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Duluth Variable Work Hours/ Transit Fare Prepayment Demonstration

**Final Report
April 1984**

UMTA Technical Assistance Program
Office of Service and Management Demonstration
UMTA/TSC Project Evaluation Series

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16. Abstract

This report describes the evaluation results of the Duluth Variable Work Hours/ Transit Fare Prepayment Demonstration. The demonstration project was intended to reduce severe peaks in demand on the bus routes of the Duluth Transit Authority (DTA). It was anticipated that these reductions in peaking would result in either reduced operating costs for the DTA or an improved level of service for DTA passengers. The project combined two major elements -- a variable work hours program, intended to increase work schedule flexibility, and a differential peak-offpeak pricing component to encourage temporal shifts in transit demand. The pricing component was implemented through regular and discounted peak-restricted monthly passes.

The program was unsuccessful in achieving its goals for several reasons. Variable work hours programs were universally rejected by employers, first because they did not perceive a peak congestion problem in Duluth, and second because they were concerned that union labor might demand continuation of variable work hours even if a trial program had unacceptable impacts on their business. Pass sales were relatively small, and the time restrictions and peak-offpeak pass price differentials were not effective in inducing shifts in travel behavior even among the small group of pass buyers. Only very small impacts could be attributed to the demonstration, while the revenue sacrificed to pass buyers was significant.

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PREFACE

This evaluation of the Duluth (Minnesota) Variable Work Hours/Transit Fare Prepayment Demonstration was prepared in the Boston, Massachusetts, office of Charles River Associates Incorporated (CRA) for the Transportation Systems Center (TSC) of the U.S. Department of Transportation (DOT) under Contract Number DOT-TSC-1757. The evaluation was undertaken as part of the Service and Methods Demonstration Program (SMD) sponsored by the Urban Mass Transportation Administration. Eric A. Ziering served as CRA's evaluation manager. Larry Doxsey of TSC served as technical advisor and monitor for the evaluation and provided useful input throughout the demonstration. Stewart McKeown was the UMTA Project Manager.

Many individuals contributed to the development of this evaluation report. Within CRA, Eric A. Ziering directed the evaluation and was the principal author of the report. John Parker performed computer tabulation work for the project. Other contributors included Frank Kelly, editor, and Sharon Ayres and Susan Novich, graphic artists. Thomas E. Parody provided many useful comments throughout the entire evaluation process. Daniel Brand, CRA's Officer-in-Charge of work conducted for the SMD program, was overall supervisor of CRA's work on this project. Larry Doxsey of TSC provided many comments and made numerous useful suggestions concerning the organization and content of this report.

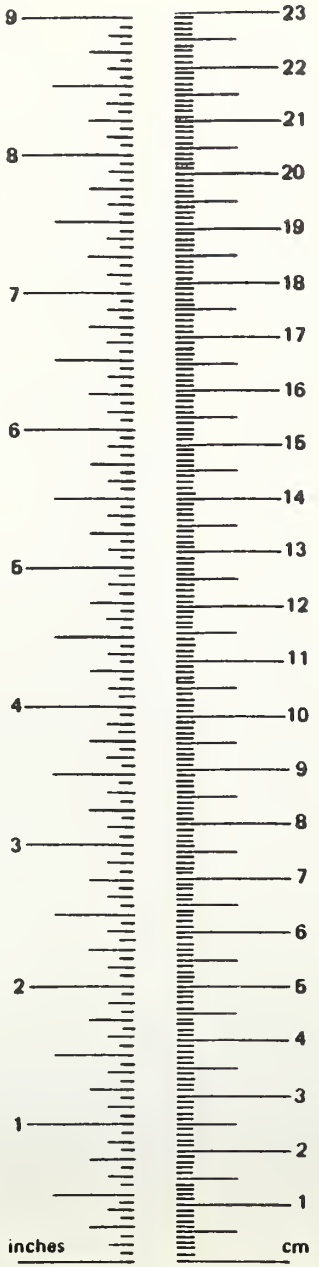
CRA accepts full responsibility for the information and conclusions presented in this report, but acknowledges that the evaluation would not have been possible without the cooperation of Linda Zemotel, who was Project Manager of the demonstration for the Duluth Transit Authority (DTA), Jim Heilig (also from the DTA), and Katie Turnbull of the Arrowhead Regional Development Council (ARDC).

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

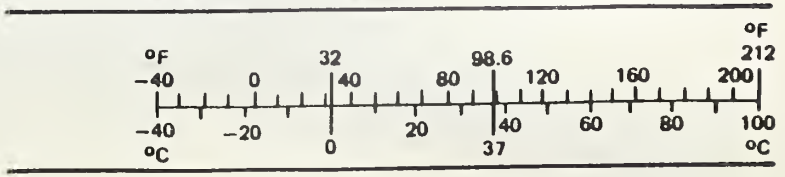
Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2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

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



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
he	hectares (10,000 m^2)	2.5	acres	
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	querts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	36	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

INTRODUCTION

The Duluth (Minnesota) Variable Work Hours/Transit Fare Prepayment Demonstration was a project intended to reduce severe peaks in demand on the bus routes of the Duluth Transit Authority (DTA). Transit operating costs are largely a function of peak vehicle and labor requirements, which are in turn based on peak passenger demand levels. By reducing peaks in demand, the Duluth demonstration was expected to permit reductions in transit operating costs. In the past, a major obstacle to the successful implementation of differential peak/off-peak pricing to reduce peaking of demand has been an inflexibility both in individuals' work schedules and the time of day that they commute. This demonstration attempted to circumvent this problem by linking the differential time-of-day fare to a variable work hours program in the Duluth central business district (CBD).

The demonstration was structured to provide incentives and new opportunities for changes in travel behavior and transit operations. Employers were encouraged to participate in the variable work hours component of the demonstration on the basis of the beneficial employee productivity impacts and reduced regional congestion that would result. As an additional incentive, participating employers were given the opportunity to sell transit passes (considered a valuable fringe benefit) to their employees. Flexible work schedules were devised to provide travelers with new opportunities to shift their time of travel; a reduced price peak-restricted pass was designed to provide travelers with an economic incentive to travel outside the sharp a.m. and p.m. peak periods. Finally, reductions in ridership peaks were to provide the DTA with the opportunity to revise its schedules to reduce fleet size and labor requirements, which are normally based on peak demand levels. The evaluation focused on the extent to which each of the incentives was successful in bringing about the desired change in behavior.

DEMONSTRATION DESIGN

The Duluth demonstration had two major phases. In Phase 1, employers in the Duluth CBD were approached and encouraged to adopt variable work hours. Those firms whose employee work schedules were not highly concentrated around 8:00 a.m. were recruited to join an employer-based transit pass program. Two different passes were offered: the "All-Day" pass (valid throughout the day), and the "Discount" pass, which was sold at a lower price but was not valid during the a.m. peak half-hour. During Phase 2 of the project, both the All-Day and Discount passes were available to all transit riders through public sale outlets.

DEMONSTRATION IMPACTS

The demonstration project had virtually no impact on employers. Only 1 firm with 30 employees joined the variable work hours program, and this firm was deeply involved in data collection for the evaluation of the demonstration. Lack of participation in the variable work hours program was principally attributed to the perception among employers that peak-period congestion was not a problem in the Duluth area. In addition, employers were resistant to adopting variable work hours because the strong union environment in Duluth might have required them to continue the program in perpetuity even if it were unsuccessful. Participation in the pass program was not effective in inducing employers to adopt variable work hours. A total of 136 employers participated at one time or another in the pass program; 20 of these ended their participation because few employees were purchasing passes. Most of the employers sold very few passes; only 3 sold 25 or more in any month. Employers experienced few costs or benefits as a result of their participation in the project.

Individuals' work hours and times of travel seemed to be unaffected by the demonstration, except at the one firm that adopted variable work hours. While some passholders reported changing their time of travel after buying the pass, there was evidence that the demonstration project was not the principal cause of shifts in time of travel. Pass purchasers were generally frequent travelers who purchased the pass at least in part because it was less expensive than paying for trips with cash or tokens. Pass buyers were equally divided in citing cost savings and convenience as reasons for buying the pass. The demonstration clearly indicated that most purchasers of the Discount Pass were able to further reduce their transit expense without in any way altering their travel behavior. Persons buying the Discount Pass were much less likely to start work during the restricted time period (7:30-8:00 a.m.), but were otherwise very similar to All-Day passholders. There was some indication that some travelers regularly used the Discount Pass during the restricted peak period, suggesting that enforcement by drivers might have been inadequate.

When pass prices were increased in Phase 2, the average trip frequency of passholders increased, as low-end pass users returned to paying a cash or token fare. Trip frequency was the only significant variable distinguishing passholders from cash or token fare transit riders. The demonstration resulted in very little switching of travel modes. Some pass users (who formerly paid cash or tokens) shifted selected trips (principally non-work trips) from automobile or walking; these additional trips resulted in overall increases in DTA ridership of 0.4 percent and 0.7 percent in 1981 and 1982, respectively. While many passholders stated that they traveled by bus more frequently after buying the pass, the limited before-and-after data available from employee surveys did not support this claim.

Transit ridership increased by at most about 1.2 percent during peak periods and by a smaller amount during off-peak periods as a result of the demonstration. These impacts were clouded by an overall demand drop of 24.6 percent due to external causes over the course of the project. While peak ridership did decrease over the course of the study, the percentage of daily demand occurring in the peak did not change significantly. Few new transit users appear to have been generated by the demonstration. Transit operations were not affected; the DTA implemented no changes in service to adapt to overall transit demand decreases over time. Changes in method of payment did not appreciably affect transit operations. There is evidence that drivers remained confused throughout the project concerning the distinction between the Discount and All-Day Port passes, despite attempts to train the drivers and to make the passes easily distinguishable. The average cost of operating the pass program was $6.28 per pass sold over the course of the project. The estimated revenue loss from the project (to passholders who traveled frequently enough to recoup their net payment to the DTA) was estimated to be $43,161, or $2.46 per pass sold.

CONCLUSIONS AND RECOMMENDATIONS

The Duluth Variable Work Hours/Transit Fare Prepayment Demonstration was not successful in reducing demand peaks or bringing about reductions in transit operating costs. While the basic demonstration concept seems to have been appropriate for the site, and although the DTA was diligent in implementing the components of the demonstration, the original demonstration design appears to have neglected the complexity and difficulty of manipulating transit demand with tools under the transit operator's control. It seems clear that employers will not participate in regional variable work hours programs unless they perceive severe and widespread congestion resulting from peaking in travel demand. This conclusion is probably valid for all types and sizes of cities. The discounted pass option appeared to provide a windfall for a substantial number of travelers without requiring them to adjust their travel behavior in any way. This in turn resulted in lost revenue for the DTA. This result was a function of both the time restrictions that were selected for the Discount Pass and travel demand patterns in Duluth. Other cities should be sensitive to this potential impact when designing differential time-of-day fare schedules to shift demand. Even if discount pass buyers had shifted their travel away from the peak, pass penetration was so low that the systemwide effects would have been minimal. It can thus be concluded that in order to successfully implement differential time-of-day pricing using fare prepayment, fare prepayment must achieve extensive market penetration. Finally, the pass program confirmed the results of previous demonstrations indicating that pass buyers are invariably individuals who reduce their transit expense by buying the pass. A high cost per pass was associated with the fare prepayment demonstration, and resulting ridership impacts were minimal.

1. DEMONSTRATION PROJECT OVERVIEW

1.1 INTRODUCTION

The Duluth (Minnesota) Variable Work Hours/Transit Fare Prepayment Demonstration project was designed to alleviate peak congestion on the bus routes of the Duluth Transit Authority (DTA). The original demonstration plan scheduled two major phases. First, employers in Duluth's central business district (CBD) were encouraged to adopt flexible or staggered working hours to permit employees to vary their work starting and ending times. Simultaneously, a prepaid transit pass (known as the "Port Pass," after the Port of Duluth) was made available, along with a discounted pass option that validated travel at times other than the peak morning half-hour. The unlimited-use monthly pass was initially priced at $14.00, equivalent to 40 one-way trips per month.* The discounted pass initially cost $11.00 per month, and the sole restriction was that it could not be used on vehicles arriving in the Duluth CBD between 7:30 and 8:00 a.m. on weekdays, unless a single-ride penalty of $0.25 was paid. The combination of increased work schedule flexibility and the financial incentive for off-peak travel was intended to bring about a shift of travelers to the shoulders of the peak.

In this first phase of the demonstration, passes were available only through employers. In order to be eligible to offer passes to its workers, a firm had to have at least 30 percent of its full-time employees start work at times other than the period between 7:45 and 8:00 a.m. The availability of regular and discounted transit passes for a firm's employees was intended to provide an incentive for employers to participate in variable work hours programs during the project's first phase. During the second phase of the demonstration, both types of passes were available to the general public.

1.2 PURPOSE AND EVOLUTION OF THE DEMONSTRATION

The primary purpose of the Duluth demonstration was to utilize differential time-of-day pricing to eliminate sharp transit demand peaks during the morning peak half-hour (7:30-8:00 a.m.). This was expected to result in operating cost savings for the DTA and improved seat availability for DTA riders.

