U.S. Department of Transportation

The First Four Years of Metrorail: Travel Changes

A Metrorail Before-and-After Study Report

September 1981

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Interim Report
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FOREWORD

The METRO Rail Rapid Transit System represents a major public investment as well as a major change in the Washington, D. C. urban transportation system. Therefore, in 1976, the Urban Mass Transportation Administration requested the Metropolitan Washington Council of Governments to initiate a long-term study of the impacts of METRO Rail. Since that time WashCOG has designed the study, collected and analyzed data on conditions before METRO Rail and analyzed information after the opening of several METRO Rail phases.

This report represents an important interim product from the METRO Rail Impact Study. It describes the changes in the transportation system and in travel behavior which can be attributed to the opening and operation of 30 miles of the eventual 101 mile system. This includes the initial downtown segment, the Silver Spring line, the National Airport to Stadium-Armory (Blue) line and the New Carrollton extension. We believe this report represents a useful summary of the travel impacts in Washington so far. It should be of interest to those interested in the impacts of rail transit and of other major transportation investments.

This report represents one of a continuing series. Future reports will cover the land use, economic and environmental impacts of METRO Rail so far, as well as travel impacts of future line openings. These reports will be distributed as they become available.

Additional copies of this report are available from the National Technical Information Service, Springfield, Virginia 22161. Please refer to UMTA-DC-09-7004-82-2 in your request.

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SUMMARY

This report describes travel changes resulting from the first four years of operation of Metropolitan Washington's Metrorail transit system--from the initial opening of the downtown subway in 1976 through the first full year of operations of the first complete route to New Carrollton, Maryland, which opened in November 1978.

This is one in a series of reports to be produced by the Metropolitan Washington Council of Governments' Metrorail Before-and-After program. The program has been supported since 1976 by grants from the Urban Mass Transportation Administration. The program was established to measure the new rail system's effects on the Washington region--both direct travel changes and indirect effects such as land development.

By 1979, although only one-third of the planned 101-mile regional system was in operation, Metrorail was already carrying almost one-half of all weekday transit trips and had already become an important fixture in the regional transportation network. Perhaps even more significantly, the early success of Metro made it a highly publicized element in real estate advertising for nearby properties, in justification for development proposals, and even in political campaigns.

It is appropriate to step back and analyze the effects of Metrorail and to develop information which may allow improvements in future Metro operations and which may provide useful experiences to other cities. This study, conducted by the Metropolitan Washington Council of Governments, describes successive evaluations before and after each segment of the rail system began operating between 1976 and 1979.

Characteristics of Metrorail Travel

The most celebrated achievement of Metrorail during its first four years was the high level of ridership. Ridership exceeded expectations on the initial downtown segment and grew continuously as the system gradually expanded.

New riders were added with each new segment of rail, and there was also growth in ridership on the segments which had already opened. Ridership was remarkably close to projections prepared in the system's planning period.

Passengers used Metrorail to travel to and from work--two of every three trips--as is typical of most large transit operations. However, non-work trips outnumbered work trips on the initial downtown segment during the first four years and dominated travel entirely within the downtown area under study.

As rail transit reached suburban locations, it attracted new riders who lived along rail corridors and commuted to the central employment area. Individual stations served jobs or homes, depending on the type of area around the station.

By the Spring of 1979, all stations in downtown Washington served mostly workers in nearby buildings, while other Washington and suburban stations mostly served residents from nearby communities or people traveling by auto or bus to more distant homes.

By 1979, nine of every 10 trips on Metrorail were to or from downtown destinations and very few riders were "reverse commuters," or people who traveled to suburban jobs on Metrorail. The 31 stations in operation in 1979 were generally found to have strong differences in the hours of predominant use, which reflected differences in the purposes of travel served.

- Sixteen stations had most arrivals in the morning two-hour rush period; most of their daily riders were traveling between their residences and Metrorail;

- Eight stations had most arrivals in the evening rush period; most of their riders were traveling to or from nearby jobs; and

- Nine stations had a mix of rush and off-rush period arrivals; except for National Airport, these stations primarily served workers, and also carried higher percentages of either residents, shoppers or visitors than did evening-rush stations.

Forty-three percent of all Metrorail passengers in the morning-rush period reached their stations by bus, and the remainder were divided almost equally among those who walked to stations and those who arrived by automobile.

Virtually all morning-rush rail passengers walked from Metro to their destinations, since most destinations were to jobs in downtown Washington. This distribution may change with the extension of Metro to additional suburban employment sites.

Changes in Bus Ridership and the Bus System

The dramatic growth of Metrorail ridership during the early years of rail operations was accompanied by a reduction in the number of regional transit riders using buses, since many transit riders were diverted from bus to rail. There were several significant stages in this pattern:

- The largest drop in bus-only ridership occurred following the opening of the second downtown rail segment, the Blue Line, when many bus routes were terminated at rail stations, rather than continuing downtown. When bus-only trips were combined with the large number of Metrorail trips at that time, the combined total was essentially unchanged compared to the daily transit ridership before Metro.

- In the following year, 1978, the number of bus-only trips continued to decline with the opening of the Red Line extension to Silver Spring, and with more changes to the bus system. However, the increase in rail trips exceeded the decline in bus trips, and for the first time caused an increase in combined transit ridership. A year later, after the opening of the New Carrollton route, there were increases in both rail ridership and bus ridership.

- The combined effect of Metrorail on the bus system was that between 1975, prior to the opening of Metro, and 1979, average bus-only trips declined by 43,000 per day, an 11 percent decline. During the same period, rail ridership grew to 266,000 trips per day. The net gain of 223,000 trips represented a 56 percent increase in regional transit ridership in four years.

During the same period when trips were being shifted from bus to Metrorail, there were also major revisions to the regional bus system. Although many of these changes were made to provide feeder service to Metrorail and to eliminate "duplicate" service, the opening of Metrorail was used as an opportunity to make other changes which had been desired for years. The net effect of all of these changes was that by Fiscal Year 1979, there had been about an eight percent reduction in the number of regional bus miles provided.

Metrorail service provided a substantial one-third increase in transit capacity entering central Washington by 1979. This area, one of the few in the region where bus ridership had approached capacity before Metro, saw the most dramatic change in bus ridership. Between the Springs of 1977 and 1979, following the penetration of central Washington by Metro lines to Virginia, Silver Spring, and New Carrollton:

- Daily Metrorail trips entering this area reached 93,000;

- Daily bus trips entering this area dropped by 36,000, a 23 percent decline;

- Combined bus and rail ridership entering central Washington increased from 160,000 to 213,000 daily trips, a growth of one-third;

- Metrorail carried 44 percent of daily transit trips entering the most congested part of the region; and

- The number of buses entering the core was reduced by 1,200 per day, a 22 percent decline.

In addition to a substantial reduction in regional bus ridership, there were also significant shifts in the orientation of bus passengers. The most substantial shift occurred in Northern Virginia, where there was a substantial decline in trips to or from the District of Columbia, but a comparable increase in trips within Northern Virginia, many of them presumably to Virginia rail stations.

Analysis of all commuting trips to central Washington and adjacent employment centers in Arlington between the Spring of 1977 and the Fall of 1978 showed:

- Relative use of transit for commuting increased from 38 percent to 43 percent;

- Relatively speaking, higher-income people who previously did not use buses were more likely to be drawn to transit after Metrorail opened than were lower-income people; and

- The largest increases in transit use occurred in the times immediately before and after the traditional "rush hours." These are the times when rail service is almost as frequent as during rush hour, while bus service is generally far less frequent than during the rush hour.

Changes in Auto Travel

It is somewhat more difficult to compare auto travel changes with transit travel changes because comprehensive regional data are not as readily available on auto trips. However, special inventories of highway travel entering central Washington make it possible to measure changes in auto travel consistent with changes calculated for transit travel between 1977 and 1979;

- There was a decline of 31,000 automobiles entering central Washington on an average weekday, an eight percent reduction;

- During the hours of heaviest congestion in the morning, there was a decline of over 6,000 autos, representing a four percent reduction; and

- The percentage of workers commuting by auto to the central areas of Washington and Arlington declined from 57 percent to 51 percent. Auto driver trips declined from 40 percent to 36 percent among these same commuters.

The Effects of Metrorail on a Suburban Employment Center

In order to complement COG's major travel studies which focused initially on the effects of Metro on the central area, a special case study of the Silver Spring station was undertaken. Rail service was extended north as far as Silver Spring in February 1978, and will eventually be extended three miles further. Because it is the largest suburban employment center, particular interest was placed on the short-term travel effects of this interim terminal station, especially on commuting to Silver Spring, as well as the attitudes of local residents and businesses.

The early findings showed:

- Metrorail commuting to Silver Spring jobs was a relatively small share of total transit commuting, and was mostly reverse commuting from the District of Columbia;

- Most Silver Spring workers lived further out along the future rail line or in other parts of Montgomery County;

- There was a greater increase in transit commuting to Silver Spring by workers using the expanded Ride-on bus service designed to bring people to the rail station. These buses also serve the adjacent Silver Spring business district;

- Forty percent of all Silver Spring employees made midday trips by Metrorail. Three of every four of these trips had previously been made by auto;

- No significant reductions in auto travel between Silver Spring and the District of Columbia were measured, even though many Metro riders using that station reported they had previously driven to the District of Columbia. Any possible reduction in auto use by these riders may have been counteracted by diversion of other drivers to this corridor;

- One negative effect of Metro on Silver Spring was an increased demand for 1,500 daily parking spaces by Metro users; and

- Extensive bus service to the Silver Spring station made it possible for 60 percent of all rail users to reach the station by bus during the peak hours of travel, one of the highest shares for any Metro station.

The magnitude of early travel changes indicates that there may be future impacts on land development. The effects of Metrorail on land developments are now being studied.

Further Steps

This report documents the key changes measured in travel behavior and transportation during the first four years of Metrorail operations. It summarizes most of the travel studies conducted under the Metrorail Before and After Program since the initial grant in 1976. The next major report planned is a summary of the land use and economic changes which occurred prior to and following the initial years of Metrorail service.

In addition, current travel data and recent land use changes will also be disseminated through annual reports. Other more specific topics of technical interest will be reported in technical reports.

PREFACE

This report is the first compilation of the travel findings of the Metrorail Before and After Program from the original opening of the Metrorail system in 1976 through the first full year of operation of Phase III during 1979. As such, it is an "event" report which documents some of the early findings in a multi-year program sponsored by the U.S. Department of Transportation.

The program is being conducted by the Metropolitan Washington Council of Governments. Many individuals and organizations have provided invaluable advice, assistance and information to this program. The most critical of these has been the Washington Metropolitan Area Transit Authority, which is responsible for the planning, design, construction, and operation of the rail system, as well as the regional bus system. Among the WMATA staff who have contributed to this study were Mr. Mark Akins, who has served as the official transit authority liaison since the beginning of the program, Mr. Robert Pickett and Mr. Warren Shindle.

The study design for the overall program was developed with the assistance of an Advisory Panel of professionals in transportation analysis, many of whom also participated in the BART Impact Program analysis of the San Francisco rail system. In addition, the advice of the BART Impact Program staff and consultants helped relate the key findings of that study to the Washington region and develop productive avenues of research. Special assistance was provided by: Dr. Gordon Shunk and Mr. Joel Markowitz, BART Impact Program, Metropolitan Transportation Commission, Berkeley, California; Dr. Richard Worrall and Dr. Ray Ellis, Peat, Marwick, Mitchell, Washington, D.C.

Since 1979, the program has received guidance from the Metrorail Before and After Study Subcommittee of the Technical Committee of the National Capital Region Transportation Planning Board. This committee has been chaired during the period by Mr. Frank Derro, Maryland-National Capital Park and Planning Commission, Prince George's County, and by Dr. Robert Winick, Maryland-National Capital Park and Planning Commission, Montgomery County.

The Urban Mass Transportation Administration's Program Manager, Mr. Richard Steinmann, as well as his predecessor, Mr. James McQueen, now with the Federal Rail Administration, provided valuable direction to the study.

As noted in the report, extensive use has been made of the Silver Spring Metrorail Before and After Study, and two of the principals: Dr. Robert Winick, Maryland-National Capital Park and Planning Commission, Montgomery County, and Mr. Stephen Smith, JHK and Associates, Alexandria, Virginia.

Consultant assistance was provided by Barton-Aschman and Associates, especially Mr. William Allen who provided many of the tabulations of COG's central area commuting studies.

The many contributions of all of these individuals are gratefully acknowledged. However, responsibility for the contents of the report and any errors therein rests with the Metropolitan Washington Council of Governments. Among COG staff who contributed to the study are George Wickstrom, who was the study director, Robert Dunphy, the project manager and co-author, and Robert Griffiths, co-author.

Editorial supervision was provided by Jay Lankford and final typing by Stacy Moss. Dolores Brandow prepared the graphics and Mark Pfoutz supervised report publication.

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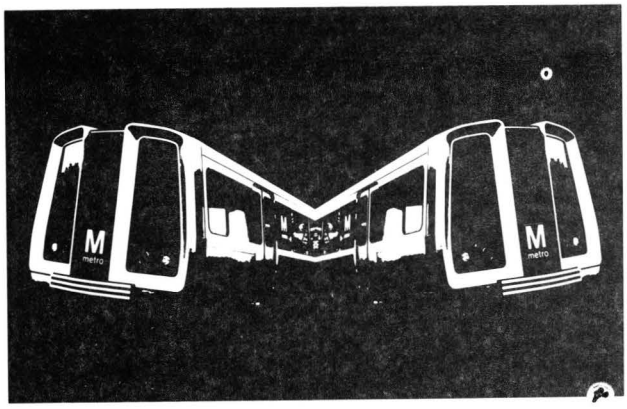

CHAPTER 1

INTRODUCTION

CHAPTER I

INTRODUCTION

BACKGROUND:

THE METRORAIL SYSTEM

A map of the planned 101-mile, 86-station Metrorail System is shown in Figure 1-1. This system is being opened in a series of phases stretching from 1976 to 1990. The sequence of actual and planned openings of new segments of the rail system is as follows:

SEQUENCE OF METRORAIL OPENINGS

LINE	SEGMENT (by new terminal stations)	DATE
Red	Farragut North to Rhode Island	March 29, 1976
	Gallery Place	December 15, 1976
	Dupont Circle	January 17, 1977
Blue	National Airport to Stadium-Armory	July 1, 1977
Red	To Silver Spring	February 6, 1978
Orange	Stadium-Armory to New Carrollton	November 20, 1978
Orange	Rosslyn to Ballston	December 1, 1979
Blue	To Addison Road	November 22, 1980
Red	To Van Ness-UDC	December, 1981
Blue	To Huntington	Early 1982
Yellow	Gallery Place to National Airport via Potomac River Metro Bridge	Late 1982
Red	To Shady Grove	Late 1983
Yellow	King Street to Van Dorn Street	Late 1984
Orange	To Vienna	Mid 1985
Green	Y-turnout from Yellow Line to Anacostia	Mid 1985

LINE	SEGMENT (by new terminal stations)	DATE
Yellow	To Franconia-Springfield	Mid 1985
Green	To Rosecroft	Late 1986
Red	To Glenmont	Late 1986
Yellow/Green	Gallery Place to Prince George's Plaza	Mid 1989
Yellow/Green	To Greenbelt	Early 1990

Currently, three lines of the planned system are in operation. These are the Red Line from Dupont Circle in downtown Washington to Silver Spring in Montgomery County, Maryland, the Blue Line from National Airport in Northern Virginia to Addison Road in Prince George's County, Maryland and the Orange Line from Ballston in Northern Virginia to New Carrollton in Prince George's County, Maryland.

The rail system when first opened operated only on weekdays between the hours of 6 a.m. and 8 p.m. On September 25, 1978 weekday service was extended from 8 p.m. to Midnight and weekend service was begun. Today, hours are 6 a.m. to Midnight Monday to Friday, 8 a.m. to Midnight Saturday, and 10 a.m. to 6 p.m. on Sunday. Train headways[1] are 3 to 6 minutes in rush hours and 6 to 12 minutes at all other times.

SCOPE OF ANALYSIS

This report focuses only on the first three operating phases of the Metrorail System. These phases are as follows: Phase I - the Red Line from Rhode Island Avenue to Dupont Circle, Phase II - the Blue Line from National Airport to Stadium-Armory, Phase IIA - the extension of the Red Line from Rhode Island Avenue to Silver Spring and Phase III - the Orange Line from Stadium-Armory to New Carrollton.

A chronology of Metrorail operations for these phases is in Table 1-1. Additional aspects of the Metrorail Before and After Program are in the description of the strategic plan, below.

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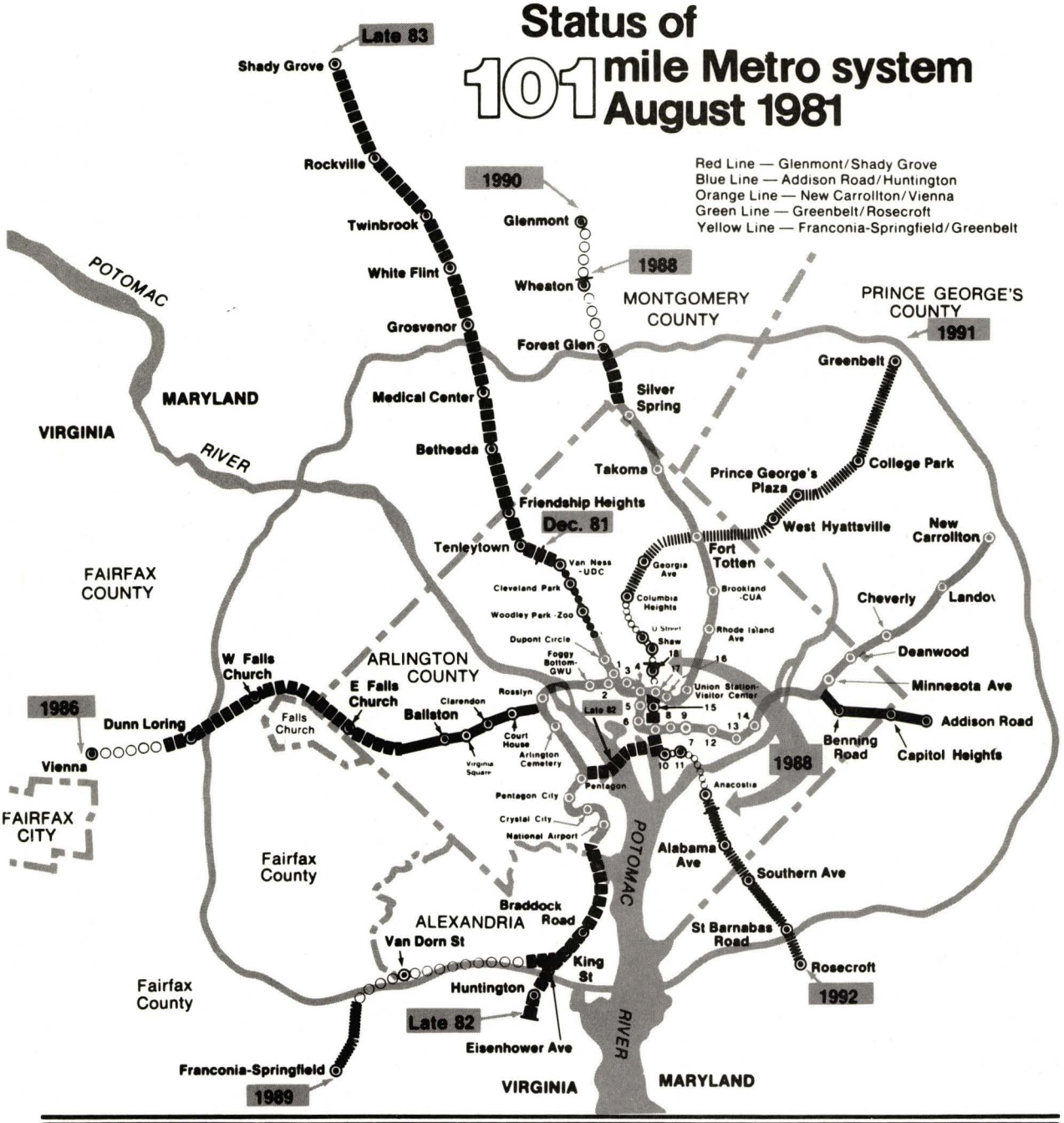
[1]A train headway is the length of time between trains, a measure of the frequency of service.

Figure 1.1
ADOPTED 101-MILE METRORAIL SYSTEM



LEGEND

Study Phases (See Figure 1.2)

- Operating Lines 37.15 miles 41 stations
- Next opening Late 81 2.06 miles 3 stations
- Under Construction or Substantially Complete 30.97 miles 20 stations
- Under Final Design 13.21 miles 10 stations
- Remainder of System 17.45 miles 12 stations
- **Late 82** Projected start of operations for this segment based on approved schedule. Applies to all stations inbound from this point

Total mileage—100.84

Total stations—86

1. Farragut North
2. Farragut West
3. McPherson Square
4. Metro Center
5. Federal Triangle
6. Smithsonian
7. L'Enfant Plaza
8. Federal Center SW
9. Capitol South
10. Waterfront
11. Navy Yard
12. Eastern Market
13. Potomac Ave
14. Stadium-Armory
15. Archives
16. Judiciary Square
17. Gallery Place
18. Mt Vernon Sq-UDC

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TABLE 1-1

CHRONOLOGY OF METRORAIL OPERATIONS

PHASE	MILEAGE	STATIONS	OPENING DATE
Phase I	4.6 mi.	5-6 Stations	March 26, 1976
Phase IA	5.7 mi.	7 Stations	January 17, 1977
Phase II	17.6 mi.	24 Stations	July 1, 1977
Phase IIA	23.3 mi.	28 Stations	February 6, 1978
Phase III	30.8 mi.	33 Stations	November 20, 1978

March 26, 1976	Phase I opens 4.6 miles and 5 stations
December 15, 1976	Gallery Place station opens
January 17, 1977	Dupont Circle station opens
July 1, 1977	Phase II opens 11.9 miles, and 17 stations
August 1, 1977	Phase II - Partial bus turnbacks (all garages except Alexandria and Bladensburg)
September 4, 1977	Phase II - Complete bus turnbacks (Alexandria and Bladensburg garages)
February 6, 1978	Phase IIA opens 5.7 miles and 4 stations
February 21, 1978	Phase IIA bus turnbacks
September 25, 1978	Rail service extended from 8 p.m. to midnight on weekdays
September 30, 1978	Saturday rail service initiated from 8 a.m. to midnight
November 20, 1978	Phase III opens 7.5 miles and 5 stations
December 4, 1978	Phase III bus turnbacks

STUDY PURPOSE

Development of the Metrorail system in the Washington metropolitan area represents the single most costly civil construction project in United States history, and only the second rapid transit system to be built in this country since the Depression. It is currently projected to cost a total of $8.2 billion. Because of the magnitude of such an expenditure to build a relatively short system, this study was designed to appraise the effects of such a major transportation investment.

In many ways, construction of the Metrorail system represents a major experiment in whether or not building a rapid rail system in a region which had experienced most of its growth in the automobile era would have effects similar to those experienced in older cities such as New York, Boston, and Philadelphia where growth followed the rail systems.

The Metropolitan Washington Council of Governments (COG) initiated the Metrorail Before and After Program in order to provide a formal record of the effects of Washington's rail system for local planners, Federal and State transportation policy makers, and the transportation profession at large. Federal officials could find such an analysis useful in dealing with other cities, and local planners could learn much to help deal with future stages of Metrorail. A similar study of the Bay Area Rapid Transit (BART) System in San Francisco was conducted, and a concurrent study of the Metropolitan Atlanta Rapid Transit Authority (MARTA) System is now underway. The Metrorail Before and After Program began with an initial planning grant from the Urban Mass Transportation Administration in 1976 for a design of a multi-year program to observe and document the influence of Metrorail on the National Capital Region. This report summarizes the findings of that study on travel impacts during the first three and one-half years of rail operations.

STUDY DESIGN

An advisory panel of 14 experts was assembled from throughout the country to assist in designing a program. Approximately half of these individuals were from the Washington metropolitan area, and others had participated in the BART Impact Program. The committee reviewed background materials and working papers, and guided staff in the study design. The objectives established for the program are to:

1. Investigate and document the effects of Metrorail in order to increase the general knowledge of rail transit impacts and thereby assist planners and the Federal Government in the planning of other rail systems; and

2. Provide information to assist in the future operations of Metrorail.

The study design advisory panel addressed four issues related to the underlying theories about the effects of rail transit and how such effects could be studied with empirical data rather than in a theoretical model. The issues are:

ISSUE 1: Timing of Impacts

Most theoretical models of travel and development produce forecasts for a particular end state, yet provide little insight into the natural growth period required to reach these end states. Although major transportation systems may be designed for such an end state or forecast year, portions of the system are commonly opened for service far in advance of such a date. This means that there will be a set of initial system impacts which can be observed immediately upon its opening, followed by more gradual changes as people learn about the system, and future growth due to migration of people and jobs and new development within the service area. It has been further suggested that some effects may take place even before the system is opened. For example, some people may move or change jobs before Metro service commences in order to take advantage of future rail service, and developers may acquire property even before construction begins.

A further complicating factor is that the Washington Metrorail system is opening in phases stretching over a period of more than 10 years. The practical limitations of finances and organization dictated that an initial 5-6 year study be conducted and be followed by limited data monitoring conducted as part of the normal transportation planning process. It was felt that a final analysis could be conducted, if necessary, following the completion of the entire system, or at least the most significant parts of it.

ISSUE 2: Incremental Implementation

The problems introduced into the research approach by the opening of Metro in stages can also serve as a major opportunity. It was felt by participants in the study design that a much greater understanding of the effects of a rail system could be obtained by separate analyses of changes associated with the opening of each phase. Not only is it possible that different segments of the full Metrorail system may have different effects on travel, but they may also influence urban activities in differing ways.

ISSUE 3: Causality

The central issue in analyzing changes associated with Metrorail service is determining which changes were "caused" by Metrorail. The two means of establishing causality are by asking those affected and by using statistical methods. The most direct of these is simply to interview travelers, developers, or employers, and ask about changes caused by Metro. This approach has provided excellent information, especially on short-term travel effects. For example, new rail commuters could report their prior means of commuting, as well as whether they were able to reduce the number of cars owned because of Metro. The longer the traveler has been using Metro, or the less common the type of trip, the more difficult such retrospective reporting on Metro-related effects will be, because of the confounding effects of other variables. In addition, persons interviewed may be subject to lapses in memory, or unable to sort out a single cause such as Metro from a complex set of factors, or possibly even misrepresent facts.

An alternative to interviews is the use of statistical methods. Not subject to some of the reporting errors which occur in attitudinal data, these techniques use objective data and test for relationships using accepted mathematical techniques. However, their principal limitation is that correlation between an independent or "causal" variable and a dependent, or "effect" variable does not prove a clear causal link. It is possible that both variables are correlated with another unspecified variable which is the true cause. The difficulty of determining causality suggests that maximum advantage be taken of both the direct survey and the statistical methods.

There are two common research models used to determine the effects of the Metrorail service in causing changes in travel and land development. The first is the "before and after" model, and the second is the "control area" model. The "before and after" model assumption is that it is possible to take measurements prior to and after the initiation of a new transportation improvement such as Metro, compare the two measurements, and attribute the difference to the system. The staged opening of the Metro system makes it difficult to apply this model in the usual approach. For example, it is possible that Metro could cause an initial reduction in highway traffic volumes along a route, but that normal traffic growth could eventually increase traffic volumes even beyond their pre-Metro levels. One method of handling such a time-dependent problem is to reduce the duration between the before and the after periods to such a small increment that other effects would be minimized. Use of the "before and after" model in the incremental approach described above serves this purpose. One problem with the "before and after" model is that over a short time span, there may be other forces at work besides the opening of

Metro service. To compensate for this, one method used in other studies is the control area model. This model is more appropriate for analyzing land use changes. It attempts to identify two areas which are alike in every way except that one has Metrorail service. This technique is limited by the fact that it is virtually impossible to find areas which are alike in every way other than the availability of Metrorail service. Moreover, it is also possible that they could be influenced by factors other than Metrorail. Even so, a modification of the control areas approach can be used to interpret growth patterns by comparing growth around certain Metro stations with growth patterns in the remainder of the region.

A final note on the causality issue is that some indirect impacts are difficult to measure directly. This includes such travel-derived impacts as localized air quality and fuel consumption. Causal models already exist which convert travel units into such secondary impacts. Therefore, travel changes were measured directly, and secondary travel impacts could then be derived from previously established relationships.

ISSUE 4: The Null Alternative

One technique which has the potential to deal with the complexities of measuring travel impacts in a growing community is the "with or without" model. This model's assumption is that an urban region is a system undergoing many changes besides new transportation. The model measures the observable conditions after the construction of a certain improvement and compares them to what might have happened without the improvement, or to the "most likely" alternative, which would have been a bus system. Such an approach was originally included in the study design, but was later eliminated after considerable concern was expressed over practical difficulties of such an analysis. It was felt that projecting alternative futures was so speculative that the inherent uncertainty could introduce much greater differences than the actual differences due to Metro. Similar difficulties had been experienced in the BART Impact Study, and with the approval of UMTA this approach was dropped.

In summary, the research approach taken was to study the changes between each operating increment of Metrorail, thereby minimizing the complicating effects of longer-range travel behavior changes. The travel changes were intended to be compared to the travel behavior theories. If the travel changes were validated by the theories, then a good case could be made that areas experiencing major travel performance improvements could also experience land development changes. Land use changes observed around stations could then be compared to changes in areas without Metro stations as a form of the "control areas model."

Three general areas of investigation were recommended:

1. Travel and Transportation Impacts: A study of the direct effects of the rail improvements on rail use, a reconnaissance of potential impacts on prior transit riders continuing to use the bus, and a review of possible effects on auto travel.

2. Land Use and Activity Impacts: A compilation of the changes in planning and zoning, housing, and jobs near existing and future Metro stations, as well as comparative analyses of areas not served by Metrorail. This program area also includes study of such economic activities as retail sales.

3. Policy Analysis: Recognizing the need for an interdisciplinary area of study, staff established a specific program area called policy analysis in order to interpret some of the findings of the two major data collection activities identified above, and to relate them to significant issues and policies at the local, regional and national levels.

