6%	20%	78	8%	47	90
Old Saybrook	01/17/77	08/14/80	52%	5%	13%	8%	20%	116	2%	73	288
Totals			40%	8%	14%	7%	27%	2621	108 (4%)	1216	3634

TABLE IV-2

CONNECTICUT COMMUTER PARKING PROGRAM

Route	Express Bus User Characteristics: Age (% under) 35	Sex % Female	Income (% over $15,000/yr.)	Major Reason for Use - In order of Importance (% citing as major factor): Reduce Trip Costs	Dislike Traffic Congestion	Dislike CBD Parking	High Cost of CBD Parking	Has Express Bus helped user to: (% "Yes"): Sell Second Car	Decide About Buying Another Car	Find Employ-ment	% Responding To Survey
Hartford Services											
Avon/Canton	43%	49%	76%	61%	63%	33%	39%	5%	5%	9%	260/301=86%
Corbins's Corner (W. Hartford)	58%	62%	60%	55%	60%	43%	57%	3%	8%	13%	304/336=90%
Glastonbury (St. Dunstan's)	40%	50%	64%	73%	51%	35%	43%	6%	21%	14%	64/68=94%
Glastonbury (St. Paul's/ St. Augustine)	34%	55%	56%	63%	54%	35%	44%	3%	13%	12%	164/196=84%
Burr Corners (Manchester)	58%	76%	76%	40%	58%	61%	48%	2%	9%	13%	462/537=86%
Old Saybrook (to Hartford)	44%	56%	87%	28%	53%	66%	28%	11%	43%	25%	77/79=99%
Vernon	49%	55%	53%	69%	54%	26%	41%	3%	17%	13%	275/300=92%
Colchester/ Marlborough	-	-	-	57%	52%	32%	35%	-	-	-	65/107=62%
Enfield	54%	41%	50%	72%	66%	27%	38%	4%	17%	19%	429/531=81%
Bristol	46%	60%	74%	65%	31%	34%	36%	5%	19%	18%	141/149=95%
Willimantic	60%	54%	64%	70%	56%	31%	21%	5%	20%	16%	82/87=94%
New Haven Services											
Branford		-	-	51%	66%	46%	57%	3%	9%	13%	253/325=78%
Milford	38%	53%	91%	67%	62%	42%	38%	-	16%	8%	88/90=97%
Old Saybrook	43%	47%	88%	75%	52%	-	54%	4%	20%	12%	121/139=87%
Totals											
Percent	44%	50%	58.6%	59%	58%	38%	44%	3%	13%	14%	
Number	1238	1391	1634	1647	1618	1064	1227	97	382	-	2785

TABLE IV-3

CONNECTICUT COMMUTER PARKING LOT PROGRAM
EXPRESS BUS USER TRAVEL CHARACTERISTICS
MODE OF ACCESS TO LOT

Route	Percent Of Users Making Trip To Work	Drove Alone (SOA)	Auto Passenger	Carpool	"Other" Bus or Walk	Percent Using Monthly Passes	Percent Of Pass Users Subsidized By Employer	Percent Rating Bus Service "Good or Better"	Total Respondents
Hartford Services									
Avon/Canton	98%	63%	19%	11%	7%	60%	-	90%	260
Corbin's Corner (West Hartford)	99%	68%	16%	11%	2%	56%	-	67%	304
Glastonbury (St. Dunstan's)	100%	50%	16%	23%	9%	72%	85%	76%	64
Glastonbury (St. Paul's & St. Augustine Lines)	98%	62%	13%	6%	19%	63%	77%	79%	164
Burr Corners (Manchester)	99%	74%	12%	10%	-	78%	-	85%	462
Old Saybrook (To Hartford)	99%	52%	13%	17%	7%	45%	-	79%	77
Vernon	99%	69%	16%	11%	Walked 4%	69%	75%	77%	275
Colchester/ Marlborough	97%	54%	20%	15%	8%	63%	-	-	65
Enfield	97%	62%	20%	15%	2%	71%	-	79%	429
Bristol	97%	55%	28%	11%	Walked 6%	61%	-	82%	141
Willimantic	99%	54%	30%	6%	10%	55%	-	70%	82
New Haven Services									
Branford	93%	68%	18%	8%	-	45%	-	94%	253
Milford	99%	75%	19%	6%	-	30%	100%	97%	88
Old Saybrook (To New Haven)	96%	69%	18%	6%	Walked 7%	53%	22%	85%	121
Totals	2721 98%	1821 65%	486 17%	303 11%	115 4%	1741 63%	501 18%	2221 80%	2785

commuters was .79 percent compared with .33 percent nationally.

c. Program Impact on Travel Behavior

The parking lot program overall has had little effect on modal usage statewide; about 2.5 percent of all trips in Connecticut were made by bus in 1970 and in 1980. Moreover, in the Harford SMSA, which is the focus of many commuter lot facilities and most of the express bus routes, transit's share of work trips declined from 10.7 percent in 1970 to 7 percent in 1975.

Reductions in vehicle-miles traveled attributable to the carpool lot/express bus program in Connecticut are small; about 194,612 VMT/day, about 1.04 percent of work trip VMT, and about .45 percent of statewide daily VMT. Emissions and fuel consumption savings (equivalent to about .27 percent of emission and .65 percent of fuel consumption associated with work travel) are even less, because most of the VMT reduced occurs in the stable phase of auto operation, when vehicular emissions and fuel consumption are lower. Although the park and ride lots seem more effective than carpools in reducing gross fuel consumption, if compensation is made for the fuel used in bus service, the carpool lots are more effective. This fact, as well as the relatively greater average length of trips diverted by carpool lots accounts for their higher share of total VMT reduction, even though fewer cars use them than bus park and ride lots.

Express bus survey data indicate that about 45 percent of riders formerly made the trip in a single occupant auto. Table IV-1 presents a breakdown of how express bus users formerly made the trip. From 31 percent to 71 percent of the riders formerly drove alone, with smaller percentages being diverted from local buses (2 to 13 percent), carpools (7 to 39 percent), and other autos (5 to 15 percent). The percentage diversion rates from other modes are normal, based on prior mode data from other U.S. locations.

d. Costs

Construction

While data on costs of lots built in the past is not readily available, it is certain that construction costs have increased sharply since 1973, due to inflation. Current construction cost information makes it clear that the costs of a commuter lot program are considerable. This is a relatively costly TSM action.

Construction costs vary considerably with the type of land used (State-owned or purchased; almost all lots are on State-owned lands or rights-of-way), surfacing and facilities provided (gravel, pavement, lighting, shelters, etc.), location (area of the state, topography of the site, etc.), size, and type of personnel employed in construction (private contractor, DOT Maintenance Department, or National Guard). Lots built on State property by the ConnDOT Maintenance in 1973-75 cost an average of $250/space for gravel lots and $750/space for paved lots. ConnDOT estimated average paved lot construction costs in 1976 at $750/space, excluding property acquisition costs (i.e., assuming construction is on state land). While average total cost per space is a useful measure for making cost comparisons with other programs, it should be noted that cost per space varies considerably in different areas of the State. Furthermore, the cost to the State of building new spaces has been less than the total cost per space given here, because most of the spaces have been built with the assistance of one of several Federal-aid programs, matched with State funds from bonding programs or from the State Transportation Fund which includes gas tax receipts and general revenue.

In 1980, the cost range for providing new spaces was $500 to $2,200 per space for paved lots (average about $1,103 per space) and $150 to $240 per space for gravel lots (average about $176 per space). As State funds were used to replace reduced allocations from various Federal programs, the State share ($448,015) increased to 44.6 percent of the total costs rather than the 39 percent anticipated, so that the average cost per space to the State was $416.75 for new spaces and $381.29 for replacement, rather than the expected $376.85 and $358.50.

Operations

Commuter parking lot program operating expenses for 1980 were as follows:

Commuter Parking Lot Leases	$ 59,936
Lot Vandalism Deterrent Signs	12,500
Bicycle Security Lockers	1,600
Maintenance by DOT	54,000
	$128,036

The cost of leasing spaces depends upon their location. ConnDOT pays a rent of about $6,000/year for 268 spaces at a shopping center in Bristol, or about $22 per space per year. License agreements to rent spaces in church parking lots are considerably cheaper ($1,000 for 100 spaces, or $10/space/year at St. Dunstan's in

Glastonbury). Until recently, the State supplied 10 percent of the funds for license agreements, which are now partially subsidized by a Federal program.

5. Conclusions

a. Space

The amount of State land in suitable locations available for use as commuter parking lots is limited, and in many areas the most desirable sites have already been developed. Future expansion of the program will increasingly require either purchase of private land and/or leasing of spaces from private facilities. Each of these options has disadvantages. Construction of new lots is already expensive and time consuming, even if State land is used. If Federal assistance continues to decline, desirable and easily developed sites on State land become harder to find, and availability of ConnDOT Maintenance workers for lot building is reduced, costs of new lots to the State are likely to rise more rapidly than in the past - even when discounting for the effects of inflation.

b. Leadtime

A related problem is the long lead-time required for lot construction. On the average, 12 to 18 months are needed to select a suitable lot site, acquire land, hold a hearing (if necessary), and to design, finance, and build a new lot. By using DOT Maintenance workers and building on State land to the maximum extent possible, ConnDOT was able to build many gravel lots quickly in the early years of the program. As State land and maintenance workers become less available, expansion of the lot program will require rental and/or purchase of land, and more construction will be done by private contractors selected by competitive bidding. This shift away from the use of limited State land and personnel for lot construction will greatly increase completion time due to time-consuming competitive bidding procedures, negotiation of land purchases, and public hearings, if needed. With construction costs rising rapidly due to the impact of inflation on labor and materials costs, increasing time needed for completion will also increase costs substantially.

c. License Agreements

License agreements, under which ConnDOT rents parking spaces for express bus users at shopping centers or churches, are a low-cost alternative to new lot construction.

In addition to the low costs, license agreements have several other advantages. First, they can be negotiated and implemented in a relatively short period of time (90 to 120 days), much less than the 12 to 18 months required to build a new lot. If the lot is not utilized sufficiently, the arrangement can be terminated quickly (30 days notice is required). If demand for spaces is high, often more spaces can be rented on fairly short notice. ConnDOT surveys show that at shopping centers, lot users generate sales and increase revenue for the stores. Because of the low cost and short period of time (90 to 120 days) needed to lease spaces as opposed to building new lots, in the future it is likely that license agreements will be used increasingly as a means of expanding commuter parking capacity quickly.

d. Costs

The carpool lot/express bus program is a relatively expensive TSM strategy. During 1980, ConnDOT spent approximately $448,015 for the State share of lot expansion costs, $128,036 for lot leases and maintenance, $981,000 for express bus operating subsidies, and $232,136 for bus maintenance and equipment, for a total program cost of $1,789,187. Since an estimated 48,653,000 VMT are reduced yearly, the cost for each VMT reduced is about 3.67¢. Clearly, this is not a low-cost TSM action, and while ConnDOT has received the bulk of the funds needed for lot expansion and 50 percent of express bus subsidies from the Federal government, it is unlikely that this level of support will continue in the future.

ConnDOT has been able to reduce the cost of increasing lot capacity by using its Maintenance Office and the National Guard to build lots, and by leasing spaces from shopping centers and churches. However, there are limits to the degree of expansion that can be accomplished in this matter, and many of the most desirable sites on State land have already been developed. This implies that future lot expansion will be done increasingly by private contractors, at considerably higher cost. Leasing of lot space at shopping centers is the most feasible alternative for expansion at reasonable cost. These leased lots also generate considerable business for the shopping centers concerned.

e. Liability Insurance

License agreements were initially difficult to conclude because of the ambiguous issue of liability for accidents in areas of privately-owned parking lots leased to the State. Several transit operators elsewhere in the

U.S., seeking to use license agreements to expand park-and-ride programs have also encountered this problem. ConnDOT dealt with the liability issue be maintaining (at its own expense) one million dollars of liability insurance covering personal injuries and property damage occuring in the commuter parking area at each leased location. The State also assumed all liability for personal injury or property damage claims arising from use of the commuter parking area (which means that if such claims exceed $1,000,000 the claimant's only recourse is to sue the State).

f. Spillover of Commuter Parking Into Non-Leased Areas

At some locations (notably the Enfield Mall), there have been problems with commuters parking outside of the designated leased areas, thereby reducing the parking space available for shoppers. This "spillover" problem has contributed to the reluctance of some private lot owners to enter license agreements, despite evidence from ConnDOT's rider surveys that express bus users account for a considerable volume of sales at shopping centers with leased park-and-ride lots.

g. Vandalism

Vandalism is a major problem at commuter parking lots. This problem tends to be more serious at remote lot locations than at leased lots in shopping centers, but it is widespread and of increasing concern to ConnDOT. Vandalism is a problem because most commuter lots are active only during the morning and evening rush hours, and inactive the rest of the day. While the State police have provided some surveillance as part of their normal patrol duties, they are not jurisdictionally responsible for policing the parking areas even though most lots are on State property. The number and dispersion of the lots would make a statewide surveillance program costly and hard to manage. To address the vandalism problem, ConnDOT has directed State personel to spot check lots in the course of normal business duties, and has allocated $12,500 in the 1980 for installation of surveillance warning signs intended to deter vandalism. In 1979, ConnDOT asked municipalities to provide as much local police surveillance as possible. Lots located in areas clearly visible from major roads and streets appear to be less susceptible to vandalism, and ConnDOT has recognized this deterrent factor in selecting lot locations. Installation of lighting at many lots has also helped in reducing vandalism, and ConnDOT has adopted a policy of installing lights at all new lots. The extent of vandalism and auto theft in terms of dollar losses is unknown, as is the effectiveness of the protective measures.