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*This breakeven trip rate is based on the token fare of $0.35 per ride. The cash fare per ride was $0.40, but most frequent DTA riders used tokens before the pass program was implemented.

In 1978, the Office of Service and Management Demonstrations (SMD) of the Urban Mass Transportation Administration (UMTA) first began to investigate opportunities for differential time-of-day pricing as part of its transit fare prepayment demonstration program. Differentiated time-of-day pricing schemes are easily implemented using exact change payment, although there is a history of problems with driver education and enforcement of these programs. On the other hand, few transit operators had adopted fare prepayment techniques in off-peak fare reduction programs. Analysis of a survey of transit operators administering over 300 fare prepayment programs found that only 1 program existed for use by the general population.* At the same time, UMTA was also interested in combining a differential time-of-day pricing program with a variable work hours program.

Discussions between SMD and several potential demonstration grantees began in late 1978 with the goal of demonstrating the differential time-of-day pricing concept using prepayment instruments. In mid-1979, Duluth, Minnesota, was selected as the best site for the proposed demonstration for several important reasons. First, it was believed that the City of Duluth had a long-term interest in implementing a CBD staggered work hours program; second, the DTA enjoyed a good reputation and working relationship with the business community and political leaders, and therefore expected to be able to generate support for the project from these sources; and third, the DTA had been providing good service to the downtown area during both peak and off-peak periods.

1.3 ECONOMIC RATIONALE AND EVALUATION ISSUES

The number of buses and drivers employed by a transit operator is usually based on peak demand loads; that is, sufficient vehicle capacity is provided to accommodate maximum loads at some acceptable vehicle load factor. As a result, system operating costs are directly correlated to peak demand and are largely independent of the excess capacity that frequently exists at times other than the peak demand period. A more uniform distribution of travel demand reduces peak vehicle and manpower requirements and can permit significant reductions in operating cost (or, conversely, increase effective passenger seat availability with no change in operating cost). Lowering off-peak fares provides an incentive for transit riders to travel outside the peak, resulting in a more uniform distribution of demand.

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*Patrick D. Mayworm, Kenneth P. Ceglowski, and Armando M. Lago, Recommendations for Transit Fare Prepayment Demonstrations (Bethesda, MD: Ecosometrics Incorporated, 1978), p. 47.

The principal obstacle to the effective use of a differential time-of-day pricing policy to reduce peaking of demand is the inability of commuters to choose their time of travel to work. The vast majority of peak-period transit trips are work trips that cannot easily be rescheduled given fixed work hours. Therefore, increasing peak-period fares and/or reducing off-peak fares can have little impact on peak-period ridership and transit operating cost. As long as these other constraints keep transit demand inelastic, a differential time-of-day pricing policy can make only a limited contribution toward smoothing traffic peaks. On the other hand, differential time-of-day pricing can be extremely effective in generating additional operating revenue, as a result of this same inelasticity of demand.

The Duluth demonstration attempted to combine variable work hours with differential time-of-day pricing to bring about a reduction in peaking of transit usage. The program provided employers, travelers, and the DTA with opportunities and incentives to change their behavior in ways that would benefit all three.

For employers, several incentives existed for the adoption of variable work hours. First, participation would contribute to the reduction of congestion in the region. Second, variable work hours could be perceived by employees as a valuable fringe benefit and have beneficial productivity impacts. Because lower off-peak fares were only (initially) available to travelers through buying a discount monthly pass from their employer, employees who wanted to purchase the pass would encourage their employers to participate in variable work hours (and the pass program). This provided a third incentive for employers to participate. Had lower cash off-peak fares been available, this incentive would not have existed. Working against these factors was the perceived workplace disruption that employers frequently associate with variable work hours programs, and the time cost of administration entailed with both variable work hours and pass distribution.

The demonstration provided travelers with both new opportunities and new incentives to change their travel behavior. Variable work hours were intended to provide increased flexibility in the travel schedules of employees, and the financial incentive of the reduced off-peak fare was intended to encourage employees to avail themselves of this increased flexibility.

Finally, reductions in peak demand were intended to provide the DTA with opportunities to reduce operating costs by trimming the size of the bus fleet or reducing labor requirements. Alternatively, the DTA could provide improved service at the same level of cost.

The major evaluation issues addressed by the demonstration, then, were the following:

1. How effective were the various incentives in bringing about employer participation in the variable work hours program?

2. Did employees take advantage of additional schedule flexibility to change their time of travel and reduce their transit expense?

3. Was the DTA able to capitalize on reduced demand peaking by improving service or reducing operating costs?

1.4 ORGANIZATIONAL ROLES OF EVALUATION PARTICIPANTS

The organizations involved in the Duluth demonstration and their relationships to one another are shown in Figure 1-1. Each organization and its role in the demonstration are described below.

1.4.1 Duluth Transit Authority (DTA)

The DTA was the recipient of a demonstration grant from the Urban Mass Transportation Administration (UMTA) and was responsible for administrative and budgetary control of the demonstration project. The DTA owns and operates the bus service in Duluth, although the bus system is managed by ATE Management & Service Company. A project manager was hired by the DTA. During the project, the DTA was responsible for advertising, public relations, and data collection activities, although these tasks were performed by subcontractors.

1.4.2 Urban Mass Transportation Administration (UMTA)

UMTA was the Service and Management Demonstration (SMD) sponsor and grantor for the Duluth project and was responsible for supervising and guiding all aspects of the demonstration.

1.4.3 Transportation Systems Center (TSC)

Overall responsibility for the evaluation rests with the Transportation Systems Center, a division of the Research and Special Programs Administration of the U.S. Department of Transportation. It was TSC's task to select and monitor the activities of the evaluation contractor as well as to specify the technical direction of the evaluation. Both TSC and the evaluation contractor interacted with the grant recipient to obtain the data necessary to perform the evaluation. TSC will also coordinate and synthesize the findings of the present evaluation with other similar demonstration projects.

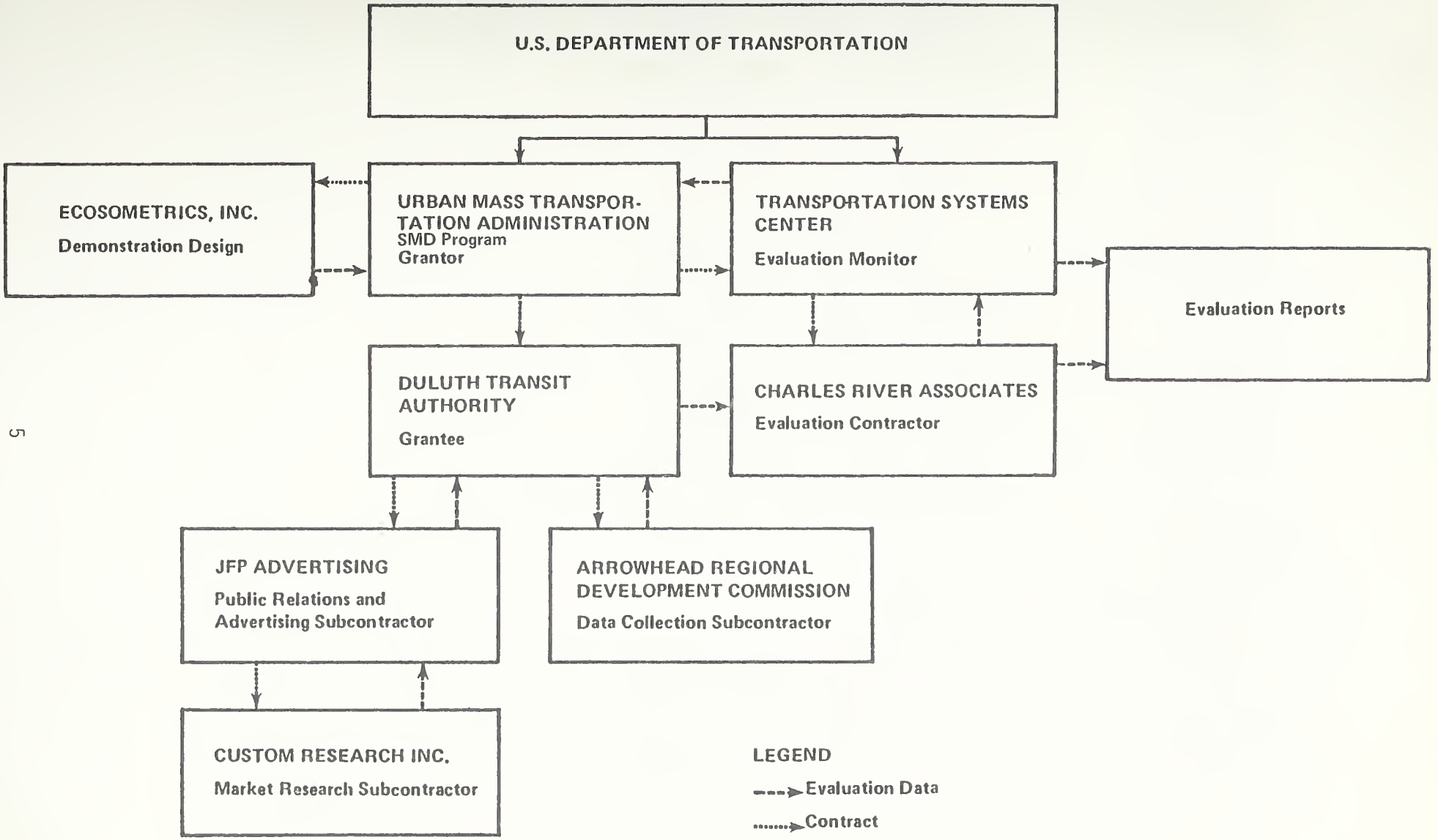

Figure 1–1. ORGANIZATIONS AND ROLES FOR THE DULUTH DEMONSTRATION

1.4.4 Charles River Associates (CRA)

CRA served as the evaluation contractor for this demonstration under a separate contract to TSC. In this role, CRA was responsible for monitoring and evaluating the demonstration project, including preparation of the project's Evaluation Plan, monthly Progress Reports, and this Demonstration Evaluation Report. CRA, in consultation with TSC, established appropriate data collection strategies, surveys, and questionnaires, as well as quality control procedures for the reduction and transmittal of data.

1.5 EVALUATION REPORT OVERVIEW

This report presents a comprehensive evaluation of the Duluth Variable Work Hours/Transit Fare Prepayment Demonstration. This first section has briefly described the project, its development, and its intended purpose, and has identified the various organizations involved in project implementation and evaluation. The second section presents a detailed discussion of the demonstration plan and its implementation, focusing on changes that took place in the original demonstration concept and the reasons behind these changes. The third section evaluates the impacts of the demonstration project on three different groups: employers, travelers, and the DTA. These results are based on extensive survey data and other data monitored continuously throughout the two-year demonstration. The fourth and final section of this Evaluation Report summarizes the results of the demonstration and synthesizes the results of related studies. Appendices at the end of the report contain descriptions of both the project site and data collection and analysis procedures, as well as reproductions of the data collection instruments used to evaluate the demonstration.

2. DEMONSTRATION PLAN AND OPERATION

This section describes the development and operation of the Duluth Variable Work Hours/Transit Fare Prepayment Demonstration. The first subsection briefly describes the original demonstration design and base conditions of the DTA. The following subsection highlights key internal and external factors affecting the project as well as other changes that occurred during the demonstration.

2.1 DEMONSTRATION DESIGN AND BASE CONDITIONS

The Duluth Variable Work Hours/Transit Fare Prepayment Demonstration was scheduled to last for three years and consisted of four specific phases: an organizational phase for planning and preparation, a solicitation phase for encouraging employers to participate in the program, and two operational phases. The organizational phase was scheduled to last seven months and consisted of five specific tasks: hiring of project staff; selection of subcontractors for data collection, market research, and advertising; implementation of "focus groups" with employers, employees, and transit users; preparation of marketing materials; and pre-demonstration data collection.

The solicitation phase of the demonstration involved the marketing of variable work hours programs to employers in the Duluth central business district (CBD). This phase was scheduled to begin in the project's fifth month and to continue well into the first operational phase of the project. CBD employers were contacted through letters of introduction and follow-up telephone calls. To maximize pass sales and program exposure, emphasis was given to interesting large firms in the program.

In the first operational phase of the demonstration (referred to as Phase 1 throughout this report), CBD employers were to adopt variable work hours. Firms that implemented variable work hours would be eligible to sell weekly or monthly transit passes to their employees. These passes were to be essentially undiscounted and would have no restrictions on use. (Note that in the original demonstration plan, only those firms adopting variable work hours were to be eligible to participate in the pass program. In addition, the discounted peak-restricted pass was not planned to be available during the first operational phase.)

Phase 1 of the project was scheduled to begin in the eighth month of the demonstration and to last for one year. Solicitation of employers was to continue during this phase. Phase 1 was also to encompass two additional activities: Phase 1 data collection; and planning for the second operational phase, including preparation of marketing and advertising materials.

The second operational phase of the demonstration (referred to as Phase 2 in this report) was to consist of two separate components: introduction of the discounted transit pass with its morning peak half-hour restriction; and introduction of sales of both the regular and discounted passes to the general public. It was also expected that solicitation of employers to participate in variable work hours and employer-based pass sales activities would continue into the second operational phase. Lastly, this phase was to encompass a final set of data collection activities for use in the evaluation.