These broad program areas were further detailed into specific tasks for the first two years. A more general task description for the succeeding two years was also defined. These tasks were then grouped into specific phases which were reviewed annually through the Washington area's Unified Work Program for Transportation Planning. The phases eventually became the basis for individual grant applications.

GOALS OF METRO

The initial report of this study described the goals for the rail system and the ways in which these had changed over a period spanning more than a quarter century. The decision to build a rail system in Washington was made for many reasons, but they can all be grouped under two principal objectives:

1. Relieve traffic congestion, especially to downtown Washington, and provide a transit alternative to the automobile; and

2. Support a compact pattern of regional centers along major corridors radiating out from a strong downtown.

The first objective was typical of studies conducted during the 1950s, and is of course still an important concern. The goal of structuring future land development along rail corridors was advanced for the time and built on the strong history of planning in Washington dating to the original L'Enfant plan laid out in 1791.

The goal of reducing travel congestion included two major aspects:

(a) Diverting auto drivers to transit. This includes not only attracting some existing drivers to transit, which can be measured through before and after surveys, but also diverting a large share of normal future traffic growth to transit.

(b) Providing an alternative means of travel to the automobile. Although this sounds similar to the above, the subtle difference is that the subway was planned as a transit alternative to the automobile which provided better service than the contemporary bus or trolley system operating in mixed traffic. The accomplishment of this goal can be monitored by comparing travel speeds and costs on Metro with the previous bus system.

The land development goals also have two aspects, both of which are closely tied to the travel goals:

(a) To preserve the beauty and dignity of the Nation's Capital. This goal was one of the primary reasons for diverting auto travel to transit, that of eliminating the need for extensive freeways disrupting the downtown area.

(b) To preserve the economic vitality of the central city. While opposing new freeway construction, the planners believed it was necessary to maintain a high level of accessibility to the central area by transit in order to protect the job base and retail sales.

More recent objectives such as improving air quality and serving reverse commuting were not explicitly anticipated in early rail system planning. However, Metro's planners must have also understood that reductions in congestion caused by automobiles would also eliminate some of the other negative aspects of auto travel not quite as clearly understood then.

RESEARCH QUESTIONS

The original goals of the Metro planners, and more recent research on travel behavior, suggest research questions and hypotheses to test. Unlike a laboratory experiment, it is not possible to control for variations in other factors such as demographic changes, business cycles in the regional economy, or external impacts such as energy shortages or price increases. These factors notwithstanding, it is still useful to develop theories of Metrorail impacts in order to focus the studies and to concentrate on some of the most likely effects.

The following research hypotheses or questions were determined during the first two years of the Metrorail Before and After Program:

1. For comparable levels of service and cost, are commuters more likely to use Metrorail than a conventional bus system?

2. What is the effect of a change in mode on the time and cost of commuting?

3. What effect does the downtown rail system have on midday travel of downtown workers? What are the implications of these changes on the downtown area?

4. Why do some people not use transit?

5. How does the initial rail system affect short-term trends in residential and non-residential development?

The following research questions were determined during the second two years of the program, originally scheduled for the period of 1979 to 1981. They relate to effects on travel behavior of new rail extensions linking suburban areas to downtown.

6. How much is transit service improved when a rail transit line reaches an area with existing bus service? Without existing bus service? How much additional transit commuting is generated by this transit improvement?

7. When a residential area is newly served by transit, how is the daily travel mobility of people affected? Does this mobility vary by income? Do new transit riders reduce their automobile travel?

8. How is airport access affected for downtown workers? For suburban residents served by transit?

9. How do suburban rail extensions affect residential and non-residential development, compared to development patterns when only the downtown system was open?

The following questions were for the continuing phase, originally intended to begin in 1981, to investigate some of the impacts of a system substantially complete, at least in certain corridors:

10. How did Metrorail service change commuting patterns?

11. What benefits accrue to people switching to Metrorail and to those not changing modes?

12. How does the cost of Metrorail compare to the cost of providing comparable services through a bus or highway system?

13. What is the relative effectiveness of rail extensions in different corridors?

14. How does rail transit affect the total mobility of different groups?

15. What impact does rail transit have on the auto demand of different income groups and people in different life-cycles, e.g., students, workers, retirees?

16. How does rail transit affect land development? Do these effects vary according to the scale of the transit system?

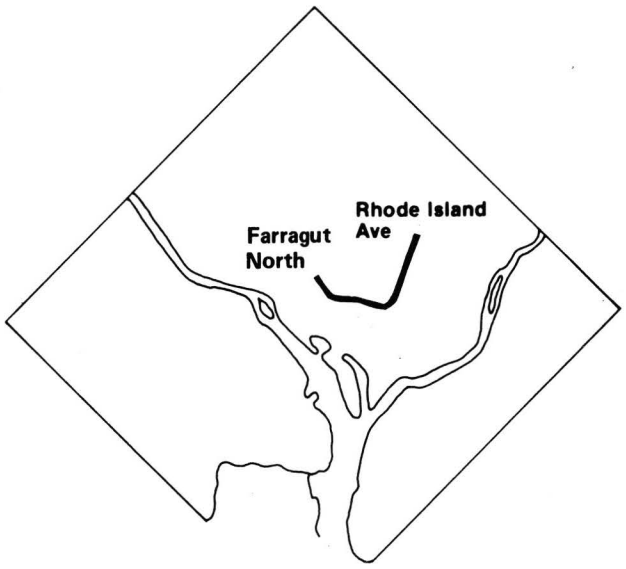
17. What effect does rail transit have on the operation of major activity centers such as the downtown, the Mall, airports, and major suburban shopping/employment centers?

18. What effect has rail transit had on the local and regional environment? How do these effects vary according to the size of the system?

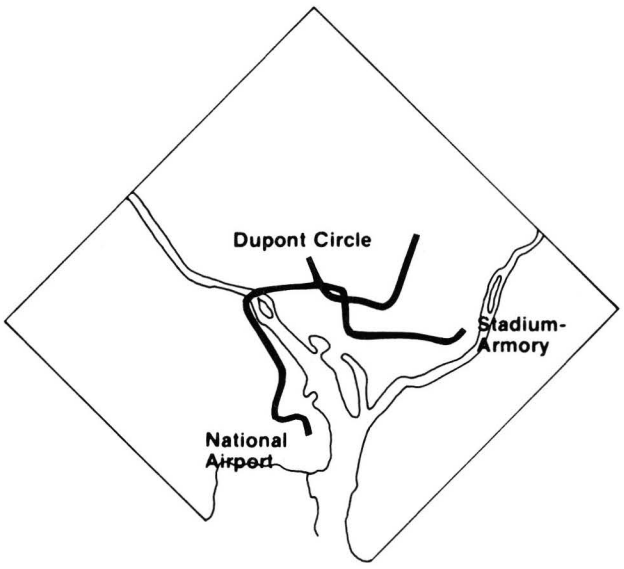
REPORT FORMAT

Some of the above questions are no longer under consideration, while some are analyzed in this report. This report is intended to be an "event" report which summarizes travel impacts of Metrorail through the operation of Phase III, including extension of

Figure 1.2
METRORAIL PHASES-1976 TO 1978



PHASE I



PHASE IA - II

PHASE IIA

PHASE III

the Red Line to Silver Spring and completion of the Orange Line to New Carrollton. The results of the study up to this event provide a great deal of descriptive analysis of the initial effects of Metrorail. The data which can be brought to bear include Metrorail passenger surveys (as reported by WMATA and special tabulations of these surveys by COG), the COG surveys of central area commuters, and the COG annual cordon counts of traffic. Each of these data sources provides a different perspective on Metrorail impacts, and each has certain limitations. Combining these data sources provides insight into the effects of Metrorail travel impacts which would not be possible using each of these data references independently. Further understanding of the impacts of Metrorail on travel will be derived from a current consultant project designed to view commuting changes in the context of COG's travel models, developed on observations taken in 1968 of an all-bus system. Where possible, this report will confirm or disprove the stated hypotheses. The purpose of each of the remaining chapters is as follows:

Chapter II - Growth of Metrorail Ridership by Phase

A reconnaissance of trends in Metrorail ridership since its opening in 1976; the changing composition of trip purposes served by different phases of Metrorail; changes in the temporal distribution of Metro travel; mode of access to and from the system; changes in the amount of induced and diverted travel; and incremental changes at each stage.

Chapter III - The Effects of Metrorail on the Total Transit System

The extent to which increases in Metrorail travel reduced bus travel (diverted transit trips); the effect of Metro on total transit travel; accompanying changes in bus service and use; growth in Metro ridership patterns over time.

Chapter IV - Travel to the Core

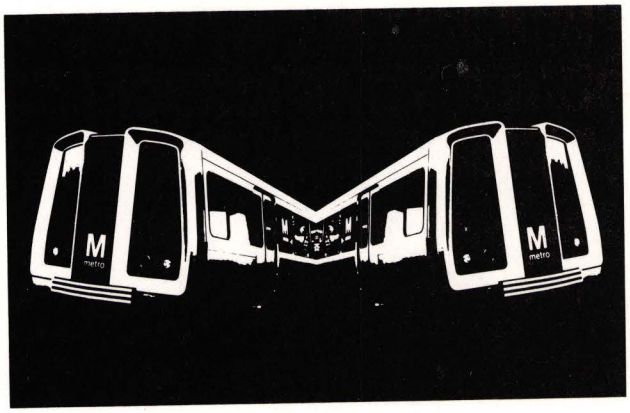
The extent to which increases in Metro travel resulted in reductions in auto travel (diverted auto trips) to the core; changes in central area travel by time of day; differential growth in auto, bus, and rail ridership by corridor.

Chapter V - Places and People: The Market for Metro

Classification of Metro stations by trip purpose, time of day, and mode of access; differences in demographic characteristics between bus and rail users; differences in system cost and performance between rail-only users and those requiring bus or auto access.

Chapter VI - The Silver Spring Case Study

Results of a special study of the initial travel impacts of the Silver Spring Station; purposes of trips and temporal distribution of travel; service of Metro to residences versus Silver Spring employees; impacts of rail service on parallel bus routes and auto traffic entering the city.



CHAPTER 2

GROWTH OF METRORAIL RIDERSHIP BY PHASE

CHAPTER II

GROWTH OF METRORAIL RIDERSHIP BY PHASE

EARLY GROWTH IN METRORAIL RIDERSHIP

The history of Metrorail ridership during its first four years has been one of spurts of growth with the opening of each additional segment and expansion of hours, and also continued growth during the interim periods. This pattern of continuous growth shown in Figure 2.1 stands in strong contrast to the historic seasonal bus ridership pattern, which typically peaks during the month of June, and then declines throughout the Summer and Fall to a low in December, after which it begins to build again. Further insight to the growth in rail travel can be obtained by analysis of the ridership data for each line shown in Figure 2.1.

The Initial Operating Segment

When the first section of the Metrorail Red Line opened from Rhode Island Avenue to Farragut North on March 29, 1976, ridership immediately reached 20,000 riders per weekday, more than double the projections for this small segment, which did not appear to serve many potential destinations. However, the rail passenger survey taken that year revealed that only one out of every eight trips were "new" trips. As shown in Figure 2.2, four out of ten riders were former bus riders and two out of ten previously used taxis for these trips. It was also found, as shown in Figure 2.3, that the majority of Metrorail trips were for non-work purposes. Although work trips were the largest category, they were less than one-half of all trips. The second most frequent trips were job-related trips, such as midday business travel which accounted for almost one out of four trips. Almost one-fourth of all trips were for personal business and shopping. The high percentage of non-work trips, which are less concentrated during peak hours, meant that the first segment of Metrorail served more trips during the midday than in either of the peaks, and that rail apparently provided better service than the midday buses. Rail ridership peaked in July of 1976 and then declined slightly throughout the Summer and Fall. With the opening of the Gallery Place station in December (not opened initially due to lack of handicapped access), and the extension to Dupont Circle in January of 1977, ridership climbed to almost 33,000 riders a day by the end of June, just before the opening of the initial segment of the Blue Line.

Figure 2.1
METRORAIL RIDERSHIP BY LINE SEGMENT

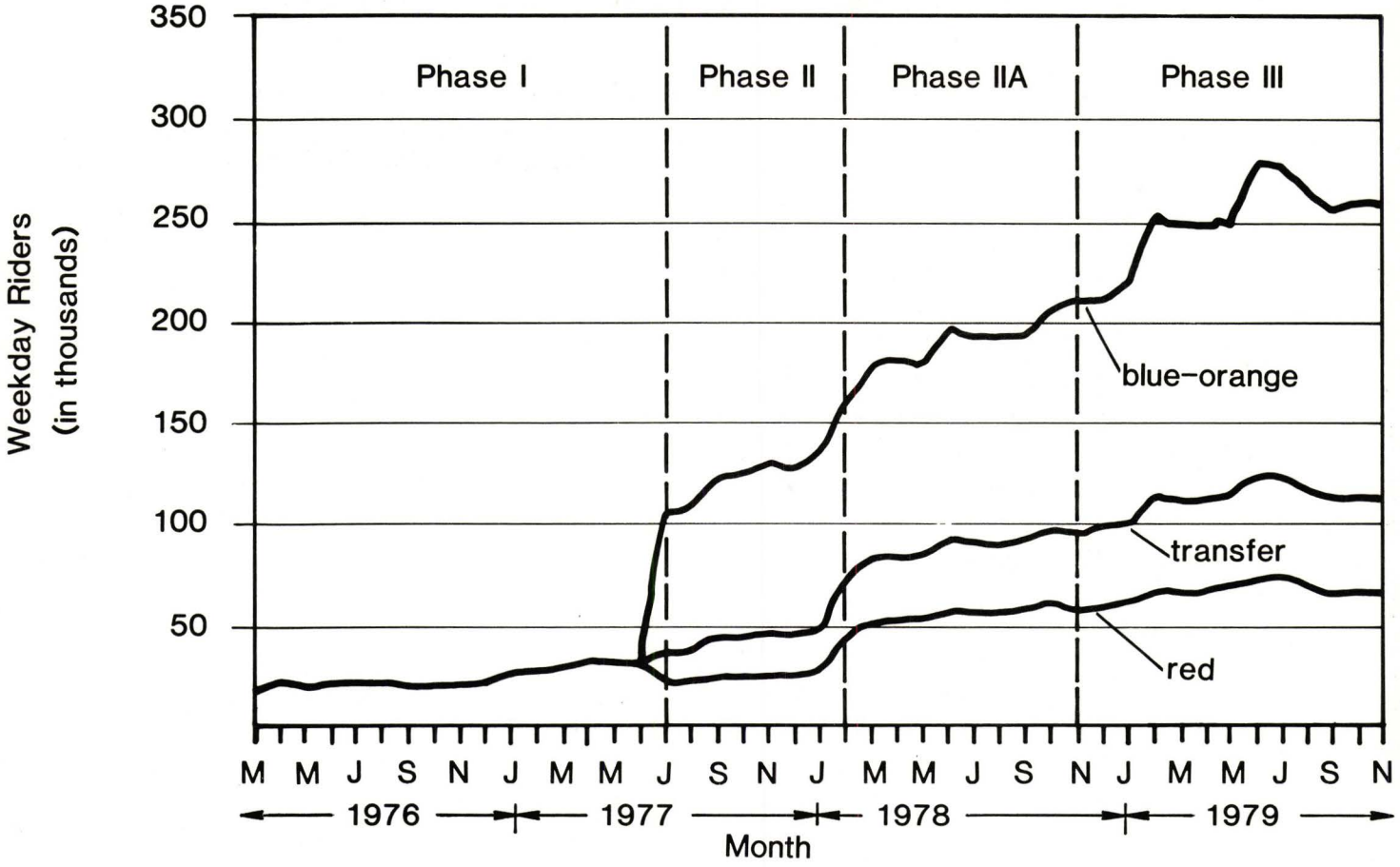
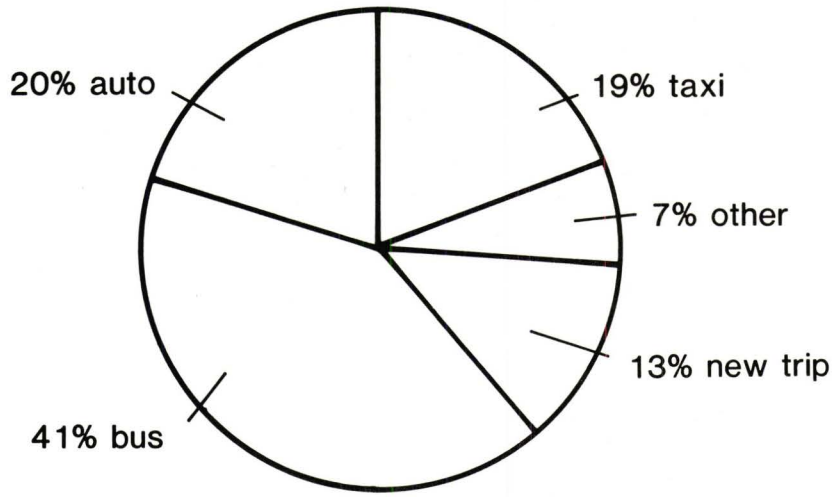


Figure 2.2
PRIOR MODE OF TRAVEL OF METRORAIL RIDERS USING INITIAL SEGMENT



Source–1976 Metrorail passenger survey,WMATA

Figure 2.3
PURPOSE OF TRIPS MADE ON INITIAL RAIL SEGMENT

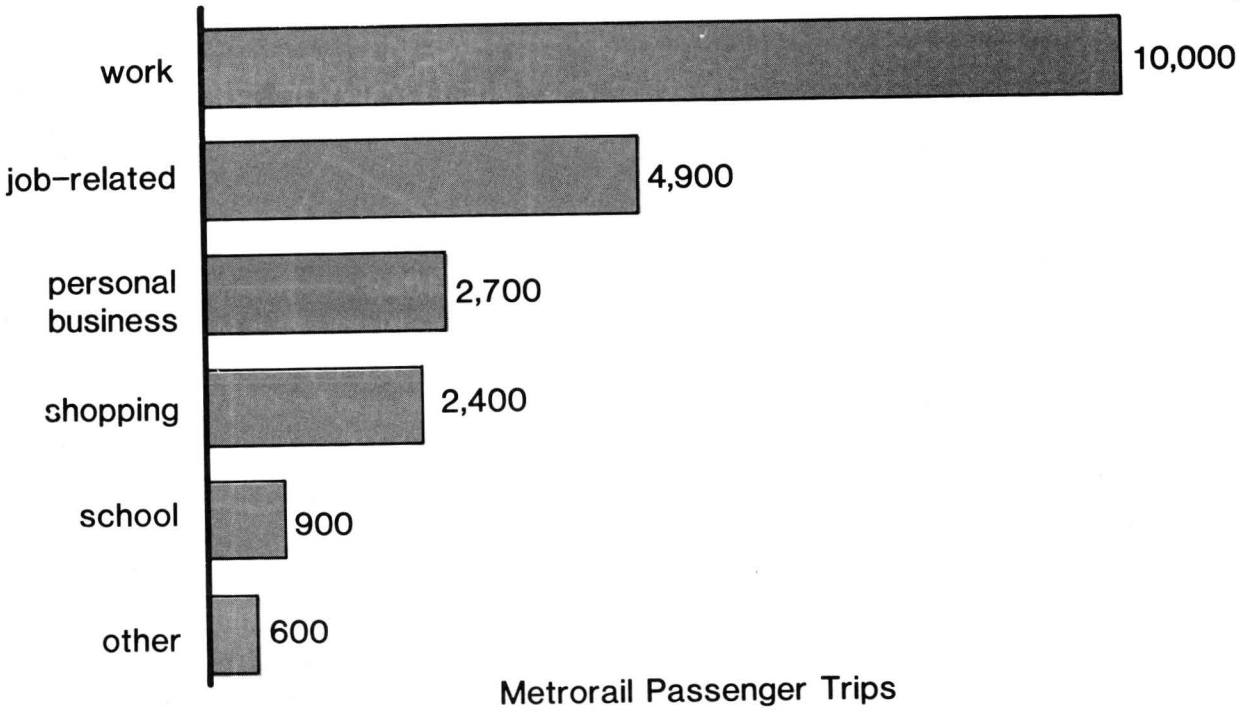
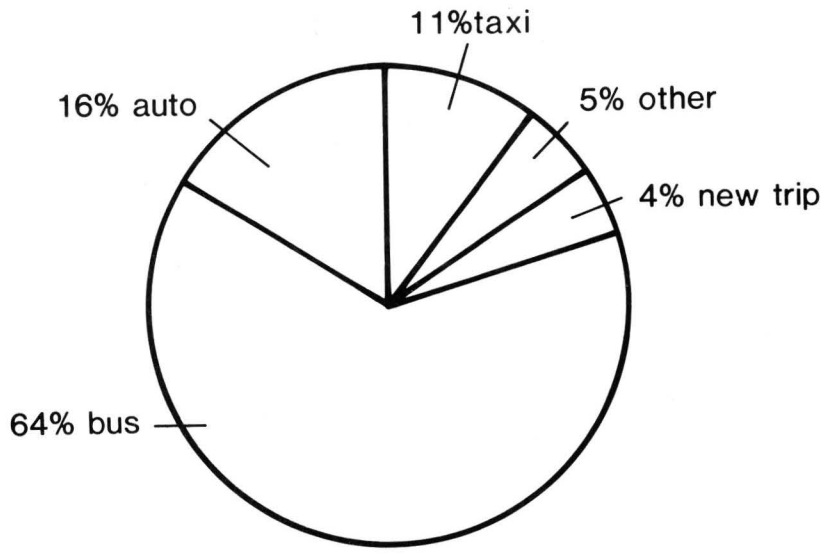


Figure 2.4
PRIOR MODE OF TRAVEL OF METRORAIL RIDERS DURING PHASE II OPERATIONS



Source-1977 Metrorail passenger survey,WMATA

The Second Downtown Line

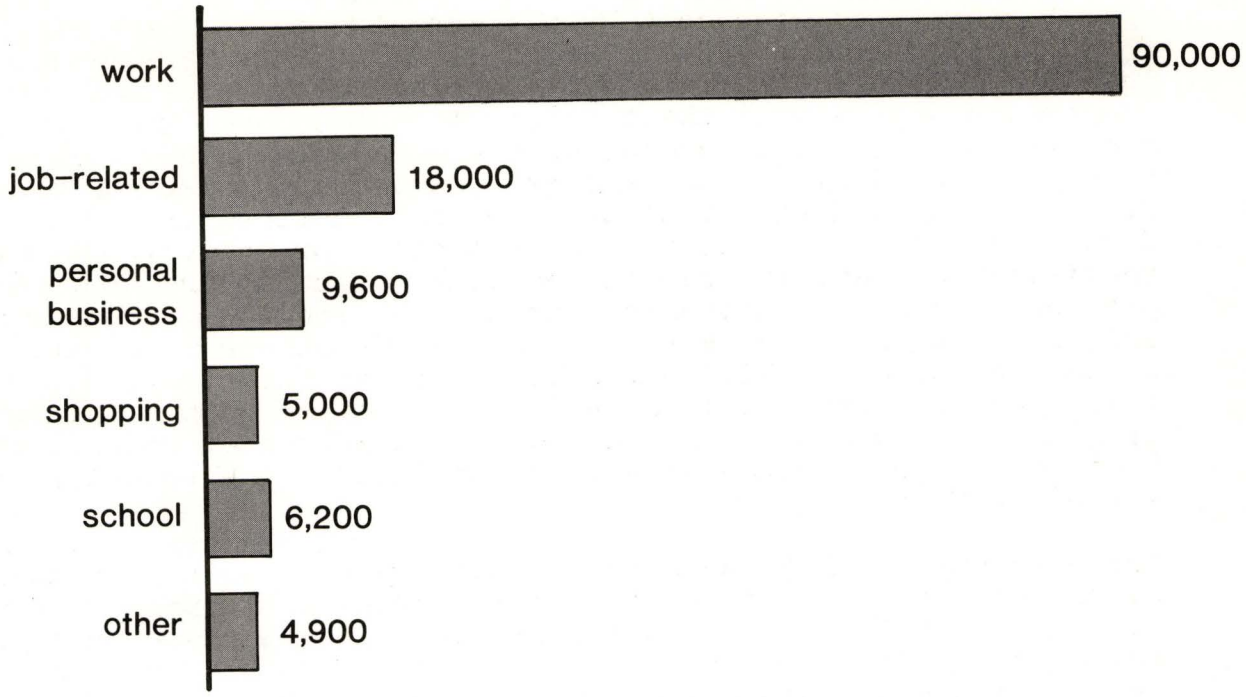
With the opening of the Blue Line in July of 1977 from National Airport through Rosslyn and downtown Washington to the Stadium-Armory station in Southeast Washington, the mileage of the Metrorail system tripled from 6 to 18 miles, and ridership more than quadrupled. This represented the largest ridership increase associated with the opening of a new line. However, operations on the new segment were not as smooth as they had been on the Red Line. Large crowds caused congestion at some stations and overloading of cars, which led to equipment breakdowns. In addition, the automatic system for collecting fares required user familiarization and contributed to the congestion problem. Even so, ridership continued to increase. Between July 1977 and January 1978 average weekday ridership on the system increased by 31,000 riders. Much of this increase, however, resulted from implementation of a policy on bus turnbacks at Blue Line rail stations in August and September which eliminated many bus routes serving destinations in Washington now served by Metrorail.

The observation that the enlarged Metro system served as an alternative means of serving existing transit trips is substantiated in Figure 2.4. Almost two-thirds of the passengers in November 1977 previously used a bus for their trip. Fewer than 5 percent probably would not have made the trip before the opening of Metrorail. This was a sharp drop from the 13 percent of the initial Red Line riders who said they would not have made the trip before Metro. The share of former taxi riders on Phase II was almost half of the percentage from Phase I. There was also a slight drop in the percentage of passengers who previously made the trip by auto.

By November 1977, the expanded rail system was found to serve a majority of users going to and from work, as shown in Figure 2.5, while the other categories declined in relative importance. Nonetheless, midday ridership remained high with almost as many riders using the system between 9:30 a.m. and 3 p.m. as in the morning peak period from 6:00 to 9:30 a.m. Ridership during the afternoon peak period grew substantially and accounted for almost 40 percent of daily use.

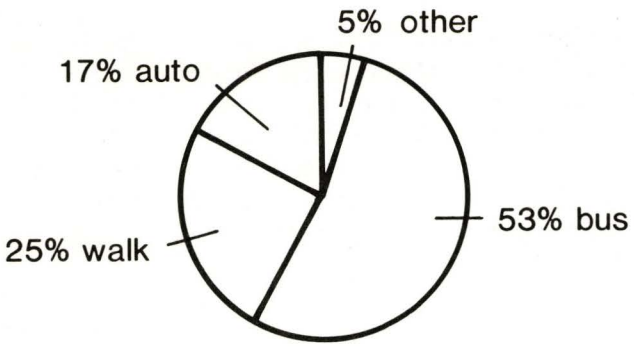
During November 1977 riders were asked about how they got to and from Metrorail. As shown in Figure 2.6, there is a sharp contrast between how people traveled to and from origin and destination stations during the a.m. peak. Slightly over half of all Metrorail users arrived at the station by bus, and about one out of four walked to the station. On the other hand, almost nine out of ten of all peak hour users walked from the destination station to their final destination, and virtually all of the rest took a bus.

Figure 2.5
PURPOSE OF TRIPS MADE ON PHASE II RAIL SYSTEM

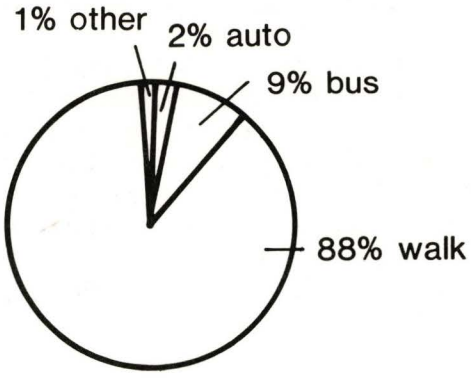


Metrorail Passenger Trips

Figure 2.6
METRORAIL PHASE II
AM PEAK PERIOD
MODE OF ACCESS AND MODE OF EGRESS



Mode of access



Mode of egress

The First Suburban Extension

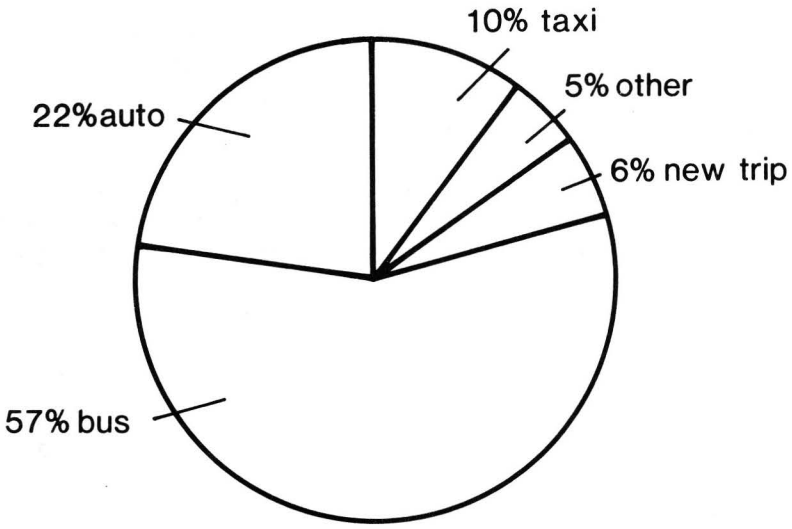
The extension of the Red Line beyond Rhode Island Avenue to Silver Spring provided the first experience with the effects of signficantly extending an existing line. Rail miles on the Red Line doubled, and ridership entirely within the Red Line increased by 80 percent. The number of transfers between the Red and Blue Lines increased by almost 44 percent. The extension provided the opportunity for some previous Metrorail riders to use rail for the entire trip instead of taking a bus to reach the system. As shown in Figure 2.7, most of the riders on the expanded system were previously bus riders, a pattern similar to that observed on the Phase II survey. An increasing share, however, about one-fourth, were former auto users.