D. Residential Parking Permit Programs (RPPP)

1. Strategy Objectives

The objectives of the RPPP studied in Cambridge, Massachusetts were:

a. to allow residents the use of curbside parking spaces for their automobiles near their homes,

b. to reduce curbside parking in general to improve traffic flow and safety,

c. to encourage a modal shift of commuters away from single-occupancy automobiles to either mass transit or car and van pools, and

d. to improve air quality by generally by reducing auto use and auto parking in the business districts.

In the course of studying the Concord, California bus signal priority system, another RPPP was examined. The Concord RPPP applies to only one small part of Concord--the residential streets near the Concord Station of the Bay Area Rapid Transit (BART) commuter rail line. The Concord RPPP had only the first objective listed above as its aim.

2. Approaches to Implementation

a. Planning & Historical Background

The Cambridge RPPP grew out of neighborhood pressure to remove commuters' cars from the streets in residential areas of the City. These commuters included not only out-of-towners who worked in Cambridge but also those who worked or went to school across the river in Boston and travelled there by walking or riding transit vehicles over bridges. Cambridge is an old, densely settled city with little off-street parking; many residents are dependent on curbside parking for their cars; and only some have driveways or apartment house parking lots.

This grass roots opposition to commuter parking coincided with the City's plan to reduce automobile use, especially for work trips, and with the adoption of a Transportation Control Plan (TCP) for the air quality program in the Boston area. However, while the RPPP began in only one neighborhood of the City, it was applied citywide within a year.

b. Participating Agencies, Organizations and Groups

Initially neighborhood groups and their City council members were the impetus in pressing for the Cambridge RPPP. As it became a citywide issue, many city or regional citizens groups became involved. The City enlarged its Department of Traffic and Parking to administer and enforce the RPPP. Powers to create the Department and create restrictive parking policies had been obtained earlier through the state legislature. The City also obtained approval from the U.S. Environmental Protection Agency (EPA) to include the RPPP as part of its Transportation Control Plan (TCP) for the Boston area.

The Concord RPPP was solely an intra-city matter.

c. Institutional Roles

The formulation of the Cambridge RPPP was almost entirely an intra-city matter. However, a significant modification to the Cambridge RPPP was made not by the City but by a State judge, who ruled that the neighborhood restrictions on parking could not apply to Cambridge residents.

d. Jurisdictional Responsibilites

The City of Cambridge had secured powers from the Commonwealth of Massachusetts to establish a Department of Traffic and Parking and to promulgate and enforce residency regulations on parking. Administration and enforcement of the program (i.e., issuing tickets and towing), were the City's jurisdiction. However, the collection of fines is the responsibilty of the State district court, which itself has limited collection powers, especially beyond Massachusetts. The City is prevented by state law from charging over $15 per violation, a limit set over twenty years ago. The other jurisdictional overlap is between the City Traffic and Parking Department, which enforces the program by day, and the City Police Department, which enforces it at night.

The Concord RPPP is entirely administered by the City with fines collected by the City.

e. Sources of Funding

The Cambridge RPPP is entirely City-funded and apparently pays for itself, collecting enough money in fines to offset the cost of maintaining the program. The Concord RPPP is also entirely funded by the City and is profitable.

3. Characteristics of the System

The Cambridge RPPP is a citywide 24-hour-a-day program, Monday through Saturday, excluding holidays. No private automobiles are allowed to park on any street in a residential zone unless it displays a resident sticker or visitor permit. Cambridge has also eliminated 10,000 curbside parking spaces since 1973 and also prohibits non-permit vehicles on non-residential streets on weekday mornings, 7:00-10:00 a.m. Metered spaces are exempt. The program is administered by the City Traffic and Parking Department, which issues the residency stickers and visitor permits.

The Concord RPPP is also a 24-hour-a-day program with similar residents' stickers but applies to only a few streets.

4. Results of Implementation

a. Modal Diversion and Energy Consumption

There is no clear evidence as to how the RPPP effected mode of travel to Cambridge or the energy used by such travel. The 1980 Census Journey-to-Work data, which is not yet available, would probably provide the clearest indication of any modal shift, since it can be compared to similar 1970 data. The RPPP has been in effect since 1973.

b. Operational Impact

The RPPP has made it more difficult for out-of-towners to come to Cambridge by car and for all automobile travelers to find parking space in the business districts, since curbside parking for non-residents has been largely eliminated. Local businesses and the Cambridge Chamber of Commerce claim the RPPP has made it difficult to attract firms to the City. While the program may have hurt Cambridge business, if only marginally, it has solved the commuter parking problem and has also enhanced intra-city automobile travel by freeing up curbside parking spaces on residential streets.

The Concord RPPP succeeded in achieving its limited objective: ridding residential streets of BART commuter cars. One result of the latter was that the BART increased feeder bus service to the Concord Station in order to improve access.

5. Problem Identification

The problem which the Cambridge RPPP sought to address was parking by non-resident workers, students and shoppers on residential streets in Cambridge leading to the consequent loss of parking to residents. However, initially the RPPP was only applied to a few neighborhoods and the non-resident parking problem "spilled over" into other neighborhoods. Also, the RPPP was perceived to be inflexible by not allowing for exceptions to be made for: visitors, patients of doctors or other professionals with offices in residential areas, commercial vehicles, autos being loaded or unloaded, vehicles rented by residents, cars belonging to handicapped people, and some shopper parking fronting commercial land uses.

The Concord RPPP was intended to remove about 800 BART commuter cars from residential streets near the BART Station. This objective has been achieved with no apparent problems.

6. Problem Resolution

Because of the problems encountered with the initial program, the Cambridge RPPP was expanded citywide and a number of modifications were concurrently adopted exempting the previously discussed classes of vehicles and eliminating Sunday from the program.

7. Unresolved Problems

a. Institutional/Jurisdictional

A number of institutional factors have limited the effectiveness of the Cambridge RPPP. They are:

1. Some auto commuters avoided the RPPP by parking just beyond the City border in Somerville, Massachusetts causing Somerville to enact a RPPP on streets bordering Cambridge.

2. The court decision nullifying residency restrictions on automobiles registered in Cambridge meant that local neighborhoods would not be protected against parking on their residential streets by motorists from other parts of Cambridge. For instance, what started the RPPP in the first place were student cars parked in a residential neighborhood at the Cambridge end of the Boston University Bridge. Students would park in Cambridge and walk across the bridge to Boston University. As long as these students' cars are registered in Cambridge the RPPP now cannot legally prevent this from occurring.

3. Fines are actually collected by the State district court, not the City. Approximately half the revenue from fined motorists is actually

collected and only a minority of the summonses issued to out-of-state vehicles are collected.

The Concord RPPP has not experienced problems of this type. Therefore, no one has tested the constitutionality of the RPPP's application to City residents as was successfully challenged in Cambridge.

b. Fiscal

State law limits the maximum fines which can be imposed. A retrenchment by Cambridge in the number of Parking Control Officers has also reduced enforcement capability.

c. Social/Economic

The RPPP certainly discourages auto trips into Cambridge and local business leaders say this has hurt business. It has also been alleged that firms do not relocate to or expand within Cambridge partially due to the RPPP. The program has greatly reduced Cambridge's total automobile parking supply and certainly makes certain events (conventions, festivals, etc.) impossible to stage within the City unless special arrangements are made, especially since Boston, comparatively rich in off-street parking facilities, is immediately across the river.

8. Future Plans

There are no plans to alter either the Cambridge or Concord RPPP. However, there is discussion going on within the City of Cambridge to further reduce curbside automobile parking in business districts and construct more off-street parking facilities.

9. Conclusions and Applications to Other Areas

RPPPs are being applied in several cities although none are as comprehensive as the one in Cambridge. The application of RPPPs, as demonstrated in the examples of Cambridge and Concord, is to prevent non-residents from parking cars in residential districts. In both cases the principal problem was commuter use of on-street parking spaces normally used by residents who live within the home area. Commuters were using the residents' spaces either because sufficient parking space at some nearby destination was unavailable or because they wished to avoid paying for available space. Wherever the above situation applies an RPPP is applicable to prevent "overspill" parking from shopping or employment areas, transit stations, sports stadiums or other trip attractors.

E. Transit Management Improvements

1. Strategy Objectives

The objective of the Lehigh Valley LANTA transit system retrenchment program was to reduce costs of the system while trying to maintain the highest level of service the budget would allow.

2. Approaches to Implementation

a. Planning & Historical Background

The Lehigh and Northampton Transportaion Authority (LANTA) implemented considerable retrenchment in its service in September, 1977. This involved route rationalization and service cutbacks. This retrenchment was in response to the public transit system's rising costs and slowing ridership gains. LANTA had been created in 1972 to take over a private bus operation and had increased service about 40 percent after the public takeover.

b. Participating Agencies, Organizations and Groups

Only the Lehigh and Northampton Transportation Authority (LANTA) and the MPO for the Lehigh Valley area, the Joint Planning Commission of Lehigh-Northampton Counties (JPC), which acts as LANTA's planning and grant processing agency, were involved. LANTA needed no state, county, or city approval to make the changes.

c. Institutional Roles

As indicated above, a bi-county metropolitan planning organization (JPC) acted as planning and grant processing agency for the bi-county metropolitan transit system (LANTA). The retrenchment was jointly worked out between these two agencies.

d. Jurisdictional Responsibilities

As indicated above no other jurisdictions were involved.

e. Sources of Funding

As cuts in cost were involved, the source of funds was the retrenchment program itself. In general, LANTA's funds - 33 percent federal subsidies, 36 percent farebox revenues (1978) and 31 percent state and county subsidies - have not been keeping pace with rising costs.

3. Characteristics of the Project

The Lehigh and Northampton Transportation Authority (LANTA) was operating 33 routes, two of which were eliminated as part of the retrenchment, out of two garages, one in Easton and one in Allentown. The retrenchment meant a decrease in annual LANTA bus route miles from 2.2 to 1.9 million.

4. Results of Implementation

a. Energy Consumption

Energy consumption by the LANTA bus fleet was reduced. With about 300,000 less miles traveled by LANTA buses annually, about 75,000 gallons of diesel fuel were saved (at a conservative estimate of four bus-miles per gallon).

b. Fiscal and Patronage Impacts

Service hours were reduced 13.5 percent while ridership declined only 2.2 percent. The annual increase in operating loss declined from 7.8 percent in FY1977 to 1.3 percent in FY1978. However, LANTA's revenue/cost ratio still dropped from 38.9 percent to 37.6 percent, lower than most small transit systems in Pennsylvania. Bus productivity, as measured in revenue per hour and revenue/cost ratio improved on all affected routes, in some cases dramatically (up to 57 percent). In the seven basic changes made to routes, four resulted in ridership gains on those routes and three in ridership losses.

5. Problem Indentification

The period 1972-1976 was one of passenger growth for LANTA. However, by 1977 growth in ridership was ending, while simultaneously costs were escalating in a system which had had no fare increases and had actually lowered fares since its inception. Because revenues were rising at a much slower pace than fares, the transit system faced the prospect of running out of money sometime before FY1977 was over. LANTA's ratio of costs over revenues had fallen from .63 (1974) to under .40 (1976). Either fares would have to be increased or service cut back. The latter strategy was chosen.

6. Problem Resolution

LANTA chose to resolve its fiscal problems by cutting its least patronized services - eliminating two duplicative routes, cutting back lightly used runs, and making some other route and scheduling adjustments which would lower costs but maintain about the same level of service. This involved a 13.5 percent decrease in operating bus miles or about 300,000 fewer bus miles annually.

7. Unresolved Problems

Despite the cutbacks, LANTA's fiscal position remained poor, and its cost/revenue ratio actually dropped from .389 to .376 from FY1977 to FY1978, a poorer performance than most other small Pennsylvania transit systems.

8. Future Plans

More retraction of the system may well be necessary, especially if federal operating assistance is cut. Fares have had to be raised twice since the FY1977 cuts, and there have also been some additional service cutbacks. Unlike the FY1977 cutbacks, these cut ridership almost in proportion to the degree of service being cut.

9. Conclusions Applicable to Other Areas

The methods employed by LANTA - eliminating closely paralleling duplicative routes, eliminating lightly patronized runs, providing continuing through trips to reduce transfering, and exchanging some route portions between routes to create proper demand/service and run-cutting adjustments - all are model methods which other transit systems, caught between rising costs and stable revenues, can emulate.

Seattle Metro

1. Strategy Objectives

The objective of the Seattle Metro part-time bus driver program was to improve labor productivity in order to allow expansion of peak hour services (necessary to achieve ridership goals), at minimum cost.