Base conditions indicate that significant peaking of demand occurred on the DTA system. The DTA operated 37 regular routes within the Duluth/Superior region, using a fleet of 109 buses. Annual ridership prior to the demonstration was approximately 7 million passengers per year. One-third of work trips and 20 percent of shopping trips to the Duluth CBD are made by bus (see Appendix A for a more detailed description of the DTA and its route and service structure). Demand on the DTA was characterized by large peaks inbound in the morning and outbound in the afternoon. Peak half-hour inbound demand represented 11.6 percent of daily inbound demand; the corresponding outbound figure was 10.8 percent. Figures 3-4 and 3-5 in Section 3 illustrate the peaking very clearly for the inbound and outbound routes, respectively. Boardings per bus in the a.m. and p.m. peak half-hours before the demonstration averaged about 80 percent in the morning and just over 60 percent in the afternoon. These loads were not evenly distributed by vehicle, however, so that there were approximately 107 and 72 standees in the a.m. and p.m. peak half-hours, respectively. Twenty-nine bus runs each took place in the a.m. and p.m. peak half-hours, representing almost 6 percent of weekday bus service (see Table 3-6). Clearly, opportunities existed to reduce peaking in transit demand.

2.2 LOG OF DEMONSTRATION ACTIVITIES

The Duluth Variable Work Hours/Transit Fare Prepayment Demonstration grant was awarded to the DTA in March 1980, and the planning phase began in April 1980 (Figure 2-1 shows a project time line indicating important events in the demonstration project). The Arrowhead Regional Development Commission (ARDC) was hired as the project's data collection subcontractor; Custom Research Incorporated and JFP Advertising were hired to perform market research and to provide advertising services, respectively. Data collection activities performed by ARDC during the planning phase of the project included the first of three short self-completion on-board surveys of riders, and the first of three "Brown Sheet" ridership counts (systemwide counts of the number of passengers riding on every run of every route on the DTA system during weekdays and weekends). A detailed description of the data collection methodology and sample copies of the data collection instruments used are contained in the appendices to this report.

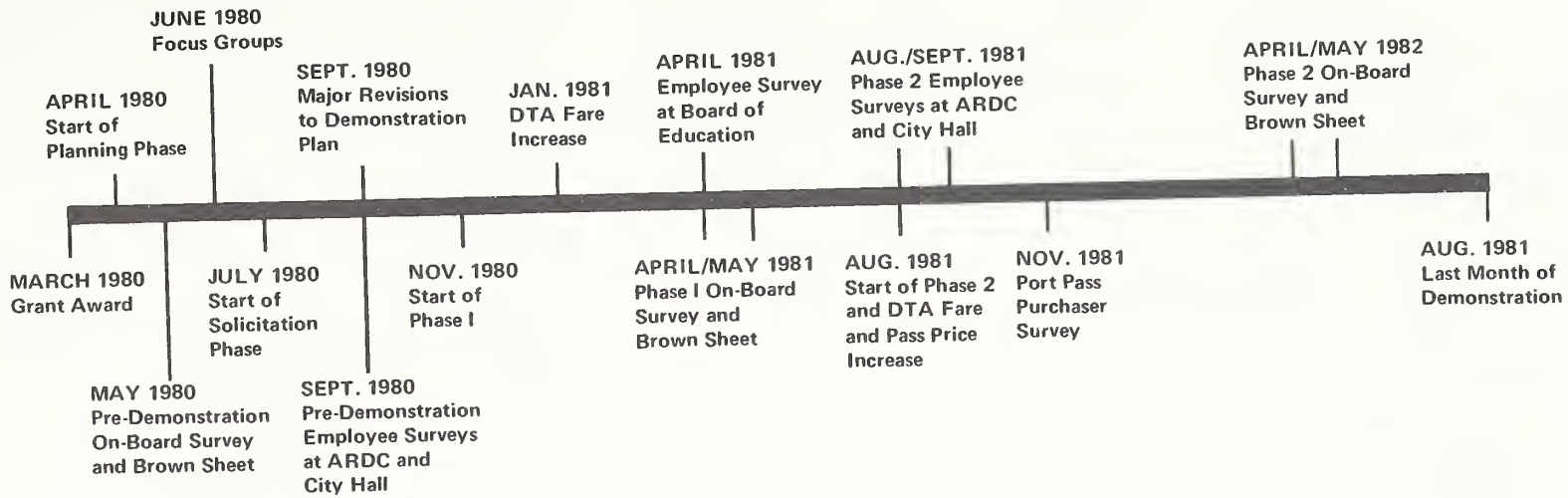

Figure 2–1. DULUTH VARIABLE WORK HOURS/TRANSIT FARE PREPAYMENT DEMONSTRATION TIME LINE OF SIGNIFICANT EVENTS

In June of 1980, Custom Research Incorporated conducted focus groups with 25 CBD employers and 25 employees (including both transit users and non-users) to test their responses both to the variable work hours concept and to the demonstration project. Employers were reluctant to support the program because they perceived no potential benefits. Among their reasons for not viewing the program as beneficial were the following:

- Employers perceived that the City of Duluth did not experience the types of problems that variable work hours are intended to solve (e.g., traffic congestion, transit system congestion);

- Some employers saw the demonstration as a poor expenditure of federal tax dollars;

- Employers were reluctant to join the program voluntarily because union employees might demand continuation of the program as a permanent fringe benefit; and

- Employers saw no financial advantage attached to the pass program for their employees, and suggested that the DTA offer an incentive discount. Without such a discount, the DTA would not be contributing in any way to the program, and only the employers would be making a financial sacrifice to administer the program.

Employees were generally supportive of the proposed program, and many individuals said they would purchase passes as well. However, most employees did not understand why their employers would want to participate in the program, since no obvious benefits accrued to employers. The results of the focus groups were confirmed in the solicitation phase. Through July, August, and early September of 1980, the DTA project manager met with a dozen large firms and other business and fraternal organizations. The response to the demonstration was universally negative, despite marketing efforts that focused on the beneficial productivity and employer morale impacts experienced in other locations as the result of variable work hours programs.

Following the negative response to the original program, three major changes were made in the demonstration. First, a decision was made in September 1980 to offer both the regular and discounted passes simultaneously at the beginning of Phase 1. The availability of the discounted pass was intended to provide employees with a potential cash benefit, thereby supplying an additional incentive for employers to join the program.

The second major change was in the eligibility requirements for participation in the pass program. Originally, only those firms that adopted flexible or staggered work hours were to be eligible to offer passes to their employees. However, the strong negative response of employers to the variable work hours concept would have resulted in virtually no participation in the pass program. Therefore, the pass program was opened up to any firm

that had more than 30 percent of its full-time employees starting work at times other than the period between 7:45 a.m. and 8:00 a.m. This eligibility requirement was intended to ensure that firms having companywide work start times within this interval (and therefore placing the heaviest commuting loads on the DTA during its peak morning half-hour) would be unable to participate. In theory, these firms would have had to adopt some kind of flexible or staggered work schedule to meet this 30 percent requirement.

The third and final change, adopted in September 1980, was the elimination of weekly transit passes from the demonstration. This was enacted primarily to ensure administrative simplicity and to reduce both confusion and program costs. At this time, the initial pass prices of $14.00 and $11.00 for the regular and discounted passes, respectively, were established. The $14.00 price was based on an equivalent of 40 one-way trips at the token fare of $0.35 (the cash fare at that time was $0.40). In addition, the terms "All-Day" and "Discount" were designated to distinguish the two passes.

Following implementation of these changes, the DTA initiated full-scale marketing of the revised pass program. Introductory letters were sent to 787 employers in Duluth (out of 1300 employers in the city) in late September. Seventy-six of these employers requested additional information, and a total of 46 employers agreed to join the pass program when it began in November 1980. The vast majority of firms that expressed interest in the program were small concerns, able to meet the program's eligibility requirements with no changes to their work schedules. By July 1981, the last month of Phase 1, 115 employers were participating.

A general DTA fare increase took place on January 1, 1981. At that time, cash and token fares (which had been $0.40 and $0.35, respectively) increased to $0.50 and $0.40, respectively. Pass prices remained at $14.00 and $11.00 in order to stimulate pass sales. Table 2-1 shows the DTA fare structure throughout the course of the demonstration. As a result, the All-Day Pass, originally priced equivalent to 40 one-way token trips, changed in price to the equivalent of 35 one-way token trips, a 2.5 percent discount.

A variety of methods were used to educate the DTA staff and bus drivers concerning the demonstration project, including a kickoff celebration, individual training, and an official memorandum from the DTA Superintendent of Transportation dictating the rules for use of the regular and discount passes. Despite these efforts, casual enforcement of the restrictions on the use of the discount pass became a problem early in Phase 1. This pass could only be used on bus runs arriving in downtown Duluth between 7:30 a.m. and 8:00 a.m. if a single ride penalty of $0.25 were paid. However, there was some confusion concerning these restrictions, and enforcement by drivers became lax. A factor that contributed to this problem was a striking similarity between the original designs for the regular and discount passes.

TABLE 2-1. DULUTH TRANSIT AUTHORITY FARE STRUCTURE

	Effective Date		
	11/1/80*	1/1/81**	8/1/81+
Regular Cash	$ .40	$ .50	$ .50
Regular Token	$ .35	$ .40	$ .50
All-Day Port Pass	$14.00	$14.00	$20.00
Discount Port Pass	$11.00	$11.00	$17.00
Peak Penalty for Discount Port Pass	$ .25	$ .25	$ .25
Senior/Handicapped Cash	$ .20	$ .25	$ .25
Senior/Handicapped Token	$ .175	$ .20	$ .25

Notes: *Start date of Phase 1 of the demonstration.

**DTA fare increase.

+DTA fare increase; start of Phase 2 of the demonstration.

SOURCE: Duluth Transit Authority.

Despite design changes that were made to distinguish the two passes (such as printing them in different colors), enforcement continued to be a problem. This could have resulted from the wide variety of fare types confronting DTA drivers, including regular and discounted cash fares, passes, transfers, tokens, etc.

The DTA project staff continued its marketing and solicitation activities during Phase 1. Extensive discussions were held with several large firms concerning variable work hours, but no additional firms agreed to participate in the program. Generally, those firms that already qualified to sell passes could be persuaded to join the pass program, while those that did not pre-qualify did not consider the pass program as sufficient incentive to adjust work schedules.

There were three major components in the pass program marketing effort: a monthly "Port Pass Press" newsletter for passholders, a series of press releases, and an advertising campaign featuring a series of bus cards saluting those employers who had joined the program (see Figure 2-2). Word-of-mouth publicity turned out to be a factor of major importance. The DTA program office received numerous inquiries concerning the program from transit users who had seen the pass being used or who had friends or relatives who had passes. These contacts frequently influenced new firms to join the program.

Data collection activities completed during Phase 1 included a second round of Brown Sheet and On-Board surveys, a small survey of pass purchasers performed by the DTA (to plan for the public sale of passes during Phase 2), and an employee survey at the City Board of Education, which was considering joining the program.

During Phase 1, the DTA considered changing the restrictions on the use of the Discount Pass to prohibit its use on buses leaving the Duluth CBD between 4:30 p.m. and 5:15 p.m. DTA personnel originally felt that there was evidence suggesting that users of the Discount Port Pass had changed their morning travel habits away from the peak, but had not made any corresponding shifts in their afternoon travel times (this perception was not verified by survey data; see Subsection 3.2.1 of this report). The change was vetoed for several reasons. First, additional restrictions would have generated confusion among pass buyers and would have exacerbated problems of enforcement. Second, the peaking problem that the demonstration was intended to resolve was far more severe during the morning peak than during the afternoon peak. Addition of the afternoon restriction might have shifted pass buyers back to the All-Day Port Pass, thereby allowing them to resume travel during the peak morning half-hour, clearly a counterproductive result.

SOURCE: Duluth Transit Authority.

Figure 2–2. BUS CARD PROMOTION FOR THE PORT PASS PROGRAM

Phase 2 of the Duluth demonstration began in August 1981 when the All-Day and Discount Port Passes were placed on sale for the general public. Simultaneously, a fare structure change took effect. Token prices were increased to equal the regular cash fare of $0.50. The All-Day and Discount Port Pass prices were increased from $14.00 and $11.00 to $20.00 and $17.00, respectively. The effective price of the regular pass was therefore reestablished at the equivalent of 40 one-way token trips.

While promotional activities for the pass program continued during Phase 2, marketing efforts for the variable work hours program had been essentially abandoned. Data collection activities during Phase 2 included a second set of employee surveys at ARDC and the City of Duluth, a third and final set of Brown Sheet and On-Board surveys, and a second and more comprehensive survey of Port Pass purchasers. The Duluth Variable Work Hours/Transit Fare Prepayment Demonstration concluded in August 1982. At that time, the DTA elected to incorporate the All-Day Port Pass into its regular fare structure effective September 1982. The price of the pass was maintained at $20.00. The Discount Port Pass was eliminated.