During the Spring 1978 rail passenger survey, there was a slight change in the method of classifying trip purposes. This modification permitted asking the purpose of the rail trip at both origin and destination. If trips from work to home are added to those with work destinations, the total represented almost two-thirds of all trips. See Figure 2.8. This percentage is similar to the percentage found in the Phase II survey. Rankings remained the same for the top three trip purposes. The second most frequent trip purpose was for job-related business, followed by personal business. Shopping trips showed the largest relative growth of any trip purpose and increased by more than one and one-half their number six months earlier. They became the fourth most common purpose of travel and exceeded school trips, which declined slightly during the period.

The increase in commuting as a percentage of all rail trips during Phase II changed Metrorail from a primarily non-work system to a work-dominant transit operation with a more typical hourly distribution of work trips. By the following May, 1978, ridership in both morning and evening peak periods exceeded total midday ridership. Between July, 1977, soon after the opening of the Blue Line, and November of the same year, there was a 63 percent increase in rail users during the two peak periods, while the number of riders during the midday actually declined, probably due to a seasonal decline in tourist trips and trips taken just to ride the system.

As shown in Figure 2.9, the majority of rail users in the morning peak hour arrived at rail stations by bus, the next-largest category of riders arrived on foot, and an almost equal percentage arrived by auto.

Figure 2.7
PRIOR MODE OF TRAVEL OF METRORAIL RIDERS DURING PHASE IIA OPERATIONS



Source–1978 Metrorail passenger survey,WMATA

Figure 2.8
PURPOSE OF TRIPS MADE ON PHASE IIA RAIL SYSTEM

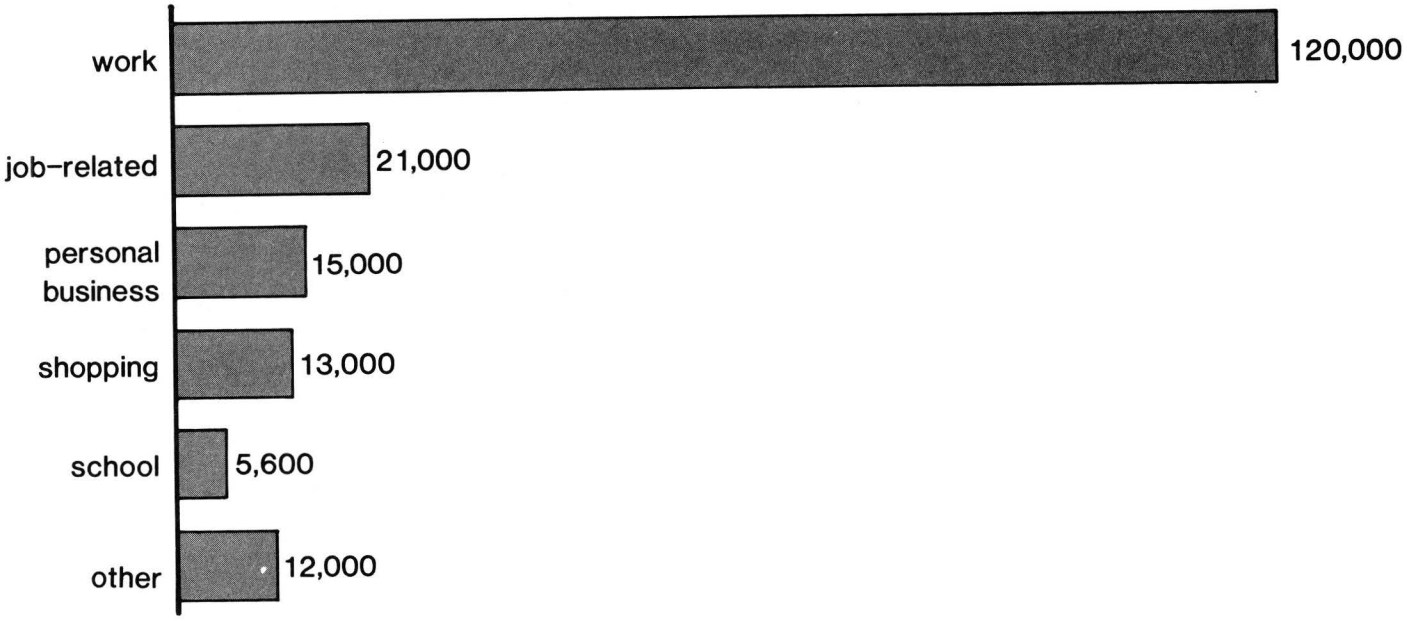
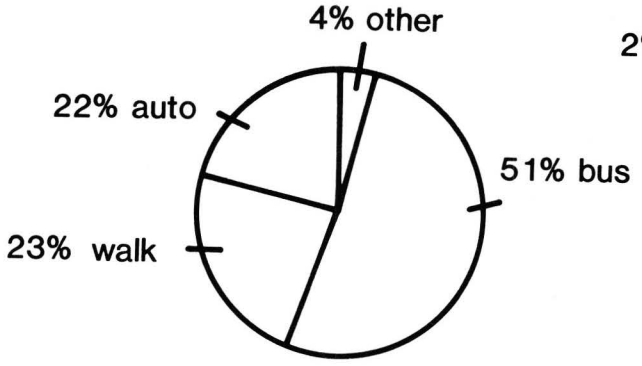
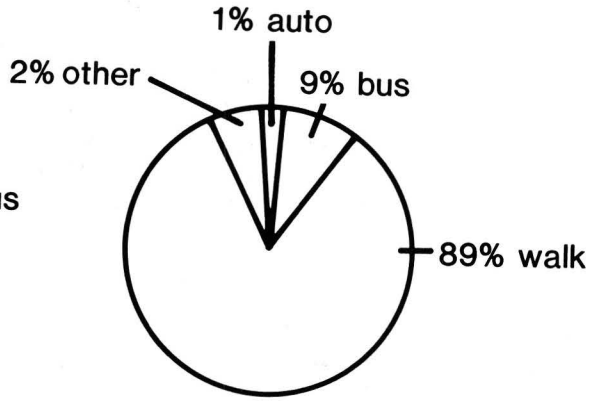


Figure 2.9
METRORAIL PHASE IIA
AM PEAK PERIOD MODE OF ACCESS AND MODE OF EGRESS



Mode of access



Mode of egress

The First Completed Route

The opening of the Orange Line to New Carrollton in November of 1978 marked initiation of service at the first station planned as a route terminus. The Orange Line shares Blue Line tracks from Rosslyn through downtown Washington to RFK Stadium, and Orange Line trains operated over the Blue Line in Virginia until the opening of the Orange Line extension to Ballston in December 1979. The length of the Blue-Orange Line increased by two-thirds, and the operating Metro system reached 31 miles. Ridership entirely within that line increased by 29 percent initially, while there was a much smaller 9 percent increase in rail transfers attributable to the new extension. During the same period, evening service was extended from 8:00 p.m. to midnight and Saturday service was initiated.

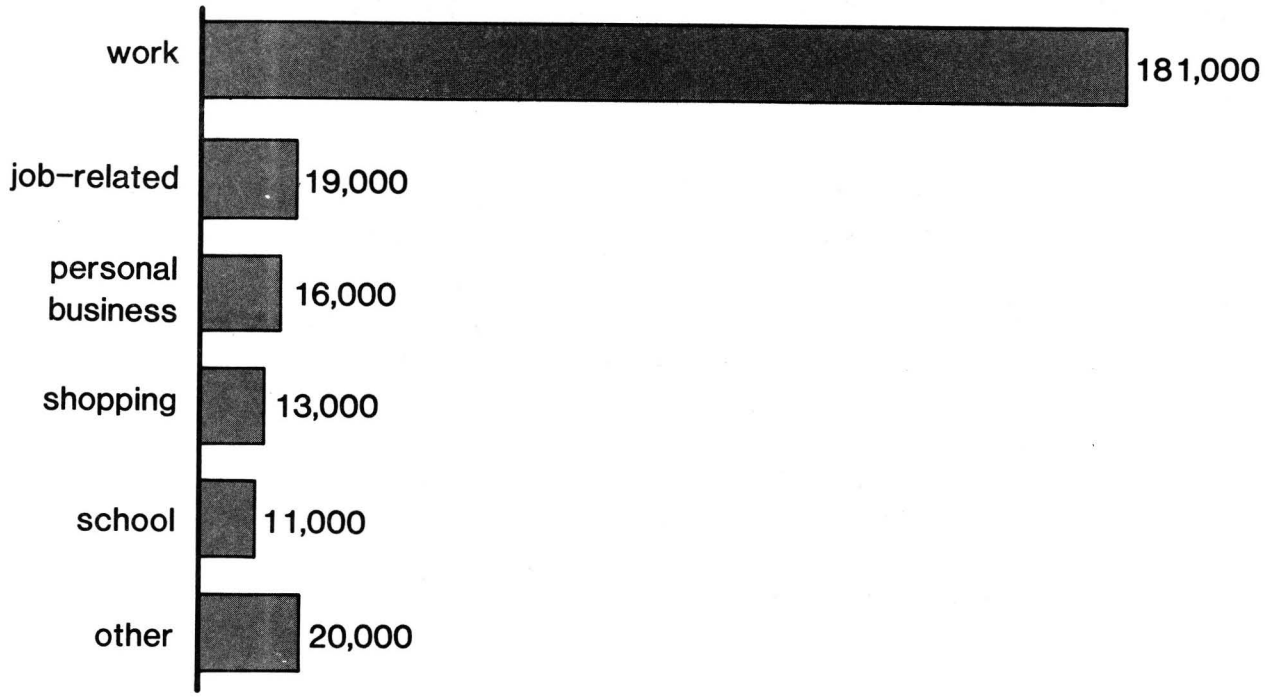
Figure 2.10 shows the destination purposes of Metrorail riders during the Spring of 1979. The dominant purpose was work, which accounted for 69 percent of all trips not destined to home. The "other" trip category became the second most frequent trip purpose, followed by job-related and personal business trips.

By the end of the third year of Metrorail operations, most of the riders still responded that they previously made their trip by bus. As shown in Figure 2.11, the second most frequent alternative mode was the auto, which accounted for over one out of every four riders. About one out of every eight riders reported that a taxi was their alternative, while one out of twenty were new trips.

With 33 stations and 31 miles of rail in operation by the Spring of 1979, there was a great diversity in the mode of access and egress from the system. As shown in Figure 2.12, the mode of access from home to Metro differed significantly from the egress mode at the destination end of the trip. While 43 percent of Metro riders rode a bus from home to the first Metro station, almost 90 percent walked from the last station to their eventual destination. The second most common mode of egress is bus, which accounts for fewer than one in ten riders. At the home end, approximately one in four Metro riders walked to the station and the same number arrived by auto, either as drivers or passengers.

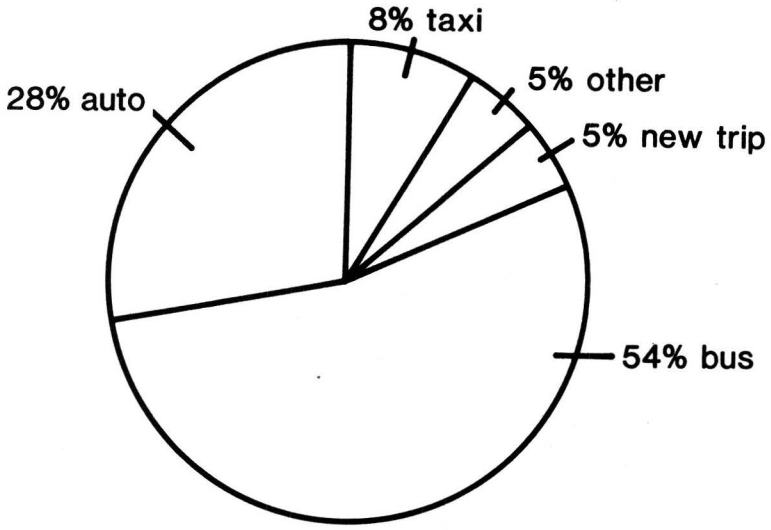
By the Spring of 1979, average weekday ridership on Metrorail reached 260,000 passengers. Although a majority of these passengers could be considered as having been diverted from the bus, the trend between 1978 and 1979 was clearly toward diverting a higher percentage of auto users. This was especially true with the extension of the Orange Line into Prince George's County and

Figure 2.10
PURPOSE OF TRIPS MADE ON PHASE III RAIL SYSTEM



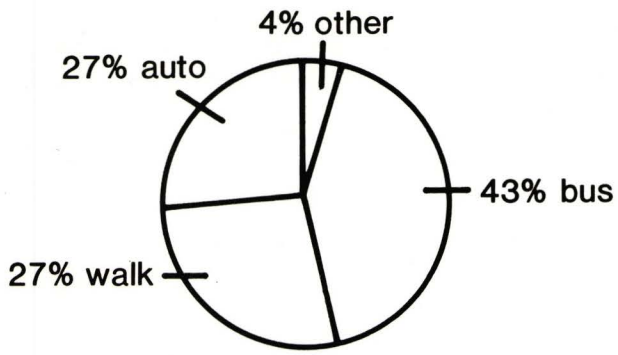
Metrorail Passenger Trips

Figure 2.11
PRIOR MODE OF TRAVEL OF METRORAIL RIDERS DURING PHASE III OPERATIONS

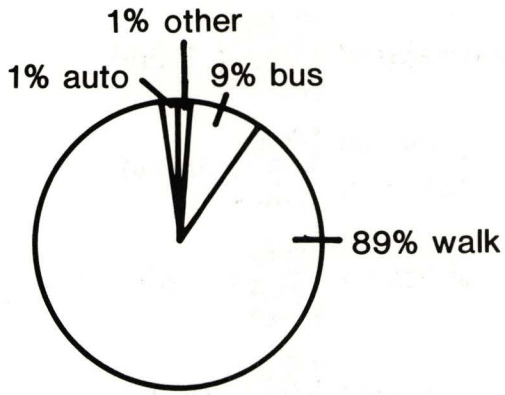


Source-1979 Metrorail passenger survey,WMATA

Figure 2.12
METRORAIL PHASE III
AM PEAK PERIOD MODE OF ACCESS AND MODE OF EGRESS



Mode of access



Mode of egress

the addition of 4,000 new parking spaces. Although a majority of trips were to or from work, there was a considerable number of trips for job-related purposes and personal business, as well as for shopping. An indication of the expanded service available for midday journeys not connected with home is that one in four Metrorail trips was for non-home based purposes. This is a vast expansion in this component of transit travel. A bus survey conducted prior to the opening of Metrorail found that only seven percent of transit trips in 1972 were non-home based.[1]

INCREMENTAL CHANGES IN RIDERSHIP

Metrorail ridership showed a pattern of continuous increases for the first three years of operation through the Spring of 1979, even before the gasoline shortages and price increases which occurred later. Because these increases occurred against a background of new operating segments each year, more insight can be obtained by an analysis of the incremental changes between each phase rather than by measuring yearly increases.

Special analysis of the annual rail passenger surveys makes it possible to classify Metro trips by line, identify transfers, and separate those trips having one end on a new extension of an existing line. Table 2.1 shows daily Metrorail ridership by line segment through the first three phases of rail operations. Growth in total trips on each line and transfers is shown in Figure 2.1. It shows, for example, that there was significant growth in trips on the Blue Line after the Red Line was extended to Silver Spring.

Between the Phase I rail passenger survey in May 1976 and the Phase II rail passenger survey in November 1977, total ridership on the initial six-mile Red Line segment increased by 45 percent to 31,000 trips per weekday. Almost all of this increase was due to the opening of the Gallery Place and Dupont Circle stations in December 1976 and January 1977, respectively.

It can be seen from Table 2.1 that ridership entirely within the initial Red Line segment during Phase I was essentially unchanged during Phase II, although transfers between the Red and Blue Lines were almost two-thirds of the Red Line-only ridership. Ridership on the initial portion of the Red Line increased by only 1,000 daily trips, or 3 percent, between November 1977 and May 1978. On the other hand, Blue Line ridership posted a 16 percent increase in this same six-month period on top of the 83,000 daily

[1]Special tablulations of the 1972 WMATA Bus Survey conducted by Wilbur Smith and Associates and summarized by COG.

TABLE 2.1

DAILY METRORAIL RIDERSHIP BY LINE SEGMENT AND PHASE
(Ridership in Thousands)

LINE OF TRIP ORIGIN AND DESTINATION	PHASE I MAY 1976	PHASE II NOVEMBER 1977 EXISTING	NEW	TOTAL	PHASE IIA MAY 1978 EXISTING	NEW	TOTAL	PHASE III MAY 1979 EXISTING	NEW	TOTAL
Red - Red	21.3	29.8	-	29.8	30.8	24.6	55.4	68.9	-	68.9
Blue/Orange	-	-	82.9	82.9	95.9	-	95.9	117.1	24.9*	142.0
Interline Transfer	-	-	18.5	18.5	20.8	9.5	30.3	40.9	3.7	44.6
Unknown	-	1.1	2.2	3.3	4.0	.4	4.4	3.9	.5	4.4
TOTAL	21.3	30.9	103.9	134.5	151.5	34.5	186.0	230.8	29.1	259.9

SOURCE: WMATA Phase I, Phase II, Phase IIA, Phase III Metrorail Ridership Survey

* Note: In this Table the New Carrollton "Orange" Line opening is treated as an Extension of the Blue Line from Stadium-Armory to New Carrollton. Figures for "Existing" and "New" ridership refer respectively to passengers traveling over route segments which were open before a particular phase or newly-opened with a phase.

trips taken within the Blue Line by November 1977. After the opening of the Silver Spring extension, the number of trips between stations on the initial Red Line segment again increased by 3 percent. Many of the trips which previously transferred from bus to rail at Rhode Island Avenue could now originate at stations along the Silver Spring extension, causing a net loss in trips using the Rhode Island Avenue station. Growth at other initial Red Line stations apparently compensated for this loss.

The opening of the Silver Spring Phase IIA extension practically doubled the number of riders on the Red Line, and during the same period interline transfers increased by 46 percent. The growth of ridership on the Red Line continued into Phase III and by Spring 1979, ridership had increased by another 24 percent.

Ridership on the original Blue Line segment also increased during Phase IIA and Phase III of the rail system. By May 1979, the number of trips on the initial Blue Line segment had increased by 22 percent over the previous year's total. Ridership generated by the Orange Line stations accounted for an additional 26 percent increase and resulted in a combined increase of 48 percent. Interline transfers in this period increased by a comparable percentage.

However, most of this increase was due to the growth of interline transfers on the pre-existing system. The number of interline transfers generated as a result of the opening of the New Carrollton extension amount to only a 12 percent increase over Phase IIA transfers.

During Phase III, as with the previous extension of the initial Red Line segment, total ridership dropped at the station which had temporarily served as terminal station. In this case, ridership dropped by 2,000 weekday riders at the Stadium-Armory station once the Blue-Orange Line was extended to New Carrollton. Again, however, this drop in ridership at the former terminal station was more than compensated for by the growth in trips between other prior Blue Line stations.

Between Phase IIA and Phase III, growth in ridership on the existing system exceeded the increase in ridership directly attributable to the opening of the new line segment. This represented the first period when normal ridership growth on the existing system exceeded that attributable to the provision of new rail service. The growth in ridership on existing line segments may represent system effects of increased accessibility. This increase in transit accessibility not only encourages ridership on the new segment, but may also encourage increases in ridership on the previously existing system.

PREVIOUS TRAVEL MODE OF NEW METRORAIL RIDERS

The question of prior transit mode provides more information on the changing character of the Metrorail system if the users on each phase are analyzed separately. The passenger survey conducted after the opening of the New Carrollton extension showed that a majority of users would have taken a bus as an alternative.* However, the same information for riders on each new segment in Table 2.2 reveals a slightly different pattern. Former bus riders declined from an overwhelming two-thirds of the new riders on the Blue Line to less than half of the new passengers on the New Carrollton extension. Former auto drivers, on the other hand, who accounted for only 14 percent of the new riders on the Blue Line increased to 38 percent of the riders on the New Carrollton extension. Figure 2.13 compares the prior mode of all riders with the prior mode of riders from the new stations of Phase III. It appears that both of the suburban rail extensions are capturing a higher percentage of former auto users and a lower share of transit users than the original central area system opened in Phase I.

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* The wording of the question was changed from "How did you make this trip previously?" to "What mode would you use if Metro were not available?" For a new segment there should be little difference in the answer.

Figure 2.13
PRIOR MODE OF TRAVEL OF METRORAIL RIDERS

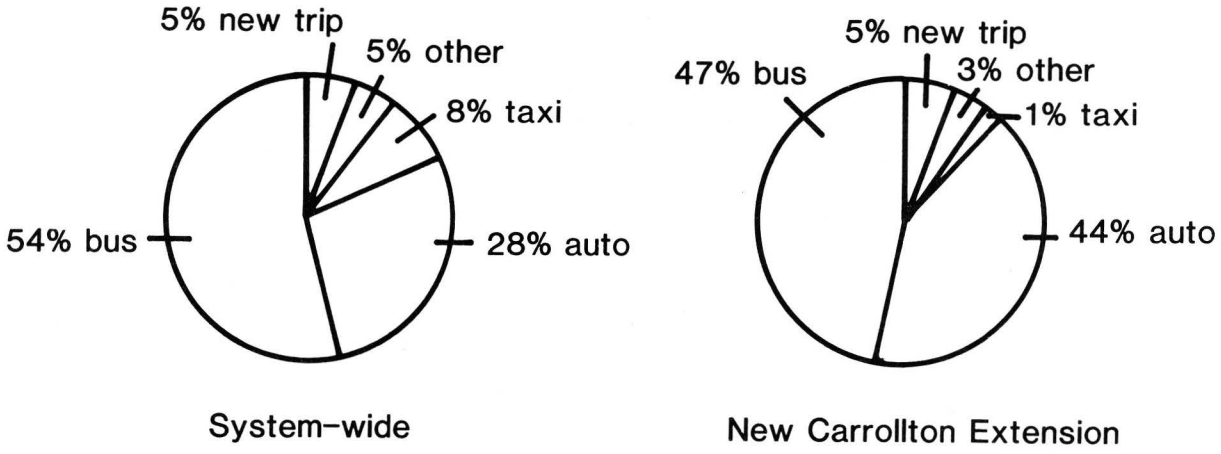

TABLE 2.2

PRIOR MODE OF METRORAIL RIDERS

ON NEW SEGMENTS BY PHASE

(Percentage of Riders)

PRIOR MODE	PHASE I INITIAL RED LINE	PHASE II INITIAL BLUE LINE	PHASE IIA SILVER SPRING EXTENSION	PHASE III NEW CARROLLTON EXTENSION
New Trip	12.8%	3.6%	4.0%	4.6%
Bus	40.7	66.9	58.0	47.2
Auto Driver	17.6	13.7	28.6	38.1
Auto Passenger	2.2	2.4	4.4	6.3
Taxi	19.1	9.5	1.7	.7
Walked	5.9	2.0	.2	.7
Other	1.7	1.8	3.0	2.2
Total	100.0%	100.0%	100.0%	100.0%

SOURCE: WMATA Metrorail Ridership Surveys

TRIP PURPOSES SERVED BY NEW RAIL SEGMENTS

Separating the Metrorail system into segments for analysis makes it possible to determine the purposes at both ends of the trip, rather than the major purpose described earlier. The most common destination purpose of all Metrorail trips in the Spring of 1979 was home, since most trips begin or end there. The percentage of work trips was almost as high as the percentage of trips to home. The distribution of trip purposes on any segment of the system can vary dramatically from the regional average, particularly so regarding a suburban extension. As shown in Table 2.3 there was a sharp contrast in the purposes served by stations on the Silver Spring and New Carrollton extensions, compared to the systemwide average. In both cases, home was the dominant purpose and accounted for about three out of every four trips on the Silver Spring extension, and five out of every six trips on the extension to New Carrollton. The second most frequent trip destination purpose systemwide was work, which accounted for about one in ten destinations on the Silver Spring extension, and one in twenty trips on the Orange Line to New Carrollton. It is clear that these extensions primarily serve trips beginning or ending at homes near the new stations, rather than commuting and commercial trips to areas with new rail service.

TABLE 2.3

RELATIVE FREQUENCY OF METRORAIL TRIPS
BY PURPOSE AT DESTINATION AND SEGMENT

(Percentage of Daily Trips, May 1979)

PURPOSE	SILVER SPRING EXTENSION	NEW CARROLLTON EXTENSION	REGIONAL AVERAGE
Home	77%	85%	40%
Work	10	5	38
Job-Related	2	1	6
Shop	2	1	4
Personal Business	4	4	5
Other	5	4	7
Total	100%	100%	100%

NOTE: These figures describe the purposes of trips made only to stations which opened in conjunction with each extension.

REVERSE COMMUTING

The sharp contrast between trip purposes served on the Silver Spring and New Carrollton extensions, predominantly to and from home, with work and other destination purposes largely concentrated downtown, results in a directional imbalance. During the morning peak period, there were almost 20,000 riders per line entering the central employment area on rail lines from Silver Spring, New Carrollton, and National Airport. However, outbound ridership during the morning peak was only 4,600 riders on the heaviest outbound route--National Airport. Outbound ridership was even lower on the Silver Spring and New Carrollton routes, as shown in Figure 2.14. The most severe directional imbalance in the Spring of 1979 occurred on the New Carrollton route which in the morning peak period carried fewer than 1,000 outbound riders, or less than one outbound rider for every twenty inbound riders. Because the same number of trains travel outbound as inbound, the capacity of each line is equal--approximately 30,000 seats in each direction between 6:30 a.m. to 9:30 a.m. as of the Spring 1979.[1]

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[1]Capacity was assumed as 142 people per rail car, including standees. Source: WMATA, Rail Performance Indicators.

Figure 2.14
METRORAIL A.M. PEAK-PERIOD RIDERSHIP-PHASE III
(IN THOUSANDS)

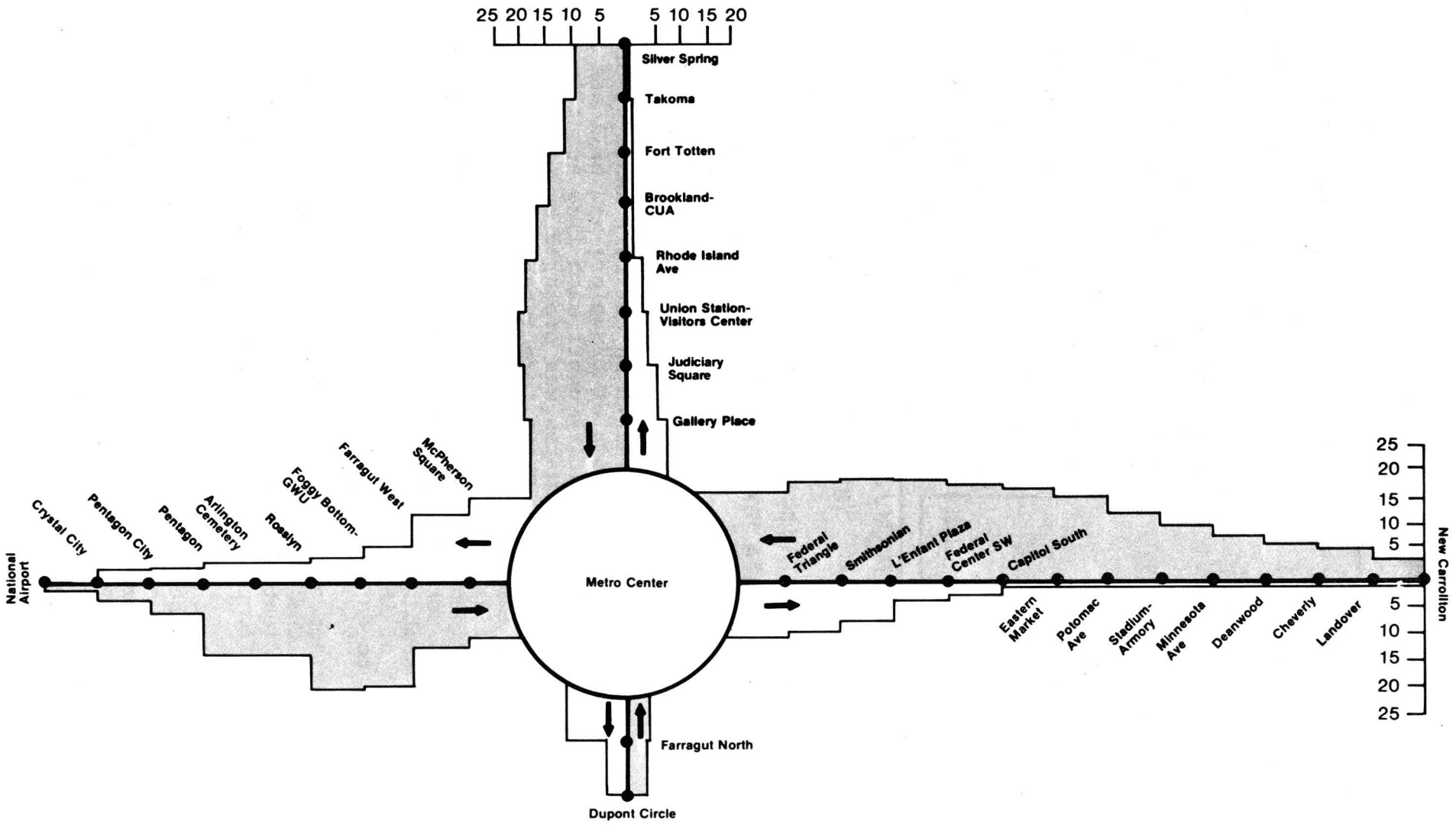
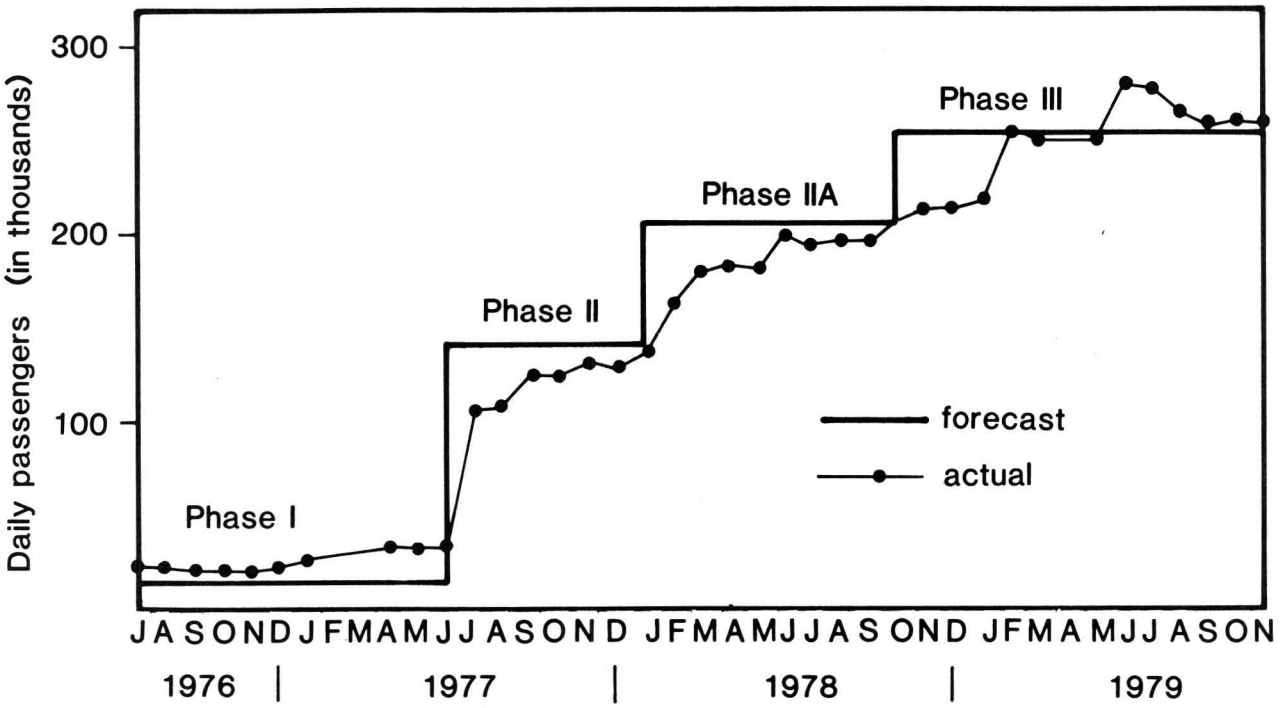


Figure 2.15
COMPARISON OF METRORAIL RIDERSHIP WITH EARLY FORECASTS



Source: WMATA Quarterly Ridership Reports
WMATA 1975 Net Income Analysis-Working Paper #8

RIDERSHIP VS. FORECASTS

Since Metrorail represents an entirely new type of transportation system, the number of travelers who will use it is very much an unknown quantity until each line actually opens. However, a set of estimates was prepared as part of the planning and design phase. These forecasts therefore represent one of the most immediate opportunities for determining whether Metrorail is living up to the expectation of its planners. The most recent ridership projections were prepared in 1974, when ridership was estimated for the full system, which cannot be checked for a number of years. However, in order to assist in the period of initial operations, these forecasts were adjusted in order to estimate ridership by phase.