2. Approaches To Implementation

a. Planning and Historical Background

Seattle Metro began planning the part-time bus operator program in early 1977, prior to contract negotiations with the Amalgamated Transit Union. The impetus for the program was the rapid increase in the cost of providing service, which threatened large deficits by the early 1980's. After a marketing survey in 1976 indicated that Metro could maximize ridership and revenues by expanding peak hour service, the costs of alternate means of increasing service were analyzed. The use of part-time drivers was recommended in conjunction with reallocation of 100,000 hours of service from off-peak to peak hours.

b. Participating Agencies, Organizations, and Groups

The major participants in program development were Seattle Metro Transit and the Amalgamated Transit Union (ATU). Metro Transit is a division of the Municipiality of Metropolitan Seattle. Seattle Metro provides transit services in King County and to cities in adjacent areas by contract. Fare policies and operating plans must be approved by the Metro Council, a 36 member board made up of elected and appointed officials from local governments, which is the governing body of the Municipality of Metropolitan Seattle. Local 587 of the Amalgamated Transit Union is the authorized bargaining agent for bus drivers at Seattle Metro, and all drivers must be union members.

c. Institutional Roles and Conventions

Plans for implementing part-time operator programs were developed mainly by the Office of Base Operations at Seattle Metro, and coordinated with service planning and scheduling units. The Metro Council's approval was needed for all service reallocations.

d. Jurisdictional Responsibilities

Only the Municipality of Metropolitan Seattle was involved in bargaining with the ATU in 1977-1978. Contract issues were resolved by the parties without outside arbitration.

e. Sources of Funding

Since the goal of the program was to improve productivity and reduce labor costs, the program required no extraordinary commitment of funds. Metro's major sources of revenue are a one percent vehicle excise tax and a sales tax of 3/10th of one percent in King County. Revenue from fares, as well as UMTA Section 5 operative subsidies, are used to cover operating expenses.

3. Characteristics of the Project

Metro Transit operates 75,000 miles of weekday transit service over 120 routes, using buses and trolley coaches. The system has about 2,200 employees and carries over 40 million revenue passengers per year. Metro assumed responsibility for transit operations (from private companies) in 1973, and patronage increased from 32.4 million riders in 1973 to 41.8 million in 1976.

4. Results of Implementation

a. Fiscal and Level of Service Impacts

Cost savings associated with the part-time driver program have been considerable, amounting to roughly $800,000 in 1978, $2,000,000 in 1979, $3,800,000 in 1980, and $4,685,415 in 1981. Cost savings result from reductions in 8-hour guarantee pay as regular drivers working short assignments (trippers) during rush hour have been replaced by part-time operators who are not covered by union work rules. Part-time drivers also receive fewer fringe benefits and are usually paid a lower hourly wage than full-time drivers. Because service has expanded significantly, from 1,803,000 bus hours of service in 1977 to 2,429,259 bus-hours in 1981 (with most of the increase in peak service), overall operating and labor costs have increased substantially, despite savings from the part-time driver program. These cost savings are indicative of the additional expense of providing a comparable level of service using full-time drivers only.

5. Problem Identification

Despite substantial patronage growth during 1973-1976, operating costs at Seattle Metro were rising at 3 percent above the rate of inflation in 1977. A 1977 report done by Metro indicated that unless costs were reduced and productivity increased, deficits would reach $2,560,000 in 1978, $2,709,000 in 1979, and $4,281,000 by 1980. Since operator labor accounts for 55 percent of Metro's opeating expenses, means were sought to increase labor productivity, thereby reducing the cost of peak-hour service expansion intended to increase ridership.

6. Problem Resolution

In order to reduce the cost of providing expanded peak-hour service, Metro won the right to hire part-time operators, who (unlike full-time drivers) were not guaranteed 8 hours pay/day. Although the number of part-time operators was limited by contract, and existing work assignments for full-time drivers were largely reserved for them, Metro has scheduled added peak service as short work assignments, or trippers, and assigned these to part-time drivers who are guaranteed only 1-1/2 hours pay. This has reduced the cost of providing peak hour service considerably.

7. Unresolved Problems

a. Institutional/Jurisdictional

The union contends that the part-time dirver program has led to an erosion of working conditions for full-time drivers by reducing the choice of work assignments and disrupting the seniority system used to make assignments. To protect its seniority system, the union wants Metro to hire all new full-time drivers from the current part-time drivers; Metro has resisted this demand.

b. Fiscal

The part-time driver program's fiscal impact is limited by two factors. First, the union contract restricts the number and employment of part-time drivers who can only be used to provide peak-hour service. Overall cost savings are also limited because rush-hour service is inherently more expensive to provide than local or off-peak service. Cost savings from use of part-time labor are directly related to the proportion of service during peak hour (i.e., the peak/base ratio), and by maximum spread time, which determines the number of "unpairable" trippers which can be assigned to part-time drivers.

8. Future Plans

In 1981 contract negotiations, Metro preserved its right to use part-time labor, and plans continued for the expansion of the part-time driver program.

9. Conclusions Applicable To Other Areas

The use of part-time bus operators has resulted in savings of 4 to 10 percent of operator wage costs in Seattle. These savings have been achieved because Metro is able to use a relatively large percentage of part-time drivers (33 percent of all operators) to provide expanded rush hour service. The effectiveness of using part-time drivers in reducing costs elsewhere depends upon the peak/base ratio and union contract restrictions on the use of part-time labor. While such programs will do little to reduce deficits, many transit systems could benefit from them.

F. Innovative Transit Subsidy Techniques

1. Strategy Objectives

The project was intended to stabilize and increase ridership on the commuter rail service provided by the Southern Pacific Railroad between San Francisco and San Jose, CA after a

25 percent fare increase in 1977. This commuter line, serving suburban San Mateo & Santa Clara Counties, had been losing ridership steadily since the 1960s. Despite numerous fare increases, the operating deficit had reached $9.4 million by 1976, and the railroad was attempting to abandon the service.

The public agencies favoring retention of Southern Pacific rail service did so because they felt the abandonment of such service, the likely scenario without any new subsidy, would cause a modal shift of rail commuters to automobile trips, increasing traffic congestion, air pollution, and energy use. The railroad was also seen as the connecting "spine" to the town centers along the linear West Bay corridor on the east side of the San Francisco Peninsula.

It was also perceived that the cost of subsidizing the existing commuter rail operation would be far less than the almost prohibitive cost of extending the Bay Area Rapid Transit (BART) system down the Peninsula from its terminus at Daly City, near the San Francisco/San Mateo Counties border.

2. Approaches to Implementation

a. Planning and Historical Background

The impetus for the Fare Stabilization Program was a 25 percent fare increase granted to Southern Pacific by the California Public Utilities Commission (CPUC) in late 1977 (effective August 6, 1977) followed by the Southern Pacific's filing of a petition with the Interstate Commerce Commission (ICC) in November, 1977 for permission to discontinue commuter rail service. Southern Pacific had repeatedly petitioned the CPUC to abandon the service, citing financial losses, declining ridership, and alleged interference with freight operations. After having a petition for abandonment denied by the CPUC in 1973 (which instead granted a fare increase), in May, 1977 SP petitioned for a fare increase of 111 percent, claiming an operating loss of $6 million in the previous year. (The CPUC, which had to approve all fare increases, had always required the railroad to absorb operating losses on the commuter line as part of its public utility obligation. However, SP had also refused to accept any subsidies, fearing loss of control over the service). While denying the 111 percent fare increase as "tantamount to abandonment", the PUC did allow the 25 percent fare increase effective January, 1978.

The San Mateo County Transit District (Sam Trans), along with transit agencies in adjacent San Francisco and Santa Clara Counties, felt that the SP commuter operation was a vital public transit service which should be upgraded, not abandoned. San Mateo County had dropped out of the original Bay Area Rapid Transit (BART) District in 1961 and later proposals to extend BART into the county were rejected by the County Board of Supervisors as too expensive (the cost of BART extension to Menlo Park was estimated at nearly $1 billion in 1975) and too disruptive of neighborhoods. Several Metropolitan Transportation Commission reports, notably the Feasibilty of Upgrading Peninsula Passenger Rail Service Report (PERSUS) in 1975 and the Peninsula Transit Alternatives Project (PENTAP) study in 1976, suggested that upgrading the SP service would be far preferable to BART extension for several reasons -- lower cost, minimal disruption of neighborhoods, and less developmental impact around stations. Bus transit altenatives were also judged inferior to upgrading the SP, since train service can provide greater peak hour capacity at lower incremental cost. These analysis studies were made at the direction of the County Board of Supervisors and the State legislature. Unfortunately, the major obstacle to service improvement was the railroad's avowed intention to abandon the service and refusal to accept any public subsidies, despite considerable losses. There also continued some uncertainty as to whether BART would be extended rather than the SP line preserved.

Sam Trans and other area government agencies denounced abandonment of the service as the worst possible alternative. The Southern Pacific was criticized for failing to promote or improve the service, and SP's proposal to replace the trains with buses or vans was rejected as too expensive and impractical, since buses would have to depart from a downtown terminal every 30 to 45 seconds during peak hours to provide capacity equivalent to the existing trains. It was also pointed out that SP had run many more passenger and freight trains over the same tracks during World War II. Although the Final Environmental Impact Statement prepared for the ICC proceedings on discontinuance of service in 1978 indicated that abandonment would have minimal impact on automotive emissions, fuel consumption, or traffic congestion, surveys determined that at least 55 percent of the rail commuters would drive autos to work if rail service was discontinued. In their testimony, Sam Trans and other agencies pointed out that this modal shift would increase VMT and peak hour congestion, contrary to federal and regional transportation and environmental management plans.

Sam Trans developed the Fare Stabilization Program during the autumn of 1977. The District's intent was to offset the impact of the 25 percent fare increase by purchasing tickets from the railroad and selling them to County residents at a 30 percent discount. SP did not object to this user-side subsidy program. However, the public utility code prohibited the resale of common carrier tickets at a discount; passage of a bill (A.B. 1853) by the State Legislature easing this restriction was necessary before the program could begin. The bill authorized the program only until January 1, 1980, though in actuality this deadline was extended seven months to allow the State and Southern Pacific to come to terms over a purchase-of-service agreement (which went into effect in August 1980). Under the purchase-of-service agreement, Caltrans subsidizes the operator, Southern Pacific, directly for the entire loss of running the train service. The riders get no direct discount or subsidy as under the Fare Stabilization Program. While Southern Pacific had to operate the trains at a substantial loss under the Fare Stabilization Program and San Mateo County granted a further direct user discount to its residents using the service, under the purchase-of-service agreement, the State guarantees Southern Pacific that it will be entirely reimbursed for the service. Since the amount of this subsidy is growing substantially, as of September 1981 there was a 25 percent rate increase pending.

b. Participating Agencies and Their Roles

The operator of the transit service was the Southern Pacific Transportation Company, one of the nation's largest and most profitable railroad corporations. Southern Pacific did not want to continue this passenger service as it lost money and was alleged to interfere with profitable freight operations. California public agencies, however, wanted the service to continue. These agencies included: the California Public Utilities Commission (CPUC), the State regulatory agency which required the Southern Pacific to continue the service even on an unprofitable basis; the affected Counties of San Mateo, Santa Clara, and San Francisco and their respective county transit districts (San Mateo County Transit District is called "Sam Trans") and the city councils of affected communities in those counties; and the San Francisco Bay regional Metropolitan Transportation Commission (MTC), which is the Metropolitan Planning Organization (MPO) for the Bay Area.

Another key actor in the development of the Fare Stabilization Program was the Federal Interstate Commerce Commission (ICC), which also has regulatory powers over the Southern Pacific. As the CPUC refused to allow the Southern Pacific either to abandon service or raise fares sufficiently to cover operating costs, the Southern Pacific petitioned the ICC for permission to discontinue passenger service.

State legislative action was required to direct the PENTAP study and to enable Sam Tran's Fare Stabilization program to come into existence. The "Sam Train Commuter Association" was a creation of Sam Trans to facilitate the program.