Over the course of the demonstration, a major external change occurred that had a marked impact on the DTA and on the demonstration. Employment in Duluth dropped by over 5 percent during this period as a result of the general U.S. economic downturn. Manufacturing and Great Lakes shipping are two major Duluth industries that were particularly severely affected by the state of the economy. These industries employ significant numbers of DTA riders.

2.3 SUMMARY OF MAJOR CHANGES IN THE DEMONSTRATION

The most important change in the demonstration was a shift in emphasis away from the promotion of variable work hours toward the marketing of a monthly transit pass program with a discounted off-peak alternative. The demonstration had been based on the hypothesis that the adoption of variable work hours would provide employees with sufficient flexibility in their choice of travel time to permit the off-peak Discount Pass to affect their travel decisions. Because only one CBD employer adopted flexible work hours as a result of the demonstration, this hypothesis could not be conclusively tested.

The changes in the demonstration were mandated by faults in two assumptions on which the original demonstration plan had been based. First, the demonstration site was selected in part because the City of Duluth had a long-term interest in a variable work hours program, and because the DTA was thought to have strong support for the project from the business community and local political leaders. Unfortunately, this interest and support did not materialize, and even the highly competent marketing efforts of the DTA and its project staff were unable to bring about the adoption of flexible work hours. This failure was in part due to a widely-held perception in the business community that the City of Duluth did not have any problem that variable work hours might solve (e.g., traffic congestion, air pollution, overcrowded buses, parking shortages).

A second basis for the original demonstration had been the notion that employers would value the pass program highly enough to view eligibility for the pass program as a sufficient incentive to adopt flexible work hours. This was not the case. Originally, the pass program was to offer only the undiscounted All-Day Port Pass, which would have provided only limited financial benefit to highly regular transit users. Employers were clearly not interested in participating in this restricted program. However, even after the DTA elected to offer both passes simultaneously, no employer found pass program eligibility a sufficient incentive to make any changes in employee work schedules.

This section of the report has examined in a general and qualitative way the structure and implementation of the Duluth demonstration. The following section addresses specific research questions and presents the results of quantitative analyses of survey and other program data.

3. IMPACTS OF THE DEMONSTRATION

This section presents the detailed findings of the Duluth Variable Work Hours/Transit Fare Prepayment Demonstration evaluation. The evaluation framework for the Duluth demonstration is shown in Figure 3-1. As is evident in Phase 1, the variable work hours and employer-based pass sales programs affect employers directly, and, through them, employees and DTA ridership. In Phase 2, the public sale of passes directly affects DTA ridership. Throughout the project, the travel behavior of DTA riders affects system operations and operating costs. This evaluation examines each of the impacts shown in Figure 3-1. The findings reported in this section are based on data collected from two principal sources. The first source is survey data collected by the Arrowhead Regional Development Commission (ARDC) as a subcontractor to the DTA. These survey data are described in detail in the appendices to this evaluation report. The second source is data that were maintained continuously throughout the project concerning progress of the demonstration and other relevant factors external to the demonstration.

The impacts of the project have been stratified into three separate major groups: impacts on employers, impacts on travelers, and impacts on the DTA.* Within each of these groupings, several specific evaluation issues and questions are addressed. At the conclusion of these three major subsections is a brief narrative summarizing significant evaluation results from all three impact categories.

3.1 IMPACTS ON EMPLOYERS

By introducing variable work hours and the employer-based sale of transit passes, the Duluth project had the potential to significantly affect employers in the Duluth CBD. The employer issues examined in this evaluation fall into two categories: level of employer participation, and the costs and benefits of the program to employers.

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*For a more detailed description of this impact classification, see Charles River Associates, Duluth Variable Work Hours/Port Pass Demonstration Evaluation Plan, October 1981.

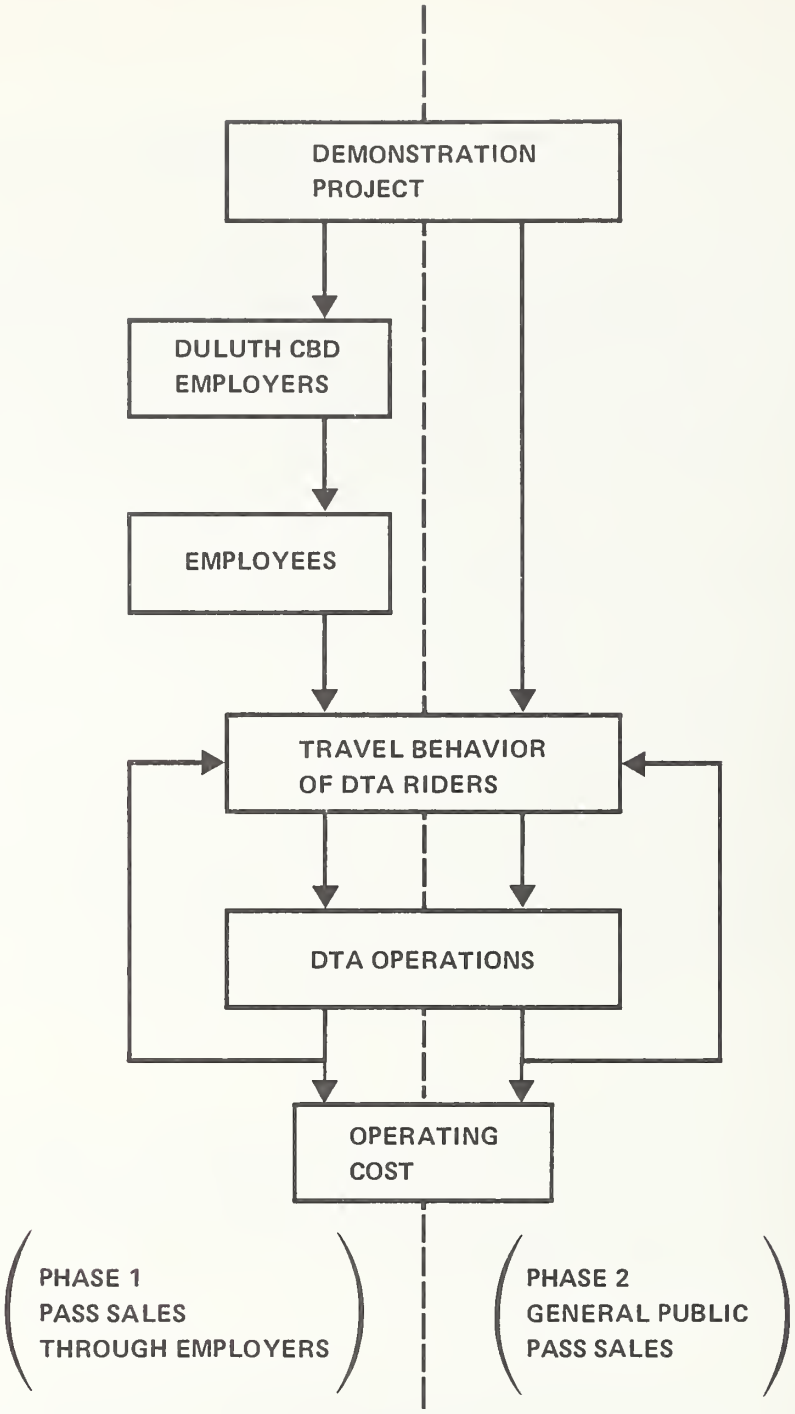

Figure 3–1. EVALUATION FRAMEWORK FOR THE DULUTH VARIABLE WORK HOURS/TRANSIT FARE PREPAYMENT DEMONSTRATION

3.1.1 Program Participation

With one exception, no employers initiated variable work hours programs as a result of the demonstration. Only two employers expressed interest in variable work hours during the solicitation phase. One of these was ARDC (the data collection subcontractor for the demonstration), an office containing about 30 persons. The second employer was the City of Duluth, which had just over 500 employees. While both of these employers joined the pass program, only ARDC adopted variable work hours, in October 1980. In fact, ARDC was the only firm to implement variable work hours throughout the entire demonstration. This agency, however, was involved to some extent in planning and implementing the project, so it can hardly be considered a "typical" employer in this respect.

The lack of coordination among the many departments in City Hall convinced the City of Duluth that adoption of variable work hours was impossible. Certain departments already permitted some level of flexibility while others were adamantly opposed to the program. Eventually, the City of Duluth elected not to adopt variable work hours, and instead decided to continue to allow the managers of various city departments to set schedules for their staffs. This was a major blow to the project staff, who viewed the participation of the City in the variable work hours program as a key element in its marketing effort.

The reasons for lack of participation were discussed in detail in Section 2, but can be summarized by saying that employers saw no problem with current work schedules and no potential benefits resulting from participation in the study. The availability of the Discount Pass was clearly not an adequate incentive to induce companies to adopt flexible work schedules.

Past experience in other cities corroborates the difficulty involved in regional variable work hours programs. In New York City, where peaking problems are severe and well-recognized, a survey was conducted to determine the potential for adoption of alternative work schedules in Manhattan as part of the regional Energy Emergency Contingency Plan.* Less than 10 percent of firms stated that they would adopt variable hours even under "extreme emergency conditions," which indicates much lower potential participation under more normal conditions. Most firms recognize the minimal impact that changes in the work schedules of their employees would have on regional congestion. This realization provides limited incentive to participate, particularly if congestion problems are perceived to be insignificant, as they were in Duluth.

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*Port Authority of New York and New Jersey, Alternative Work Schedules Survey -- Manhattan Central Business District, September 1980.

A total of 135 employers participated in the Port Pass element of the demonstration. The number participating in any single month rose from 46 in November 1980 to 114 in July 1981 (see Table 3-1), out of an estimated 1300 employers in Duluth (see Appendix A). These figures can be compared to the 787 CBD employers who received introductory letters describing the program. The vast majority of participating firms sold only a small number of passes during Phase 1. In November 1980, at the start of Phase 1, 43 of 46 participating firms sold 10 or fewer passes. At the end of Phase 1, 102 of 115 firms sold 10 or fewer passes, and only 3 firms sold more than 25 passes.

Of those employers who participated in Phase 1 of the program, the vast majority either purchased passes with cash or with a company check and resold the passes directly to their employees, or sold passes on consignment from the DTA. Two firms utilized payroll deduction plans for their employees, and three very small firms subsidized the pass for their employees as an added fringe benefit. Three of the larger firms were reluctant to join the program because of the time and cost required for its administration. At these three locations, DTA project staff went on-site one day per month to sell passes directly to employees.

During the course of the project, 20 firms that had joined the pass program ceased to participate. All except one of these companies had very low pass sales (an average of 1.9 passes per month), and the average time spent in the program before withdrawal was just under 4 months. Most of the firms that left the program did so because they did not feel it was worth administering the program for such a limited number of pass purchasers. Of the 136 participating employers, 3 subsidized employee pass purchasers. Two firms bought passes for one employee each; one other firm distributed passes to between eight and nine employees for the full nine months of the employer-based program.

Generally, employer participation did not appear to be a function of any characteristic of the firm (e.g., firm product, employee job mix, etc.). Most firms joined the program because one or more of their employees had heard about the pass program and encouraged company participation. Frequently, such an employee would end up managing the program at that firm and be responsible for collecting money from other employees and for distributing passes in return. Larger firms tended to shy away from the program because of the administrative expense, and three of these firms requested the DTA project staff to come on-site and sell passes directly to employees. Twenty-one firms paid for passes with company checks. Only two employers used the payroll deduction method for employee pass purchases.

TABLE 3-1. PHASE 1 EMPLOYER PARTICIPATION AND PASS SALES

Month	Number of Employers	All-Day Passes Sold	Discount Passes Sold	Total Passes Sold
November 1980	46	17	174	191
December	56	39	263	302
January 1981	65	171	330	501
February	84	231	419	650
March	100	279	478	757
April	111	296	500	796
May	118	305	503	808
June	116	283	483	766
July	114	248	450	698

SOURCE: Duluth Transit Authority.

3.1.2 Employer Costs and Benefits

Because no employers who were not directly involved in the demonstration initiated variable work hours as a result of the project, there are no data available on the costs or benefits of these programs. ARDC had a typical experience with flextime; while the costs of the program (principally for administrative effort) were not strictly allocated, they were small, due for the most part to the small number of employees (about 30). Typical employee morale improvements resulted from adoption of flextime at ARDC. The Commission also reported slightly improved office coverage and, to some extent, increased availability of office equipment, such as microcomputers. Productivity probably increased as a result of the program, although no data are available for corroboration.

The pass program also appeared to have very small cost and benefit impacts on employers. For the majority of participating firms, a single individual coordinated the sale and distribution of passes, which generally required a minimal level of effort (as little as a few minutes) per month. For firms where the DTA staff sold passes on-site, the only costs to employers were for announcing to employees when passes would be sold, using posters or memoranda. The firms using payroll deduction almost certainly incurred higher costs, but since their payroll deduction plans were strictly voluntary, these were not considered major barriers affecting participation.