Comparison of ridership projections with actual ridership during each of the early operating phases of Metro as shown in Figure 2.15 indicates that these estimates were quite accurate through Phase III.

Ridership on Phase I was twice that projected, probably because of the difficulty of estimating the midday travel market for such a short segment of rail. Ridership for Phase II and Phase IIA grew to almost precisely the level forecast by the end of the phase. Ridership during Phase III exceeded the forecasts during the summer energy shortage of 1979, and dropped down to a level slightly above the forecast near the end of Phase III.

Changes in the staging of Metro since these forecasts were made invalidate any future comparisons, but the early results indicate the use of Metro to be quite close to that projected.

CONCLUSIONS

Analysis of Metrorail ridership during the first three years of rail operations reveals a pattern of continuing growth, even during seasons when transit ridership usually declines. The initial six-mile segment entirely within the central area provided the first indication of rail transit ridership within downtown. It carried many more passengers than expected, primarily because of the extensive amount of job-related, shopping and business trips. Most of these trips had been made before Metrorail, primarily on bus, and the new transit service provided a much faster alternative to the bus. The large share of non-work trips served on the initial rail segment resulted in a much higher level of midday transit ridership than is found on bus systems.

The second rail line to open provided not only additional downtown service, but also a connection to residential areas in Virginia and east of the Capitol in Washington. This resulted in extensive use of the expanded rail system, especially for commuting, which grew to about two-thirds of all trips by the Fall of 1977 and remained near that level through 1979. Ridership during this period, and following both rail extensions, grew to match the projections prepared in 1974. Most of the growth in rail travel served by these new extensions was for work trips. The extension of the Red Line to Silver Spring doubled the number of miles on the line, and new riders having both origin and destination on this line increased ridership by 80 percent.

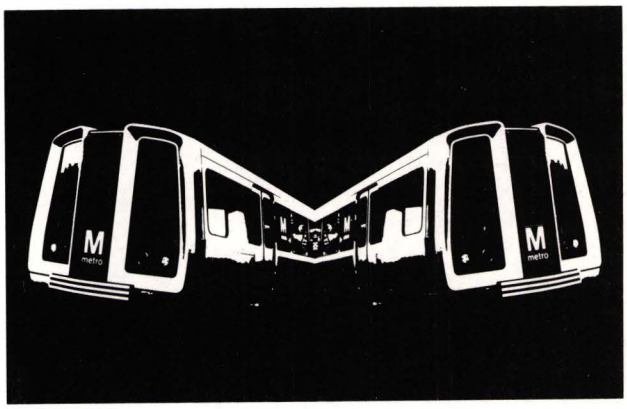
The extension of the Blue-Orange Line to New Carrollton lengthened that line by 63 percent, while ridership entirely within the line increased by 48 percent. Moreover, significant growth in transit occurred in addition to growth related to rail service expansions. Between 1978 and 1979, when rail service was extended to New Carrollton, growth in ridership on the existing system exceeded growth on the rail extension.

Following the opening of the Blue Line, almost two-thirds of all rail passengers claimed their trip had previously been made by bus, while only 16 percent had traveled by auto. However, diversion of auto travelers was much more extensive on the rail extensions, which appeared to attract from the automobile 33 percent of new riders on the Silver Spring extension and 44 percent of new riders on the New Carrollton extension. Extensive parking lots at New Carrollton were apparently an important factor in diverting almost as many new riders from auto as from

bus. The modes of access to Metrorail appear to reflect the mode used for the trip before Metro. In the morning peak period at the origin end of the trip (usually the home), 43 percent of Metrorail riders reported arriving at their origin station by bus. Another 27 percent came by auto, and an equal number walked. At the other end of the trip, (usually the job), virtually everyone walked to their destination.

Reverse commuting, which was not an important concern during the early planning of the rail system, appeared to be rare during the first three years. The trips beginning or ending on the extensions of the initial two rail lines were overhwhelmingly to and from home. Counts of riders in each direction at the downtown end revealed that a very small percentage of riders traveled in the off-peak direction during peak hours.

Three years after the opening of the rail system, when less than one-third of the planned regional rail system was operating, the system carried 260,000 riders daily, slightly more than one-third of the ridership projected for the full system.



CHAPTER 3

THE EFFECTS OF METRORAIL ON THE TOTAL TRANSIT SYSTEM

CHAPTER III

THE EFFECTS OF METRORAIL ON THE TOTAL TRANSIT SYSTEM

The growth in Metrorail ridership seen in Chapter II occurred within a regional transit district which included an extensive regional bus system as well. In order to develop a proper perspective on the effects of Metrorail on regional transit, parallel trends in bus travel must also be interpreted.

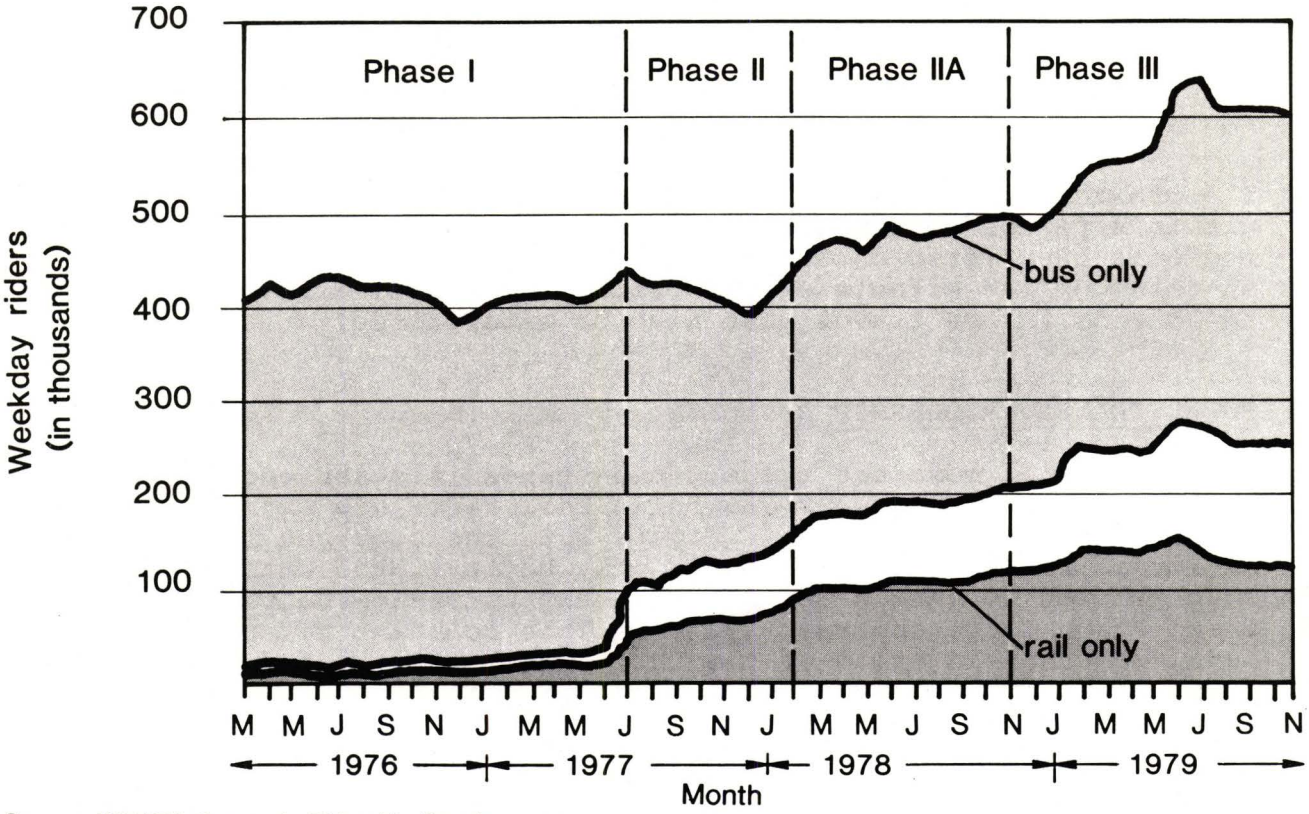
TOTAL TRANSIT RIDERSHIP BY PHASE

The pattern of combined transit use stands in sharp contrast to the picture of continuous growth in rail ridership presented in Chapter II. As shown in Figure 3.1, the combined total of Metrorail riders and those using only buses--total WMATA ridership--showed no change in total weekday patronage between Phase I and Phase II of the rail system. This constant ridership level occurred in spite of the fact that Metrorail ridership during this same period grew to 135,000 weekday riders. It was not until the opening of the Silver Spring extension that rail ridership increased faster than corresponding losses in bus ridership, resulting in a net gain in regional transit ridership. Between February 1978 and November 1978, the beginning and end of Phase IIA, rail-related ridership increased by almost 75,000 daily trips and total ridership increased by more than 90,000 trips. The rapid growth in total transit use which started during Phase IIA continued into Phase III, and between November 1978 and November 1979 rail-related ridership increased by 60,000 daily trips, while total weekday patronage grew by another 100,000 trips.

COMPARISON BETWEEN BUS AND RAIL RIDERSHIP BY PHASE

Traditional variations in transit use from season to season complicate the analysis of ridership changes due to new Metrorail phases which commenced service at different times of the year. However, by analyzing ridership statistics for months common to each new phase one may compare changes in ridership between different phases of the rail system. The months of July through October appear to be quite stable for transit ridership, as shown in Figure 3.2,and were selected for comparative analysis. Table 3.1 presents ridership data for these months by phase of Metrorail. The changes in ridership between years are shown in Table 3.2.

Figure 3.1
TOTAL WMATA RIDERSHIP BY PHASE



Source: WMATA Quarterly Ridership Counts

Figure 3.2
MONTHLY DATA SELECTED FOR ANALYSIS BY PHASE

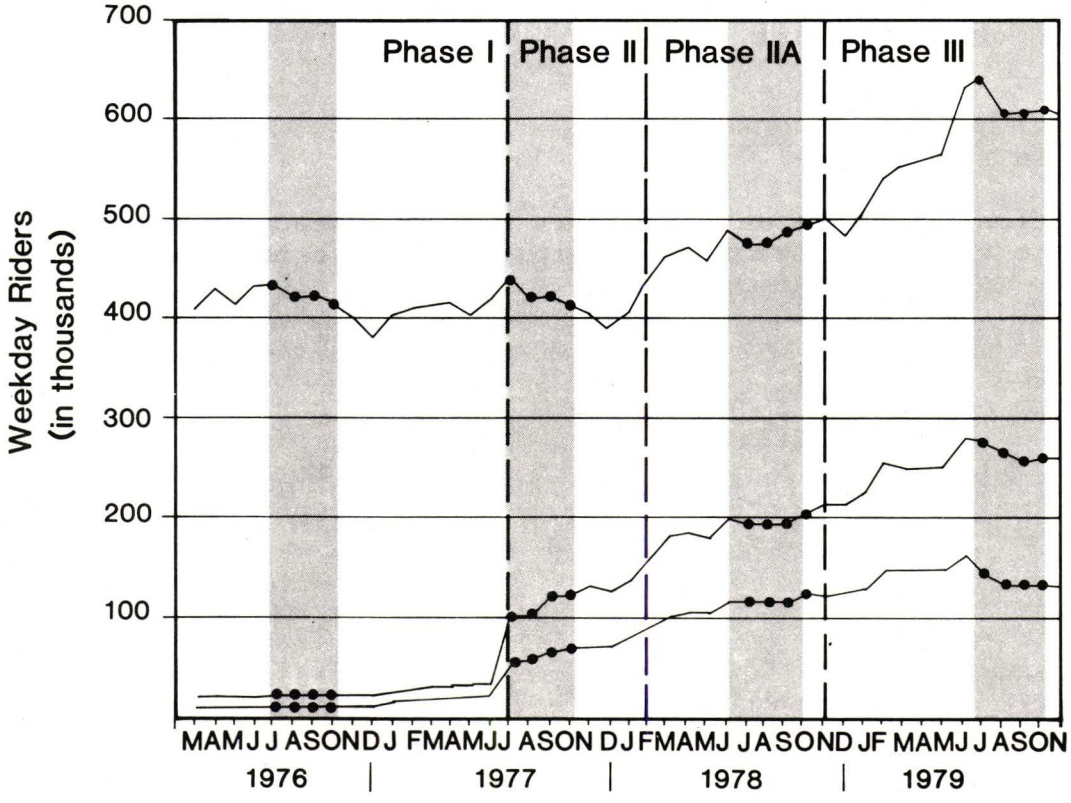


TABLE 3.1

WMATA TRANSIT RIDERSHIP BY PHASE

(AVERAGE WEEKDAY: JULY - OCTOBER)

	PRE-METRO (1975)	PHASE I (1976)	PHASE II (1977)	PHASE IIA (1978)	PHASE III (1979)
Rail Only	0	16,000	64,000	115,000	134,000
Bus-Rail	0	6,000	52,000	83,000	132,000
Rail-Related	0	22,000	116,000	198,000	266,000
Bus Only	396,000	403,000	311,000	286,000	353,000
Total Transit	396,000	425,000	427,000	484,000	619,000

SOURCE: WMATA Quarterly Ridership Reports

(All figures Rounded to Nearest Thousand)

TABLE 3.2

WMATA RIDERSHIP CHANGES BY PHASE

(AVERAGE WEEKDAY TRIPS:JULY-OCT.)

	PRE-METRO TO PHASE I		PHASE I TO PHASE II		PHASE II TO PHASE IIA		PHASE IIA TO PHASE III	
	NUMBER	%	NUMBER	%	NUMBER	%	NUMBER	%
Rail Only	+ 16,000	-	+ 49,000	306%	+ 51,000	80%	+ 19,000	17%
Bus-Rail	+ 6,000	-	+ 45,000	750	+ 31,000	62	+ 49,000	59
Rail-Related	+ 22,000	-	+ 94,000	427	+ 82,000	72	+ 67,000	34
Bus Only	+ 7,000	2%	- 92,000	- 23	- 25,000	- 8	+ 67,000	23
Total Transit	+ 29,000	7%	+ 2,000	NC	+ 57,000	13%	+ 134,000	28%

SOURCE: WMATA Quarterly Ridership Reports

(All figures Rounded to Nearest Thousand)

Phase I - The Initial Red Line

Following the opening of the first phase of Metrorail, total WMATA weekday patronage increased by 29,000 trips, a 7 percent increase over the pre-Metro bus ridership. Three-fourths of this increase was directly attributable to the opening of the initial segment of the rail system. Rail trips transferring to or from bus (bus-rail ridership) totaled 6,000 riders per weekday and accounted for 20 percent of the total increase in weekday ridership. Rail-only ridership was 16,000 trips and accounted for over half the total increase in transit patronage. This reflects the downtown nature of the initial rail segment. During this same period, there was also a 2 percent increase in bus-only trips.

The opening of the initial segment of the rail system, while successful in attracting many new riders to transit, particularly during the midday hours, had only limited effects on the regional bus system. Bus-only ridership levels during this phase showed no significant change compared to the pre-rail condition. Moreover, only minimal changes were made in bus routes to feed bus riders to the rail system during this phase. Total rail-related ridership during this period accounted for only 5 percent of total WMATA weekday patronage.

Phase II - The Initial Blue Line

In spite of the largest increase in Metrorail ridership measured to date, total weekday transit patronage during Phase II did not change appreciably.

In the July-October period during Phase I, total transit ridership averaged 425,000 riders per weekday. For the same period during Phase II, total transit ridership averaged only 427,000 riders. In fact, between October of 1977 and October of 1978, there was actually a decline in combined average weekday transit use.

Although there was no change in total ridership, Phase II brought about a significant shift in the distribution of transit ridership between bus and rail. Major changes were made in the bus network to serve the newly opened segments of the rail system. These changes, in turn, resulted in significant shifts between transit modes. Bus-only ridership dropped sharply by 92,000 at the same time that rail ridership jumped by 94,000 trips. The rail system's share of total weekday patronage grew from 5 percent to 30 percent practically overnight.

The net effect of Phase II was thus not to increase total transit ridership, but to substitute rail trips for one quarter of the region's daily bus patronage. As reported in Chapter II, almost two-thirds of the Metrorail riders in November 1977 were prior bus riders. More than one-half of the rail riders, however, still required a bus to get to and from the rail system.

Phase IIA - The Red Line Extension to Silver Spring

During Phase IIA, total weekday transit ridership began to increase sharply. Daily ridership on the combined bus and rail system increased by an average of 57,000 daily trips over the comparable period for Phase II. This represented a 13 percent increase in total WMATA weekday patronage.

However, bus-only ridership during this same period continued to decrease and dropped by approximately 25,000 trips. This decline was primarily due to the continued effort to maximize the use of the rail system by re-routing existing bus service to serve the rail system and by eliminating those bus lines that provided service parallel to the rail system. Also during this period, Montgomery County greatly expanded the County's Ride-on "midibus" transit service. Many of the new Ride-on routes replaced WMATA bus service in the close-in neighborhoods around Silver Spring.

While bus-only ridership declined during Phase IIA, rail-related ridership exhibited considerable growth. The increase in ridership on the rail system more than offset the drop in bus-only ridership. Daily volumes on the rail system increased by 82,000 trips per weekday. Bus-rail ridership increased by 31,000 trips and rail-only trips grew by 51,000 weekday trips. The large increase in rail-only ridership reflected the fact that the Silver Spring extension directly served many medium to high-density neighborhoods in the District and Maryland. It also reflected, to a limited extent, the success of Ride-on in providing access to Metrorail, since a combined Ride-on and Metrorail trip is recorded as a "rail-only" trip for WMATA. Combined Metrorail/Ride-on trips of this type actually accounted for approximately 7,300 weekday trips in this period.

The growth in ridership during Phase IIA represents a significant turning point in total WMATA weekday patronage. The increase in total ridership during this Phase was supported by the continued growth of ridership on the rail system which, by the end of this Phase, accounted for 40 percent of total WMATA weekday patronage.

Phase III - Completion of the New Carrollton Route

Total weekday transit ridership, as shown in Table 3.2, increased by an unprecedented 134,000 trips during Phase III, a full 28 percent increase over the comparable period a year earlier. This time period included not only the extension of rail service on the Orange Line to New Carrollton, but also the severe gasoline shortages which occurred in the Washington metropolitan area during the summer of 1979.

The impact of the gas shortage on total transit ridership is most significant in the growth of bus-only ridership during this period. For the first time since Phase I, bus-only ridership did not decline as rail ridership increased. In fact, bus-only ridership grew by an average of 67,000 daily trips and represented one-half of the increase in total weekday transit patronage. Whether all of this increase in bus-only ridership can be linked to the gasoline shortage cannot be determined at this time. Much of the increase may, in fact, be due to bus system improvements intended to simplify and consolidate routes.

Bus-rail ridership also grew appreciably during Phase III and actually exceeded the growth in rail-only trips. Bus-rail trips accounted for nearly three-quarters of the total increase in rail-related ridership. The growth in rail-only ridership, which includes riders who drive to rail stations, was facilitated by the addition of more than 4,000 parking spaces at stations along the New Carrollton Line, and accounted for one-third of the total increase in rail travel. Rail-only ridership posted a 17 percent increase during Phase III.

Overall ridership changes during Phase III continued the sharp upward trend in total and rail-related ridership started during Phase IIA. In fact, since all three components of total WMATA patronage grew during this phase, rail-related ridership remained at 40 percent of the total. Again, the question of whether the growth of bus-only ridership during this phase reflects a temporary aberration due to the gasoline shortage or is a response to a restructured and improved bus system must await future data. Nevertheless, the strong growth of bus-rail ridership does indicate that transit riders are willing to use a bus to reach the rail system, if good bus access is provided.

GEOGRAPHIC DISTRIBUTION OF RAIL TRAVEL

The function of the Metrorail system in the regional transit network can be better understood through an analysis of the geographic distribution of rail trips and how they have changed during the first three phases of Metrorail operations.

The focus of the rail system is on downtown Washington, where Metro construction began and where all lines of the system converge. This area, described for transportation planning purposes as the D.C. core, is shown in Figure 3.3. It is the subject of extensive historical data on transportation and development.

The distribution of Metrorail travel with respect to this central area is shown in Table 3.3. Since only the Rhode Island Avenue Station on the Phase I rail system was outside this area, almost three out of every four initial rail trips were made entirely within this downtown core. The opening of the Blue Line into Virginia and through Southwest and Southeast Washington in Phase II resulted in a tripling of these trips made within the D.C. core. However, there was an even larger absolute increase in the number of trips to or from the D.C. core, bringing them to one-half of all rail trips during Phase II.

The growth in rail travel to and from the D.C. core area was primarily due to the extension of the Blue Line into Northern Virginia. Three-quarters of the increase of this type of rail travel was due to the opening of this new line segment.

Much of the increase in rail travel to and from the core was due to the official policy of truncating line-haul bus routes and using the equipment as feeder buses for the rail system. This was particularly the case in Northern Virginia. Most of the bus routes which formerly linked Northern Virginia and the District were rerouted to provide feeder service to Metrorail stations at the Pentagon, Rosslyn, and National Airport. In the District of Columbia and in Prince George's County, bus routes were rerouted to feed the Stadium-Armory and Potomac Avenue stations. However, not all bus routes were cut back, and many routes continued to operate all the way downtown. The remaining bus routes were permitted to continue line-haul service to alleviate some of the fare and service inequities of the partial rail system. Transfers to Metrorail from bus and commuter rail accounted for approximately 21 percent of Metrorail trips made within the D.C. core.

The extension of the Red Line to Silver Spring during Phase IIA resulted in another large increase of almost 40,000 weekday rail riders to and from the D.C. core, a 56 percent increase over the previous phase. Three-quarters of this growth was on the new segment. Because there was only a small absolute increase of 5,000 trips within the D.C. core, this share of all Metrorail trips declined to only one-third. More importantly, it showed no absolute growth during Phase III operations, suggesting that this travel market may be saturated until a new downtown rail line is opened or until there is additional growth in downtown employment.

Figure 3.3
D.C. CORE

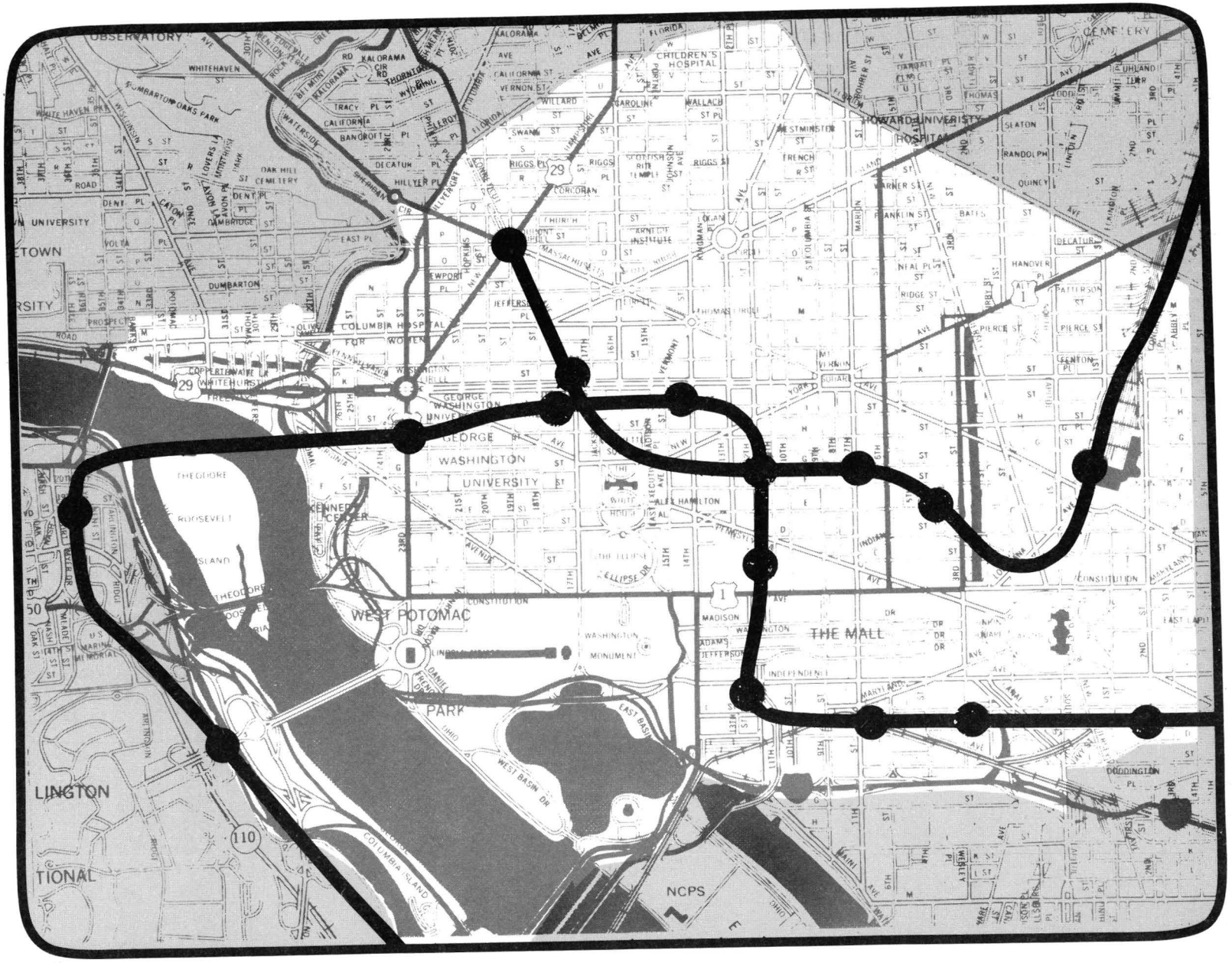


TABLE 3.3

GEOGRAPHIC DISTRIBUTION OF RAIL TRAVEL BY PHASE

	Rail Trips Within D.C. Core		Rail Trips To/From D.C. Core		Rail Trips Through D.C. Core		Rail Trips not Crossing D.C. Core Cordon	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
PHASE I	15,700	70.7%	6,300	28.4%	-	-	200	0.9%
PHASE II	57,900	43.1	67,400	50.1	1,700	1.3	7,400	5.5
PHASE IIA	62,900	33.8	105,200	56.6	4,900	2.6	13,000	7.0
PHASE III	62,700	24.1	171,600	66.1	12,500	4.8	13,000	5.0

SOURCE: WMATA Rail Passenger Surveys

While rail trips within the core did not change appreciably during Phase III, rail trips to and from the D.C. core increased substantially. Trips to and from the D.C. core increased by approximately 66,000 weekday trips, a two-thirds increase over Phase IIA. The relative share of this type of rail trip also increased from 57 percent to 66 percent.

Once again, a suburban extension of the rail system had greatly increased the number of daily transit riders using the rail system to get to and from the D.C. core. Analysis of the detailed station-to-station data from the Phase III rail passenger survey further reveals that 37 percent of this increase was directly attributable to the opening of the New Carrollton line segment.

However, not all of the growth in rail travel to and from the D.C. core in this phase can be attributed to the opening of the New Carrollton line extension. Twenty-eight percent of the increase in rail travel to and from the D.C. core was due to growth of ridership on the Silver Spring line, and almost 26 percent of the increase was due to the growth in rail travel on the Blue Line in Northern Virginia. Although the data may indicate a lag between the extension of rail service and development of full ridership potential, it appears that part of the large growth in core-oriented ridership on these segments may have been due to the sharp rise in price and limited availability of gasoline in the Washington metropolitan area.