c. Sources of Funding

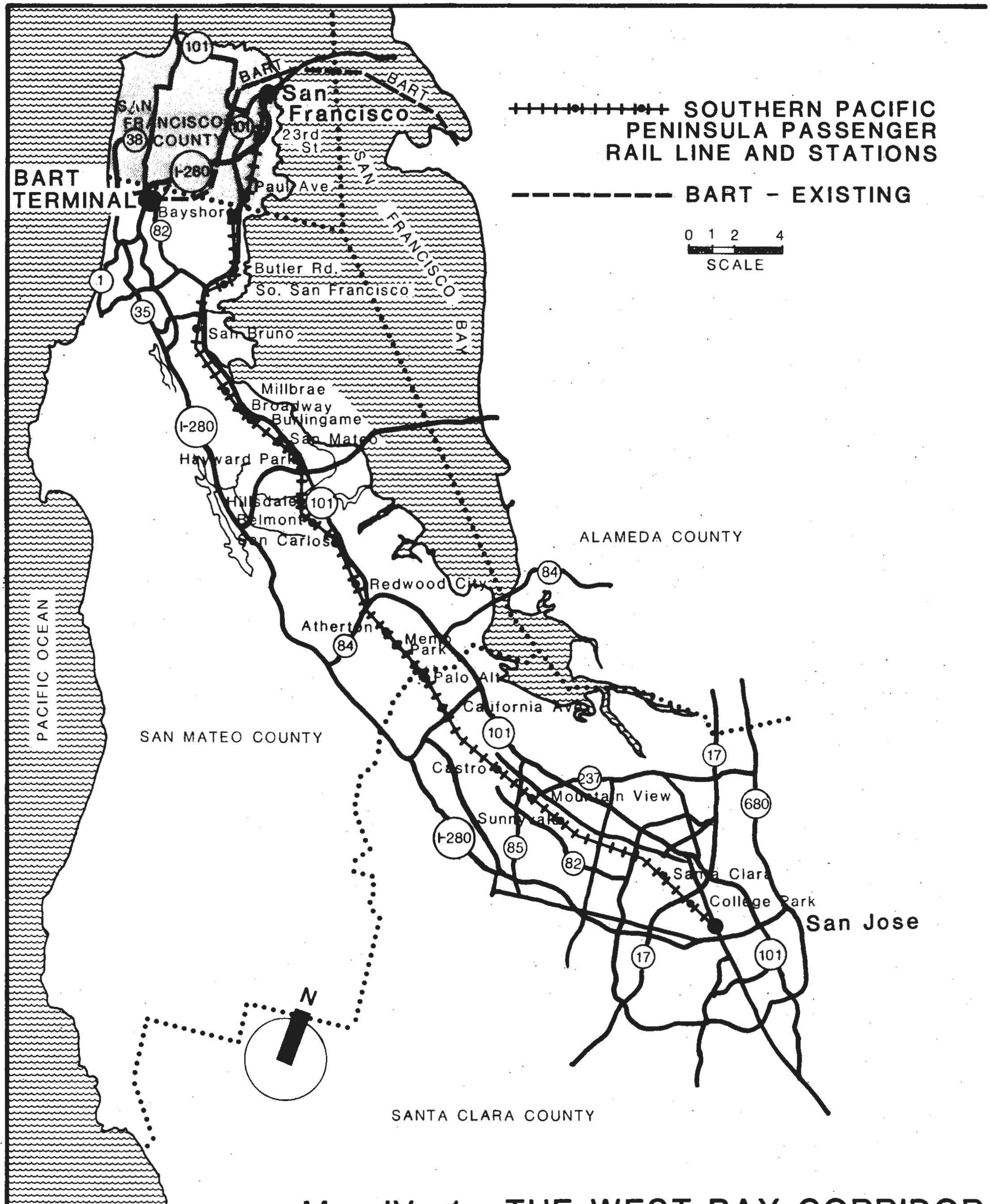
The entire Fare Stabilization Program was paid for out of funds allocated to the affected counties by the State of California under the Transit Development Act (TDA), which reserves 1/4 of revenues from a 1 percent regional sales tax collected in Bay Area counties to mass transit.

3. Characteristics of the Project

The Southern Pacific commuter rail line, whose preservation the Fare Stabilization Program was intended to assure, is the last surviving commuter rail line in California. It is a diesel-operated 47-mile at-grade line from San Jose to San Francisco, with push-pull locomotives and bi-level coaches. There are two city terminals and twenty-four suburban stations (fifteen in San Mateo County), typically in town centers, along the line, which formed the connecting "spine" of the Peninsula communities of the West Bay Corridor (see Map IV-1). Presently there are twenty-two train runs in each direction on weekdays, twelve of them in the peak (6:00-9:00 a.m. northbound and 4:00 -7:00 p.m. southbound) periods. Most peak period trains skip stops, enabling a San Jose - San Francisco travel time of one hour and twenty minutes. Most stations have six or fewer peak period train stops. There are twelve trains in each direction on Saturdays and nine on Sundays. Patronage is overwhelmingly oriented to the San Francisco.

The rail line is in excellent condition, capable of high speed performance and serves as a heavy freight carrier. Passenger operation between San Francisco and San Jose has been continuous on this line since 1864. The line is at grade, even in San Francisco. The biggest deficiency in the operation is that the diminutive San Francisco terminal of the line is at the periphery of the CBD and most Southern Pacific commuters must take local buses to reach work places, typically a mile from the SP terminal.

According to a 1980 Caltrans survey, 70 percent of the line's riders reach their stations by automobile.



Map IV-1: THE WEST BAY CORRIDOR

4. Results of Implementation

a. Modal Diversion

The impact of the Fare Stabilization Program on modal shift cannot be ascertained precisely, but was probably minimal. While commuter and total ridership increased substantially between the beginning and the end of the program (about 42 percent), the discount fare program was only partially responsible for this increase (see Figure IV-14 and Table IV-4). The largest increases in ridership occurred in 1979-1980, coincident with a gasoline shortage during the April-July period of 1979 and a 50 percent increase in gasoline prices between mid-1979 and mid-1980. The coexistence and interaction of the discount fare program and the large increase in gasoline prices does not allow determination of the relative influence of these factors on increasing rail ridership during 1979-1980.

In 1977, about 450,000 person-trips (in both directions) crossed the boundary between San Mateo and San Francisco Counties daily. Of these, approximately 14,400 were Southern Pacific passengers (7,200 in each direction, based on the December 1977 ridership survey), or about 3.2 percent of the total. If a minimum increase in total ridership attributable to the program is assumed at 2 percent between 1977 and 1978, ridership would have increased from about 7,200 to 7,344, or 144 additional daily riders. Hence, in 1978, daily rail patronage may be estimated at about 3.26 percent of the total. This amounts to a statistically insignificant increase of only .06 percent in trips made by rail in the three county area. (If total trips increased to 460,000 in 1978, there would be essentially no increase in the share of trips by rail.)

However, even this estimate of modal shift attributable to the program is generous, because the increase in rail ridership had two elements. The increase in commuter ticket sales and the associated increase in total rides sold during the program were partially the result of an unknown number of former single ticket riders purchasing discounted commuter tickets (the 30 percent discount did not apply to single tickets); hence not all of the increase in commuter ticket sales is indicative of modal shift. In addition, it is likely that a significant number of riders who took advantage of the discount program were attracted from other transit modes (particularly from buses, since the program essentially equalized bus and rail fares), as well as from autos. Unfortunately, the 1980 Caltrans' survey did not collect information on travel mode or the type of tickets purchased prior to riding the train.

TABLE IV-4

Southern Pacific Railroad Peninsula Commute Service
Monthly Ridership Data (Based of Ticket Sales) and Important Events, 1977-1980

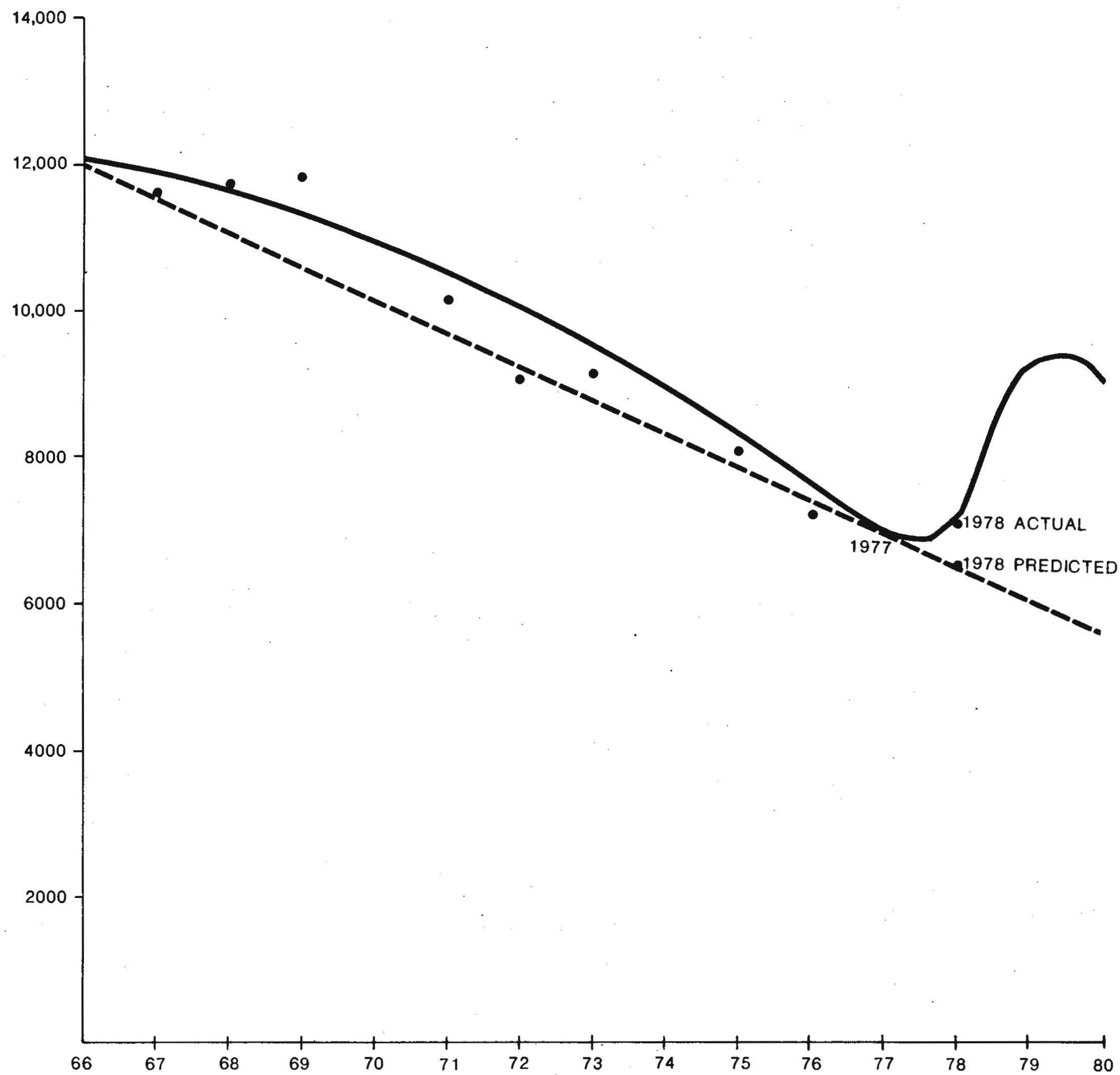
	Commute Rides Sold--1977	Commute Rides Sold--1978	Commute Rides Sold--1979	Commute Rides Sold--1980	Commute Rides Sold--1981
Jan.	318,698	(2) 327,432	351,780	471,172	417,842
Feb.	291,430	327,432	307,102	440,376	386,586
Mar.	348,190	336,270	(3) 350,656	460,352	436,626
Apr.	304,940	301,748	353,298	464,436	424,256
May	323,466	333,432	429,306	455,970	394,412
June	309,990	301,248	391,254	440,780	
July	295,602	292,964	420,344	(4) 467,864	
Aug.	(1) 306,628	310,984	410,468	360,390	
Sept.	295,578	287,408	364,077	409,178	
Oct.	297,078	334,540	472,232	439,672	
Nov.	300,004	317,370	440,796	386,654	
Dec.	272,392	293,068	387,214	394,740	
TOTALS	3,663,996	3,726,864	4,678,527	5,191,584	
% Change		+1.7%	+25.5%	+10.9%	

	One Way & Round Trip Rides Sold 1977	One Way & Round Trip Rides Sold 1978	One Way & Round Trip Rides Sold 1979	One Way & Round Trip Rides Sold 1980	One Way & Round Trip Rides Sold 1981
Jan.	53,941	(2) 66,442	53,173	74,171	85,240
Feb.	47,032	50,188	45,193	62,260	69,716
Mar.	53,518	58,258	(3) 54,530	72,398	93,219
Apr.	43,838	49,246	78,884	74,921	91,898
May	53,955	54,560	136,188	73,623	93,065
June	55,795	55,739	98,276	76,959	
July	67,388	55,536	108,257	(4) 86,672	
Aug.	(1) 86,398	59,834	114,374	89,510	
Sept.	67,710	54,464	111,173	81,241	
Oct.	67,982	57,677	89,246	89,579	
Nov.	72,009	62,409	83,326	104,388	
Dec.	76,223	56,809	84,793	94,467	
TOTALS	745,789	681,152	1,057,413	980,189	
% Change		-8.6%	+55.2%	-7.3%	

	Total Rides Sold--1977	Total Rides Sold--1978	Total Rides Sold--1979	Total Rides Sold--1980	Total Rides Sold--1981
Jan.	363,544	(2) 386,356	403,074	541,703	498,605
Feb.	331,054	333,559	348,883	500,648	450,985
Mar.	394,338	388,750	(3) 400,195	531,418	523,268
Apr.	352,375	344,392	430,082	536,858	514,464
May	369,869	383,148	562,058	526,448	478,722
June	357,862	351,601	489,530	504,846	
July	353,214	342,889	517,960	(4) 550,445	
Aug.	(1) 382,831	366,342	522,446	445,774	
Sept.	349,558	336,367	475,716	484,225	
Oct.	356,297	386,332	558,965	522,870	
Nov.	367,033	378,230	521,976	485,118	
Dec.	341,998	343,045	468,565	482,537	
TOTALS	4,319,973	4,341,011	5,699,406	6,112,890	
% Change		+0.5%	+31.1%	+7.25	

Events 1977-1980 Event	Date	Ridership Changes* Commute	O.W./RT	Total
(1) 25% Fare Increase	(8/6/77)	- 3.6%	-21.6%	- 8.7%
(2) Start of Fare Stabilization Program	(1/1/78)	+20.2%	-12.8%	+12.9%
(3) Gasoline Shortage (4/79-8/79) and Price Increase	(4/79-5/80)	Depends on interval selected		
(4) Fare Stabilization Program Ends	(1/8/80)	-22.9%	+ 3.2%	-19.0%

*Monthly ridership change between the month before the event and the month after.