3.2 IMPACTS ON TRAVELERS

The Duluth demonstration was originally expected to have a wide variety of impacts on bus riders and other travelers. It was anticipated that employees of participating firms would change their travel behavior in response to both the pass program and the variable work hours program. Other bus riders would be affected directly by the pass program and indirectly by the variable work hours program (if that program caused aggregate shifts in transit demand). Presumably, these impacts would affect both passholders (program participants) and cash and token users as well. Possible impacts can be separated into five categories: time of travel; work schedules; pass purchase; travel mode; and trip frequency. The following subsections address each of these issues. Because time of travel and work schedule are inextricably linked together, these two issue areas have been combined for discussion.

3.2.1 Time of Travel and Work Schedule

It was expected that employees of firms participating in the program would change their work schedules and, therefore, their travel times. As mentioned earlier, only one firm (ARDC) adopted variable work hours. Within

this one firm, 11 out of 27 respondents indicated that they had changed their normal working hours since the introduction of flextime. Of these, six had done so principally to accommodate other family-related activities, two to accommodate medical or personal activities, and three to facilitate participation in other outside activities. There were some transit users among these individuals, but insufficient data were available to draw any statistical conclusions. Only 6 of 27 employees stated that they had not changed their working schedules at all after the adoption of flextime. Transit passholders were also asked if they had changed their times of travel to or from work as a result of the Port Pass program. Unfortunately, at the time of the Phase 1 survey, none of the firm's regular transit riders was a pass purchaser. Overall within the firm, the number of employees arriving between 7:30 and 8:00 a.m. dropped from 16 to 13.

The City of Duluth was the only other employer to conduct both a before and after employee survey. This employer did not change its work schedule in any way, but did adopt the pass program. Twenty-one out of 74 Phase 1 pass buyers reported that they now commuted to work at an earlier time than before they were pass buyers; only 9 people reported leaving work earlier in the afternoon. (These were responding to the direct question: "Have you changed your time of travel...?".) Only three pass buyers reported commuting at a later time in the morning, and six reported leaving work at a later hour. Unfortunately, all of these shifts in time of travel were reported equally by holders of the regular and discounted passes. That is, buyers of the All-Day Pass (who had no logical incentive to change their time of travel) changed their travel behavior to the same extent as buyers of the Discount Pass (who presumably might have adjusted their schedules to take advantage of the $3.00 discount). Therefore, these work schedule changes cannot logically be attributed to the demonstration project. Interestingly, histograms of actual work start and end times for City Hall employees indicated virtually no change in the aggregate work schedule distribution as a result of the demonstration. This further suggests that the response of passholders may have been biased to imply a change in work schedule when none really existed. At this employment site, the total percentage of employees arriving at work between 7:30 and 8:00 a.m. did not change significantly between 1980 and 1981.

Similar evidence was provided by the Port Pass User Survey. Sixty out of 382 passholders reported commuting to work at an earlier hour (12 of these 60 reported leaving earlier as well); 20 reported commuting to work at a later hour (5 of whom reported leaving work later). However, these changes were once again reported equally among holders of the All-Day and Discount passes. Clearly, the cash savings offered by the Discount Pass did not provide the principal cause for shifts in travel time. Additionally, the time of travel to work reported by those who claimed to have changed their time of travel was not significantly different from the distribution for the

entire population of passholders, and a number of these passholders indeed appeared to travel during the restricted time period. Therefore, the evidence concerning the impact of the pass program on work schedules and times of travel is at best inconclusive.

The Port Pass Survey did provide other insights into the work schedules of pass buyers. The average passholder began work at 8:34 a.m. and finished at 4:15 p.m. This average was not significantly different for holders of All-Day versus Discount passes. The average work start time was considerably later than was expected. In fact, only 28.3 percent of respondents started work between 7:30 and 8:00 a.m. This figure was 44.1 percent and 19.5 percent for All-Day and Discount passholders, respectively, a result that has significant implications for the pass purchase issue. By contrast, the percentage of City Hall employees arriving at work during this interval was about 52 percent, and for ARDC was 60 percent and 40 percent in 1980 and 1981, respectively. This indicates that pass buyers were more likely to be traveling outside the peak than employees in general, which suggests that the program was not effective in attacking the peaking problem.

The average work schedules reported above were quite different for different job types. Average schedules for administrative/clerical and professional/technical employees spanned the hours from 8:12 a.m. to 4:32 p.m. Other groups had later schedules, with sales people starting and ending the latest at 9:33 a.m. and 5:10 p.m., respectively. Work start and end times for each job type were, however, quite diverse (i.e., the variances were very large relative to the mean), so that once again statistical comparisons became invalid. The employee surveys also addressed the question of work schedule variability of employees. Nearly 45 percent of ARDC employees reported arriving late for work "often" or "sometimes" in the 1980 survey. The introduction of flextime clearly eliminated this problem. At City Hall, only 12.0 percent reported arriving late often or sometimes in 1980. In 1981, more specific questions were asked concerning the amount of flexibility permitted in employee work schedules (of those individuals who indicated in the survey that they worked on a fixed schedule). Of 315 respondents, 14.9 percent indicated that they could determine their own work start times. Concerning day-to-day variability in work schedules, 8.9 percent indicated that they could arrive at work any time each day as long as they worked the correct number of hours; an additional 7.7 percent indicated that they had up to 10 or 15 minutes of flexibility in their work schedules. The remainder were permitted no day-to-day variability in their work schedules. Before and after data were not available for these survey questions, but there is no reason to expect that the demonstration had an impact on permitted levels of variability in work schedules at City Hall.

The implications of these results are that travelers did not perceive the differential time-of-day pass program as a factor that caused them to change their work or travel schedules. In no instance could shifts in work schedule or in time of travel be linked to purchase of the Discount Pass. While the adoption of flextime at ARDC obviously affected work and travel schedules, no other site revised work schedules in any way.

3.2.2 Pass Purchase Behavior

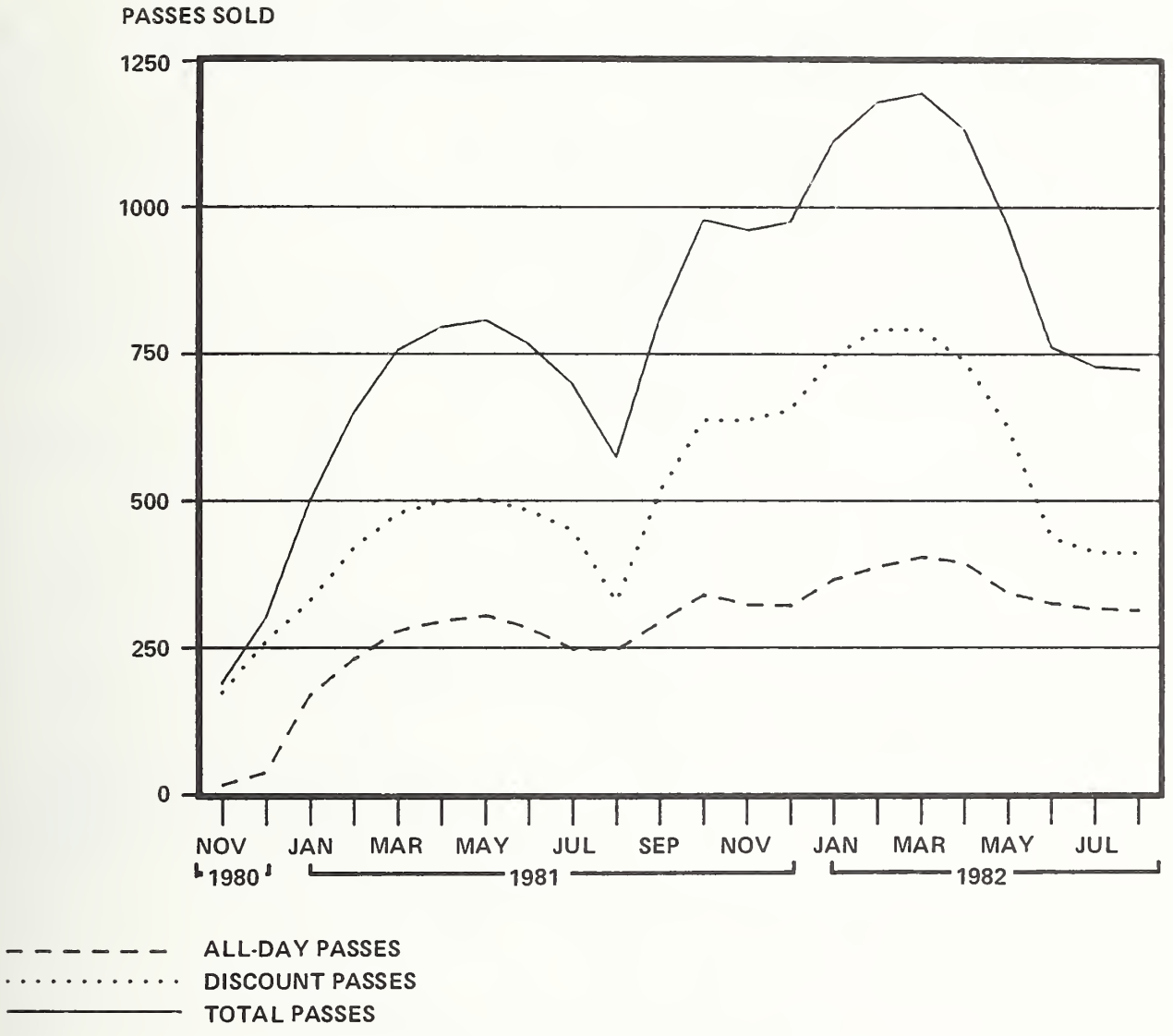
Table 3-1 shows the level of employer participation and pass sales during Phase 1 of the demonstration. Total pass sales rose from an initial level of 191 up to 698 in July 1981. The significant growth occurring in January and February of 1981 is largely a result of the increase in DTA cash fares that went into effect on January 1, 1981. In Phase 2 of the demonstration, the DTA elected to discontinue pass delivery to most employers, except for those who were willing to order 10 or more passes on a C.O.D. basis. Only about 10 employers were eligible under these conditions, and most of these elected to discontinue direct delivery of passes. General public sales outlets were established at the DTA Normandy Travel Center (the DTA's downtown information center), City Hall, the DTA General Offices, the First National Bank of Superior, and the University of Minnesota at Duluth (UMD). Public pass sales were implemented during August of 1981 in part because it is historically a low-ridership month, a factor which, it was thought, would facilitate smooth operation at new sales outlets. During the first month of public pass sales, 574 passes were sold (compared to 698 passes in July 1981, the last month of Phase 1). The increase in pass prices was probably a major cause of the drop in pass sales. This drop may also have been due to the reduced convenience of purchasing a pass for individuals who formerly bought a pass from their employer but who now had to travel to one of the public pass sale outlets. Pass sales increased dramatically to 809 in September and 978 in October. Maximum pass sales of 1,196 were achieved in March 1982. Complete pass sales figures for Phase 2 of the demonstration are shown in Table 3-2. Figure 3-2 shows pass sales by month over the course of the entire project.

The principal questions concerning the prepaid monthly passes were who purchased them, and why. The answers, stated in simplest form, appear to be that frequent travelers purchased passes in order to save money. An analysis of the 1981 and 1982 On-Board surveys compared the characteristics of travelers with their method of payment for transit trips. No correlation existed between payment method and age, sex, income, or time of travel, except when these correlations could be explained by correlations between these variables and transit trip frequency of users.

TABLE 3-2. PHASE 2 PASS SALES

Month	All-Day Passes Sold	Discount Passes Sold	Total Passes Sold
August 1981	246	328	574
September	294	515	809
October	340	638	978
November	323	638	961
December	321	655	976
January 1982	366	748	1,114
February	388	793	1,181
March	404	792	1,196
April	394	739	1,133
May	342	625	967
June	325	437	762
July	316	412	728
August			

SOURCE: Duluth Transit Authority.