While the rise in gasoline prices and its limited availability had a positive effect on transit ridership in all rail corridors, Table 3.3 shows that this growth was limited to ridership to and from the D.C. core. Although rail trips through the core increased by 5,000 weekday trips, most of this increase was due to trips from New Carrollton and Silver Spring line stations to Northern Virginia. Rail trips between stations outside of the core area show no growth at all in this period. It appears that there was a large market for trips within the downtown area largely satisfied with the opening of the second downtown rail line. Further increases in rail ridership appear to be dependent on increased rail travel to the central area from suburban lines.

CHANGES IN THE GEOGRAPHIC DISTRIBUTION OF BUS RIDERSHIP

Analysis of changes in the geographical distribution of bus travel complements the analysis of rail patterns described above. Bus surveys in this region typically report travel by jurisdiction, rather than by orientation to the D.C. core. Table 3.4 shows the geographic pattern of bus ridership observed in a 1972 survey prior to WMATA's takeover of the four private bus companies, and in the four succeeding WMATA bus

TABLE 3.4

BUS PASSENGER TRIPS BETWEEN JURISDICTIONS

Between Jurisdictions	Fall[a] 1972	Fall[b] 1976	Fall[b] 1977	Fall[b] 1978	Spring[c] 1979
D.C. - D.C.	218,000	227,300	197,100	213,600	259,800
Mont.-Mont.	4,600	9,300	10,400	11,600	1,000
P.G.-P.G.	2,600	4,200	5,800	5,900	12,400
Va.-Va.	20,900	23,500	48,600	53,300	63,100
D.C.-Mont.	35,800	22,000	22,900	14,900	20,700
D.C.-P.G.	32,400	20,100	17,000	16,700	21,000
D.C.-Va.	59,000	69,900	31,000	29,600	23,400
Mont.-P.G.	1,400	1,900	2,100	1,800	2,100
Mont.-Va.	700	600	400	300	100
P.G.-Va.	1,000	800	300	500	200
TOTAL	376,400	379,439	335,700	348,200	423,700

a/ All bus trips including D.C. schools.

b/ Did not include rail to bus transfers in D.C., Montgomery County, and Prince George's County.

c/ Includes all passengers, except WMATA, police, postal, school token and Metrobus transfers.

SOURCE: WMATA Bus Revenue Allocation Surveys

revenue allocation studies. Some figures in the table are not directly comparable. The 1972 survey covered all bus passengers and included D.C. school trips. The 1976, 1977, and 1978 surveys specifically excluded bus passengers who transferred from rail to bus in the District of Columbia and in Maryland. The 1979 survey included bus passengers transferring from rail to bus, but excluded D.C. school trips.

Despite these limitations, some meaningful comparisons can be made from this data. For example, comparison of the 1976 and 1977 data shows that Metrorail's crossing the Potomac halved bus travel between the District of Columbia and Northern Virginia. In this period, bus trips between D.C. and Virginia dropped from almost 70,000 weekday trips to 31,000 trips. Similarly, bus travel entirely within Virginia increased by 25,000 trips.

Extension of the rail system to Northern Virginia resulted in a shift of the geographical patterns of bus travel between the District of Columbia and Northern Virginia. The continuation of this pattern is evident in the data for 1978 and 1979. Bus travel between D.C. and Virginia shows a decline and Virginia-to-Virginia bus travel shows an increase. It cannot be determined from this data, however, how many of the former bus trips between D.C. and Northern Virginia are now being made by rail, or how many of the additional intra-Virginia bus trips are due to the shift from bus-only trips to bus-rail trips.

In order to obtain comparable data, one can select only those surveys in which all or almost all bus trips were included (in this case the 1972, 1976, and 1979 surveys). This allows a comparison of a 1972-1976 pre-Metrorail period with a 1976-1979 post-Metrorail period.

Table 3.5 presents changes in bus ridership patterns between the pre- and post-Metrorail periods. D.C. school trips have been eliminated from the 1972 survey figures to make them more comparable to the 1976 and 1979 figures. Although the 1976 survey did not cover bus passengers transferring from rail to bus, rail-to-bus transfers accounted for only 4,000 daily trips in that year.

As shown in Table 3.5, bus ridership within each jurisdiction increased in the 1972 to 1976 period. During this time Metro acquired the four private bus companies and began to improve equipment, add service, and integrate routes. Bus trips between Northern Virginia and the District also showed a considerable increase. However, bus ridership between Montgomery County and D.C. dropped by almost 14,000 trips, and that between Prince George's County and D.C. dropped by more than 12,000 weekday trips.

TABLE 3.5

CHANGE IN BUS PASSENGER TRIPS BETWEEN JURISDICTIONS:
1972 - 1976 - 1979

	BEFORE METRO			AFTER METRO	
Jurisdiction	1972	1976	Change 72-76	1979	Change 76-79
D.C. - D.C.	178,000	227,300	49,300	259,800	32,500
Mont.-Mont.	4,600	9,300	4,700	21,000	11,700
P.G. - P.G.	2,600	4,200	1,600	12,400	8,100
Va. - Va.	20,900	23,500	2,600	63,100	39,600
D.C. - Mont.	35,800	22,000	-13,800	20,700	- 1,300
D.C. - P.G.	32,400	20,100	-12,300	21,000	900
D.C. - Va.	59,000	69,900	10,800	23,400	-46,400
Mont.-P.G.	1,400	1,900	400	2,100	200
Mont.-Va.	700	600	- 100	100	- 500
P.G. - Va.	1,000	800	- 200	200	- 600
TOTAL	336,400	379,400	43,000	423,700	44,300

In the 1976 to 1979 period, the period reflecting the opening and operation of the Metrorail system, bus trips within the suburbs and within the District of Columbia continued to increase. The increase in Virginia resulted directly from expansion of the rail system. The increase of 40,000 weekday trips in intra-Virginia bus travel compares closely with a 46,000 weekday trip decrease in bus travel between the District of Columbia and Northern Virginia. However, the situation is less clear for Maryland and the District. Here, the increase in intrajurisdictional bus travel does not appear to be offset by a corresponding decline in interjurisdictional travel. Intra-Montgomery County bus travel shows an increase of almost 12,000 weekday trips, but bus travel between the County and the District of Columbia shows practically no change. Likewise, weekday bus trips within Prince George's County show an increase of 8,000 trips, and only minor changes in interjurisdictional bus travel. From this aggregate analysis, it appears that the extension of the rail lines into Maryland may have added new transit riders while retaining the previous number of bus users. The prior discussion of total transit use indicated that following the first Maryland extension, the total transit market increased for the first time.

CHANGES IN BUS SERVICE

Since the opening of Metrorail service, extensive changes have been made in the regional bus system. Many of these changes were intended to integrate the bus and rail systems. At the same time these changes were made, many other adjustments were made in order to improve the bus system itself, which was taken over by WMATA from four private operators in 1972. Many improvements recommended in 1972 had not been made because of public resistance to changes.

As shown in Table 3.6, the total annual amount of bus service in the WMATA region declined from 55 million miles during Fiscal Year 1977, when only the initial Red Line was operating, to 51 million miles in Fiscal Year 1979. This represents an eight percent reduction in bus service through the summer of 1979, when Metrorail was operating to New Carrollton.

The reduction in bus service in individual Metro corridors is more complex to measure, not only because of the extensive number of changes, but also because many of them were unrelated to the rail system. One place where it is possible to identify major changes in bus service is the Silver Spring corridor. Prior to the extension of Metrorail service in this corridor, there were 332 a.m. and p.m. peak-period bus trips in the principal direction on 16th Street and Georgia Avenue. With the turnback of some bus routes and reductions in others, there was a net reduction of 154 peak-period bus trips between Maryland the District. These eliminated bus trips had carried 2,491 passengers--one-third of the ridership in the corridor.

TABLE 3.6

TRENDS IN BUS SERVICE & RIDERSHIP

YEAR[a]	Annual Bus Miles	Annual Bus Passengers[b]
1975 - 1976	55,400,000	126,806,000
1976 - 1977	55,422,000	127,000,000
1977 - 1978	52,356,000	112,599,000
1978 - 1979	50,990,000	119,848,000

[a]Reported on a June-June Fiscal Year.

[b]Includes Passengers Transferring To or From Metrorail as well as those using Buses Only.

CONCLUSIONS

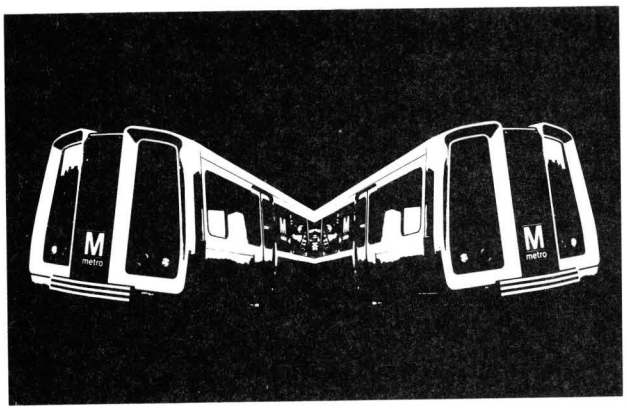
The prior chapter discussed the dramatic growth of ridership on the Metrorail system between its opening in 1976 and its expansion to a 31-mile system in 1979. This system was opened, however, in a region already served by one of the largest regional bus systems in the United States. As already cited, the majority among the 266,000 rail riders by the Fall of 1979 had previously been on the bus system. As the downtown rail network was expanded, the increases in rail trips were matched by losses from the bus system. Some of the reduction in bus travel was attributable to a choice by passengers to take the faster mode, while in other cases the transit operator terminated bus routes at rail stations, or eliminated competing routes.

The opening of the Blue Line resulted in an increase in rail trips which was almost equal to the loss of bus-only trips. With the extension to Silver Spring, the increase in rail trips exceeded the loss in bus-only trips and resulted in a net gain in regional transit for the first time. During the following year, there were increases in both rail trips and bus trips not

using rail. Between 1975 and 1979, there was a net increase of 223,000 regional weekday transit trips, a gain of 56 percent since 1975, somewhat less than the current rail patronage of 266,000 daily trips. By that time, the Metrorail system carried 43 percent of all weekday transit trips served by WMATA. The importance of bus access to Metrorail is indicated by the fact that one-half of all rail trips in 1979 also used a bus.

During the early stages of Metrorail, a large number of rail trips were made entirely within the downtown area. However, this number has peaked at about 60,000 riders per day, and virtually all of the recent growth has been for rail trips to and from the D.C. core. Over nine out of every ten rail trips in 1979 had one or both ends inside Central Washington.

While the rail system has begun to carry transit riders to and from the core area, the focus of the bus system has slowly shifted from carrying commuters into the city to serving trips made entirely within the suburbs or the city. Bus trips between the suburban jurisdictions and the core are down while intra-suburban trips are up. More and more of the growth in bus travel represents travel to and from rail stations within the same jurisdiction. This is more clearly seen in Northern Virginia where bus operations are linked to the rail system in all major travel corridors.

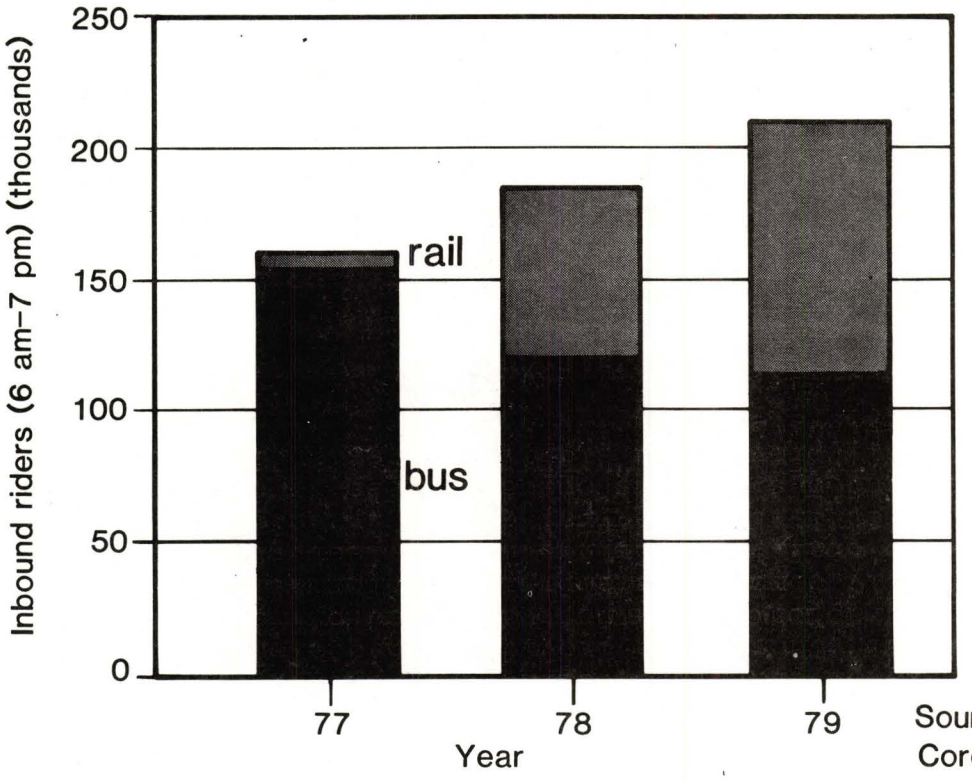


CHAPTER 4

TRAVEL TO THE CORE

Figure 4.1

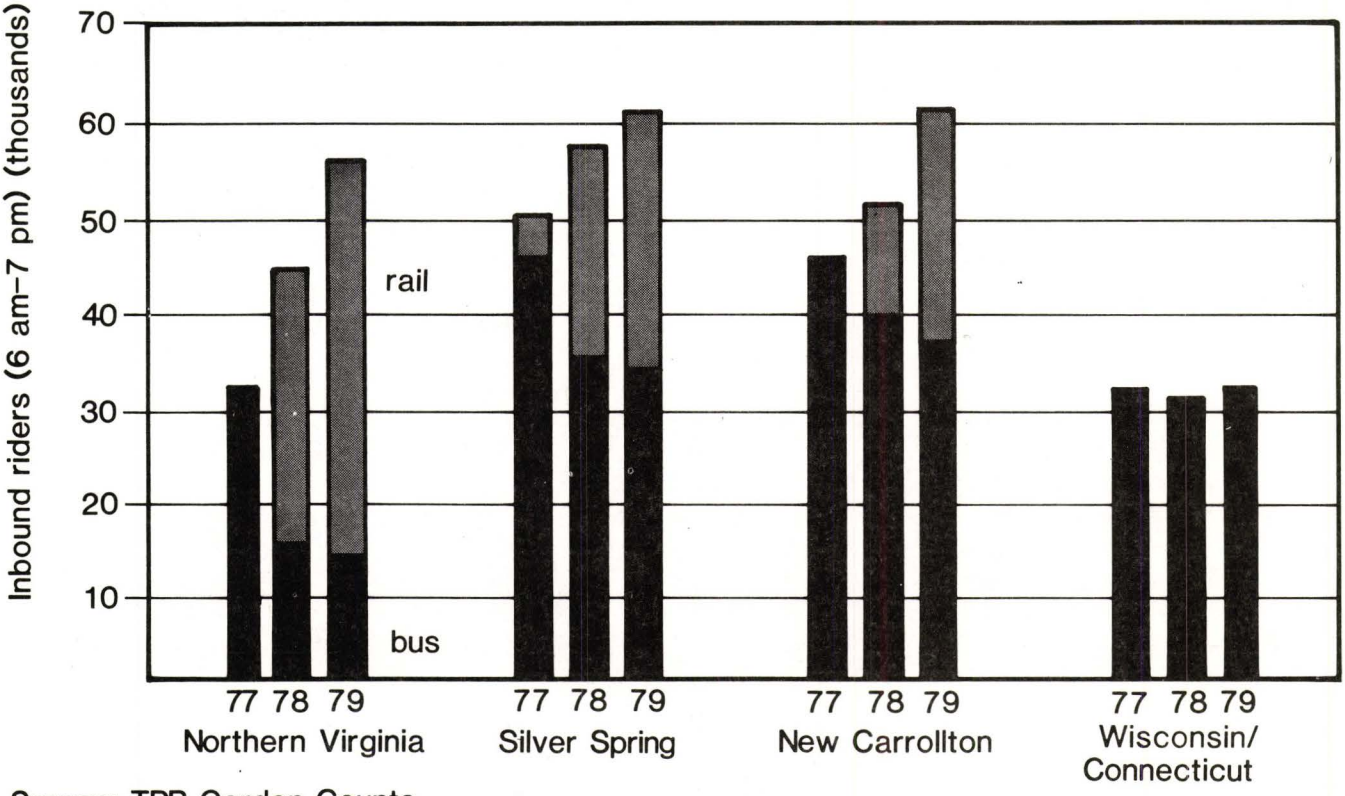
CHANGE IN TRANSIT RIDERSHIP TO THE DC CORE 1977–1979



Source: TPB Cordon Counts

Figure 4.2

CHANGE IN TRANSIT RIDERSHIP TO THE DC CORE BY TRAVEL CORRIDOR



Source: TPB Cordon Counts

CHAPTER IV

TRAVEL TO THE CORE

Of the 31 miles of Metrorail in operation by 1979, almost half were located in the core areas of downtown Washington and adjacent employment centers in Northern Virginia. Approximately 90 percent of all rail ridership in this period represented travel to and from the D.C. core (see Figure 3.3). It is likely, therefore, that any Metro-related travel changes will occur first in this area.

The Transportation Planning Board of the Metropolitan Washington Council of Governments has collected extensive data over the past several years on traffic entering the central employment area of the region. These data provide a unique opportunity to isolate the geographic region most affected by Metrorail and to obtain directly comparable empirical information on Metrorail, bus, and auto traffic entering the heaviest travel cordon in the region. It is this central cordon in which both the existing highway and bus systems operate close to capacity, and for which Metrorail provided a significant expansion in the capacity of the transit system.

CHANGES IN TRANSIT RIDERSHIP TO THE D.C. CORE

Total transit ridership across the D.C. core cordon line increased from 160,000 inbound riders in 1977 to 213,000 inbound riders in the Spring of 1979, as shown in Figure 4.1. The proportion of this ridership on the rail system increased substantially, growing from 2.5 percent in 1977 to 34 percent in 1978 to 44 percent in 1979.

Expansion of rail service in this period also allowed a net reduction of 1,200 core area bus trips, a 22 percent decrease over the 1977 total. Consequently, bus ridership across the D.C. core cordon decreased in absolute as well as relative terms. Total bus ridership dropped by approximately 36,000 inbound trips or 23 percent, a decline slightly greater than the reduction of bus trips.

These observations at the central cordon reveal the same pattern observed in the analysis of the regional bus and rail survey data. The role of the rail system in carrying transit passengers to and from the D.C. core areas has expanded with each new rail line, while at the same time the role of the bus system in serving line-haul central area trips has declined. As shown in Figure 4.2, the change in total core area transit use is even more dramatic when individual transit corridors are examined.

The emerging changes in core area transit travel are most clearly seen in Northern Virginia. Total transit ridership in this corridor practically doubled while bus ridership was cut in half. Total bus trips between Northern Virginia and the D.C. core dropped by 56 percent. By 1979 the proportion of total transit ridership traveling to the D.C. core from Northern Virginia on Metrorail approached 75 percent.

The same general pattern of change in transit ridership observed in the Northern Virginia corridor was also seen in the Silver Spring corridor. Bus ridership showed a significant decrease, 23 percent in this case, while rail and total ridership showed sizeable increases. Bus trips dropped by 22 percent as rail ridership became a larger proportion of total transit in the corridor. Rail grew from 9 percent of the total in 1977 to 37 percent in 1978 after the opening of the Silver Spring extension, and then to 44 percent in 1979.

Although the change in transit travel observed in the New Carrollton corridor follows the same general trend noted in the Northern Virginia and Silver Spring corridors, the decrease in bus ridership in this corridor was not as great. One of the reasons for this fact is that the New Carrollton corridor defined for the purposes of this analysis covers a rather broad area. The totals for this corridor include all transit trips entering the D.C. core between New York Avenue, N.W., and 14th Street, S.W. While the decrease in bus travel has not been great, Metrorail is capturing an increasing share of total transit ridership in this corridor. After an initial share of 23 percent of total transit ridership in 1978, the percentage of total ridership on rail grew to 39 percent in 1979.

The pattern of transit ridership changes shown for the Wisconsin/Connecticut Avenue corridor is quite different from that seen in the other travel corridors to the core area. The Wisconsin/Connecticut Avenue corridor was the only major radial corridor not directly served by the rail system in the 1977 to 1979 period. Although the Dupont Circle Metrorail station on Connecticut Avenue opened just inside the D.C. core cordon in January 1977, rail service in this corridor is not scheduled until 1981 when the Red Line will reach Van Ness/UDC. The Wisconsin/Connecticut Avenue ridership data shown in Figure 4.2 show virtually no change in total transit use, a sharp contrast to the Metro corridor pattern. Total transit ridership is seen fluctuating at around 31,000 daily inbound riders. This lack of change is particularly striking when compared to the ridership changes in the Northern Virginia corridor. Total transit ridership in the Northern Virginia travel corridor was about the same as ridership in the Wisconsin/Connecticut Avenue corridor in 1977. By 1979 ridership in the Northern Virginia corridor, spurred by the expansion of rail service, showed a 75 percent increase,

while in the Wisconsin/Connecticut Avenue corridor, where there was no similar expansion of rail service, total ridership showed no growth at all. The increase in ridership in Northern Virginia after the opening of Metrorail suggests substantial increases will occur in the Wisconsin/Connecticut Avenue corridor following the extension of the Red Line beyond Dupont Circle.

CHANGES IN AUTO TRAVEL TO THE D.C. CORE

The effect of Metrorail on travel to and from downtown Washington has not been limited to transit travel. Figure 4.3 shows that total auto person travel across the D.C. core cordon decreased by 48,400 inbound trips between 1977 and 1979.

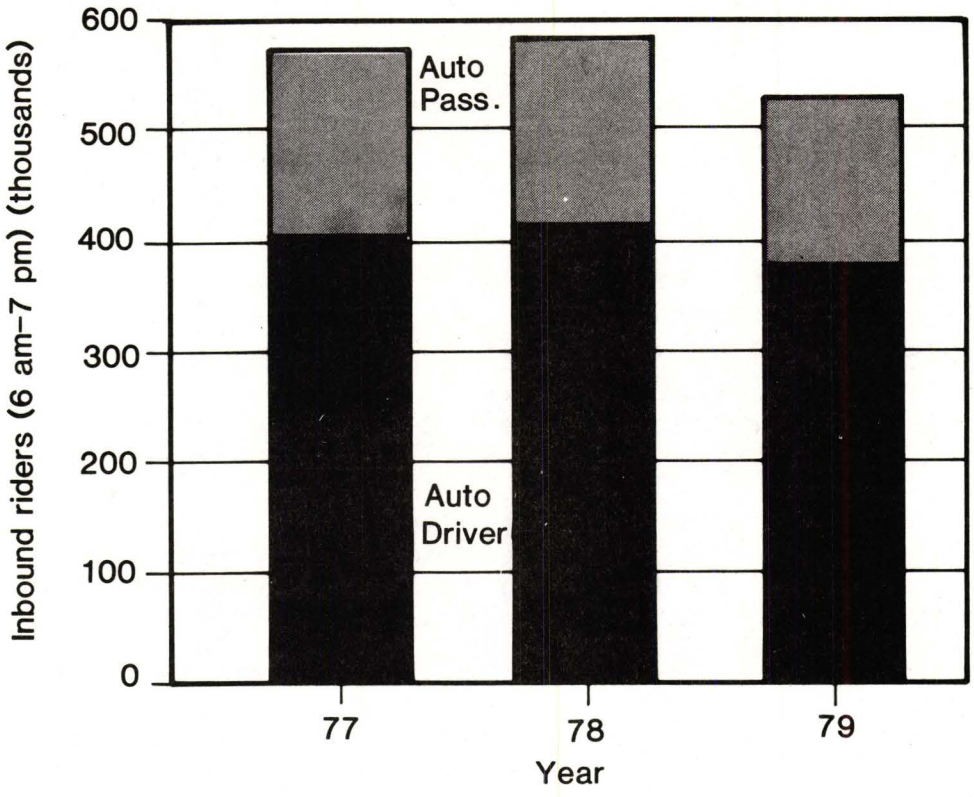
At the same time the total number of autos entering downtown Washington decreased by 30,800. These two decreases represent respectively an 8.3 percent reduction in core area auto person travel and a 7.6 percent reduction in core area auto driver trips.

Figure 4.3 clearly shows that it was not until 1979 that the drop in auto travel was observed. The 1979 counts were taken five months after the opening of the New Carrollton Metrorail line with over 4,000 parking spaces at its stations, but well before the Summer 1979 gas shortage. This was also the same period when total transit use began to show large increases. The 1977 cordon count was taken in the Spring prior to the opening of the Metrorail Blue Line. The 1978 count was taken in the Spring of 1978 just after extension of the Red Line to Silver Spring. Consequently, it was not until the 1979 count that the full effects of the two suburban rail extensions on auto travel could be seen. Further insight into these changes in core area auto travel is gained by looking at each of the major travel corridors individually as shown in Figure 4.4.

The most significant reduction in auto travel occurred in the Northern Virginia travel corridor which also showed the largest increase in Metrorail ridership. Total auto travel in this corridor declined by 13 percent between 1977 and 1979. Auto driver trips decreased by 15,000 inbound trips and auto passenger trips fell by 10,100 inbound trips.

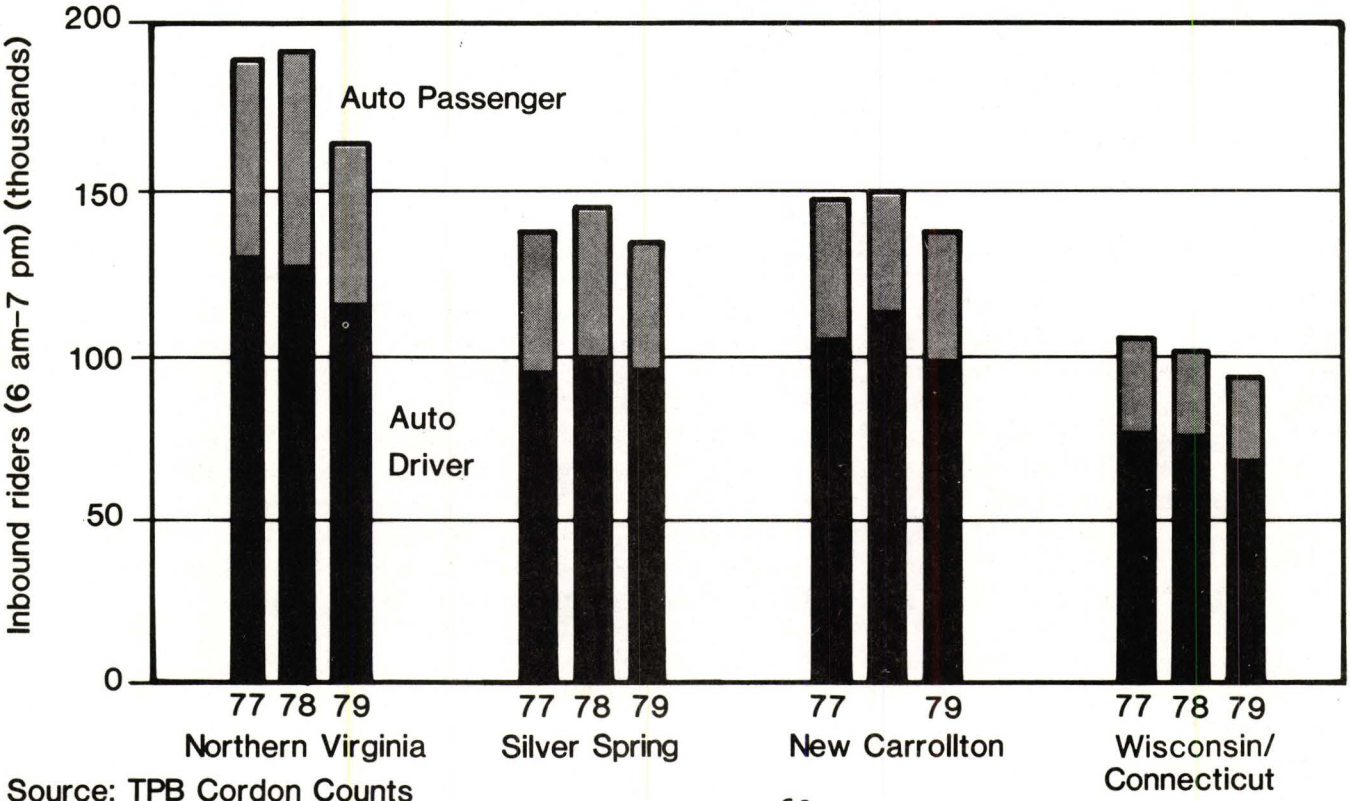
Metrorail's effects on auto travel in the Silver Spring corridor were not as significant. Total auto travel in this corridor decreased slightly between 1977 and 1979. However, this decrease is not uniform. Total auto travel increased by 5 percent between 1977 and 1978 and then decreased by more than 6 percent between 1978 and 1979. This study's definition of

Figure 4.3
CHANGE IN AUTO TRAVEL TO THE DC CORE 1977–1979



Source: TPB Cordon Counts

Figure 4.4
CHANGE IN AUTO TRAVEL TO THE DC CORE BY TRAVEL CORRIDOR



Source: TPB Cordon Counts

the Silver Spring corridor includes a rather wide area. For this reason it is very difficult to pinpoint auto travel coming from areas close to the rail line. Detailed analysis of changes in auto travel at individual count sites in this corridor shows a significant reduction in auto use on 16th Street entering the core. A 15 percent reduction in auto person travel at this site was first observed in 1978 and was followed by an additional 10 percent reduction in 1979 for a total reduction of 24 percent for the 1977 to 1979 period.

The decrease in auto travel on 16th Street is especially significant because 16th Street is where a change in auto travel between Silver Spring and D.C. would most likely be seen. Most of the decline in auto travel on 16th Street was due to a drop in auto passenger trips. While total auto person trips declined by 24 percent in this two-year period, total auto driver trips declined by only 16 percent.