LEGEND:

- - - - - PREDICTED TREND LINE

——— ACTUAL RIDERSHIP LINE

Figure IV-14:
SP PENINSULA RAIL SERVICE RIDERSHIP, 1967-1980

BASED ON OCTOBER PASSENGER COUNTS

b. Impact on Energy Consumption

VMT reduction attributable to the program was 2,122 VMT/day (for San Mateo County only). Daily VMT for the three-county area (San Mateo, San Francisco, and Santa Clara Counties) in 1978 was 10,481,000; hence the reduction is .0202 percent of total daily VMT in SP's service area.

The program's impact on fuel consumption is also insignificant, since it is based on the VMT reduction. Using Caltrans suggested 1978 fuel consumption rate of 14.5 miles per gallon, the daily fuel savings attributable to the program is: 2122 ÷ 14.5 = 146 gallons/day or about .005 percent of the three county total in 1976-1977 (2,799,000 gallons/day).

c. Ridership Increases

Between January, 1978 and July, 1980, ridership on the San Francisco - San Jose commuter service increased by 42 percent. During this period, there were no changes in equipment used, service quality, or frequency. While this period partially coincided with a period of gasoline shortages and price increases (52 percent), ridership increased 12 percent during the first eight months of the program. This strong upward ridership trend is in marked contrast to ridership declines during the 1973-1974 gasoline shortages and price increases. In the year since the program ended, ridership has declined only slightly (less than 5 percent). Secondary impacts on traffic congestion, energy consumption, and vehicle emissions had been minor.

5. Unresolved Problems

a. Fiscal

The enabling legislation to establish the Fare Stabilization Program passed by the state legislature had called for the program to terminate on January 1, 1980. The program actually had to be extended to August, 1980 because no satisfactory replacement could be worked out between the State and Southern Pacific until then. An ICC Administrative Law Judge had ruled in July, 1979 that Southern Pacific was not obligated to operate the passenger service at a loss as its discontinuance would not have an "unwarranted impact on the quality of the human environment." Since August 1980, Caltrans has been subsidizing fares on the Southern Pacific service on a purchase-of-service arrangement.

b. Physical

The relocation of the rail line's San Francisco terminal to a new location nearer the heart of the CBD is widely perceived as the line's greatest need. This, as well as the possible relocation of the San Jose terminal to a proposed light rail/bus/Southern Pacific intermodal facility are under study.

c. Institutional/Jurisdictional

As the continued operation of Southern Pacific passenger rail service is not deemed feasible without heavy subsidization, the line's future is at the mercy, as the Southern Pacific has warned, of political allocations of government funds. It is not clear for how long or to what extent California will continue to subsidize the operation.

6. Future Plans

Until funding sources are certain or there are major changes in ridership, it is unlikely that any major change (e.g., relocation of the San Francisco terminal) will be made. The rail service is presently the subject of two related studies: the first, a rail station relocation and improvement study, which is examining the possible relocation of both San Francisco and San Jose terminals, as well as improvements to suburban stations; the second, an operational study, which will produce recommendations on new rolling stock and right-of-way facilities.

7. Conclusions Applicable to Other Areas

The user-side subsidy employed by San Mateo and its neighboring counties to stabilize Southern Pacific fares is applicable to other ticket-based rail or bus operations. It is most appropriate where the operator is a private company (as public agencies usually obtain subsidies directly). A benefit of the approach is that it provides no inducement to let system costs rise on the part of the operator - he does not receive the subsidy. Also, providing a user-side subsidy creates the idea of a sale or discount, which is a useful marketing device. The user-side subsidy can also be applied by local or county governments to a service operating over a larger regional area. San Mateo County's 30 percent discount program was not dependent on whether other counties served by Southern Pacific adopted similar measures.

G. Bus Signal Priority

1. Strategy Objectives

The objective of the Concord, California bus signal priority system was to speed up the movement of local buses on a congested suburban arterial, along which were located several large shopping centers. This was intended both to reduce transit costs and to encourage transit ridership.

2. Approaches to Implementation

a. Planning & Historical Background

Concord, California is a burgeoning Sun Belt city, characterized by automobile-dependent spread growth and constantly increasing traffic. In an effort to cope with traffic congestion in its growing commercial district, Concord has encouraged bus use. The delay to buses along the Willow Pass Corridor between a regional shopping center and the Concord BART Station was becoming so bad that buses were falling far behind schedule and additional buses were required at times to compensate for "lost trips." The City, which was contracting for most of this bus service, sought means to extricate buses from the growing traffic congestion.

Following the development and application of a bus signal preemption system in the Sacramento area, the City of Concord conducted a speed and delay study of bus movement on the Willow Pass Corridor and applied for a grant to the local Metropolitan Planning Organization (MPO) for funds to create a bus priority signal system on the Willow Pass Corridor. These funds were granted to Concord and utilized to design, install, and modify the bus priority system placed into operation on the Willow Pass Corridor between April 1978 and May 1980.

b. Participating Agencies

The lead agency for the TSM implementation was the City of Concord's Department of Public Works. Also involved were: 1) the Alameda-Contra Costa Transit District (AC Transit), which was the bus operator; 2) the Metropolitan Transportation Commission (MTC), the local MPO which authorized state and regional funds for the project; 3) the Bay Area Rapid Transit District (BARTD), which was also contracting for bus service with AC Transit on the Willow Pass Corridor; 4) the Minneapolis Mining and Manufacturing (3M) Company, which custom designed and manufactured the "Opticom" signal system used for Concord and worked closely with the City to modify the system to Concord's requirements; 5) the California Department of Transportation; and 6) a local transportation engineering consulting firm, TJKM, which conducted an evaluation of the system's performance.

c. Institutional Roles

The design and installation of the system was performed by 3M and the City of Concord. AC Transit had to install emitters and cab cables in several of their buses which were to operate on the four Willow Pass Corridor routes--three routes contracted for by the City and one by BARTD. The funding, based on state and regional sales taxes, was provided by MTC.

d. Jurisdictional Responsibilites

The City had full jurisdiction over the project except for the bus operation, which was the responsibility of AC Transit. So that other communities might benefit from evaluating the project, the evaluation notes were made by contract to be joint MTC/City property.

e. Sources of Funding

MTC drew demonstration grant money from two sources: 1) the MTC Development Fund, a multi-purpose fund from Bay Area county sales taxes; and 2) Transit Development Act (TDA) funds from the State sales tax. No Federal funds were involved. Some indirect, non-capital costs of the project were paid for out of City and AC Transit operational budgets.

3. Characteristics of the Project

The project consists of bus priority devices (not bus preemption) at twelve signalized intersections along the 3.5 mile Willow Pass Corridor in Concord. The devices at each intersection are a beam detector and a phase selector box. The beam detector receives a pulsating infra-red beam from the strobe light emitter of an approaching bus and activates the phase selector to either hold or accelerate the signal cycle so as to extend a green cycle or accelerate the oncoming of green time for the approaching bus. Buses must be equipped with emitters in order to send signals to the beam detector. While the intersection detector and phase selector apparatus is the property of the City of Concord, the emitters belonged to AC Transit. Only 18 buses were originally equipped with emmitters and some of these were later scrapped. During most of the day four buses per hour per direction operated on the Corridor. That number is currently three per hour as one City route was changed. During the peak hour seven buses per hour operate in each direction along the Corridor.

The "Opticom" system was originally designed as a bus preemption system as opposed to a bus priority system, which the City wanted and was to eventually install. Under a preemption system buses automatically get a green signal phase, interrupting the normal cycle sequence even in the middle of a pedestrian "Walk" phase or when demand for cross street traffic existed. A succession of buses could keep preempting the signal for several cycles, delaying cross street traffic. Under a priority system, the bus' emitter signal would not necessarily result in green time for the bus. Instead, the phase selector would either extend an existing green phase for the bus or speed up the cycle so that the light would turn green for the bus as it approached the intersection. A priority system was thought to be safer and less disrupting to cross street traffic.

Modifications were made to the "Opticom" system to change it from a bus preemption system to a bus priority system. These modifications, including a "lockout" feature to prevent continuous signal preemption by buses, resulted in a system under which a subtle speeding or slowing of the signal progression--as opposed to immediate and automatic preemption--gave buses priority approximately 60 percent of the time.

Installation of the bus signal priority system was completed between November 1977 and March 1978 at a cost of $119,375.

4. <u>Results of Implementation</u>

The system enabled emitter-equipped buses to move faster and preempt signals on the average of 60 percent of the time. Travel time in the Corridor for buses was reduced 13.7 percent and average delay declined 31.6 percent. The system enabled the bus operator to save about $18,000/year by eliminating an extra standby bus required to make up "lost trips" on days in which serious congestion occurred.

The original delay problems were largely solved by the bus priority system. However, there were problems with the "Opticom" signal system as originally designed and in maintaining the system in proper working condition after it was implemented. These problems included: 1) construction projects at four intersections during the two years subsequent to implementation which temporarily closed the system at these intersections; 2) the modification of detectors and phase selectors after the intersection construction work was completed; 3) maintenance required by the apparatus which temporarily kept them out of service due to malfunction; and 4) the bus operator's inability to dispatch all buses to the Corridor emitter-equipped.

In the spring of 1980 the entire system was turned off because the new centralized, computer-operated VMS 220 Multisonics signal system permitted bus signal preemption but not bus priority operation as had formerly been in operation. Preemption was considered too dangerous.

5. Problem Identification

As a result of increasing traffic congestion related to commercial development, four bus routes which ran along the Willow Pass Corridor between the Sun Valley shopping center and the Concord BART Station, were falling so far behind schedule that additional buses and drivers had to be used to maintain the schedule headway. This problem was most severe during the Christmas shopping season in November and December, affecting Saturday operations as well as weekdays. The routes affected were the 303A, 306W and 307 (City-contracted) and the "M" (BART-contracted). The operator in all cases was the Alameda-Contra Costa Transit District (AC Transit). All routes served the Concord BART Station and ran weekdays, the first two operating on Saturday as well.

The City of Concord was concerned about the delay to the bus routes it was subsidizing, especially because: 1) the buses going off schedule were destroying the timed bus transfer system at the BART Station, and the City's objective to build non-captive transit ridership; and 2) a reliable bus service was needed to serve BART commuters, who experience severe parking shortages at the BART Station.

6. Problem Resolution

As traffic grew on the Willow Pass Corridor in the mid-1970's, City traffic engineers became increasingly concerned about the delay to buses and the negative implication of this for future transit ridership. They sought some way of giving buses priority over private automobiles to free them from the growing traffic congestion. With bus volumes less than 1 percent of overall traffic and with only four-lane roads to deal with, a bus lane was out of the question.

Following reports that a bus signal preemption system in the Sacramento area had significantly reduced bus delays, in 1977 Concord's traffic engineers applied for a grant to the Metropolitan Transportation Commission (the Bay Area's Metropolitan Planning Organization) to install and test the Opticom system on the Willow Pass Corridor. In 1976, the City had conducted a bus speed-and-delay study on three bus routes, operating the length of the Willow Pass Corridor from the Sun Valley Shopping Center to BART. This study found that about 40 percent of all delay to buses was incurred at eleven signalized intersections. Based on study results, Concord's Traffic

Engineer estimated that given the existing level of pedestrian usage, an Opticom system at these eleven intersections would achieve at least a 25 percent decrease in overall delay on runs along the Willow Pass Corridor, saving an estimated 2.1 minutes per one-way run.

The City installed the Opticom system at twelve of the sixteen intersections between the Sun Valley shopping center and the Concord BART Station. Of the sixteen signalized intersections along the route, seven were part of Concord's downtown coordinated signal system while nine were independent, traffic-actuated signals. Opticom equipment would be installed at three of the coordinated signals and on all the nine independent signals and on eighteen AC Transit buses. Since Concord's Traffic Department felt that a bus signal priority system would be safer and less disruptive to traffic than the signal preemption system used in Sacramento, Traffic Department engineers and 3M specialists modified the Opticom system, changing it from a bus preemption system to a bus priority system.

7. Unresolved Problems

The operational problems of the system could not be entirely solved due to construction activity and the problems of the bus operator in maintaining and dispatching his limited number of emitter-equipped buses. Assuming that the system becomes operative once more the problems of maintaining and dispatching emitter-equipped buses may be resolved because buses would be dispatched from a local garage under the jurisdiction of a new local transit district.

No resolution has yet been found to the problems associated with modifying the City of Concord's new central computerized signal system for bus priority from its existing bus preemption-only capability. However, the new transit district, the Central Contra Costa Transit District, is applying for MTC grant funds to allow the City to make these modifications. Given the practical superiority of priority over preemption systems, it is probably only a matter of time before such modified priority versions will become widely available.

8. Future Plans

Concord and the new Central Contra Costa Transit District plan to reactivate the system. However, until a bus priority system can be re-established in Concord it cannot be extended elsewhere in the City. The City has identified another major arterial corridor east of its CBD, Clayton Road, as suitable for development as a major transit corridor. Many intersections on this corridor may also be adapted into a bus priority system.

9. Conclusions Applicable to Other Areas

Bus priority systems can work if applied where conditions warrant them but there are still technical problems which only further research and development can solve. Other communities should seek complete signal systems which will allow bus priority on a computer-based traffic signal system. Such a system should provide signals with factory-installed phase selectors in control cabinets with the design for each intersection programmed. Buses should be equipped with less vulnerable emitters located in the cab rather than on the roof of the bus. The emitter apparatus should be factory-installed in order to prevent costly retro-fitting.