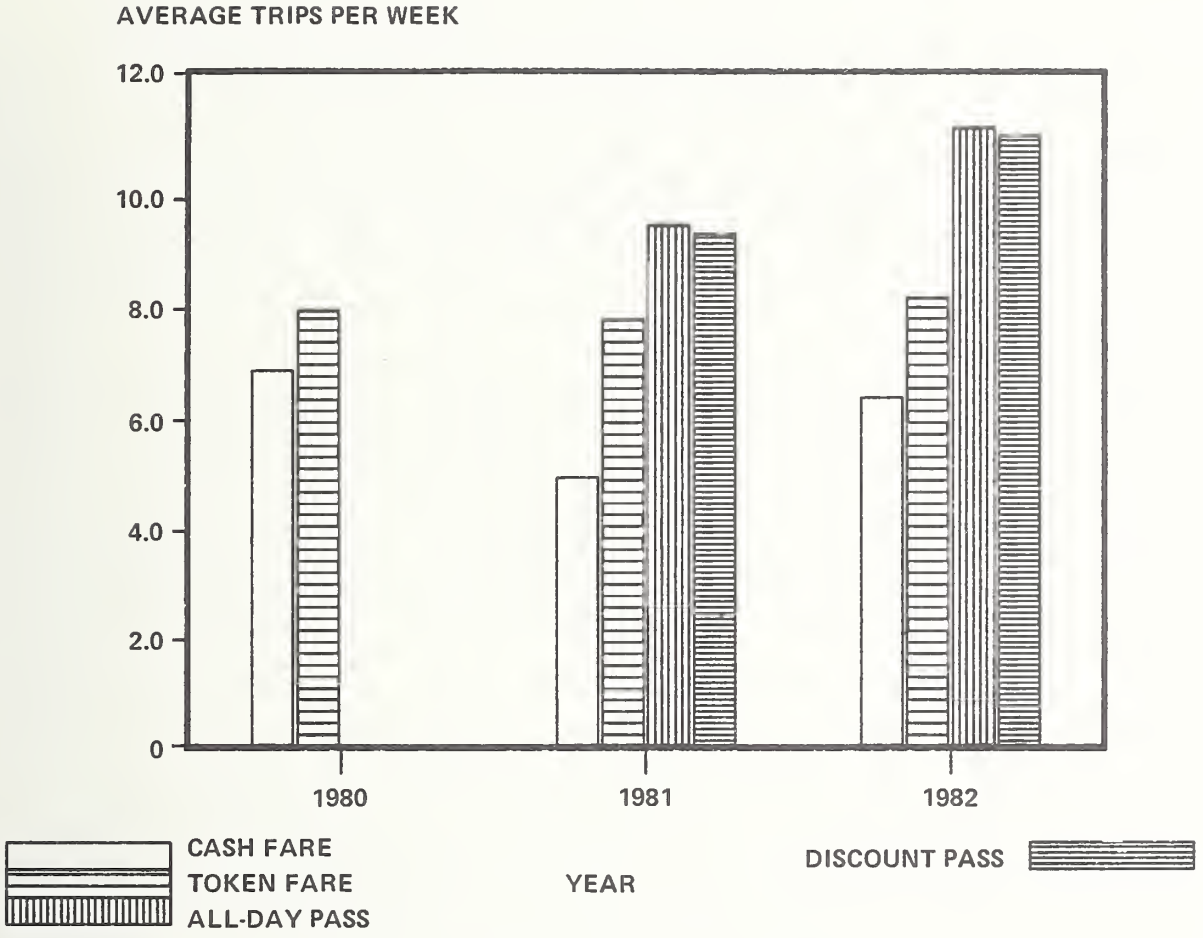
SOURCE: Duluth Transit Authority.

Figure 3–2. DULUTH TRANSIT AUTHORITY PASS SALES

The relative transit trip frequencies of users of different payment methods are shown in Figure 3-3 for the a.m. peak period. In 1980, the average trip frequency for token users was 7.8 trips per week, versus 6.7 trips per week for those paying cash, suggesting that more frequent riders sought the cash savings available through the purchase of tokens. In 1981, a marked shift took place as high-frequency riders switched to the All-Day and Discount passes. The average trip frequencies of these two groups of users were 9.3 and 9.1 trips per week, respectively. By using the weighted average pass price for passholders in May 1981 and the average "alternate" price (a weighted combination of the cash and token fares), the "breakeven" pass price was derived as the equivalent of 28.2 trips per month, or 6.5 trips per week. Token buyers indicated an average trip frequency of 7.6 trips per week, greater than the breakeven pass price. This probably resulted because passes were not available to all transit users during Phase 1. Transit users with high trip frequencies who were not employees of participating firms continued to purchase tokens as the most economical means of travel.

In 1982, the trip frequency of pass purchasers rose in response to an increase in pass prices and pass multipliers. In 1982, the "breakeven" pass price was 36.5 trips per month, or 8.4 trips per week. As a result, individuals who were traveling just under 8.4 trips per week (who had in 1981 found the pass to be economical) switched back to cash or token payment. This left only the very high-frequency riders in the pass-buying category, increasing the average trip frequency of this group. This shift also increased the average trip frequencies for cash and token buyers from their 1981 levels. Note also that the large difference between cash and token user trip frequencies that was measured in 1981 (4.8 and 7.6 trips per week, respectively) was reduced significantly in 1982 (cash and token user trip frequencies of 6.2 and 8.0 trips per week, respectively). This was the result of the increase in token prices to $0.50, equal to the cash fare. In 1981, frequent users had both a convenience and a financial incentive to use tokens rather than cash; in 1982, only a convenience factor was applicable. In 1982, the average token user trip frequency was less than the breakeven pass price, implying that the majority of token users were not losing money by paying with tokens. Logically, this would result from the general availability of passes to all transit users. This relationship between trip frequencies and payment type was similar across all time periods, although for most other time periods the number of passholders was too low to allow statistical comparisons.

In examining the correlations between other variables and method of payment, it became clear that trip frequency was the driving factor behind the pass purchase decision. The method of payment for work trips was weighted more toward passes, because work travelers tend to be regular commuters with higher-than-average trip frequencies. The relationship of other variables such as auto access, age, income, and sex to trip frequency was generally statistically unclear. In those few cases in which statistical differences were found between pass purchasers and cash and token users,



SOURCE: Derived from On-Board Survey Data.

Figure 3–3. AVERAGE TRIP FREQUENCY OF A.M. PEAK TRANSIT RIDERS BY METHOD OF PAYMENT

these differences could be linked to trip frequency. Low-income riders (with the exception of students), for example, tended to use cash, but this group also had a low trip frequency (probably because these individuals are not employed). Similarly, the age distribution of passholders showed a greater concentration of persons in the 25-64 age group, again likely the result of greater employment in these age groups and higher trip frequencies.

These results were generally replicated within the two firms participating in the employee survey, although the number of pass buyers at both ARDC and City Hall was fairly small, precluding the derivation of statistically significant results. The major difference between cash/token and pass users was in both cases transit trip frequency. No correlation was identified between the other variables mentioned above and pass purchase in the employee survey data.

The Port Pass Survey questioned passholders concerning the principal reasons for which they bought the pass. Responses were somewhat evenly divided between financial savings (146 responses) and convenience (144 responses), with a significant number (136) of respondents checking off both of these reasons. There was no measurable correlation between the reason for pass buying and trip frequency, type of pass purchased, or any socioeconomic characteristic. Passholders were very satisfied with the pass program; only 8 out of 433 respondents indicated that they did not plan to continue buying the pass.

A second interesting issue concerning pass purchase is the selection of either the All-Day or Discount Pass. Here, the key independent variable appeared to be the work start time of the pass purchaser. In November 1981 (the time of the Pass Purchaser Survey), 35.6 percent of all passholders held the All-Day Pass. For those passholders who started work between 7:30 and 8:00 a.m., however, 55.7 percent had All-Day passes. Persons starting work during the restricted interval were clearly more likely to purchase the All-Day Pass. Of those starting work between 7:00 and 7:30 a.m. or 8:00 and 8:30 a.m., 34.4 percent held All-Day passes. Of those on other work schedules, only 24.4 percent used the more expensive All-Day Pass. The remainder were able to take advantage of the Discount Pass to reduce their transit expense without any change in travel behavior.

These data may be viewed in another way; out of the entire population of All-Day passholders, 44.1 percent started work between 7:30 and 8:00 a.m. On the other hand, only 19.5 percent of Discount passholders started work in this interval. Work start times were far more distributed for Discount passholders than for All-Day passholders. An examination of the time work ends in the afternoon uncovered a similar type of impact in the 4:00 to 4:30 p.m. interval. The use of the All-Day Pass was relatively much higher for persons ending work in this interval than at other times of the afternoon. The 4:30 to 5:00 p.m. interval (the afternoon transit demand peak) showed only a slight tendency toward use of the All-Day Pass.

It appears from the data that 51 out of the 262 Discount passholders responding to the survey began work between 7:30 and 8:00 a.m. (the restricted time interval). A more detailed examination indicates that 33 of these persons actually arrived at work between 7:30 and 8:00 a.m., with most of the rest arriving early. (Generally, persons with every stated work schedule reported arriving early by an average of seven minutes.) Still, 33 Discount passholders appear to have arrived at work on buses arriving between 7:30 and 8:00 a.m., implying that they were either paying a $0.25 surcharge when they boarded the bus, or that the Discount passes were accepted by drivers during this interval. No data were collected on the frequency of surcharge payments, but the earlier discussion of enforcement issues in Section 2 indicates that drivers may in fact have accepted the passes during the restricted interval.

The type of pass purchased was not correlated with auto availability, household size, age, sex, or job type, with one small exception: 48 percent of passholding students purchased the All-Day Pass, compared to only 34 percent of passholders overall.

In addition, type of pass was correlated with neither the stated reason for buying the pass nor the stated changes in trip frequency and/or time of travel that resulted from the purchase of the pass. In fact, the only correlation that was identified (other than work start time) was income; the average estimated household annual income for Discount passholders was $15,260, compared to $12,260 for All-Day passholders. This correlation is due in part to student passholders who had very low reported household income but who were more likely to buy the All-Day Pass.

Another pass purchase issue was the stability of sales for the two types of passes; in other words, to what extent did individuals switch back and forth between the two passes? Survey data indicate that switching was extremely rare among passholders. Out of 92 respondents who purchased passes in November 1980 (25 All-Day and 67 Discount), only 6 had changed pass types by November 1981. Of these six, three changed from All-Day to Discount, and three changed from Discount to All-Day. On a month-to-month basis, pass sales to individuals rarely changed at all.

3.2.3 Mode of Travel

The demonstration project did not appear to have a significant impact on individuals' mode of travel. The employee surveys at ARDC and City Hall revealed no significant change in travel by any mode (including carpool size) as a result of Phase 1. ARDC, of course, would have been the only available source of data regarding the impacts of variable work hours on mode of travel. The only source of data on changes in mode of travel due to the pass program is the On-Board Survey (which, of course, will only capture shifts to

transit pass use from other modes). This survey included the question, "If you didn't have a Port Pass, how would you have made this trip?" The results of this question are tabulated for several time periods in Table 3-3. Using these results and multiplying by the percent of all transit trips made with passes, as well as weighting each time period by the percentage of ridership occurring in that time period, it is possible to estimate the percent of total ridership that was switched from other modes as a result of the prepaid pass. The 1981 mode shift was estimated at 0.4 percent (the bulk of these trips were former auto trips). A 95 percent confidence interval around this estimate yields a range of between 0 and 0.9 percent. In 1982, a mode shift of about 0.7 percent occurred (a 95 percent confidence interval range of between 0 and 1.6 percent).

3.2.4 Trip Frequency Impacts

A final issue of concern relating to individual travel behavior was the impact of passes on transit trip frequency. The best source to evaluate this impact was before and after data from the employee surveys (in matched pairs) on Phase 1 pass users. Unfortunately, these data did not indicate a significant change in transit trip frequency for the employee population as a whole or, more specifically, for transit users and/or transit passholders. On the other hand, when passholders in the Phase 1 Employee Survey were asked directly, "Do you use the bus more often, less often, or the same since you started buying the Port Pass?", the results suggested that trip frequency should have increased. In fact, 30.6 percent of passholders reported using the bus more often to go to and from work, 38.8 percent reported an increase in other weekday bus trips, and 40.4 percent reported an increase in the use of the bus on weekends. Some of these reported increases were offset by individuals who reported a decrease in their trip frequency (2.8 percent, 8.2 percent, and 4.3 percent of passholders for the three time periods, respectively). However, phrasing the question in this manner apparently resulted in a severe overstatement of the true impacts of the pass program on transit travel, since before and after trip frequency estimates suggested that no change actually took place. This overstatement was possibly either a result of respondents' desires to report favorably on the impacts of the pass program, or a reflection of their own inaccurate recall of their prior travel behavior.

This result was mirrored by the results of the Pass Purchaser Survey: 28.8 percent of passholders reported an increase in the use of the bus for work trips (0.5 percent reported a decrease); 55.6 percent stated that they increased the use of the bus for other weekday trips (4.8 percent reported a decrease); and 47.9 percent of passholders stated that their weekend bus use had increased (5.2 percent reported a decrease). Unfortunately, no before and after trip frequency data were available for this group to verify or refute whether these reported changes in fact occurred. It seems likely that

TABLE 3-3. ALTERNATE MODE FOR PASS TRIPS

	Number of Passholders Who Would have Used Alternate Mode			
	Transit			
	Cash	Token	Auto and Other	Would Not Have Traveled
A.M. Peak Inbound Half-Hour				
1981 (n=42)	6	32	3	1
1982 (n=11)	5	4	1	1
Total A.M. Peak Period				
1981 (n=181)	47	120	13	1
1982 (n=42)	21	13	7	1
Total Off-Peak				
1981 (n=16)	9	6	1	0
1982 (n=19)	9	7	2	1
Weekend				
1981 (n=21)	5	13	1	2
1982 (n=41)	23	9	6	3

SOURCE: Derived from On-Board Survey data.

this group would also have tended to overstate the impact of the program on their travel behavior, for the same reasons as in the employee surveys. A final piece of evidence concerning trip frequency is provided by the "prior mode" question on the On-Board Survey; passholders in some time periods claimed that up to 21.9 percent of trips would not previously have been made by transit. Once again, however, before and after data were not available for this group to corroborate this result.

A closer examination of stated changes in trip frequency from all three survey sources (On-Board, Passholder, and Employee) did not reveal any systematic variation among passholders whose trip frequency increased, remained the same, or decreased as a result of any demographic, job-related, or travel behavior characteristic.