A significant reduction in total auto travel entering the D.C. core occurred also in the New Carrollton corridor after the extension of Metrorail service. Total auto person travel in this corridor declined by about 9,700 inbound trips. Auto driver trips decreased by 7,600 inbound trips or 7 percent. Analysis of the decline in auto travel at individual count sites in this corridor reveals significant reductions at most locations. Auto driver trips declined by 14 percent at the East Capitol Street and Pennsylvania Avenue, S.E. count sites and by 18 percent at the Southeast Freeway count site.

Figure 4.4 shows that auto use declined in the Wisconsin/Connecticut Avenue travel corridor also, even without Metrorail. Inbound auto driver trips in this corridor declined by 8,400 trips and inbound auto passenger trips decreased by 3,000 trips, both representing 11 percent reductions. Most of the decrease in auto travel occurred on Connecticut Avenue where peak-period capacity was severely reduced by Metrorail construction on the Van Ness line.

METRORAIL IMPACTS ON RUSH HOUR TRAFFIC

A primary goal of Metrorail is to reduce traffic congestion by providing an alternative to the private automobile for commuting. An indication of Metrorail's initial impact on peak-hour commuting can be obtained by isolating travel to the D.C. core area during the 6:30 - 9:30 a.m. peak period when most commuting trips are made and when travel capacities on the approaches to downtown are most strained. Table 4.1 shows that total morning peak-period auto travel entering the D.C. core cordon declined by approximately 5 percent between 1977 and 1979. Auto passenger trips dropped by 4,300 inbound trips and auto driver trips dropped by 6,300 inbound trips. Although peak-period auto

travel was less in 1979 than in 1977, the data in Table 4.1 show that auto driver and auto passenger trips in 1978 were slightly higher than in 1977. This rise and fall in auto travel does not reveal a clear pattern, although it is indicative of a downward trend.

TABLE 4.1

PEAK-PERIOD TRAVEL TO THE D.C. CORE
(6:30-9:30 a.m. Inbound Trips)

AUTO PERSON TRIPS	1977	1978	1979	Change 77-79
Auto Driver	151,200	153,400	144,900	- 6,300
Auto Passenger	72,500	74,900	68,200	- 4,300
Total Auto	223,700	228,300	213,100	-10,600
Average Auto Occupancy	1.48	1.49	1.47	- .01
WMATA TRANSIT TRIPS				
Metrobus	91,500	68,200	63,700	-27,900
Metrorail	2,600	38,800	57,800	+55,100
Total WMATA	94,100	106,000	121,300	+27,200
Percentage Transit	30%	32%	36%	+6%

The change in peak-period transit ridership is consistent and significant. The increase of more than 27,000 inbound peak-period transit riders across the D.C. core area cordon represents a 30 percent increase in transit riding in just a two-year period.

The growth in transit ridership in this period directly parallels the expansion of rail service. In the Spring of 1977, only five miles of Metrorail were in operation and Metrorail ridership was only three percent of all transit ridership entering the D.C. core. After extensions of Metrorail to Northern Virginia and Silver Spring, total morning peak-period transit increased by 11,900 riders and Metrorail's share of the total increased to 37 percent.

By the time of the 1979 cordon count, Metrorail had been extended to the Beltway (New Carrollton) in Prince George's County and again total ridership increased as the rail system's share of total ridership grew. The 1979 count showed that Metrorail accounted for almost half the peak-period transit ridership crossing the D.C. core cordon.

Looking at the combined changes in peak-period transit and auto travel, one sees a net diversion of 10,600 peak-period auto trips to transit, and a net increase of 16,500 "new" peak-period transit riders to the D.C. core.

This growth in new transit ridership was made possible by the expanded peak-period transit capacity provided by Metrorail. The expansion of Metrorail service resulted in the replacement of approximately 600 peak-period buses from congested downtown streets. These buses were replaced with almost the same number of rail cars seating almost twice as many passengers. This substitution of rail service for bus service represented an increase of 21,000 seats in peak-period capacity to the D.C. core, an increase of 17 percent over the all-bus sytem.

CHANGES IN MORNING PEAK-PERIOD TRAVEL BY CORRIDOR

Table 4.1 shows the cumulative effects of the extension of the rail system in serving regional trips to the core. Analysis of these data by corridor shows a pattern similar to that described above for daily travel.

Table 4.2 shows that in the Northern Virginia corridor morning peak-period auto travel decreased by 6 percent while transit use increased by 44 percent. Auto driver trips showed a 2,700 trip decline. Average auto occupancy was the same in 1979 as it was in 1977. However, auto occupancy in 1978 appeared to be at a much higher level. Transit use in this travel corridor showed a large percentage increase and rose from 25 percent in 1977 to 34 percent in 1979. The largest increase in transit ridership occurred between 1978 and 1979.

Table 4.3 shows the change in morning peak-period travel at the Silver Spring count site of the D.C. core cordon. Although total bus and rail ridership in this period grew by 25 percent, morning peak auto use showed virtually no change. Average auto occupancy decreased from 1.51 to 1.42 in this period and the absolute number of auto driver trips rose slightly. Percentage transit use increased from 34 percent in 1977, to 38 percent in 1978, and to 40 percent in 1979.

TABLE 4.2

NORTHERN VIRGINIA PEAK-PERIOD TRAVEL TO D.C. CORE
(6:30-9:30 a.m. - Inbound Trips)

AUTO PERSON TRIPS	1977	1978	1979	Change 77-79
Auto Driver	46,000	46,700	43,000	- 2,700
Auto Passenger	25,500	29,800	23,800	- 1,700
Total Auto	71,500	76,500	67,100	- 4,400
Average Auto Occupancy	1.55	1.64	1.55	NC
WMATA TRANSIT TRIPS				
Metrobus	24,100	12,800	11,200	-12,900
Metrorail	-	15,600	23,500	+25,500
Total WMATA	24,100	28,400	34,700	+10,600
Percentage Transit	25%	27%	34%	+ 9%

TABLE 4.3

SILVER SPRING PEAK-PERIOD TRAVEL TO D.C. CORE
(6:30 - 9:30 a.m. - Inbound Trips)

AUTO PERSON TRIPS	1977	1978	1979	Change 77-79
Auto Driver	33,700	33,500	35,000	+ 1,300
Auto Passenger	17,200	17,000	14,800	- 2,400
Total Auto	50,900	50,500	49,800	- 1,100
Average Auto Occupancy	1.51	1.51	1.42	- .09
WMATA TRANSIT TRIPS				
Metrobus	24,200	16,800	15,800	- 8,400
Metrorail	2,600	14,700	17,600	+15,000
Total WMATA	26,800	31,400	33,400	+ 6,600
Percentage Transit	34%	38%	40%	+ 6%

Peak-period auto travel in the New Carrollton corridor reported in Table 4.4 showed a 4 percent decrease, while peak-period transit use increased by 34 percent in the 1977-1979 period.

Most of the reduction in auto travel occurred among auto driver trips which decreased by 2,400 inbound trips. Peak-period transit trips increased by 9,400, almost as much as the increase from Virginia. They also increased as a proportion of total peak-period travel by 7 percentage points.

TABLE 4.4

NEW CARROLLTON PEAK-PERIOD TRAVEL TO D.C. CORE

(6:30 - 9:30 a.m. - Inbound Trips)

AUTO PERSON TRIPS	1977	1978	1979	Change 77-79
Auto Driver	42,600	43,500	40,200	- 2,400
Auto Passenger	19,500	17,100	19,300	- 200
Total Auto	62,100	60,600	59,500	- 2,600
Average Auto Occupancy	1.46	1.39	1.48	+ .02
WMATA TRANSIT TRIPS				
Metrobus	27,600	23,000	20,400	- 7,200
Metrorail	-	8,500	16,600	+16,600
Total WMATA	27,600	31,500	37,000	+ 9,400
Percentage Transit	31%	34%	38%	+ 7%

In contrast to the other radial travel corridors, transit travel in the Wisconsin/Connecticut Avenue Corridor remained stable over the same time period. Table 4.5 shows that in the 1977 to 1979 period morning peak-period transit travel increased by only 3 percent. Although peak-period auto travel decreased by 5 percent, much of this decline may have been due to Metrorail construction on Upper Connecticut Avenue. Average auto occupancy and percent transit use changed very little while the total volume of person travel entering the D.C. core from this corridor in the morning peak period actually declined by 3 percent, the only corridor with such a decline.

TABLE 4.5

WISCONSIN/CONNECTICUT AVENUE PEAK-PERIOD TRAVEL TO THE D.C. CORE

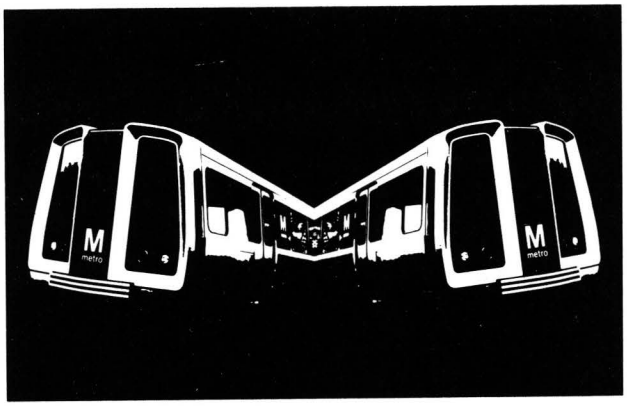
(6:30 - 9:30 a.m. - Inbound Trips)

AUTO PERSON TRIPS	1977	1978	1978	Change 77-79
Auto Driver	28,900	29,800	26,400	- 2,500
Auto Passenger	10,300	10,900	10,400	+ 100
Total Auto	39,200	40,700	36,800	- 2,400
Average Auto Occupancy	1.36	1.36	1.39	+ .03
WMATA TRANSIT TRIPS				
Metrobus	15,500	15,600	16,200	+ 700
Metrorail	-	-	-	-
Total WMATA	15,500	15,600	16,200	+ 700
Percentage Transit	28%	28%	31%	+ 3%

CONCLUSIONS

The focus of Metrorail service and ridership to the regional core makes this probably the most important target area in which to measure the initial effects of Metro. The three rail lines which entered the D.C. core in 1979 added a total capacity of about 90,000 additional transit riders which could be carried during the peak period. This represents an increase of about one-third in transit capacity to the regional core, probably the only place where ridership is close to capacity. Between 1977 and 1979, peak daily transit ridership entering this area had increased by 33 percent and by the Spring of 1979, 44 percent of transit trips entered the core on rail. Parallel trends were observed in each of the three major sectors served by Metrorail as of 1979, with a larger impact on trips from Virginia, than from the two rail corridors extending into Maryland. The only exception was the Wisconsin/Connecticut Avenue corridor, which did not yet have an operating rail line, and which showed no change in transit trips entering the core. If the experience in the other rail corridors is a forerunner, the planned extension of the Red Line to Van Ness in December of 1981 should produce similar gains in total transit use in that corridor.

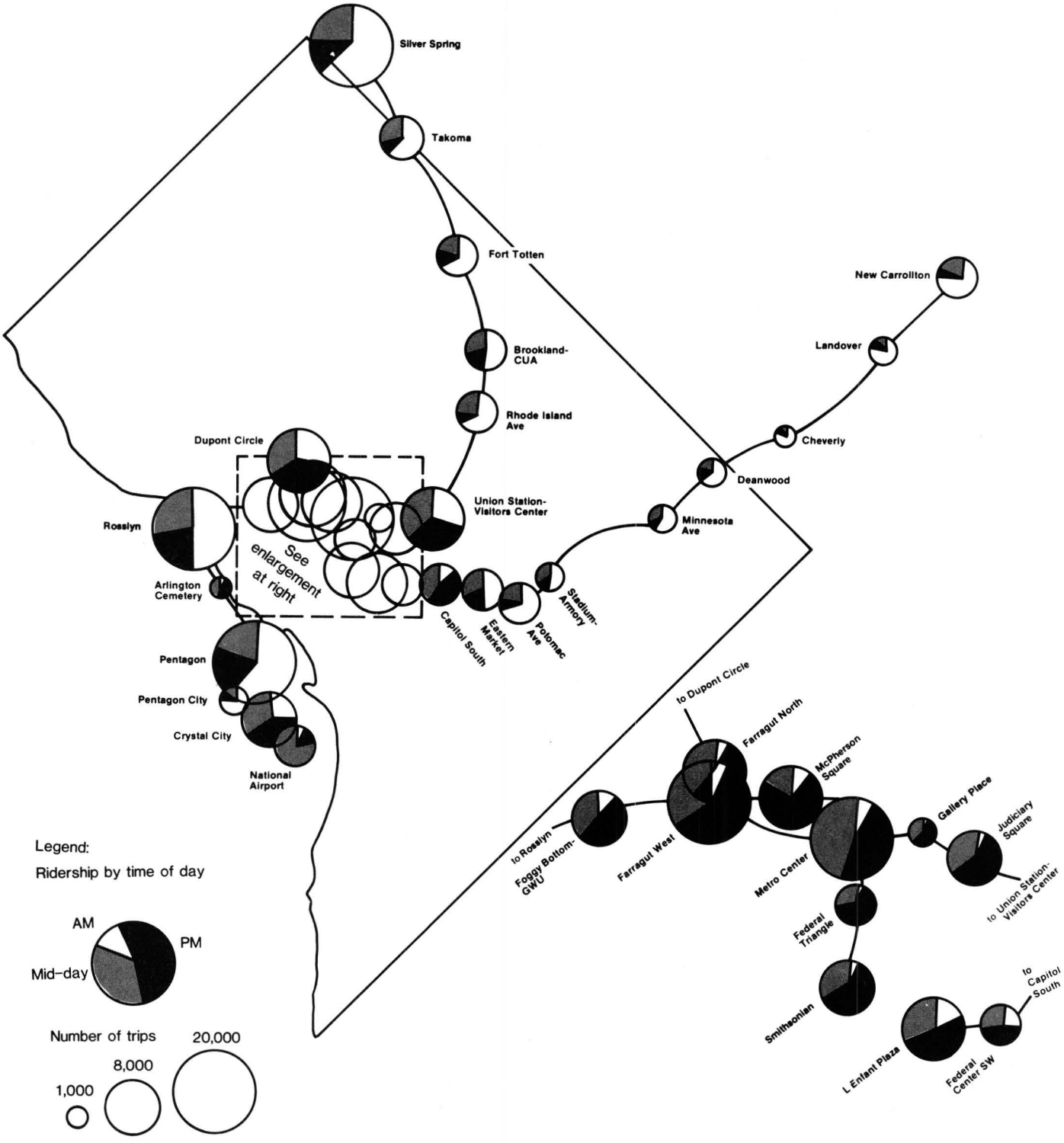
The increase in transit ridership entering the D.C. core during the morning peak period was 30 percent between 1977 and 1979, close to the growth of one-third in daily transit trips entering this area. This increase was accompanied by a decline in peak period auto travel of 6,300 auto driver trips and 4,300 passengers, a 4 percent decline over two years. The additional capacity opened up by such a reduction in auto congestion would enable the construction of approximately 3 million square feet of additional office space downtown. Moreover, the large increases in transit capacity and ridership have more than made up for the loss in travel by auto, with a net increase of 16,600 people entering the D.C. core during the first two years of Metrorail operations. The rail system in its period of initial operations has allowed substantial increases in travel to the central area without increases in highway capacity, supporting the principal goals of its planners.



CHAPTER 5

PLACES AND PEOPLE: THE MARKET FOR METRORAIL

Figure 5.1
METRORAIL STATION ARRIVALS BY TIME OF DAY



CHAPTER V

PLACES AND PEOPLE: THE MARKET FOR METRORAIL

Previous chapters dealt with regional trends in the level and composition of transit trips. However, the effects of a major service such as Metrorail do not occur at the regional level. They are observed at specific places, generally transit station areas, and they affect specific people, the Metrorail users. It is the purpose of this chapter to analyze both the geographical distribution of Metrorail travel at different stations and the characteristics of the riders served from the beginning of rail service through Phase III of rail operations in the Spring of 1979.

STATION CLASSIFICATIONS

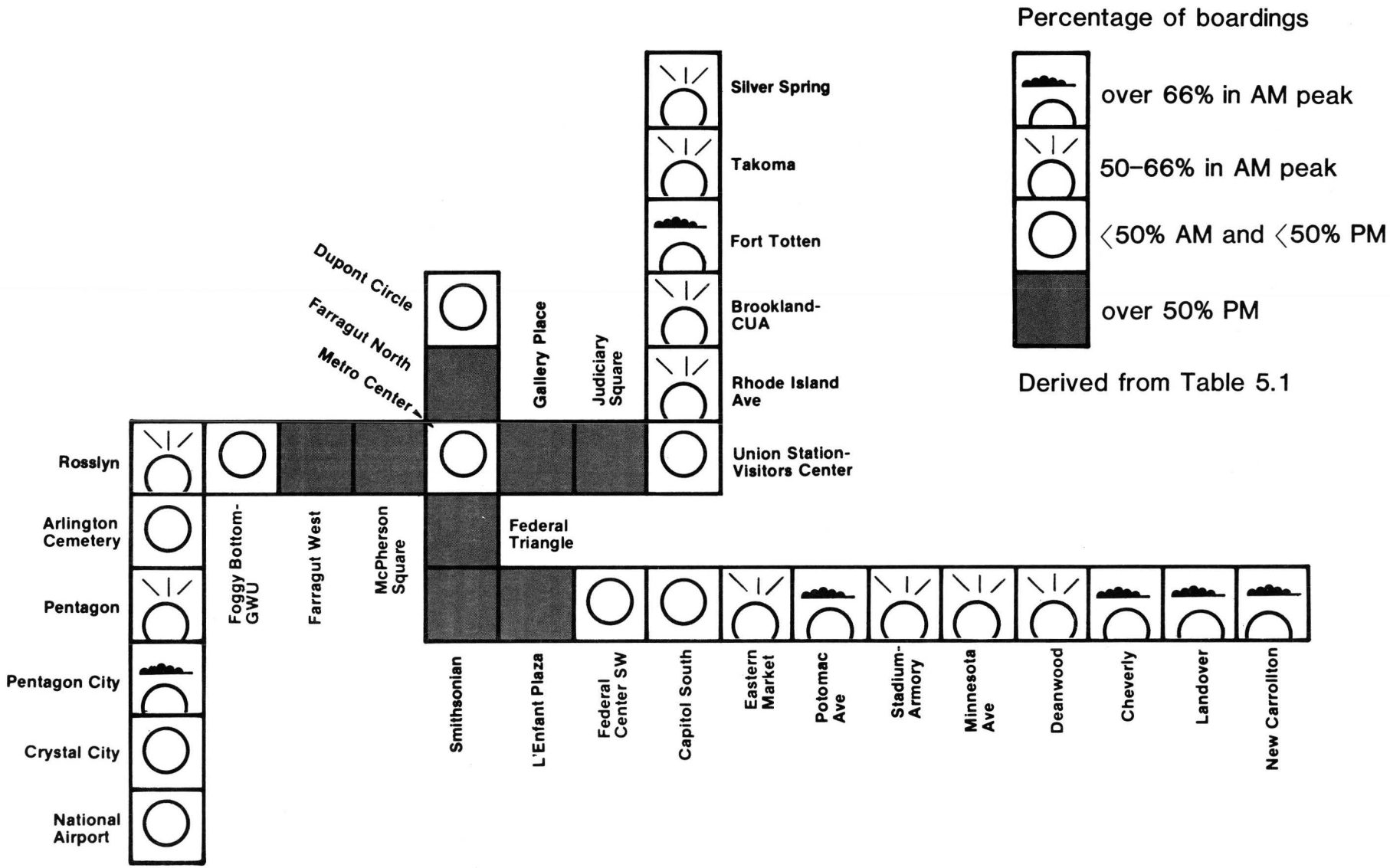
One of the earliest differences observed between Metrorail and traditional transit services was that trips were much less concentrated in the peak hours during the initial period of operations. In fact, lunch hour ridership actually exceeded passenger loads during the peak. With extension of Metrorail service to Virginia, and successive extensions to Silver Spring and to New Carrollton, ridership became much more concentrated during the morning and afternoon peak periods.

By the Spring of 1979, slightly fewer than one-third of all Metrorail passengers traveled during the morning peak, and more than one-third traveled in the evening peak, meaning two out of every three passengers traveled during the peak travel periods. Most non-work trips are carried during the midday.

The number of passengers boarding each Metrorail station during different times of the day is shown in Figure 5.1. The wide variation in station volumes is clearly shown. The station carrying the highest daily volume in 1979 was Farragut West (23,000), followed closely by Metro Center, Rosslyn, and the Pentagon. The next most heavily used stations were Silver Spring, Dupont Circle, McPherson Square, and Farragut North. These eight stations, which represented one-fourth of all of the 33 Metro stations in operation during 1979, were used by one-half of all daily Metrorail passengers.

Analysis of the pattern of arrivals by time of day at each station shows that there are few locations with "average" conditions. In most cases, sharp differences in peaking characteristics occur. All but 9 out of 33 stations can be identified as peak-period stations with the majority of passengers entering during a peak

Figure 5.2
CLASSIFICATION OF METRORAIL STATIONS BY TIME OF ARRIVAL–MAY 1979



period. Of these peak-period stations, 16 are morning peak stations and 8 are evening peak stations. Further analysis of the morning peak stations shows that 6 of these stations can be further classified as almost exclusively morning peak stations, with more than 7 out of every 10 daily riders arriving in the morning peak.

The classification of Metro stations into these categories is shown in Figure 5.2 and Table 5.1 All of the stations having evening peak dominance are in downtown Washington and extend from Farragut West to L'Enfant Plaza on the Blue/Orange Line and from Farragut North to Judiciary Square on the Red Line. The exception is Metro Center Station, which does not have a majority of trips during either peak, indicating a balanced pattern of trip arrivals throughout the day. Other stations having such a "day long" trip arrival pattern occur immediately beyond the evening stations on each line. Three other stations having this pattern are Arlington Cemetery, National Airport, and Crystal City.

It can be inferred from the analysis of arrival times that certain stations serve primarily residential areas, others serve employment areas, and others may serve a mixture of both, as well as shopping and other types of travel. As shown in Table 2.3, on an average weekday approximately four out of every ten Metrorail trips in 1979 were destined to work. The remaining trips were destined for job-related, personal business, shopping, or other destinations, including home.

However, when the system average is broken down by individual station as shown in Figure 5.3, there are no stations which conform exactly to the regional average. The classification of stations into three purpose categories in Table 5.2 indicates that more than one-half (17 out of 33) of the stations have a majority of their destinations as home, and the majority of other trips destined to these stations are for purposes other than work. There is an exact correspondence between these "residential" stations having most of their trips to home and the stations classified as morning peak-period stations, except for National Airport which is a unique generator. The stations dominated by work trip purposes appear to fall into two categories: those having a significant percentage of trips to home (30 percent or more), and those with relatively few trips to home (25 percent or less). All of the stations previously classified as evening-peak stations fall in the first category of stations having a very high percentage share of non-work trips. In addition, there are three other stations in this employment-dominant category classified as having a high percentage of off-peak travel. These stations -- Metro Center, Capitol South, and Foggy Bottom/GWU -- all have less than 50 percent work trips, although the percentage of trips to home is low and the percentage of non-work trips is very high. In fact, the only station with a higher percentage of non-work trip destinations than these was Gallery Place.

TABLE 5.1

CLASSIFICATION OF METRORAIL STATIONS BY TIME OF ARRIVAL - MAY 1979

	Percentage of Arrivals in AM Peak	PM Peak	Off-Peak
Peak Morning-Peak (More than 66 Percent of Arrivals in AM Peak)			
Cheverly	79%	7%	14%
Landover	78	7	15
Pentagon City	77	5	18
New Carrollton	74	5	21
Potomac Avenue	70	7	23
Fort Totten	68	10	22
Morning-Peak (Between 50-66 Percent of Arrivals in AM Peak)			
Deanwood	63	11	26
Rhode Island Avenue	62	11	27
Takoma	62	10	28
Silver Spring	62	13	25
Pentagon	60	20	20
Minnesota Avenue	57	14	29
Stadium/Armory	53	12	35
Brookland/CUA	51	18	31
Eastern Market	50	20	30
Rosslyn	50	22	28
Evening-Peak (More than 50 Percent of Arrivals in PM Peak)			
McPherson Square	8	71	21
Federal Triangle	6	66	28
Farragut West	6	60	34
Smithsonian	5	59	36
Judiciary Square	6	58	36
Farragut North	7	55	38
L'Enfant Plaza	17	53	30
Gallery Place	6	53	41
Off-Peak (Fewer than 50 Percent of Arrivals During Either Peak)			
National Airport	7	12	81
Arlington Cemetery	8	42	50
Metro Center	6	48	45
Capitol South	13	45	42
Dupont Circle	26	34	40
Foggy Bottom/GWU	14	46	40
Crystal City	26	40	34
Union Station/Visitor Center	30	35	35
Federal Center S.W.	25	47	28
System Average	31%	37%	32%

TABLE 5.2

CLASSIFICATION OF METRO STATIONS BY TRIP PURPOSE AT DESTINATION
MAY 1979

HOME DOMINANT - (More than 55% of Trips to Home)

	Percent of Trip Ends by Purpose		
	Home	Work	Other
Potomac Avenue	90	3	7
Deanwood	90	3	7
Cheverly	88	4	8
New Carrollton	86	5	9
Pentagon City	86	4	10
Fort Totten	85	8	7
Takoma	83	7	10
Landover	83	5	12
Minnesota Avenue	80	7	13
Rhode Island Avenue	79	7	14
Silver Spring	76	11	13
Pentagon	75	16	9
Stadium-Armory	74	12	14
Eastern Market	70	12	18
Brookland	66	14	20
Rosslyn	64	22	14
National Airport	56	10	34

WORK DOMINANT - (Over 40% Work, Below 25% Home)

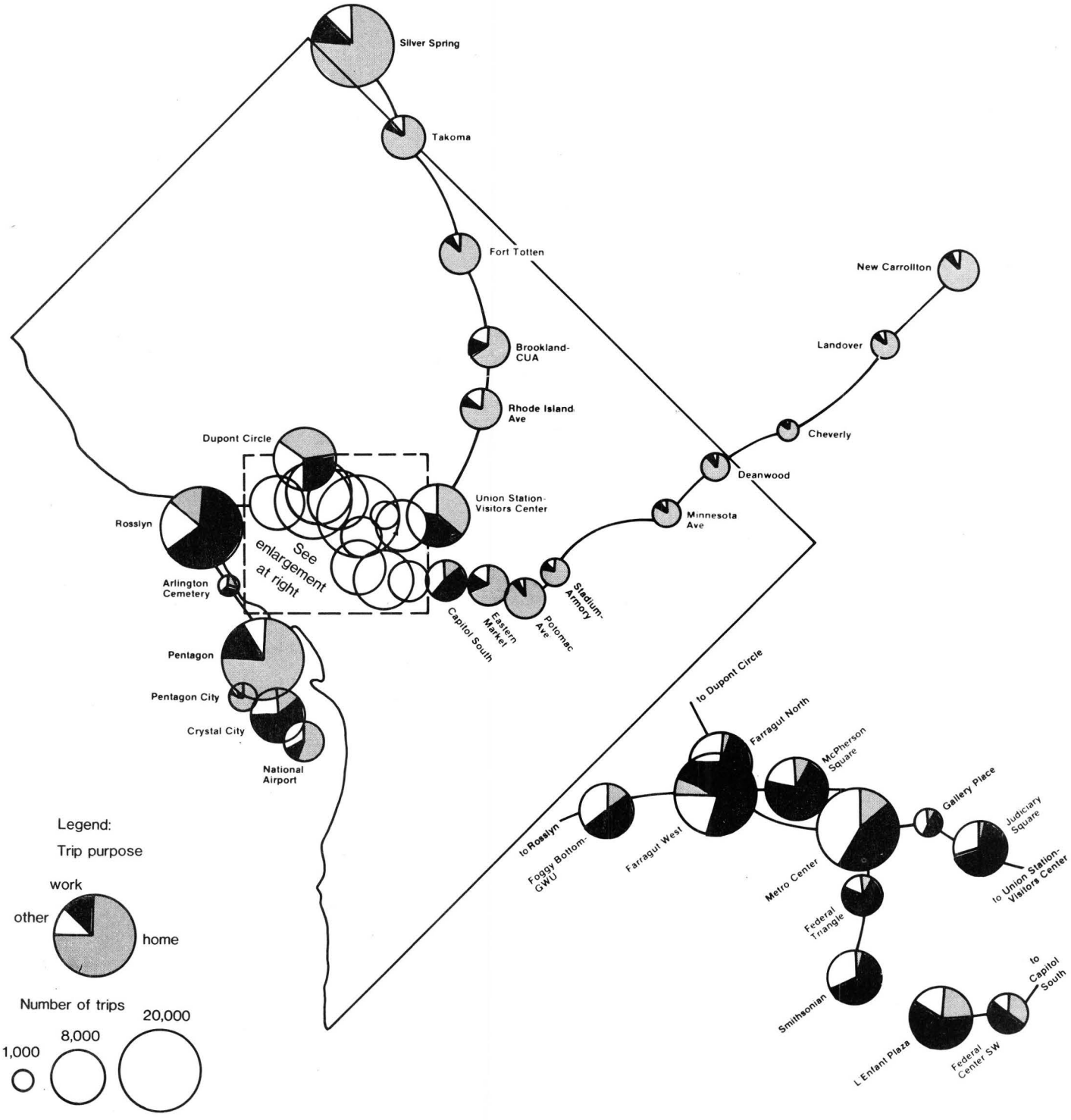
Farragut West	6	73	21
Federal Triangle	10	71	19
MacPherson Square	9	70	21
Farragut North	5	69	26
Judiciary Square	2	68	30
Smithsonian	4	63	33
L'Enfant Plaza	22	61	17
Gallery Place	5	50	45
Foggy Bottom	16	48	36
Metro Center	13	45	42
Capitol South	15	44	41

WORK DOMINANT WITH HIGH PERCENT HOME - (Over 30% Work, 25-40% Home)

Federal Center	34	53	13
Crystal City	30	45	25
Union Station	36	41	23
DuPont Circle	37	35	27
Arlington Cemetery	30 1/2	32 1/2	37
SYSTEM AVERAGE	40 1/2	38	21 1/2

SOURCE: 1979 WMATA Rail Survey

Figure 5.3
METRORAIL STATIONS BY TRIP PURPOSE AT DESTINATION



The final category consists of stations for which the dominant purpose was work and the number of trips to home exceeded the proportion of non-work trips. All of these "mixed commercial" stations were classified earlier as having a high percentage of midday trips. Since the trip purpose applies to the ultimate destination of the trip rather than to the station, the results could seem somewhat illogical for stations having a high percentage of trips traveling by bus or auto to a destination far from the station.