Most applications of bus priority systems so far have been on suburban arterials or other major roads through low density areas in which pedestrian and cross-street traffic demand is minimal, traffic is heavy enough to cause bus delays, and buses are a low proportion of traffic. The Concord system was operative along a corridor with only three to seven buses an hour in each direction. At several intersections the number of buses was even lower. Arterials with higher volumes and greater ridership would benefit far more from bus prioritization.

Such low bus volume applications have proved to be useful as experimental or demonstration projects in order to gain operational experience and provide useful system information. Expansion of such bus priority systems onto arterials with higher volumes of bus traffic and greater bus ridership would yield greater benefits.

V. SUMMARY AND CONCLUSIONS

This report has discussed the results of applications of six basic types of Transportation System Management (TSM) techniques:

1. Exclusive Bus Lanes

2. Park-and-Ride Lots

3. Residential Parking Permit Programs (RPPPs)

4. Transit Management Improvements

5. Innovative Transit Subsidy Techniques

6. Bus Signal Priority Systems

To the extent that available information permitted it, this report has identified and described: (1) the events which led to the selection of the TSM action in each area; (2) the issues which needed to be resolved in the planning, coordination, implementation, and operations of the project: (3) how these issues were resolved: and (4) the types of transportation, traveler, and environmental impacts produced by the project. In addition, for the Exclusive Bus Lane strategy, the differing results achieved in each of four cities which used this strategy were described. A summary of major findings is given below.

1.0 Exclusive Bus Lanes

Two types of exclusive bus lanes were analyzed: 1) a median reversible suburban arterial bus lane (Portland, Oregon): and 2) CBD contra-flow bus lanes (Los Angeles, New York, and Minneapolis). The Portland project was designed to facilitate rapid bus movement to and from the CBD while those in Los Angeles, New York City, and Minneapolis were intended to facilitate movement of buses within the CBD. In all four case studies the main objective was to free suburban express buses from traffic congestion.

Because of the different nature of the two types of bus lanes analyzed - CBD contra-flow versus median reversible on a suburban arterial - they are discussed separately.

1.1 Median Reversible Bus Lane On Barbur Boulevard, Portland, Oregon

This project has not yet met up to its projected time savings for bus trips. However, the projected 3-5 minute of time savings per one-way bus trip were based on 1995 projections of heavy traffic volumes. Presently the 1-2 minute travel time savings of buses using the lane is not so much attributable to the lane *per se* but to the change in bus operation - buses operating on the lane are running express and do not have to stop to pick up or discharge passengers. This is the major reason why express buses on the project section of Barbur Boulevard run faster than local buses on the same roadway.

Traffic accidents have been a major problem with the median bus lane. While these bus lane-related accidents decreased substantially after the first year of operation and are now largely isolated to one single problematic intersection, the conflict between median reversible lanes and left-turns is an inherent operational problem which has been evident in other reversible median lane operations in Phoenix, Arizona and Washington, D.C.

The median reversible lane is underutilized: it carries only 19 buses in the a.m. peak hour - about one bus every three minutes. Buses during the peak hour are, on the average, over 1,600 feet apart. Only about 35 buses use the lane in the entire peak period (7:00-9:00 a.m.), corresponding to one bus every four minutes. The number of buses - and riders - using the lane has not increased in its first two years of operation despite a systemwide ridership increase.

The Barbur Boulevard Bus Lane, which carries seven of the fourteen bus routes linking Washington County to the Portland CBD, was envisioned as a major transit conduit between the CBD and the projected 100 percent population growth in suburban Washington County.

When planning for this corridor began, Portland had had no experience with bus priority signal systems and bus priority ramps. But from 1975 on, the City had successful experiences with a median freeway bus and carpool lane on the Banfield Freeway. Given traffic and population projections, it was felt that buses would be caught up in traffic congestion unless strong priority measures were taken and bus lanes seemed the only practical way to go. However, because of the lane's low utilization and the energy invested in constructing the lane and ancillary facilities, the project has clearly caused more fuel consumption than it has saved. Construction of the lane involved the widening and partial repaving of Barbur Boulevard. The lane system also contributes to higher consumption of operating energy: automobiles crossing Barbur Boulevard during peak periods must use more fuel to execute circuitous turning maneuvers.

1.2 Contra-Flow CBD Bus Lanes

The CBD contra-flow bus lanes (Los Angeles, New York, Minneapolis) studied have resulted in negligible to slight increases in bus operational speed but in all cases have improved schedule reliability. In the New York City case (Second Avenue approaching the 59th Street Queensboro Bridge), it was found that buses saved an average of one to two minutes per trip and up to seven minutes during the most congested periods. Bus speeds from Third Avenue and 57th Street to the Bridge (Second Avenue and 59th Street) increased from six to eight m.p.h. In the Minneapolis case (Second and Marquette Avenues downtown), a 20 percent speed improvement was realized - a little over a minute saved per bus trip over ten blocks. In the Los Angeles case (Spring Street), after contradictory and controversial conclusions, it was generally acknowledged that buses operating the entire length actually were operating slightly slower than when they ran with-flow, leading one consultant to conclude that " ...contra-flow lanes in themselves do not save travel time if they are constructed without preferential traffic signalling...". However, Los Angeles buses operating only on the most heavily used northern segment of the lane did move about 17 percent faster after a segment of the lane was widened in 1979.

The major reason why CBD contra-flow bus lanes may not operate as efficiently as expected is that the degree to which traffic congestion has been perceived as the obstacle to bus movement has been exaggerated. In Los Angeles it was found that 89 percent of the delay experienced by pre-lane buses was due to passenger stops and red lights, not traffic congestion. This emphasizes the need to limit (or skip) stops and the need to coordinate bus movement with favorable traffic signalization. The New York lane resulted in the greatest time savings per unit distance because on the contra-flow lane buses run express and traffic congestion was the major problem.

1.2.1 Ridership

In all three cases the implementation of contra-flow bus lanes coincided with substantial passenger increases, though these could not be attributed to the contra-flow lanes *per se* because so many other factors were involved. These other factors were: 1) the growth of suburban express bus service; and 2) the higher cost of gasoline and reduced gasoline supply, which were experienced in this period. Annual ridership on New York express buses using the Second Avenue contra-flow lane went from 5,538,000 (1978) to 6,772,000 (1979) despite a long 1979 strike against one express bus operator. Daily passengers grew from 8,176 (October, 1977) on 194 buses to 8,373 (October, 1978) on 233 buses to 10,780 (October, 1979) on 210 buses (decrease in buses due to strike).

While exact ridership figures are not available for the Minneapolis lanes, the number of buses using the lanes has increased since 1975. In October, 1975, 50 percent of those leaving the Minneapolis CBD were doing so by bus. There are about 5,000 peak hour bus riders on Marquette Avenue in the peak hour. Within one year of implementation, Los Angeles ridership on the express buses using the Spring Street contra-flow lane grew from 10,500 to over 15,000. On the most heavily used segment of the Los Angeles lane, approximately 240 buses carry about 9,000 riders during the peak hour.

1.2.2 Traffic Speed

In New York, the institution of the Second Avenue contra-flow lane took a lane away from with-flow Second Avenue traffic, whose speed dropped from 11.2 to 8.2 m.p.h. Some of the Second Avenue speed reduction may be attributed to an increase in traffic recorded on the Avenue after the lane was instituted. However, since the contra-flow buses had been diverted from First and Third Avenues, traffic speeds on these arterials increased slightly from 8.6 to 9.7 m.p.h. on First Avenue and from 5.7 to 5.8 m.p.h. on Third Avenue.

In Minneapolis, automobile travel times in the peak hour on Second and Marquette Avenues increased 5 percent, despite a traffic diversion of 10 percent to other avenues. Evening peak hour traffic volumes declined 9.3 percent on Marquette and 15.4 percent on Second after the bus lanes were put in.

In Los Angeles, the initial May 1974 institution of the Spring Street contra-flow lane resulted in a 19 percent reduction in peak period traffic speeds, undoing most of the speed advantages gained by a resignalization scheme five months earlier. The traffic level of service on Spring Street dropped from C to D in the morning and from C to the C-D boundary in the evening. Traffic speeds rose slightly on Main Street, from where the buses had been diverted. The June 1974 traffic counts noted a 6 percent decrease in peak traffic volumes on Spring Street and an even greater decrease in traffic (18 percent less in the morning and 10 percent less in the evening) on Main Street.

1.2.3 Air Quality

No air quality studies were done on the impact of the bus lanes on air quality. However, applying the USEPA's MOBILE 1 Source Emmissions Model to the New York Second Avenue lane, it was found that air pollution levels on the effected two-block portion increased - carbon monoxide by 31 percent, hydrocarbons by 34 percent, and nitrous oxides by 46 percent. These pollution increases must be balanced against pollution decreases on nearby avenues from which buses were diverted and against pollution decreased by any modal shift from autos to buses.

1.2.4. Accidents

Unlike the median reversible bus lane in Portland, CBD contra-flow lanes do not seem to be accident-prone. No accidents have been identified in New York as attributable to the contra-flow lane. Accident levels on the affected portions of avenues in Minneapolis have remained the same, and in Los Angeles a rise in bus-related accidents had no significance as accidents rose even more on the street from which contra-flow buses had been diverted.

1.3 Costs

The cost of establishing exclusive bus lanes can vary greatly. In Portland, an additional lane was built; in Minneapolis, a permanent concrete divider/median was deemed necessary; while in New York City, the operation is only part-time and is labor-intensive. One aspect common to all these TSM bus lane projects is flexibility of investment - it can be done incrementally or be a multi-purpose investment, useful under several different future scenarios.

The Minneapolis bus lane was operated on an "experimental" basis for two years with only $25,000 (1974 dollars) as capital investment and with no extra operating personnel. During those two years enough was learned to test the impacts of the lanes, make several modifications, and plan a final design which was efficiently integrated with an innovative CBD transportation system--the pedestrian skyway network--and computerized signalization. Minneapolis took over a year of planning and two years of actual operating experience before it invested $805,000 (1976 dollars) to put the project in final form. $118,000 of that amount was for electrical loop detectors and amplifier installation for eventual bus signal priority treatment, and $614,000 was for the construction of permanent concrete median dividers.

The Portland Barbur Boulevard median reversible bus lane cost $608,000 (1978). However, much of this money was for improvements which would benefit all traffic even if the median lane was not used exclusively for buses. The median lane can be used as a bus lane, HOV lane, reversible traffic lane, or left-turn lane. The ancillary transit station and park-and-ride lot on Barbur Boulevard is so situated that it can be used by autos from several directions and by buses traveling on several routes.

Implementation data was not available for New York's contra-flow bus lane. However, the New York operation is unusually labor-intensive, requiring six to eight traffic officers for four hours daily. The Los Angeles contraflow lane does not require much extra labor and it cost only about $48,500 to implement (1974) with another $4,500 spent for modifications (1979).

The source of funding for all the CBD contra-flow lanes was local. The Portland median bus lane was constructed mostly with Federal funds (with State and local match), traded-in from the Mount Hood Freeway, for which they were originally intended.

1.4 Physical Problems

Most exclusive bus lanes are separated from other lanes only by double-striped yellow lines and contain diamond and/or "BUS LANE" markings. However, when the bus lane operates only part-time, such as New York's Second Avenue , temporary cone markers are used. To separate the bus lane from other traffic lanes, some cities have used dividers other than lane-lines.

Originally, in Minneapolis, it was felt that a 6-foot concrete median would be necessary to separate with- and contraflow lanes on a permanent basis. However, when the City established the need for a contra-flow lane 18-20' wide, it was realized that the roadway width was not available. Therefore, it was decided that a one-foot mountable barrier would suffice as a permanent median. In the experimental stage the contraflow lane was divided from other lanes by double yellow lines and orange highway cones. The one-foot, concrete median barrier used in Minneapolis presents a problem for snow ploughing and street cleaning - either ploughs or brushes must be partially raised or they must avoid the barrier.

Oil drums are used as dividers on Minneapolis' new Hennepin Avenue bus lane. In all four bus lane applications, overhead signs were used to inform oncoming motorists of the bus lanes.

The width of the bus lane is also an important consideration. There must be adequate width for passing maneuvers, especially if the buses will stop in the lane to pick up or discharge passengers. When a heavily-used section of the Los Angeles contra-flow lane was widened from 12-13' to 21-26', bus idling was reduced and an annual savings of 270 diesel gallons was achieved, and bus travel time declined 17 percent.

1.5 Other Contra-Flow Considerations

a. Circuitry

While the New York contra-flow lane reduced bus route circuitry and saved an estimated 5,200 bus miles (1,730 gallons) annually, the Los Angeles contra-flow scheme actually increased VMT on some routes.

b. Use Control

Bus lanes reduce conflict between different classes of vehicles by segregating buses out of the traffic stream. Unlike the with-flow bus lanes, into which other vehicles can easily enter and across which right turns are made, the contra-flow bus lanes tend to be self-enforcing (see Figure V-1).

c. Passing Maneuvers

There may be no speed advantage to exclusive bus lanes in CBDs unless the buses have the ability to pass one another. This requires that the bus lane be really two lanes - a stopping lane to pick up and discharge passengers, and a moving lane. In both the New York and Minneapolis cases, the transit operators viewed a double- lane arrangement of at least 18' as necessary for effective contra-flow operation. Such double-laning also had to be instituted (1979) to the narrow 12-13' Los Angeles Spring Street contra-flow lane.

d. Access To Buildings

A small but nagging problem with CBD bus contra-flow lanes is their impact on building access, especially on parking garages and hotels. The problem is least where taxis and trucks are permitted on the contra-flow lanes (Minneapolis) or where the disruption to buildings and commercial traffic is minimal (New York). Because these problems tend to be highly localized, details must be worked out for each individual case. The example of the Minneapolis contra-flow lanes, on which commercial delivery vehicles are permitted in off-peak hours, is worth noting.