3.3 IMPACTS ON THE DULUTH TRANSIT AUTHORITY

The principal purpose of this demonstration was to reduce transit demand peaking, thereby enabling the DTA to reduce its peak vehicle and manpower requirements and reduce operating expenses. Therefore, the impacts of the demonstration on the DTA were among the most important to be examined in this study. This discussion concerning impacts focuses on three separate issues: transit ridership and pass sales, operations, and costs and revenues.

3.3.1 Transit Ridership and Pass Sales Impacts

Total transit ridership decreased significantly over the course of the demonstration project. This large decrease obscured any aggregate measure of ridership increase as a result of the project. Aggregate ridership data indicate a 24.6 percent reduction during the 12 months ending May 1982 when compared with the 12 months ending May 1980. Data from the three Brown Sheet surveys also indicate a significant drop in demand. The average total weekday ridership of 16,720 in May 1980 dropped to 14,236 in May 1981 and to 13,763 in May 1982, an overall decrease of 17.7 percent. This decrease in transit usage was attributable to the economic downturn in Duluth and to increased transit fares. Token fares rose by 43 percent during the study, and cash fares by 25 percent. The net fare increase (based on the original payment method distribution) was about 34 percent. This overall fare level increase could explain an 11 percent decrease in overall ridership (assuming a relatively high price elasticity of -.33, which is consistent with the low level of transit dependency and convenience of automobile travel in Duluth).

While aggregate data are not sufficient to isolate the effects of the demonstration on ridership, an examination of more detailed data indicates that the potential increase due to the demonstration was small. The only groups that might have experienced increased ridership are passholders who

increased their trip frequency or formerly did not ride transit at all. According to the 1981 On-Board Survey, 7.5 percent of all peak morning passholder trips would not have been made on transit if the pass had not been available. During this time period, 13.4 percent of all trips were made with passes. This implies an increase of (.134)(.075) or a 1.0 percent increase in peak ridership resulting from the pass program. Using the corresponding numbers from the 1982 On-Board Survey (20.2 percent and 5.8 percent, respectively), a ridership increase of 1.2 percent is implied. Data from other time periods show similar or smaller possible ridership increases. Note that responses to the On-Board Survey question on which this result is based are probably biased to exaggerate this demand increase.

The distribution of travel usage by time of day also appears not to have changed significantly as a result of the demonstration. Because the demonstration focused on the peak morning half-hour, a decrease in peak a.m. half-hour demand could indicate that the demonstration had the desired impact. To correct for the general demand decreases described above, the peak half-hour demand is examined as a percentage of total weekday demand and of peak two-hour demand. The project demonstration plan also anticipated that shifts in morning travel time would be accompanied by similar shifts in afternoon travel time (since, presumably, such a change would result from individuals moving both their work start times and work end times either forward or backward). Therefore, we are also interested in changes in demand peaking during the afternoon. We would nominally expect each phase of the demonstration to result in reductions in demand peaks.

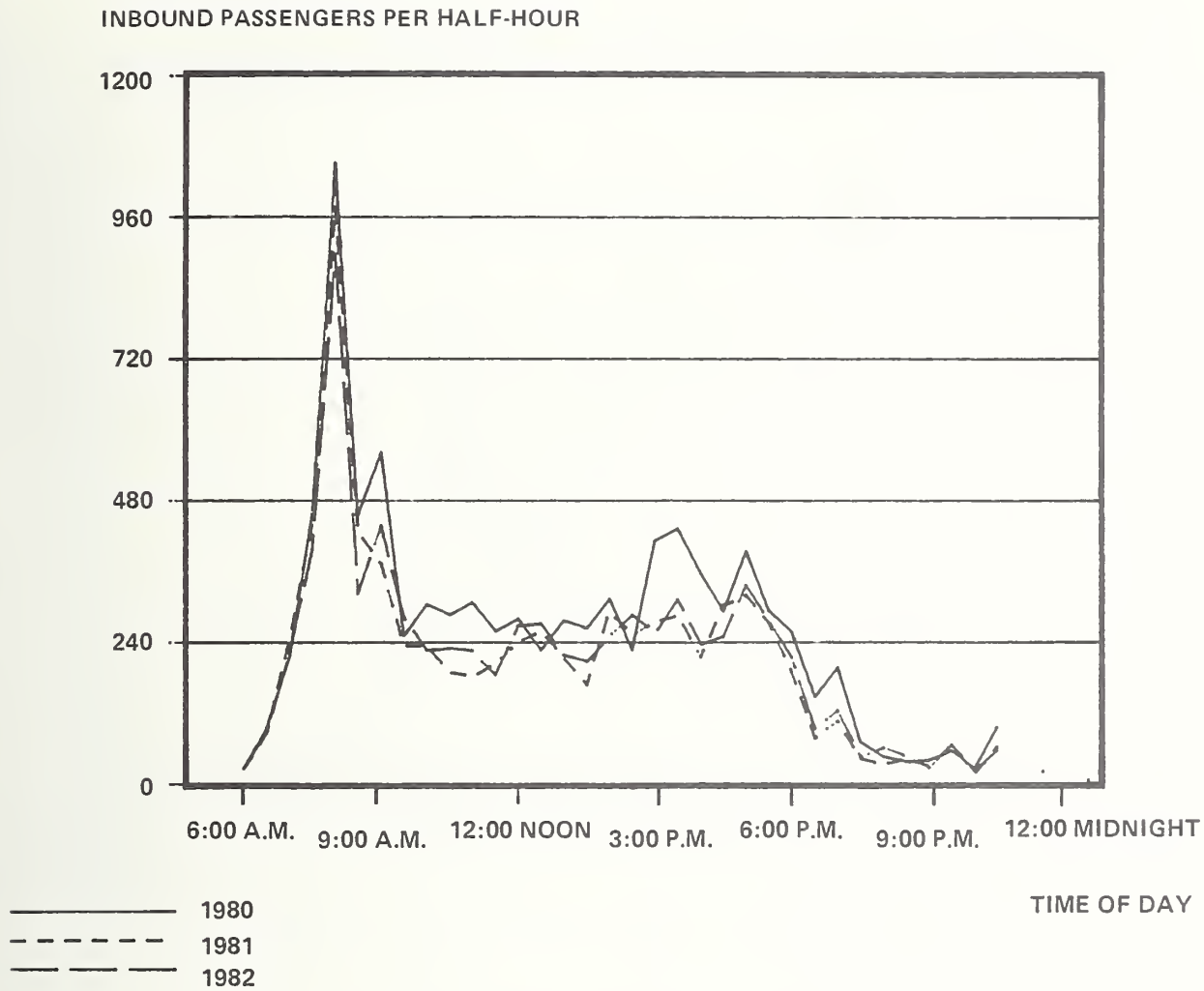
The Brown Sheet ridership results are tabulated in Table 3-4. Peak half-hour demand decreased in absolute terms during both phases of the demonstration in both mornings and afternoons. However, the percentage of daily demand occurring in the peak half-hour did not demonstrate a consistent change over the course of the demonstration. In Phase 1, a.m. peak demand as a percentage of total inbound demand increased from 11.6 percent to 13.2 percent. At the same time, the corresponding outbound number decreased from 10.8 percent to 9.6 percent. Clearly, shifts in a.m. peaking were not mirrored in the p.m. peak period. In Phase 2, a.m. peaking decreased to 12.0 percent while p.m. peaking increased to 9.8 percent of daily demand. (Note that in all cases, the peak half-hour demand as a percentage of total two-hour peak demand followed the same trend as it did when expressed as a percent of total daily demand.) Figures 3-4 and 3-5 show DTA weekday ridership by half-hour period in the inbound and outbound directions, respectively. The decrease in overall demand is evident in comparing the curves for 1980 with those for 1981 and 1982. Figure 3-6 shows the similar drop in demand experienced on weekends. Figures 3-7 and 3-8 display inbound and outbound weekday demand as a percentage of total inbound or outbound weekday demand.

In order to isolate the impacts of the demonstration from these aggregate shifts, we must first account for shifts in demand peaking that

TABLE 3-4. AVERAGE WEEKDAY TRANSIT DEMAND PEAKING CHARACTERISTICS

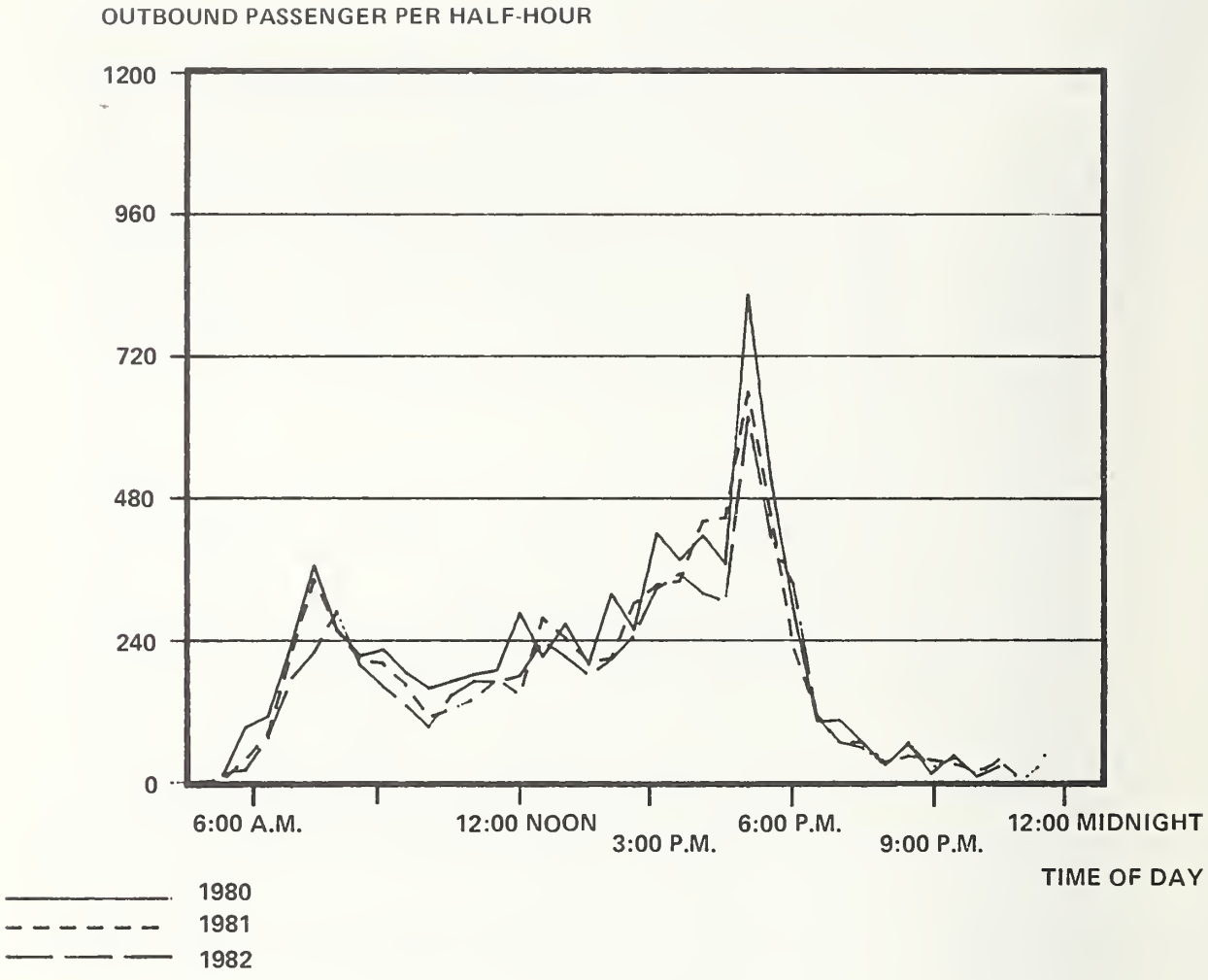
	Before	Phase 1	Phase 2
Inbound			
Peak Half-Hour Ridership (Number of Riders)	1,053	977	896
Peak Half-Hour Ridership as a Percent of Total Daily Inbound Ridership	11.6%	13.2%	12.0%
Peak Half-Hour Ridership as a Percent of Total Peak Inbound Ridership	41.7%	44.1%	43.6%
Outbound			
Peak Half-Hour Ridership (Number of Riders)	825	659	617
Peak Half-Hour Ridership as a Percent of Total Daily Outbound Ridership	10.8%	9.6%	9.8%
Peak Half-Hour Ridership as a Percent of Total Peak Outbound Ridership	38.8%	33.0%	37.3%

SOURCE: Brown Sheet Survey data.