The analysis in Chapter II pointed out that reporting a system total for mode of access could be confusing because of the very sharp differences between the mode of arrival to the first Metrorail station and the mode of departure from the last station. Reporting these totals for individual stations clears up this problem, since most people are likely to use the same mode to and from a station.

Figure 5.4 shows that most stations are pedestrian-oriented. The classification shown in Table 5.3 indicates that 19 of the 33 Metro stations have more than 40 percent of their riders walking to their destination. It is not surprising that all 16 stations having a work-dominant purpose were pedestrian stations, except for Union Station, where more people transferred to commuter rail than walked. In addition, pedestrian-oriented stations serving mostly home purposes are Rosslyn, Eastern Market, Stadium-Armory, and Brookland/CUA, each of which serves a large residential area. There are seven stations for which the dominant access mode was transit, only one of which, Union Station, primarily serves work trips. There are only four stations for which the dominant access mode was auto. Three of these are the last stations on the New Carrollton route, which have considerable amounts of parking. There are three stations for which there is no clearly dominant access mode. Fort Totten and Takoma have an almost equal distribution of auto and transit access, and a slightly lower level of walking. Deanwood, on the other hand, has almost equal amounts of pedestrian and transit access, and also a higher level of auto access.

This analysis of ridership characteristics (classified according to Metrorail station used) shows sharp differences between stations according to whether or not they primarily serve work or home trips. These generally correspond to whether the station serves a residential or an employment area. The residential stations -- those serving mostly trips to home -- have most of their trip arrivals in the morning peak period. The principal means of travel between Metrorail stations and homes varies among walking, transit, and auto, depending on the number of residents within walking distance, the availability of transit and parking.

Figure 5.4
CLASSIFICATION OF METRORAIL STATIONS BY ACCESS MODE

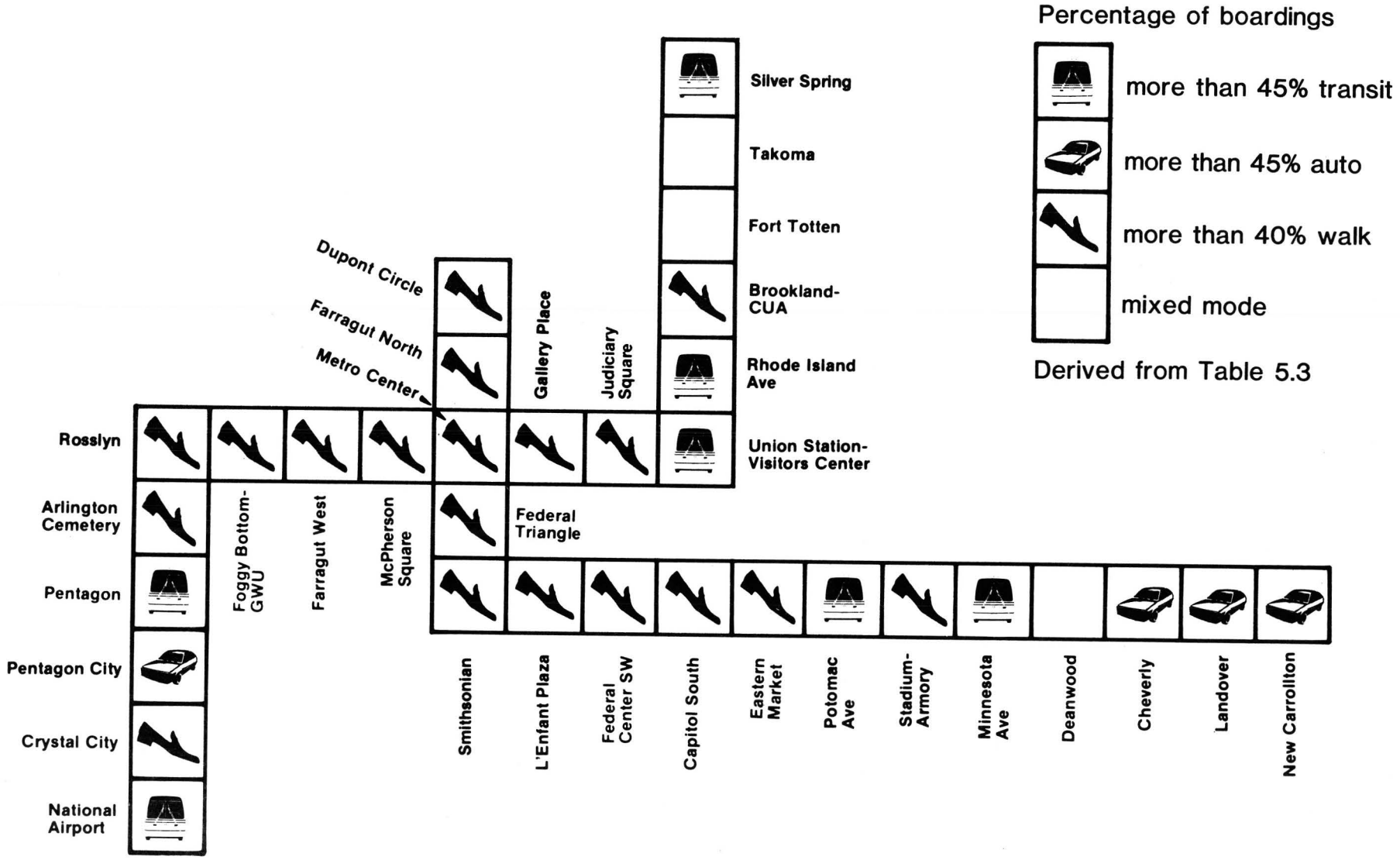


TABLE 5.3

CLASSIFICATION OF METRORAIL STATIONS BY MODE OF ACCESS- MAY 1979

	Percentage of Trips by Mode of Access		
	Walk	Auto	Transit
Walk-Dominant (More than 40 Percent Walk)			
Federal Triangle	94%	3%	3%
Judiciary Square	94	4	2
Smithsonian	94	3	3
Capitol South	92	7	1
Farragut North	92	2	6
Farragut West	91	3	6
McPherson Square	91	2	7
Foggy Bottom/GWU	89	3	8
Crystal City	87	10	3
Gallery Place	86	3	11
Metro Center	85	3	12
L'Enfant Plaza	83	5	12
Arlington Cemetery	83	12	5
Federal Center S.W.	77	2	21
Eastern Market	77	8	15
Dupont Circle	74	2	24
Rosslyn	49	12	39
Brookland/CUA	43	22	30
Stadium/Armory	42	34	24
Transit-Dominant (More than 45 Percent Transit)			
Pentagon	17	7	76
Union Station/Visitor Center	27	10	63
Potomac Avenue	24	14	62
National Airport	38	13	49
Silver Spring	25	27	48
Rhode Island Avenue	22	30	48
Minnesota Avenue	33	19	48
Auto-Dominant (More than 45 Percent Auto)			
Cheverly	17	80	3
Landover	14	76	10
New Carrollton	3	71	25
Pentagon City	35	61	4
Mixed-Mode (No Single Mode Clearly Dominates)			
Takoma	32	34	34
Deanwood	29	41	30
Fort Totten	19	41	40
System Average	28	27	45

SOURCE: Metro Rail Passenger Survey, Spring 1979

Commercial stations -- those where work trips exceed trips to home -- are served almost exclusively by pedestrian trips. Those with the highest percentage of work trips have most of their daily boardings in the evening peak. Other stations in commercial areas with a higher percentage of non-work and home trips have a more evenly balanced distribution of arrivals throughout the day. Because they are downtown stations, the major access mode for these is walking.

USER CHARACTERISTICS

The analysis of Metrorail station characteristics makes it possible to understand where Metrorail appears to be having its largest impact and the differences in the types of trips served on various segments and at different stations. Other data sources provide insight on who are the likely Metrorail riders and how well they have been served by Metro. In the following section, general characteristics of central area commuters are described, along with some specific analyses of Metrorail commuters to the central area. An overall description will then be made of the characteristics of Metro riders in general.

Central Area Commuters

A major factor in the early planning for Metrorail was the heavy concentration of regional employment in the core of Washington, D.C. described earlier, and in the office areas of Rosslyn, Crystal City, National Airport, and the Pentagon. These areas shown in Figure 3.3 included more than one out of every four regional jobs in 1977. Moreover, Metrorail stations located within this area accounted for over 90 percent of all Metrorail trips destined to work. For this reason, the initial travel behavior studies conducted under the Metrorail Before and After Program have focused on the regional core. Studies were conducted during the Spring of 1977 prior to the opening of the Blue Line and in the Fall of 1978 following the extension of the Red Line to Silver Spring. This time period made it possible to investigate early changes in relative transit use to the central area due to the initial phases of Metrorail. Changes in commuting characteristics described below are derived from these surveys. Demographic and economic characteristics of commuters, which did not change over such a short time period, are reported from the first "after" survey in the Fall of 1978.

In less than two years relative transit use for central area transit commuting increased by five percentage points after the opening of Metrorail. At the same time, as shown in Table 5.4, there was a relative decline in auto commuting to the central area.

TABLE 5.4

CENTRAL AREA COMMUTING BEFORE AND AFTER PHASE II METRORAIL

Trip Mode	Percentage of Trips Before[a]	Percentage of Trips After[b]
Auto Driver	39.7%	35.8%
Auto Passenger	17.7	15.7
Total Auto:	57.4	51.5
Transit Only	28.0	30.1
Transit and Other Mode	9.3	10.0
Commuter Rail or Bus[c]	.4	2.9
Total Transit:	37.7	43.0
Other	4.9	5.5
Total	100.0%	100.0%

[a] Spring 1977

[b] Fall 1978

[c] Some of the differences reported in this category are caused by slight definitional differences.

Personal income is the single characteristic which in the past has been considered the major determinant of transit use. The survey showed that the average annual household income of central area workers was approximately $25,200 in 1978. Although there are no current sources of worker income data which allow a direct comparison between the central area and the rest of the region, a special Census survey in 1977 showed regional income to be $22,400. The income of workers in the central area would be expected to be higher than that of other workers, because of the highly specialized technical and decision-making nature of jobs in the central headquarters of Federal agencies and private businesses. In addition, higher transportation and other expenses make it necessary to pay higher salaries than comparable suburban jobs to attract workers downtown. The median income from the jobs held by central area workers was $18,000 in 1978. Major differences are observed, however, in comparing the income of the average transit user with an auto commuter:

- Median Salary of Auto Commuters was - $21,000
- Median Salary of Transit Riders who walked to Bus or Rail was - $15,000

This indicates a major disparity between transit and auto commuters in terms of income. The strong influence of income on the means of travel used in commuting is shown more directly in Table 5.5. About one out of every seven central area commuters earned less than $10,000 a year, and the majority of them used transit prior to Metrorail. The next four out of every ten central area workers earned between $10,000 and $20,000 a year, and the majority of them commuted by auto, 56 percent, compared to 39 percent transit users, which was close to the average transit use for all central area workers. Two out of every three workers earning more than $20,000 a year commuted by auto to the central area, and fewer than one-third by transit.

TABLE 5.5
COMMUTING MODE AND INCOME OF CENTRAL AREA WORKERS BEFORE METRORAIL

Percentage of Workers Using	Annual Worker Income			
	〈$10,000	〈$10-$20,000	〉$20,000	All Workers
Auto	40%	56%	66%	57%
Transit	55%	39%	29%	38%
Other	5%	5%	5%	5%
Total	100%	100%	100%	100%

The comparable figures for the first "after Metro" period shown in Table 5.6 indicate that income continued to be a major determinant of transit use for central area workers, even though there had been a significant increase in overall transit commuting. Perhaps the most important finding in this case is that the increase in transit use came uniformly across all income levels, rather than being concentrated in only the high or low income groups.

TABLE 5.6

COMMUTING MODE AND INCOME OF CENTRAL AREA WORKERS AFTER METRORAIL

Percentage of Workers Using	Annual Worker Income			
	<$10,000	$10-$20,000	>$20,000	All Workers
Auto	35%	50%	60%	52%
Transit	60%	45%	34%	43%
Other	5%	5%	5%	5%
Total	100%	100%	100%	100%

Vehicle ownership is a variable more likely to indicate if workers are captive to transit or if they may choose from serveral modes. Central area workers owned an average of 1.6 autos, a figure considerably higher than the regional average of 1.3 reported in the 1970 Census. However, auto drivers reported a total of 1.9 vehicles per household compared to only 1.1 vehicles owned by transit users' households. Although 84 percent of all transit commuters claimed to own at least one vehicle per household, it may have been used by another household member. These rates did not appear to have changed between the before and after periods. The lowest rate of vehicle ownership, 0.9 per household, was reported by central area workers who walked to work.

The strong influence of vehicle ownership on transit use is shown in Table 5.7, where three out of every four commuters from households without cars used transit prior to Metro. These same households are also more likely to use other modes, primarily walking, than they are to use auto, even as passengers. Not quite half of all persons from one-car households commuted to the central area by auto prior to Metro, and almost as many of these

workers used transit. It also appears that, while there is another large relative increase in average auto use and a comparable decline in transit commuting among workers from two-car households, further increases in vehicle ownership do not appear to change the choice of commuting mode significantly.

TABLE 5.7

VEHICLE OWNERSHIP AND COMMUTING MODE TO CENTRAL AREA BEFORE METRO

Percentage of Commuters Using	Vehicles per Household 0	1	2	3 or more	All Workers
Auto	10%	49%	71%	73%	57%
Transit	74%	44%	27%	25%	38%
Other	16%	7%	2%	2%	5%
Total	100%	100%	100%	100%	100%

The strong pattern of increasing auto commuting with increasing ownership of vehicles is observed in the after Metro condition as shown in Table 5.8. In comparing relative transit use before and after Metro, however, it is found that increases in transit use came only from car-owning commuters. Since the early phases of Metrorail provided service in areas which generally already had good bus service, transit-dependent commuters did not increase their overall use of transit, even though they may have switched from bus to rail. The most significant increases in transit use occurred in households owning one or two vehicles, where the transit share went up by five percentage points. It is possible that some of these households will find in the future that they are able to reduce their vehicle ownership. In fact, by the Fall of 1978, more central area commuters from one-car households reported commuting by transit than by auto.

TABLE 5.8

VEHICLE OWNERSHIP & COMMUTING MODE TO CENTRAL AREA AFTER METRO

Percent of Commuters Using	Number of Vehicles per Household 0	1	2	3 or more	All Workers
Auto	9%	44%	66%	68%	52%
Transit	74%	49%	32%	29%	43%
Other	17%	7%	2%	3%	5%
Total	100%	100%	100%	100%	100%

The analysis of vehicle ownership suggests that for commuters from vehicle-owning households, the determinant of whether they were able to "choose" transit was the availability of a vehicle to them for the work trip. As shown in Table 5.9, there are a considerable number of users who do not have a vehicle available for commuting, even though one or more is owned by the family. The table also contrasts vehicle availability of Metrorail users with that of bus commuters to the central area. It appears that Metrorail users are much more likely to have a car available for commuting than are bus riders. As reported earlier, persons without access to a car had been transit commuters before Metrorail. On the other hand, a higher percentage of Metrorail riders than bus riders drive to transit, thereby gaining the advantages of convenience and speed, but avoiding downtown parking costs and congestion.

TABLE 5.9

PERCENTAGE OF COMMUTERS REPORTING AUTO AVAILABILITY FOR TRIP TO WORK

Means of Travel	Yes	No
Auto Driver	100%	-
Auto Passenger	86%	14%
Transit	63%	37%
Metro	69%	31%
Bus	55%	45%
Taxi	36%	64%

Changes in Transit Use by Time of Day

Most central area commuters reported arriving at work between 7 - 9 a.m. (87 percent), and a slightly lower share (80 percent) departed between the hours of 4 - 6 p.m. These are the hours when bus service is most frequent. Prior to the opening of Metrorail, most express bus service was almost exclusively operated within these hours. An increase of 4 percentage points in relative transit commuting to the core was observed during the two-hour morning peak between the Spring of 1977 and the Fall of 1978. Evening transit use during the peak two hours (which had been higher than during the morning peak), showed virtually no change. However, as shown in Table 5.10, there were substantial gains reported in relative transit use by people who arrived or departed outside of the traditional two-hour commuting periods. In fact, by the Fall of 1978, relative use of transit by central area workers going home early or late was almost equal to that of the peak period. The most dramatic gains were observed in both late arrivals and late departures, who were found to be as likely to use transit as those having more traditional schedules. Relative transit use by workers who stayed late increased by over 80 percent. In addition to these increases in relative transit use, it was also found that by the Fall of 1978, there had been an increase in the percentage of commuters arriving on an earlier or later schedule from 8 to 14 percent of all central area workers. Only a very minimal change was observed in the evening departure pattern.

These dramatic changes in transit use outside of the normal commuting hours point up another important attribute of rail service besides capacity -- the day-long service which can be provided. This is markedly different than an express bus operation, which can provide excellent service during peak periods, but none for the rest of the day.

TABLE 5.10

RELATIVE TRANSIT USE FOR CENTRAL AREA COMMUTERS BY TIME OF ARRIVAL AND DEPARTURE

	Percent of Workers Using Transit	
	Spring 1977	Fall 1978
Work Arrival Time	Before Metro	After Metro Phase IIA
Before 7:00 a.m.	33%	37%
7:00 - 9:00 a.m.	40%	44%
After 9:00 a.m.	27%	45
Work Departure Time		
Before 4:00 p.m.	26%	40%
4:00 - 6:00 p.m.	43%	43%
After 6:00 p.m.	23%	42%

Metrorail User Characteristics

The survey of central area commuters reported some findings about Metrorail riders traveling to and from work in the central area which accounts for more than one-half of all Metrorail users. Further insight into the characteristics of other rail commuters as well as riders using Metrorail for non-work purposes can be obtained from a special survey conducted by WMATA in June of 1979. This was a somewhat smaller survey than those conducted for estimating ridership patterns. The four main characteristics described below are vehicle availability, income, education, and frequency of travel.

1. Vehicle Availability

   When asked whether a vehicle was available for this trip, 53 percent of all weekday Metrorail riders claimed that it was. This is somewhat lower than the percentage reported above for work trips and suggests that a lower number of riders using Metro for non-work trips are "choice" riders. However, 51 percent of bus riders reported a car was not available for this trip.

2. Income

   The distribution of all Metrorail riders by income is shown in Table 5.11. The median income of all Metrorail riders is $24,000. Although this is slightly lower than the income reported for all central area workers, it is considerably higher than the income of bus riders estimated at $17,500 in June 1979.

3. Education

   The education levels reported by Metrorail riders are shown in Table 5.12. A very high percentage of Metrorail riders are high school graduates, and most of them have been to college. This is consistent with the income characteristics, since income is generally correlated with education. It does, therefore, appear that Metro is fulfilling the goal of serving both the upper-income as well as the better educated, many of whom may not be willing to come to the central area without Metrorail, and probably not by bus.

TABLE 5.11

INCOME CHARACTERISTICS OF WEEKDAY BUS & RAIL PASSENGERS

Annual Household Income	Percentage of Riders	
	Bus	Rail
Below $8,000	15%	5%
$ 8,000 - $15,999	31	24
$16,000 - $23,999	21	21
Over $24,000	33	50
Total	100%	100%

TABLE 5.12

EDUCATIONAL ACHIEVEMENT OF WEEKDAY BUS AND RAIL PASSENGERS

Education Level	Percentage of Riders	
	Bus	Rail
No higher than High School	26%	11%
Some College	27	23
College Graduate	19	24
Post-Graduate	28	42
Total	100%	100%

Source: WMATA Marketing Survey, June 1979

4. Travel Frequency

One of the advantages claimed for rail transit is that, unlike a bus system, it is much easier for a potential rider to learn where the system goes. The effect of such a characteristic is that a rail system should have a high percentage of occasional users, as compared to "regular" users who are willing to invest the effort to learn about the best transit route and schedule for them. The theory appears to be supported by Table 5.13 which shows the distribution of Metrorail riders according to frequency. Approximately three-fourths of all Metrorail riders reported that they use the system four or five times a week. This is considerably lower than the comparable percentage on the bus, where almost 90 percent of passengers are regular riders.

TABLE 5.13

FREQUENCY OF TRAVEL OF BUS & RAIL PASSENGERS

Number of Days Riding Transit per Week	Percentage of Riders	
	Bus	Rail
Less than once a week	3%	10%
1 - 3 days a week	8	14
4 - 5 days a week	62	66
6 - 7 days a week	27	10
Total	100%	100%

SOURCE: WMATA Marketing Survey, June 1979

TRAVEL TIME AND COST

An important concern for commuters diverted to rail from bus or auto is "What benefits do the riders get from Metro?" Specifically, how do the time and cost characteristics compare with bus or auto? In order to obtain information on this question, it is necessary to analyze the Central Area Commuter Surveys described above. Since commuting patterns change very slowly in comparison to shopping or other non-work trips, the most valid way to compare time and cost characteristics is to analyze work trips before and after Metrorail.

The analysis of commuting distances showed that there had been no change during this period for either auto or transit trips. Therefore, the time and cost comparisons can be assumed to be based on approximately the same commuting patterns before and after Metrorail.

Table 5.14 shows that the average reported commuting time to jobs in the central area did not appear to change for either of the primary modes by the Fall of 1978, before the opening of the New Carrollton extension. However, the travel times for sub-modes within the transit category show sharp differences among transit riders after the opening of Metrorail, according to whether or not they used it. Commuters who could walk both to and from Metrorail reported a travel time of only 31 minutes, considerably shorter than the average transit commuting time before Metro. On the other hand, all other transit commuters claimed a longer time to get to work in the central area than the pre-Metro average. Those requiring bus access to Metro reported an average of 52 minutes, 7 minutes longer than the pre-Metro average. Those commuters requiring a double transfer from auto to bus and then to Metro required over an hour to complete their trip. However, these findings must be interpreted with the understanding that the only suburban line operating during the survey period was that to Silver Spring. Since extensions such as those to New Carrollton and Ballston are now open, it is likely that more Metrorail riders are in the Metro-only or Metro and bus categories, which should lower the average trip time for central area commuters.

The other factor of concern to commuters is the cost of the trip. For many people, the choice of mode involves a trade-off between the higher speed of an auto trip and the lower cost of transit travel, especially if a parking cost is involved. As reported in Table 5.15, the average out-of-pocket commuting costs did not change significantly before and after Metrorail for transit users. Once again, however, transit users appeared to sort themselves out according to whether they used Metrorail. Transit commuters riding the bus paid a slightly higher cost to reach the central area, primarily because of a fare increase in July of 1978. However, those using Metro only saved money

in comparison to the pre-Metro condition. Transit riders requiring a bus transfer to reach Metrorail paid a higher cost than the average pre-Metro commuter for their round trip, even though there was a free transfer from Metro to bus on the way home. It appears that for central area commuters Metrorail was more expensive to use than the bus, but was probably cheaper than the auto for those commuters who switched.

TABLE 5.14

REPORTED COMMUTING TIMES TO THE CORE

Travel Mode	Average Minutes Per Trip: Before Metrorail Phase II-Spring 1977	Average Minutes Per Trip: After Metrorail Phase IIA-Fall 1978
Auto Driver	38	38
Auto Passenger	39	39
WMATA Transit	45	45
Bus Only	42	38
Bus and Auto	54	53
Metrorail	-	49
Metrorail Only	-	31
Metrorail and Bus	-	52
Metrorail and Auto	-	49
Metrorail, Commuter Bus, and Auto	-	64
Metrorail, Bus, and Auto	-	82
Commuter Bus and Rail	57	63

SOURCE: MWCOG Central Area Commuting Surveys

TABLE 5.15

AVERAGE COSTS OF COMMUTING TO THE CORE

Type of Transit	DAILY ROUND TRIP COST Before Metrorail Phase II-Spring 1977	After Metrorail Phase IIA-Fall 1978
Bus Only	$1.44	$1.37
Auto and Bus	$1.87	$1.59
Metrorail	-	$1.70
Metrorail Only	-	$1.12
Metrorail and Auto	-	$1.71
Metrorail and Bus	-	$1.91
Metrorail, Bus & Auto	-	$2.03
Overall Average:	$1.54	$1.55

Source: MWCOG Central Area Commuting Surveys

CONCLUSIONS

This chapter has compared the characteristics of people who rode Metrorail during its early years to characteristics of bus and auto travelers. It has also identified major differences between ridership patterns at stations. The analysis of ridership patterns at rail stations generally found that Metro stations could be easily classified into three or four major categories based on characteristics of (1) time of arrival, (2) purpose of travel, and (3) mode of access. Significant interrelationships were found among these categories:

- The majority of daily arrivals at 24 stations occurred during either the morning or evening peak period. At 16 of these stations most of the daily riders arrived in the morning peak period while at the other eight most passengers arrived in the evening peak.

- All of the evening peak stations primarily served workers, as well as a significant share of shoppers and other non-residents.

- There were nine "all day stations" - those with less than a majority of passengers entering in either peak period. With the exception of National Airport, these stations mainly served workers, although they carried a higher percentage of either residents or shoppers and visitors than the evening peak stations.

- All morning-peak dominant stations primarily served residents, and all stations with a majority of daily arrivals from homes were morning-peak stations.

- All stations in the D.C. core except Union Station primarily served workers, most of whom walked to the Metro station.

- Those stations primarily serving residents were reached by a variety of modes, depending on parking, transit service, and residents within walking distance as follows:

    . Five were transit dominant;
    . Four were auto dominant;
    . Four were pedestrian dominant; and
    . Three had an even balance.

Surveys of workers commuting to the regional core showed an increase in relative transit use from 38 percent to 43 percent between the Spring of 1977, when only the short downtown section of the Red Line was operating, and the Fall of 1978, after the opening of the Blue Line and extension of the Red Line to Silver Spring. Futhermore, as indicated in the previous chapter, there has been an increase in the total number of persons entering downtown since 1977, and much of this increase is probably due to employment growth. Thus, it appears that transit is capturing a larger share of an increasing travel market to the central area Some of the significant findings on central area commuters are:

- Prior to Metrorail service, substantial differences were observed in annual income levels of central area commuters driving to work -- $21,000 -- and of those using transit -- $15,000.

- However, similar increments were found in the transit share for low, middle, and upper income commuters to the central area by the opening of Phase II of Metro.

- Lack of an automobile is the strongest indicator of transit use. In the "before Metro" survey, 74 percent of central area commuters from households without cars used transit to get to work.

- All of the increase in central area transit commuting was observed in the car-owning categories.

- After the opening of Metrorail, there was a dispersion in arrival times to the edges of the peak period, and a substantial increase in transit use for those trips.

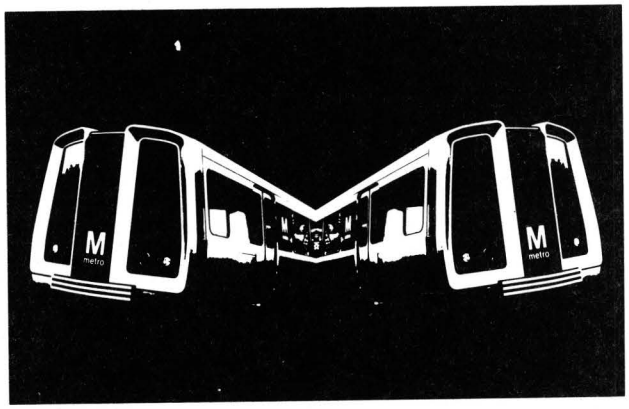
Comparisons between all weekday Metrorail riders and transit riders using only buses showed the following differences in 1979:

- Rail users were much more likely to be choice riders, who had a car available for their travel, than were bus riders.

- Rail users were much more likely to be college graduates than were bus riders.

- Rail users came from substantially higher-income households than did bus riders.

Finally, analysis of commuting times and costs found that by Phase III of Metrorail operations, transit riders who were able to walk to and from Metro stations had a much shorter trip than transit riders had prior to the opening of Metrorail. On the other hand, if a bus were required to reach Metrorail, the trip took much longer. Similarly, Metrorail trips requiring bus access were much more expensive than prior bus trips, because of the extra fare, while rail-only trips were less expensive. As the transit system is expanded, more riders will be able to walk to the Metrorail system and will therefore improve their transit trip.



CHAPTER 6

THE SILVER SPRING CASE STUDY

CHAPTER VI

THE SILVER SPRING CASE STUDY

In order to determine the initial travel effects of Metrorail on a suburban community served by a rail station, a short-term study of the localized impacts of Metrorail in the Silver Spring area was undertaken by the Maryland-National Capital Park and Planning Commission (MNCPPC) with assistance from the Urban Mass Transportation Administration. This study was closely coordinated with the regional Metrorail Before and After Program so that both could share data and findings. Much of this chapter is drawn from the final report of the study for the MNCPPC[1] and from a later research paper by consultant Steven Smith and Robert Winick of MNCPPC.[2]

STUDY AREA DESCRIPTION

The unincorporated community of Silver Spring lies in the southern portion of Montgomery County, immediately north of the District of Columbia and approximately seven miles north of the D.C. core employment area. The resident population numbered over 77,000 in 1970 and exceeded that of any city in Maryland except Baltimore. Silver Spring also served as the leading major retail center in the Washington suburbs from the time the Census Bureau began collecting such data until 1972. Finally, the Silver Spring CBD is a major office center with nearly 3 million square feet of office space, 1.7 million of commercial, and about 17,000 employees.