While taxi and truck operations were only incidental to the contra-flow lane project in Minneapolis, and were not originally part of it, they were the modes which benefitted most. Taxis are permitted on the contra-flow lane. In addition, taxi and truck CBD circulation became easier because these vehicles were exempted from the one-way traffic system and had to traverse fewer links. Trucks and taxis retained the right of access to buildings on both sides of Marquette and Second Avenues, yet did not have to compete with automobiles for parking and standing places along these curbs. Observations made before and after the project was implemented noted an increase in offpeak truck use of the reverse-lane curb, and a 50 percent decrease in such use for the peak hours.

A problem common to the contra-flow lanes of Los Angeles and Minneapolis, is the passenger's confusion in locating the

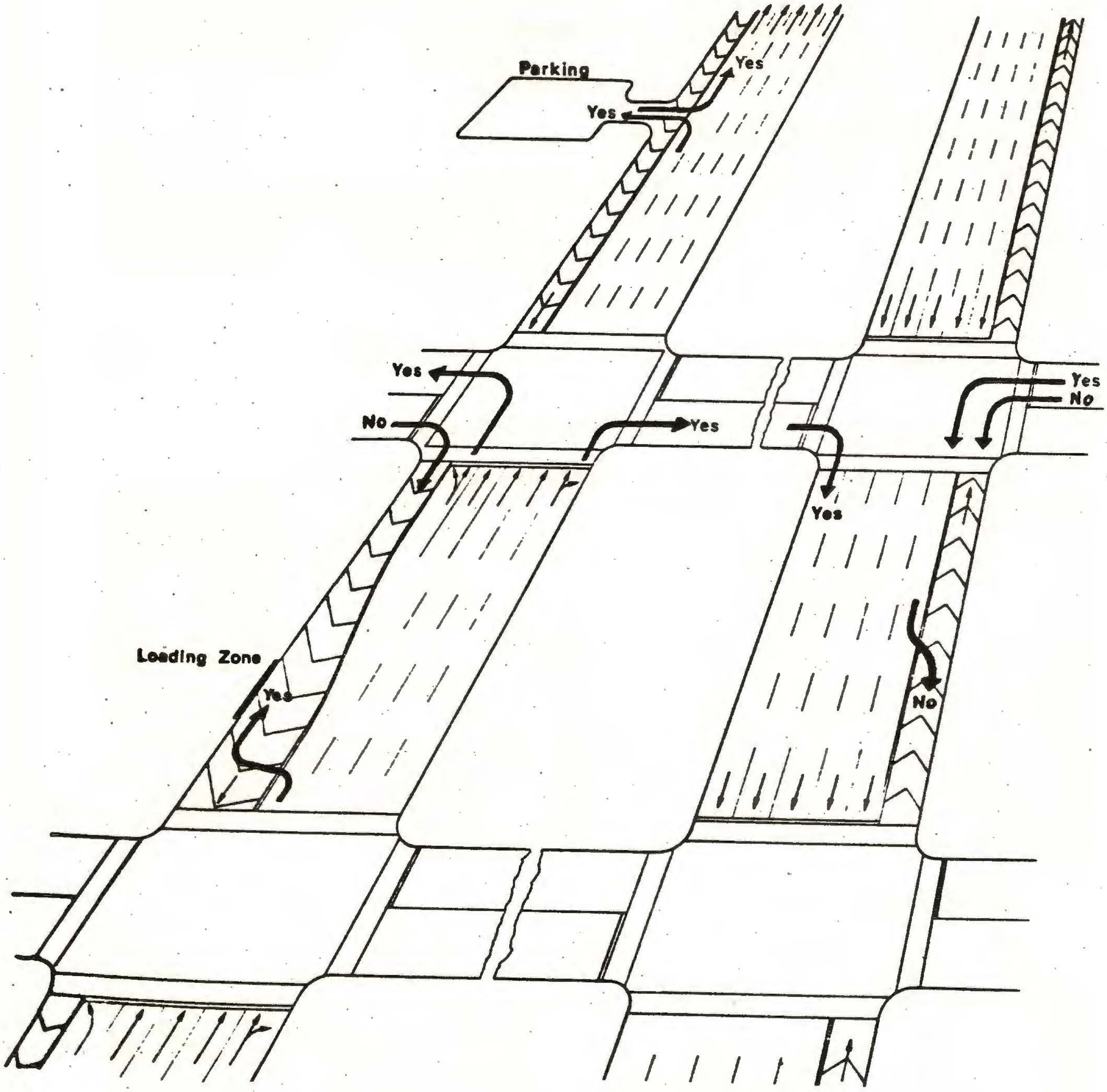


Figure V-1
CONCEPTUAL DIAGRAM OF CONTRA FLOW OPERATION

From Figure 15, Wilbur Smith Associates, Downtown Distribution Plan, San Bernardino Freeway Express Busway, March 1973.

bus they want along the block-length queue. This problem was largely solved in Los Angeles by segregating express and local stops on alternating blocks (the same system used on the Oregon Transit Mall described in that case study). However, where buses form a continuous line of movement, as they do in Minneapolis, this solution is not possible.

1.6 Insights And Observations

The four bus lane projects studied in this report were implemented to enhance express bus service between outlying suburbs and the central city business district. Their primary objective were to support high downtown employment and to shift commuting from automobiles to mass transit.

Removal of parking along affected arterials was common to all four bus lane projects.

1.6.1 Exclusive Lanes Versus Signalization

The Los Angeles traffic engineers had argued that new signalization could actually grant buses greater travel time savings than an exclusive, contra-flow bus lane. In Portland, the exclusive bus lane has saved buses very little time - time savings there were gained by having some buses run express. In view of the Portland lane's underutilization (three minute peak period headways) and the need for more lanes by the general traffic, it has been suggested that the Portland lane be dropped in favor of a bus priority signal system and express bus movement in mixed traffic. In Minneapolis the contra-flow bus lanes were installed with bus signal priority apparatus. Many exclusive bus lanes increase operational efficiency only for brief, peak hour periods, while signalization schemes - synchronization, computer operation, or priority can increase day-long operational efficiency for <u>all</u> traffic.

1.7 Project Planning

The bus lane projects were all tied into other city and regional plans. In Minneapolis there was sufficient planning participation by all the key downtown elements - the bus operator, the police, the city traffic engineers, business, labor, and the City Council. The original bus lane plan was modified several times. It was originally a plan only for bus movement, integrated with the establishment of a computerized signalization system. It developed into a comprehensive CBD plan to facilitate taxi and freight vehicle operations as well, with proper consideration to public utility underground work, pedestrian access, traffic flow, and a bus signal priority system. The Minneapolis project was entirely sound from a traffic engineering viewpoint and was developed by City traffic engineers. The nagging problem of automobile access to buildings along the contra-flow lanes was minimized. Freight access by commercial vehicles and direct passenger access by taxi or bus was provided.

In Portland the creation of the Barbur Boulevard median reversible bus lane was part of a much larger plan to improve transit service in Portland's Southwest Corridor and in the area as a whole. Prior to the establishment of the express bus lane, a transit station and park-and-ride lot had been constructed on Barbur Boulevard for suburbanites who would board buses using the lane. The bus lane was an effort to recreate the same sort of exclusive transit service that had existed in the old trolley car days for the same corridor.

In Los Angeles, most express buses using the lane come to the CBD on the San Bernardino Freeway Express Busway - a bus road built on an old trolley interurban right-of-way. Giving these buses an exclusive right-of-way to free them from downtown auto congestion was also an effort to recreate the trolley situation which had prevailed in Los Angeles earlier in the century. The local transit district could not get the authorization to construct any light or heavy rail facilities and looked upon the creation of CBD contra-flow lanes as the only practical means available to grant transit exclusive right-of-way and travel time advantages. However, its plans were not coordinated with the City's CBD signalization scheme, which was designed to speed with-flow traffic movement of all vehicles, including buses. Also the Los Angeles contra-flow lane, which does not permit commercial vehicles, involved greater interference with CBD commerce than did Minneapolis' lanes or New York's. As of 1981, serious consideration was being given in Los Angeles to recreate a light rail system on the San Bernardino Busway, with light rail cars operating underground in the CBD, perhaps obviating the contra-flow lane.

New York's short exclusive bus lane on Second Avenue was similarly part of a much larger plan to build up express bus service. The City considers express buses as the best way to provide outlying suburban areas rapid transit access to the CBD. The Second Avenue bus lane was treated as a shortcut for express buses leaving the Manhattan CBD via the 59th Street/ Queensboro Bridge.

The Second Avenue contra-flow lane came into existence partly because new subway or commuter rail construction to connect the CBD with the suburban neighborhoods of Queens was not progressing. There was growing congestion for outbound buses, due in part to the closing of the bridge's upper roadway in 1972, because it was deemed structurally too weak to accommodate buses.

In examining the political process of planning, hearings, meetings, and studies which led to the creation of the four bus lanes, a general conclusion is that including all interest groups in the planning and design of a project will result in a better product. The participation and feedback given by traffic engineers, bus operators, businesses, freight movers community leaders, and planners greatly reduces the potential negative impacts of implementation.

The Minneapolis and Portland bus lanes were most extensively planned projects. Rather than a single sponsor, these projects involved two or three major agencies each. In the case of Minneapolis, the lead agency was the City Department of Public Works but a great deal of coordination and joint planning was done with the transit operator (the Metropolitan Transit Commission). In the case of Portland, the lead agency was the Oregon Department of Transportation but the transit operator (Tri-Met), and the City of Portland were also involved in producing a mutually acceptable plan. In both cases several years were spent in plan development and many meetings and discussions preceeded implementation. In Minneapolis the implementation was in two phases: the first one a low capital experimental phase, and the second phase incorporated the refinements and adjustments made possible by experience with the first phase.

The Minneapolis and Portland bus lanes were designed to dovetail into many other projects, fitting into an overall plan with synergistic effects to enhance the CBD and to increase suburban transit access. The Minneapolis lane was meant to be a continuum of the I-35 express bus priority system and to supplement the CBD transit/pedestrian infrastructure of interior malls, pedestrian bridges and tunnels, the Nicollet (pedestrian/transit) Mall, and CBD traffic signal computerization. The Minneapolis Downtown Council (an important business and labor forum), and the City Council were important in analyzing the bus lane proposal. A similar process occurred in Portland, where the bus lane was a link between a suburban park-and-ride lot/transit station and a CBD Transit Mall.

In New York, the contra-flow lane operates for only two blocks, on the fringe of the CBD, and did not generate controversy. The development of the plan was handled internally by the City DOT, though a general CBD consultant study and project meetings influenced the final bus lane plan.

In Los Angeles, the bus lane project suffered from many shortcomings, largely because it was developed without the participation of the City Department of Traffic and the local business community. Eventual modification came long after implementation, and was the result of a more coordinated and participatory planning process.

2.0 Commuter Parking Program

In order to encourage express bus and carpool ridership to the cities of Hartford and New Haven, ConnDOT has built commuter parking lots at convenient locations throughout the State, usually near highway interchanges. The program has resulted in a network of 123 lots throughout the State, most on State-owned highway land. About a quarter of the 10,420 spaces now available were obtained through leasing agreements with shopping centers and churches for the use of their parking facilities.

The commuter lot/express bus system in Connecticut is well utilized (parking lots are over 75 percent occupied), reflecting the popularity of the program. Implementation was not controversial.

Attitudinal surveys indicate that the most important motive for carpooling is cost savings; consequently, the rising price of gasoline has probably been the largest factor in increasing carpooling, although employer support of ridesharing programs has also been helpful. The most important motives for express bus usage are cost savings, and the desire to avoid driving in congested traffic.

On the basis of data from Connecticut and previous studies, carpool and express bus parking facilities appear to be used almost exclusively for work trips. Park-and-ride lots tend to be most heavily used by commuters who travel between 10 and 15 miles.

The most efficient express bus routes tend to average 9.4 miles, one-way, and serve areas where densities are high enough to attract sufficient patronage, and where traffic congestion allows bus service to compete with the travel time by auto.

Only about 2.5 percent of all work trips use ConnDOT's park and ride or carpool lots.

Reductions in vehicle-miles traveled attributable to the carpool lot/express bus program in Connecticut are small (about 194,612 VMT/day) or 1.04 percent of work trip VMT.

The carpool lot/express bus program is a relatively expensive TSM strategy. During 1980, ConnDOT spent approximately $448,015 for the State share of lot expansion costs, $128,036 for lot leases and maintenance, $981,000 for express bus operating subsidies, and $232,136 for bus maintenance and equipment, for a total program cost of $1,789,187. Since an estimated 48,653,000 VMT are reduced yearly, the cost for each VMT reduced is about 3.67¢. While ConnDOT has received from the Federal government the bulk of the funds needed for lot expansion and for express bus subsidies, it is unlikely that this level of support will continue in the future.

ConnDOT has been able to reduce the cost of increasing lot capacity by using its Maintenance Office and the National Guard to build lots, and by leasing spaces from shopping centers and churches. However, there are limits to the degree of expansion that can be accomplished in this manner, and many of the most desirable sites on State land have already been developed. This implies that future lot expansion will be done increasingly by private contractors, at considerably higher cost. Leasing of lot space at shopping centers is the most feasible alternative for expansion at reasonable cost. These leased lots also generate considerable business for the shopping centers concerned.

Reverse commuter services, intended to improve access to suburban employment sites for city residents, have not done so mainly because these services are usually scheduled at inconvenient times, and because no distribution service is provided to the dispersed suburban employment locations.

3.0 Residential Parking Permit Programs (RPPPs)

The Cambridge, Massachusetts RPPP is one of the most comprehensive (citywide, 24 hour daily) and oldest (since 1973) in the United States.

The objectives of the RPPP studied in Cambridge, Massachusetts were:

a. to allow residents the use of curbside parking spaces for their automobiles near their homes,

b. to reduce curbside parking for the purpose of improving traffic flow and safety,

c. to encourage a modal shift of commuters away from single-occupancy automobiles, to either mass transit or car and van pools, and

d. to improve air quality by reducing auto use and auto parking in the business districts.

The City of Cambridge had secured powers from the Commonwealth of Massachusetts to establish a Department of Traffic and Parking and to promulgate and enforce residency regulations on parking. Administration and enforcement of the program (i.e., issuing tickets and towing) are the City's jurisdiction. However, the collection of fines is the responsibility of the State district court. About half of all fines are not collected, especially those imposed on vehicles with out-of-state registrations. The City is also prevented by state law from charging over $15 per violation, a limit set over twenty years ago. However, the Cambridge RPPP appears to have been fiscally self-supporting, raising enough revenues to offset costs despite these handicaps.

From resident feedback and general surveys of residential neighborhoods it is apparent that the RPPP has solved the problem of allowing residents use of curbside parking spaces in front of their homes. Curbside parking in general has been reduced by about 10,000 spaces in business districts.

While the number of parking spaces in Cambridge has been reduced by 10,000 spaces and non-residents have been virtually banned from most curbside parking, it is not clear where the thousands of out-of-town commuter and shopper cars went. Passenger counts in the 1970's do not reveal a transit ridership increase at Cambridge's four rapid transit stations. Also, traffic cordon counts taken in 1971 and 1981 provide inconclusive results. The RPPP does not seem to have caused a modal shift of commuters and shoppers to mass transit. Fifty-eight thousand non-resident commuters to Cambridge and an estimated 35,000 non-resident commuter cars were effected.

While the ability of RPPPs to change travel behavior is unclear, they clearly do work to ban non-resident vehicles if enforced. While the courts have upheld the constitutionality of RPPPs in general, the Massachusetts district court in Cambridge ruled that the Cambridge RPPP could not apply against Cambridge residents. So far no similar court challenges have been successfully made against other RPPPs. Rulings, similar to the one in Cambridge, that RPPPs cannot exclude residents of the same municipality and therefore cannot apply exclusively to residents of a particular neighborood, would undo much of the intent of many cities' RPPPs, which are intended to free neighborhoods from cars of other residents of the same city.

Four other major conclusions can be drawn about RPPS: 1) they would work much better in places where alternative off-street parking is available - not the case in Cambridge or by the Concord BART Station; 2) many classes of exemptions have to be granted - for customers and clients of home-based and small businesses in the residential neighborhoods, service and delivery vehicles, visitors, people with business in the area, the handicapped, etc. - and there must be flexibility in administering the program; 3) the programs can be profitable for municipal governments by collecting fines and selling resident permits; 4) some areas which have a large number of out-of-state motorists - a problem in college towns and in many cities near borders will have a problem enforcing the program because of the relative immunity out-of-state drivers have against local regulations in another state.

4.0. Transit System Retrenchment

Transit system retrenchment was studied in the Lehigh Valley metropolitan area (Allentown, Bethlehem, and Easton) in Pennsylvania, where the Lehigh and Northampton Transportation Authority (LANTA) in FY1977 eliminated two duplicative routes, cut service on others, and made some other route adjustments in order to cut 13.5 percent of its bus service miles. These cuts resulted in only a 2.2 percent ridership loss and a 12 percent increase in passengers carried per service hour. This action reduced the annual rate of cost increase from 7.8 percent to 1.3 percent.

These figures bear out the efficacy of the retrenchment program. Almost as many people were served at lower cost. This was accomplished by the judicious elimination of two routes which largely duplicated others, by cutting service frequencies to better reflect actual passenger demand on the least productive routes, and by making adjustments to make routes more direct or provide service closer to areas where demand was strongest. LANTA did not on the other hand, reduce or eliminate service to outlying areas where there is low demand, in order to maintain coverage.

The LANTA retrenchment program provides a good example of how to eliminate unproductive transit services and run a more efficient transit system.

5.0 Innovative Transit Subsidy Techniques: San Mateo, California Case Study

The Southern Pacific commuter rail line, is the last surviving commuter rail line in California. It is a diesel-operated 47-mile at-grade line with push-pull locomotives and bi-level coaches. There are two city terminals and twenty-four intermediate suburban stations (fifteen in San Mateo County), typically in town centers. The line, begun in 1864, traditionally formed the connecting "spine" of the Peninsula communities of the West Bay Corridor. Patronage is overwhelmingly San Francisco CBD-oriented. Seventy percent of the riders reach the stations by automobile.

The rail line, which also serves as a freight carrier, is in excellent condition and capable of high speed performance.

Southern Pacific had repeatedly petitioned the CPUC to abandon the service, citing financial losses, declining ridership, and alleged interference of commuter service with freight operations. After having a petition for abandonment denied by the CPUC in 1973 (which instead granted a fare increase), in May 1977 SP petitioned for a fare increase of 111 percent, claiming an operating loss of $6 million in the previous year.

However, SP had also refused to accept any subisidies, fearing loss of control over the service. While the PUC denied the 111 percent fare increase which it regarded as "tantamount to abandonment", the Commission did allow a 25 percent fare increase effective January 1978.

In July 19 , Sam Trans, the San Mateo County Transit District, had offered to purchase tickets in bulk from the Southern Pacific at CPUC-approved rates, and sell those tickets at a discount, to commuters. Bona fide residents of San Mateo County could register to join a "Sam Train Commuter Association" and receive the discount. Membership entitled commuters to free Sam Trans feeder bus service and to purchase weekly, monthly or 20-trip tickets at a 30 percent discount at Southern Pacific ticket offices. Single ride tickets were not discounted.

The Fare Stabilization Program was a user-side subsidy, not a subsidy of the operation, which Southern Pacific had refused. It was entirely paid for out of the County's share of the Transit Development Act (.25 percent sales tax) funds. State legislative enabling legislation authorized the program only until January 1, 1980, though in actuality this deadline was extended seven months to allow the State and Southern Pacific to come to terms over the present purchase-of- service agreement which is now in effect.

Between January 1978 and July 1980, ridership on the San Francisco - San Jose commuter service increased by 42 percent. During this period, there were no changes in equipment used, service quality, or frequency. Ridership increased 12 percent during the first eight months of the program. This strong upward ridership trend is in marked contrast to ridership declines during the 1973-1974 gasoline shortages and price increases. Since the program ended (July 1980), ridership has declined less than 5 percent. Secondary impacts on traffic congestion, energy consumption, and vehicle emissions were negligible.

The Fare Stabilization Program, like most subsidy arrangements, did succeed in preserving the commuter rail service and its ridership.

6.0 Bus Signal Priority Systems

For two years, Concord, California (a low density satellite city of 100,000) operated a bus signal priority system along the Willow Pass Corridor, a 3.5-mile corridor between a regional shopping center and the Concord BART Station. The system was implemented to reduce the bus time lost to traffic congestion. It was financed, in part, with a grant from the

Metropolitan Transportation Commission using state and regional funds.

The Concord bus priority system consisted of fixed beam detectors and control box phase selectors installed at each traffic signal. This signal priority apparatus could be activated by buses equipped with light beam emmitters mounted on their roofs. The emmitter's signal would activate the priority mechanism as the bus approached. However, some serious problems developed. Because of the small number and vulnerabilty of the emitter-equipped buses, the transit operator was unable to dispatch enough emitter-equipped buses. Also the City, which has been growing rapidly in population and in traffic, had to do major construction work at some intersections located on the bus priority routes. This caused the priority system to be temporarily turned off, and the signals and their priority apparatus had to be modified. In the spring of 1980 the City installed a new, citywide, computer-run traffic signal system. This new system permitted only bus preemption (automatic and immediate green time for approaching buses) as opposed to the bus priority system (safer speeding or slowing of the normal signal sequence rather than immediate interruption). These events led to the termination of the bus signal priority system. There are now plans to reactivate it, pending modification to the citywide traffic signal system.

When the system was operative, it improved bus speed performance and reduced bus delay. Also, valuable lessons were learned from this experimental program.

The following conclusions can be drawn from the Concord experience:

1. The bus priority system does reduce delay for buses at intersections.

2. The effectiveness of the system depends upon the ability of the operator to schedule emitter-equipped buses onto priority system routes.

3. Mechanical malfunctions can cause frequent breakdowns of equipment and require a good deal of maintenance.

4. If bus roof emitters are used, such emitter-equipped buses should not be scheduled along routes which have overhead clearance problems (bridge overpasses, etc.).

5. The system is subject to disruption when construction at prioritized intersections occurs.

6. Different signal systems may not be compatible with each other (as in the case of the Opticom system and Multisonics).

7. Bus signal priority systems increase bus service reliability.

Bus priority, under which signal cycles are merely slowed or speeded but not interrupted, appears quite practical and safe. A priority system can operate more efficiently than a bus preemption system with higher bus volumes and with a low-to-moderate degree of crossflow.

Bus priority systems have application on roads in suburban or low density urban areas. To avoid costly retro-fitting these systems ought to come factory-installed with phase selector boxes in the traffic signal control cabinets, and with emitters installed in buses as to avoid clearance problems.

It is hoped that further technical development and mass production will bring down the costs of bus priority systems (about $10,000 per signal in the Concord example). This would make them a better alternative to exclusive bus lanes where bus volumes are low or traffic conditions are congested. It appears that, in many cases, the cost-efficiency of bus signal priority systems is superior to exclusive bus lanes.

7.0 Use of Part-Time Bus Operators

On the basis of Seattle Metro's experience, modest cost savings (on the order of 4 to 10 percent in operating costs and 2 to 5 percent in total service costs) can be achieved through the use of part-time labor. Cost savings available by employment of part-time drivers will be determined by:

1. The system service profile (i.e., the percentage of service during peak hours, or the peak/base ratio).

2. Union work rules applicable to full-time drivers (maximum spread time and spread penalty time). As the peak/base ratio increases and maximum spread time and spread penalty time decreases, the percentage of trippers that can be paired into runs will decrease. These unpairable trippers can be assigned to part-time drivers, who are generally paid less than full-time drivers and are not subject to the same work rules as full-time drivers (notably, tripper operators are not guaranteed 8 hours pay, take longer to move up the pay scale, and receive fewer fringe benefits). Most cost savings from part-time drivers result from reduced 8-hour guarantee pay for full-time drivers; fringe benefit savings are relatively minor. Cost savings are not apparent, but a measure of what comparable service would cost <u>without</u> part-time labor.

3. The number of pieces of work that can be assigned as unpaired trippers, and the number of part-time drivers who may be used to cover them: this will depend on negotiations with transit unions. Seattle Metro has achieved relatively large cost reductions because it has been able to increase the proportion of trippers to runs substantially (from 666 runs, 290 trippers in 1977 to 735 runs, 822 trippers in 1980) while concurrently increasing its peak to base ratio from 2.6 to 4.1. To handle the increase in trippers, Metro now has 812 tripper operators, roughly 35 percent of total operators. This increase in unpairable trippers, as well as the right to use enough part-time drivers to cover them, is essential to maximize savings from part-time labor. Metro's increased utilization of part-time drivers has helped to increase its efficiency in providing service; the ratio of platform hours to pay hours has increased from 69 percent (1977) to 80 percent (1981).

4. Cost savings elsewhere are likely to be less than at Metro, which has been able to increase tripper work assignments substantially and hire the part-time drivers to cover them. The major factor in whether a successful part-time driver program can be implemented is the bargaining strength of the unions concerned. To the extent that work rules dictate driver assignments and limit the use of part-time drivers, savings will be reduced.

5. Contrary to assertions by critics, part-time drivers have been very dependable, having lower accident and absenteeism rates than regular drivers. Although part-time drivers have increased training costs somewhat, there is evidence that they have reduced overall absenteeism significantly.

6. The use of part-time drivers has increased friction between labor and management. Full-time drivers feel that part-time labor has disrupted their seniority system and reduced their share of the work created by system expansion. Many union members feel that part-time workers are responsible for a deterioration in working conditions, asserting that their choice of work assignments has been reduced. To the extent that these issues remain unresolved, they will continue to arise in contract talks and encourage unions to demand contractual protection and/or extra compensation.

7. Although it is quite possible that initial labor cost reductions attributable to part-time labor may be offset by compensatory wage concessions made to

full-time workers, this is not inevitable. Management and labor must analyze the potential costs and benefits of part-time labor contracts carefully.

8. In short, the use of part-time labor has great potential for reducing operating costs at most districts, although it has not prevented service costs from rising and will do little to reduce deficits. Nevertheless, it is an option worth investigating.

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