Silver Spring has developed around an extensive transportation network. The B&O Railroad built its main line to the west through Silver Spring in 1869, and electric streetcars commenced service around the turn of the century. Commuter rail service continues today. Located one and a half miles south of the Capital Beltway, Silver Spring has no freeways, and is structured by the B&O, an extensive network of streets and three major highways which were served prior to Metro by extensive express and local bus services. County policy eliminated express bus service

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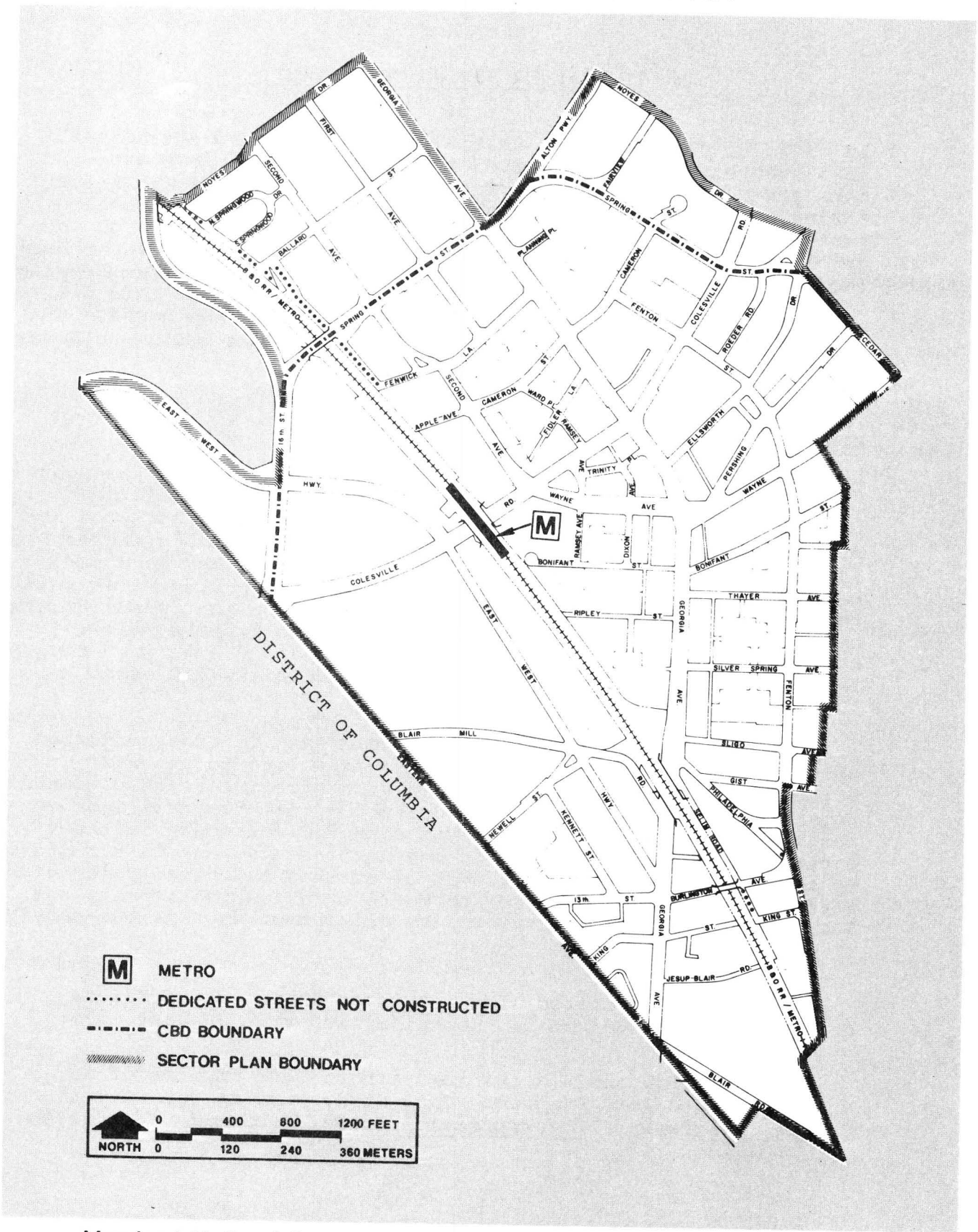
[1] JHK and Associates, Inc., "Silver Spring Metro Before and After Study, Volume 1: Technical Report," January 1979.

[2] S.A. Smith and R.M. Winick, "Short Term Impacts of a Suburban Rapid Rail Station: Case Study Results for Silver Spring, Maryland," Transportation Research Record, 760. 1979.

Figure 6.1
SILVER SPRING STUDY AREA



Maryland-National Capital Park and Planning Commission:
Approved and Adopted Sector Plan for the
Silver Spring Central Business District, 1975

to Washington and redirected it to the Silver Spring Metro Station in 1978.

Silver Spring is unique as the site of the first system of public parking lots in this part of the country. The extensive County-operated parking program provides 6,400 off-street spaces, representing about one-half of the total parking supply in the CBD. In addition, the County inaugurated its own innovative Ride-on bus service in 1975, which was greatly expanded when Metrorail service began.

In February 1978, the Red Line of Metrorail was extended to the station at Silver Spring. It will serve as the interim terminal until the line is extended to Glenmont, now scheduled to take place in early 1987. The station itself is located along the B&O Railroad right-of-way and about 1,200 feet from the retail core as shown in Figure 6.1. Bus feeder services were coordinated with the station opening and involved relocation of the previous bus terminal to the station area, the termination of express bus routes into Washington, and expansion of bus services to the station by WMATA and the County. Other changes were made in transportation including several roadway improvements, increases in the parking rates several months after the station opening, and reduction of the maximum time limit for many of the parking meters from 12 hours to 9 hours.

Because it was the first major suburban employment center served by Metrorail as well as the first suburban terminal station, Silver Spring provides a unique case study of the impacts of inaugurating Metrorail service to a suburban CBD. Not only was rail service established, but there were also extensive feeder bus services added. These expanded routes provided access to Metrorail as well as improved bus accessibility to Silver Spring jobs and stores.

The study focused on five important short-term localized impacts:

- Transit ridership;
- Travel habits;
- Traffic;
- Parking; and
- Reactions of community residents and businesses.

The findings are summarized below.

TRANSIT RIDERSHIP

As shown in Figure 6.2, the growth in average weekday transit use in the corridor linking Silver Spring and the District of Columbia has been steady and dramatic. Within the first 10 months, rail ridership approximately doubled over the pre-Metro

Figure 6.2
DAILY IN-BOUND TRANSIT USERS CROSSING DC/MD LINE FROM SILVER SPRING

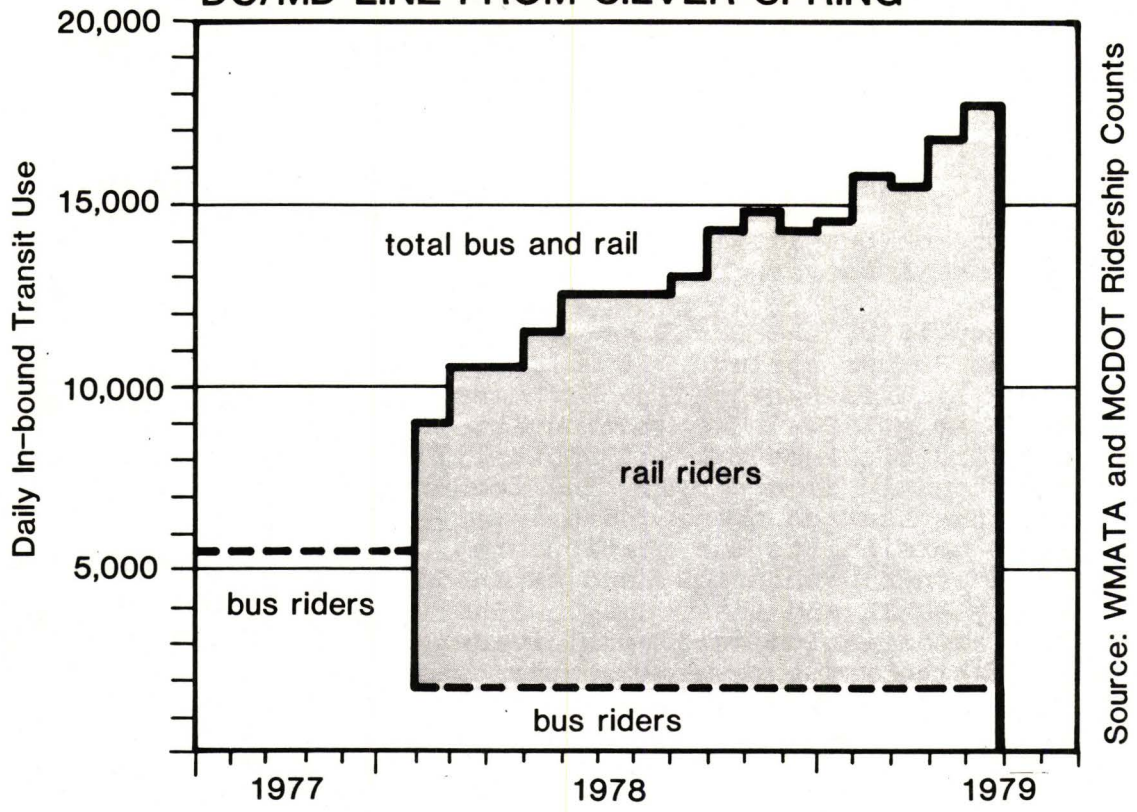
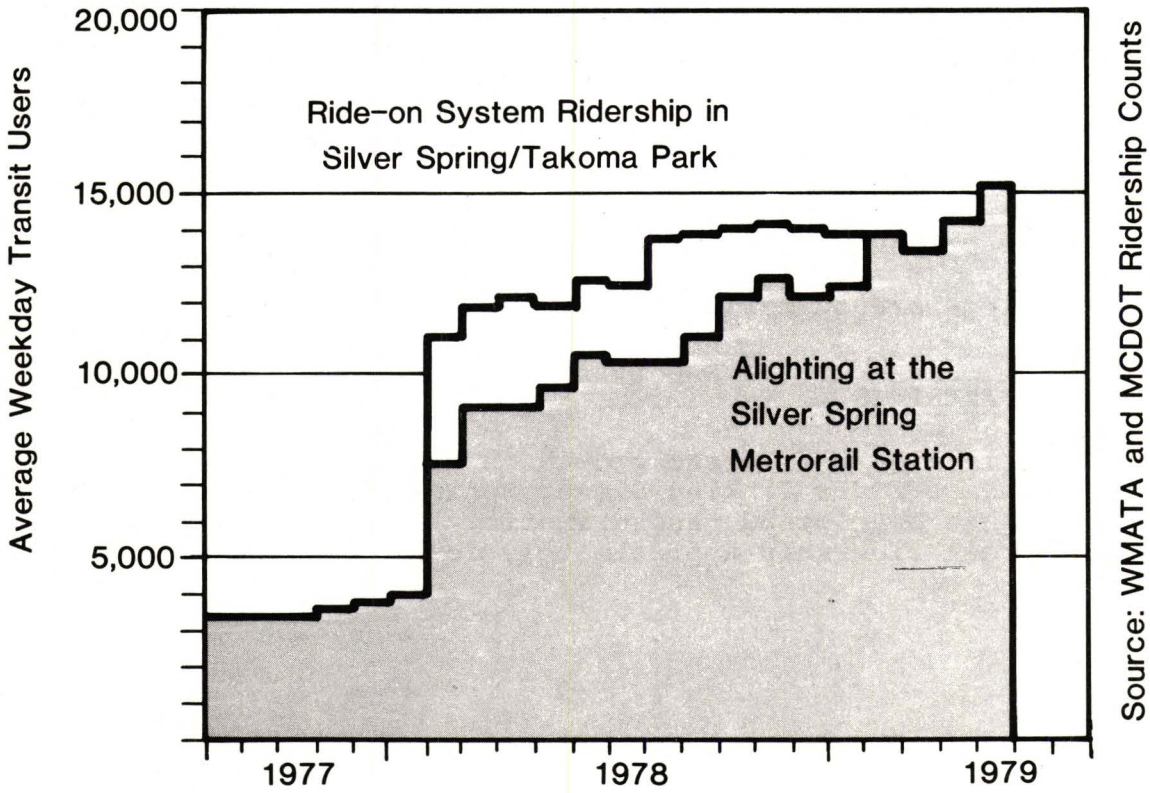


Figure 6.3
COMPARISON OF RIDE-ON SYSTEM RIDERSHIP WITH METRORAIL RIDERS AT THE SILVER SPRING STATION



bus ridership. The "after" surveys as part of these studies were conducted in May, 1978 when there were about 9,500 average daily alightings at Silver Spring for the month. In the next year ridership increased again by nearly 6,000 to a total of 15,200 daily alightings, making it the fifth busiest station in the system.

When rail service was extended to Silver Spring, there was also a major expansion in the County-operated Ride-on System. The initial response tripled ridership from somewhat under 4,000 daily riders to 12,000 at the time of the after surveys. This represents travel not only to and from the Silver Spring CBD but also to other locations in the vicinity of Silver Spring and Takoma Park including the Takoma Metrorail Station. It is estimated that about one-half of the initial Ride-on ridership was related to Metro access. Figure 6.3 compares growth in Ride-on system ridership with passengers leaving Metrorail at Silver Spring and shows a close parallel between the growth of the two transit services.

A review of classifications of the Silver Spring Station cited in Chapter V provides a regional context within which this particular rail station can be understood. First, it is classified as residentially dominant based on the distribution of purposes at the trip end nearest the station. This classification was the same for all four rail stations on the Red Line extension. Although Silver Spring is a major employment center, the majority of riders using the station were residents of the community traveling elsewhere on Metrorail, rather than commuters or shopper traveling to Silver Spring. This is not surprising since the Metrorail line links Silver Spring to the downtown core, but does not yet extend further into the suburbs. While it does provide excellent transit access to a smaller group of workers and shoppers living in Washington, D.C., most Montgomery County residents can so far use Metro only for trips into the District and Virginia. The classification of station arrivals by time of day shows that most people using the Silver Spring station boarded during the a.m. peak period, a pattern consistent with the residential nature of the larger Silver Spring market area. The classification of the station by daily mode of access shows a clearly transit-dominant station, one of the only seven such stations in the system during the Phase III period. Not only was there extensive Metrobus and Ride-on service feeding the rail station, but also a large resident population within walking distance, as well as scarce commuter parking. The initial effects of Metrorail at Silver Spring can be best understood by keeping in mind the finding that the rail station primarily serves Montgomery County and nearby D.C. residents traveling from or through Silver Spring to other destinations whose most common mode of access to the station is by bus.

TRAVEL HABITS

The impact of Metrorail on travel habits to and from Silver Spring was assessed for four categories of Metrorail trips:

- Work trips to Silver Spring;
- A.M. peak period trips from Silver Spring;
- Non-work trips by employees in Silver Spring; and
- Off-peak period trips to and from Silver Spring.

Work Trips to Silver Spring

Work trips to Silver Spring include the initial daily commuting trip by persons employed within the Silver Spring CBD boundary. It was estimated that 16,800 employees commuted to this area on an average weekday in 1978, one of the largest suburban employment centers in the region.

Mode of Travel--As described above, only a fraction of Silver Spring Metrorail riders were using it to commute to Silver Spring. The relative increase in transit commuting was understandably small, with only 2 percent of Silver Spring employees traveling to work by Metro soon after the station opened. In fact, there was a larger increase in commuting to Silver Spring via the expanded Ride-on service, which went from 2.3 percent of workers before Metro to 4.9 percent after. Total transit ridership to jobs in Silver Spring increased from 10.3 percent in the before Metro period to 13.0 percent in the after period. Since most Silver Spring employees live in Montgomery County, the impact of the Metro line which did not yet provide access to their jobs was small, as expected. However, the number of employees driving their cars to work decreased by nearly 4 percent after Metro opened, a statistically significant reduction.

A much greater impact was found on Silver Spring employees residing in the District of Columbia. Although this group represents only 6.7 percent of Silver Spring employees, fully one in seven used Metro after it opened. Since many parts of Washington were not served by Metrorail, the relative share of the D.C. to Silver Spring travel market captured by Metro is much higher.

Prior Mode of Travel--A significant shift from auto to transit had occurred with the opening of Metrorail and the expansion of Ride-on service for employees working in Silver Spring. Employees were asked about their travel mode prior to Metro, with the following results:

- 47 percent of Metrorail riders were previously auto drivers;
- 31 percent of Metrorail users were previously Metrobus riders;
- 19 percent of Metrorail riders did not work in Silver Spring before Metro; and
- Of employees arriving by Ride-on, 22 percent were previously auto drivers.

It is clear that Metro captured a major share of its users from the automobile in the first suburban employment center it served. This occurred before Metrorail service was available to the home locations of the great majority of workers in that center.

Arrivals and Departure Times--Arrival times of employees in Silver Spring shifted slightly to earlier arrival times. This appears to be attributable to the need to arrive earlier to compete for parking shared with commuters who drive to Metro.

Auto Occupancy-- There was no change in the average number of persons per auto commuting to work in Silver Spring --1.2 -- with the advent of Metro, indicating that both drivers and passengers were equally likely to be diverted to Metro. This is consistent with the analysis of travel to the D.C. core and contradicts the hypothesis that Metrorail will attract only auto passengers, thereby resulting in no change in the level of automobile congestion.

A.M. Peak-Period Metrorail Trips From Silver Spring

It has been observed that the majority of Metrorail riders at Silver Spring are Montgomery County residents. Therefore, an analysis of people boarding during the morning peak period included mostly residents of Silver Spring and areas to the north who commuted to the District of Columbia. The following characteristics were found:

Mode of Access--The dominant mode of access to the Metro station in the a.m. peak period was bus, just as it was for the entire day. There were approximately as many people walking as driving to Metro. The distribution for all access modes during the a.m. peak was:

- Metrobus - 31%
- Ride-on - 25%
- Auto driver - 15%
- Auto passenger - 12%
- Walk 16%
- Other 1%

As indicated earlier, there were only four Metrorail stations having a higher relative use of transit as an access mode on a daily basis.

Alternative Mode of Travel--If Metrorail had not been available to those surveyed the modes of travel below were indicated by Metro riders as preferred alternatives in the a.m. peak period:

- No trip - 2%
- Metrobus - 53%
- Taxi - 1%
- Auto driver - 32%
- Auto passenger - 6%
- Walk - 0
- Other - 6%

Although a majority of riders claimed that without the rail system, they would travel by bus, there were a significant number of commuters who would drive if Metrorail had not been available. Because Metro riders were surveyed so soon after the opening of the rail extension, it is expected that their answers to this question would be similar to their prior mode of travel.

Diversion of Automobile Travel--The 32 percent of the 6,000 riders boarding Metrorail between 6 and 9 a.m. who reported an alternative mode of driving amounts to a total of 1,900 autos from the corridor during that period. The comparable reduction during the peak hour of 7 - 8 a.m. would be approximately 900 autos.

Work Trips by Metro for Silver Spring Residents--Approximately 10 percent of residents in close proximity to the Silver Spring CBD use Metro to get to work five days a week. It was estimated that Metro was capturing nearly 50 percent of Silver Spring residents who considered themselves to have convenient walk access to their place of work from a Metro station.

Non-Work Trips by Silver Spring Employees

In this study area, Silver Spring employees probably represent the largest current market for non-work Metro travel. Once at work, most of them are only a short walk from the rail station, and have excellent accessibility to downtown Washington and other areas for job-related travel as well as shopping and personal trips.

Mode of Travel--Non-work travel by Silver Spring workers to locations within the Silver Spring CBD was generally on foot--79 percent. Trips to locations other than the CBD and the District were generally by car --83 percent. In contrast, 40 percent of non-work trips made into the District by Silver Spring workers were by Metrorail. This represents an extremely high percentage of transit use for non-work travel, and indicates that Metrorail can attract workers in suburban centers who travel elsewhere during the day.

Alternate Mode of Travel--Of non-work Metrorail trips by Silver Spring employees, nearly 75 percent of the riders reported that the trip would have been by auto had Metro not been available. This indicates that, even for non-work travel, good accessibility to Metrorail makes it possible to divert a major portion of travel from auto to transit. Approximately 15 percent would have taken a bus, 2 percent would have taken a taxi, 5 percent would have made the trip to a location in Silver Spring instead, and 5 percent would not have made the trip at all.

Trip Purpose--Trip purposes for non-work Metrorail trips by Silver Spring employees were as indicated:

- Job-related - 66%
- Shopping - 4%
- Social/recreational - 4%
- Education/cultural - 2%
- Meal or snack - 7%
- Personal business - 9%
- Home - 7%
- Other - 1%

Most Metrorail travel by Silver Spring employees during the day (excluding commuting travel) was for job-related purposes. This finding is consistent with the regional data, and indicates that availability of Metrorail is a major benefit to employers whose workers travel during the day.

Off-Peak Metrorail Trips

To and From Silver Spring

Through analysis of the Metrorail surveys, it is possible to describe not only midday Metrorail travel by Silver Spring workers, but also rail trips made to Silver Spring by visitors and shoppers, and non-work trips by residents.

Mode of Access--The most frequent Silver Spring Metrorail arrivals during the midday period -- 39 percent -- came by automobile. While commuter parking is scarce, short-term parking is available during the midday, and includes a lot immediately adjacent to Metro. Of people arriving by car, 22 percent were drivers and 17 percent were passengers which indicates a higher auto occupancy than for work trips.

Even though midday bus service is much less frequent than during the peak hour, fully 31 percent of off-peak rail passengers arrived by bus, equally Metro bus and Ride-on. One out of every four midday Metrorail riders came on foot, more so than during peak hours. The higher midday pedestrian access is due to the large number of workers and shoppers in Silver Spring during the day.

Alternate Mode of Travel--If Metro had not been available, the alternate mode of travel for off-peak Metro trips from Silver Spring would have been as follows:

- Metrobus - 11%
- Auto driver - 43%
- Auto passenger - 6%
- Taxi - 3%
- Other - 2%
- No trips - 11%

Of all midday riders at Silver Spring, one-half would have used auto if Metrorail had not been available. It was pointed out above that a much greater 75 percent of Silver Spring employees riding Metrorail would have gone by car had the subway not been available. The lower percentage reported for all midday Metro users probably includes mostly residents who would have been more likely to use the bus for midday trips prior to Metrorail. Of all midday riders, 35 percent would use bus as an alternate. Approximately 10 percent claimed they would not make the trip if Metrorail had not been available.

Trip Purposes--The most common purpose of trips using Metrorail to and from Spring Spring even during the off-peak period was work, which accounted for slightly more than one-third of Metro trips between 9 a.m. and 3 p.m. This figure includes people going to work much later than normal as well as those returning to work on Metro from trips elsewhere. Job-related trips were the next more frequent trip purpose for midday trips on Metro from Silver Spring followed by personal business and sightseeing trips. The second most frequent trip purpose for trips to Silver Spring by Metrorail during the midday was personal business, followed closely by job-related, and shop or lunch.

TRAFFIC IMPACTS

The dramatic increases in transit use predicted because of the rail extension and feeder bus services to the Silver Spring station were expected to result in corresponding changes in auto use. Studies were designed to measure changes in auto use to Silver Spring and to the District of Columbia, as well as changes in turning movements at insersections.

Traffic Volumes

Traffic volumes entering the Silver Spring business district from the north increased. This had been expected, because of the anticipated numbers of Metrorail users who would drive to the station. However, the traffic increase was less than expected, probably because many of those driving to Metro previously drove through Silver Spring to their destination.

On the southern boundary of Silver Spring traffic volumes entering the District of Columbia declined slightly on Georgia Avenue, the main arterial most closely aligned with the Metro route. However, there were slight increases in highway volumes on 16th Street, N.W. which provides the most direct route to the CBD. Traffic volumes are extremely difficult to use as a measure of Metrorail impacts, because of the seasonal variations as well as possible changes in highway use between major highway corridors for reasons other than Metro. In addition, a special through trip analysis determined that most peak-hour travel crossing the Silver Spring boundary in the predominant direction of flow was through traffic. Through trips accounted for 70 percent of the outbound traffic in the morning peak hour and 55 percent of the inbound traffic in the evening peak hour. However, it was pointed out in Chapter IV that the annual traffic counts taken at the D.C. core showed a significant decline in traffic on 16th Street.

Turning Movements

Turning movements at intersections in Silver Spring changed only slightly, with most of the impact at intersections near the Metro station. There were a few large relative increases on streets which were minor collectors prior to Metro and which became key access points to the station.

Driver Attitudes

Another indication of traffic impacts is driver attitudes. After Metro, three out of every four Silver Spring employees who drove to work reported that they perceived no difference in travel time from the period before Metro. Of the remainder, twice as many reported a slower trip to work than before. This supports the traffic data observations of a slight increase in traffic due to the inauguration of Metrorail service in Silver Spring.

Parking

The most noticeable short-term impact of Metro was in parking demand. Parking accumulation data collected by the Montgomery County Department of Transportation indicate a significant increase in parking demand immediately after the opening of Metro. The parking sector adjacent to the Metro station was most heavily affected, with peak-hour usage increasing from 50 to 100 percent. Acute parking shortages were experienced throughout the northern part of the CBD where employment densities are highest.

Metro surveys on mode of access and prior travel mode were used to estimate additional parking demands. On balance, it appears that an additional 700 cars were parked in County-operated facilities in the morning peak hour for the purpose of riding Metro-

rail. An additional 150 Metrorail riders were estimated to be parking in residential areas. The increase in parking demand was noticeable to those parking in County-owned facilities. Almost one out of every four parkers reported that either they took longer to find a space, parked further away, or had to arrive earlier in the morning. Because of displacement of parking spaces by Metro users, there was an increase in parking in residential neighborhoods by Silver Spring employees and shoppers.

REACTIONS OF COMMUNITY RESIDENTS AND BUSINESSES

To broaden the perspective of Metrorail's effects beyond specific travel impacts, surveys were conducted of 99 businesses and 201 residents to obtain their perceptions of the total impact of Metro on their lives or business operations. Some of the problems related to Metrorail in Silver Spring had been widely reported. It was very important to the County to know how serious these problems were perceived to be.

Many of the concerns were related to businesses, which are closer to Metro and its "spillover" impacts of traffic and parking. Although it had been reported that many businesses were planning on moving out, the survey found that five out of every six businesses intended to stay. Half of the remainder did not know, and only seven percent indicated plans to leave Silver Spring. Since there is normally a certain percentage of migration of businesses, the findings certainly belie the fears of extensive business departures. On the positive side, most (56 percent) of the businesses reported that their business had benefitted due to Metro. Such a high positive response is particularly notable since the survey took place six months after Metro opened when it was unlikely that much data was available on changes in business receipts. One out of every four businesses reported that Metro had benefitted them by bringing more people into the area. One business in six reported that they had been helped by easy access to other areas. They confirmed the employee travel survey data cited above which show that one of the most significant relative impacts of Metro was in attracting 40 percent of the midday trips by Silver Spring workers to destinations in Washington, where most of them would have previously driven. Other benefits reported were:

- Easier commuting by employees - 10%
- Area more accessible to customers - 8%
- Lower transportation costs - 5%
- Brings more business into area - 2%
- A plus when advertising - 2%

When asked about problems, seven out of ten businesses mentioned a problem created by Metro. The most common complaint was the lack of restriction of parking, mentioned by one-half of all businesses. Traffic congestion and loss of business were the

next biggest problems, but were cited by fewer than one in ten businesses. When asked for an overall rating of Metro as far as business was concerned, businesses gave positive marks to Metro by a margin of 5:1.

Residents of Silver Spring agreed with the business people that parking problems had gotten worse, although concern about parking problems was less among citizens (25-30 percent) than among businesses. Some residents also complained about traffic congestion, but the 28 percent of residents who listed this as a problem were somewhat counter-balanced by the 13 percent who felt traffic problems in Silver Spring had gotten better. When asked for an overall evaluation of advantages and disadvantages of Metro, residents were overwhelmingly positive, by a 9:1 ratio.

CONCLUSIONS

The evaluation of Metrorail impacts on Silver Spring provides a unique glimpse into the effects of a rail transit station on a major suburban employment and population center. Since Metrorail currently terminates at Silver Spring, rather than linking the community to future residential stations north in the Georgia Avenue corridor, the current rail system serves only a portion of its intended purposes. Even so, transit use in the corridor between Silver Spring and downtown Washington approximately doubled with the opening of the Metro station, and increased by a like amount during the rest of the year.

Some of the major characteristics and impacts of this transit increase are listed below:

- If Metrorail had not existed, 38 percent of inbound peak-period riders would have used auto. The diversion of auto trips to rail in the corridor between Silver Spring and downtown Washington initially reduced auto travel by 2,000 vehicles in the peak period. Because this reduction was divided among several arterial streets, and there may have been corresponding increases in routing of travel through Silver Spring, traffic counts revealed no significant reduction in auto travel.

- The 53 percent of Metrorail riders who would have used the bus as an alternate were former bus riders newly provided with the increased convenience of rail service during both off-peak and peak periods. Former bus commuters who may have been restricted to "peak-hour only" service now have rapid rail transit service available throughout the day and evening.

- Relative transit use by employees commuting to Silver Spring increased from 10 to 13 percent. Almost one-half of the workers going to Silver Spring on Metrorail were formerly auto users. The increase in transit commuting to Silver Spring on the expanded local Ride-on bus service was greater than the number commuting there on Metrorail.

- The most significant diversion of auto travelers was among the 40 percent of Silver Spring workers who made midday trips into the District of Columbia by Metrorail. Three out of every four of these workers previously made the trip by auto. Reducing the need for an auto during the day may facilitate transit use by these workers for commuting, even though most of them live where the present access to work is only bus. Benefits to the employer include a reduction in cost of owning, storing, and maintaining company cars, as well as higher productivity of workers who do not waste time trying to locate scarce midday parking. In addition, workers may be able to use their travel time productively.

- Approximately 56 percent of the peak-hour Metrorail users come to Silver Spring by bus. The remainder are divided equally among pedestrians, drivers, and auto passengers. If there had been no rapid rail, almost 40 percent of those trips would have been made by auto.

- The most noticeable short-term negative impact of Metrorail was on parking demand. The increased demand for parking by 1,500 daily Metro users, however, was partially offset by a reduction of half that number of Silver Spring employees who switched from auto to transit.

- When those most affected by the negative aspects of Metro, Silver Spring residents and businesses, were asked about the overall impact, they were overwhelmingly favorable. This finding is particularly notable because Silver Spring was not designed as a terminal station, and many of the short-term parking and traffic impacts will be mitigated once the rail line is extended.

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