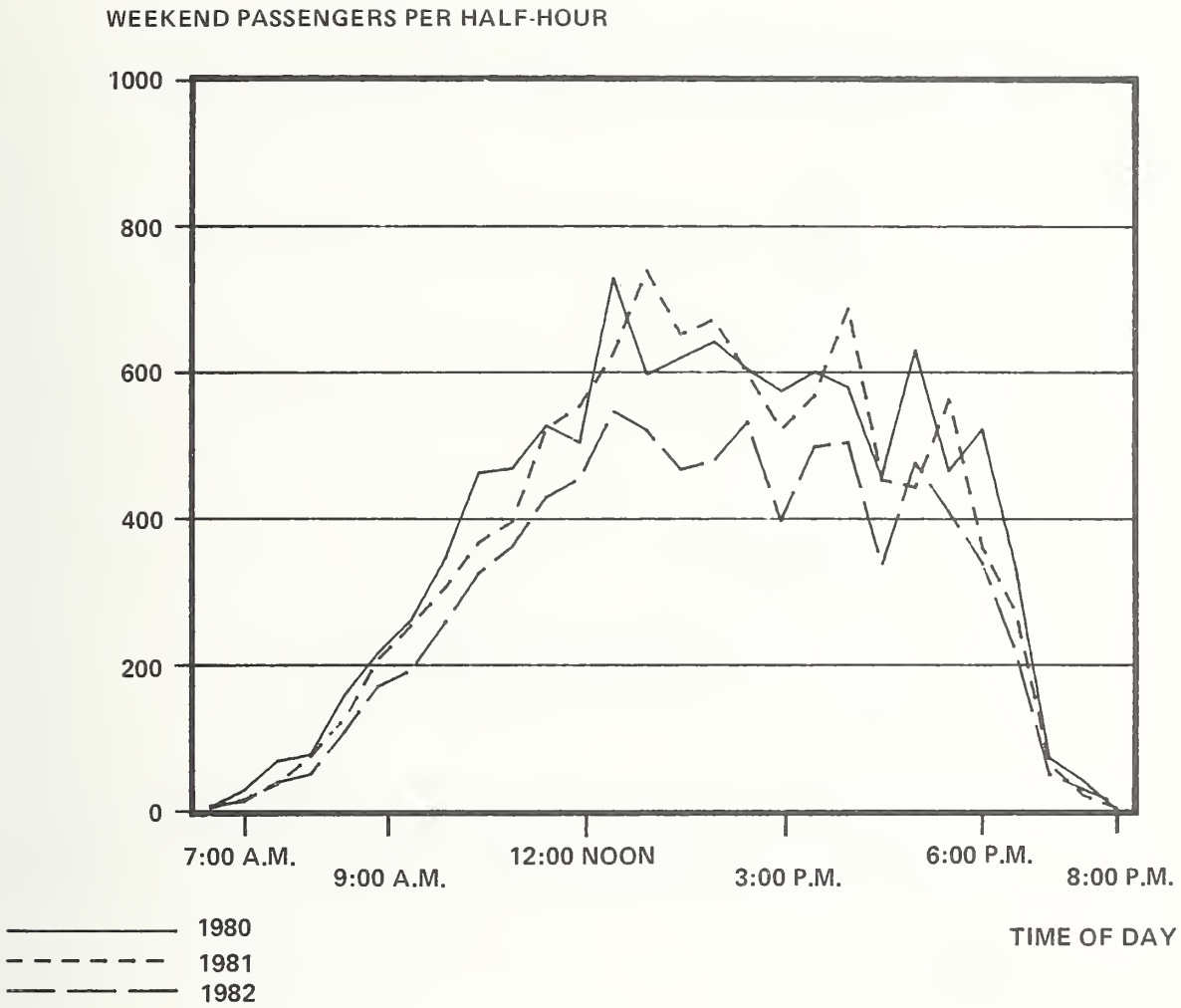
SOURCE: Derived from Brown Sheet Survey Data.

Figure 3–4. WEEKDAY INBOUND PASSENGERS BY HALF-HOUR TIME PERIOD



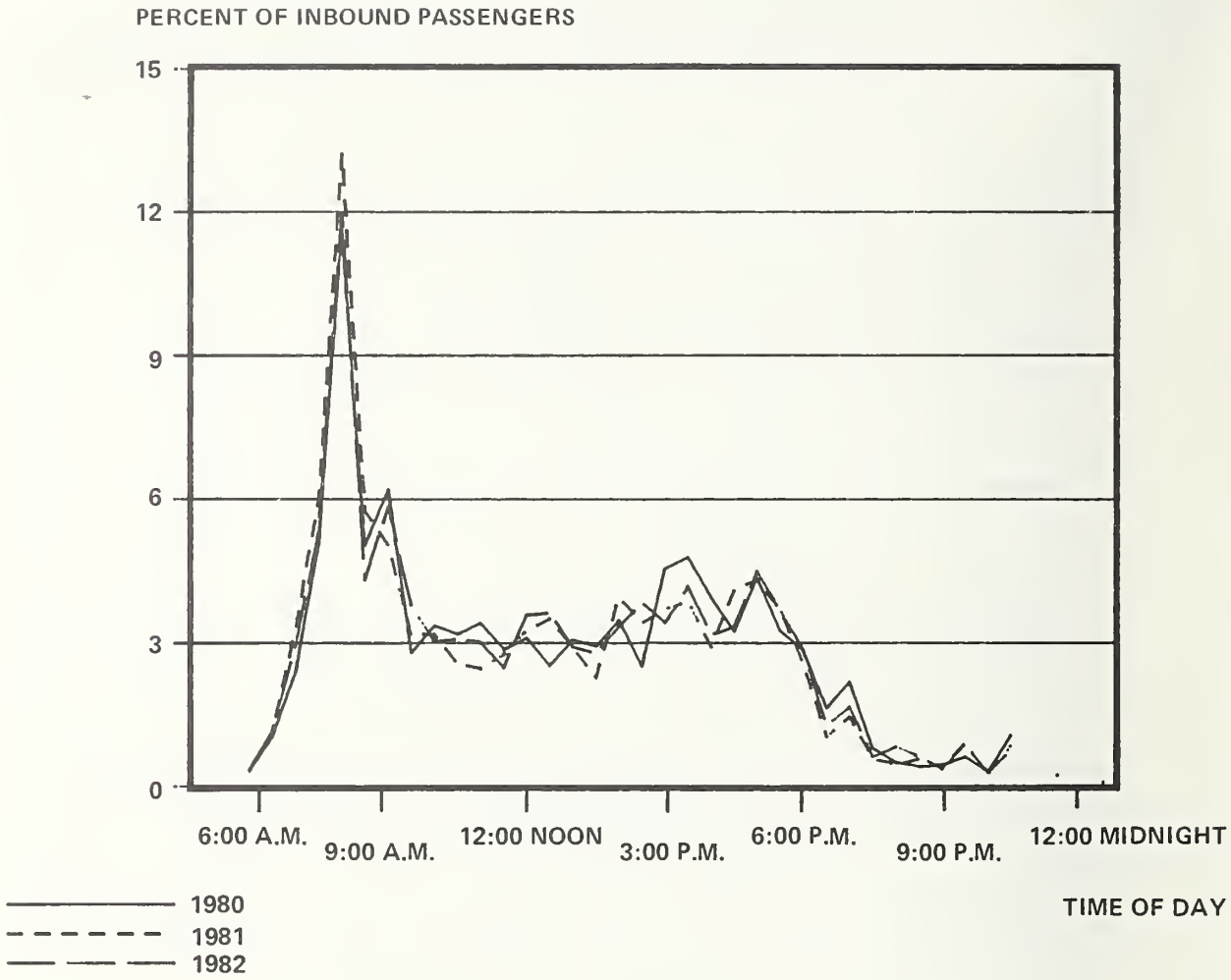
SOURCE: Derived from Brown Sheet Survey Data.

Figure 3–5. WEEKDAY OUTBOUND PASSENGERS BY HALF-HOUR TIME PERIOD



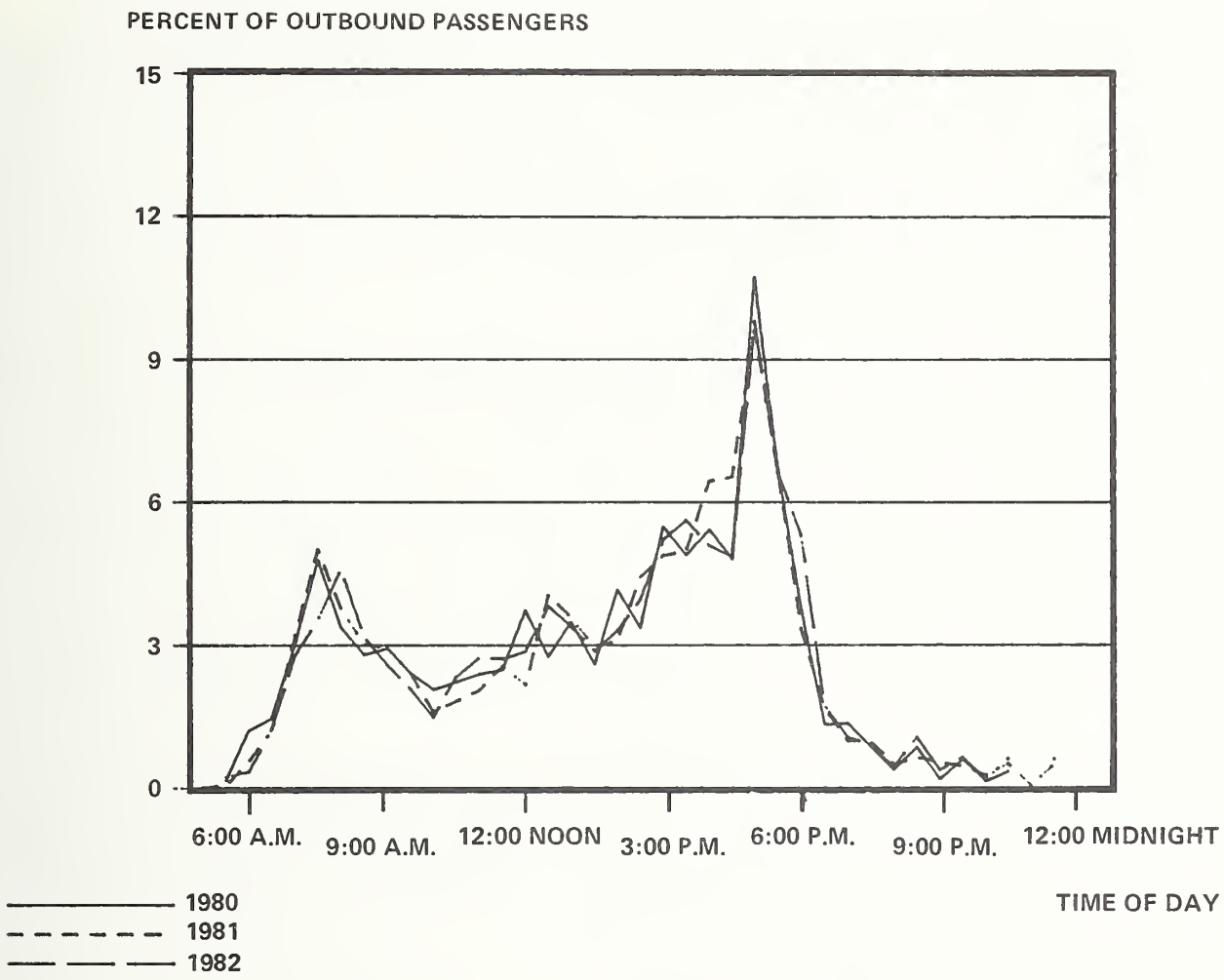
SOURCE: Derived from Brown Sheet Survey Data.

Figure 3–6. WEEKEND TOTAL RIDERSHIP BY HALF-HOUR TIME PERIOD



SOURCE: Derived from Brown Sheet Survey Data.

Figure 3–7. PERCENT OF WEEKDAY INBOUND PASSENGERS BY HALF-HOUR TIME PERIOD



SOURCE: Derived from Brown Sheet Survey Data.

Figure 3–8. PERCENT OF WEEKDAY OUTBOUND PASSENGERS BY HALF-HOUR TIME PERIOD

result from the general DTA fare increases. In doing this, two important elements must be considered. First, peak-period transit fare elasticities are normally lower than off-peak elasticities. As a result, systemwide fare increases would result in a greater proportional loss in off-peak ridership and an increase in peaking in transit demand. Second, the token, cash, and pass prices were increased by different rates with each fare increase. These payment mechanisms are used to a different extent in different time periods; passes and tokens, for example, are used more frequently during the peak than during the off-peak because they are used by work trip commuters. As a result, the percent fare increase experienced by peak and off-peak riders was very different. By estimating the impact of these two factors on demand peaking, it is possible to isolate the impact of the demonstration (a detailed explanation of these calculations is provided in Appendix D).

Table 3-5 shows the results of this exercise for the peak half-hour periods. There is clearly no consistent impact of the demonstration on demand peaking, even when shifts in peaking resulting from general fare increases are taken into account. During Phase 1, peaking increased slightly in the morning and dropped in the afternoon; the reverse occurred during Phase 2. As a basis for comparison, the original demonstration plan stated as a goal the shift of 200 morning peak riders away from the peak half-hour. This would have reduced peak half-hour inbound ridership to 9.4 percent of total inbound ridership. This goal was clearly not approached. In addition, the shifts in peaking reported here are not corrected for any changes that may have resulted from the overall drop in DTA ridership. It is likely that shifts in peaking resulting from that 24.6 percent decline overwhelmed any changes due solely to the demonstration.

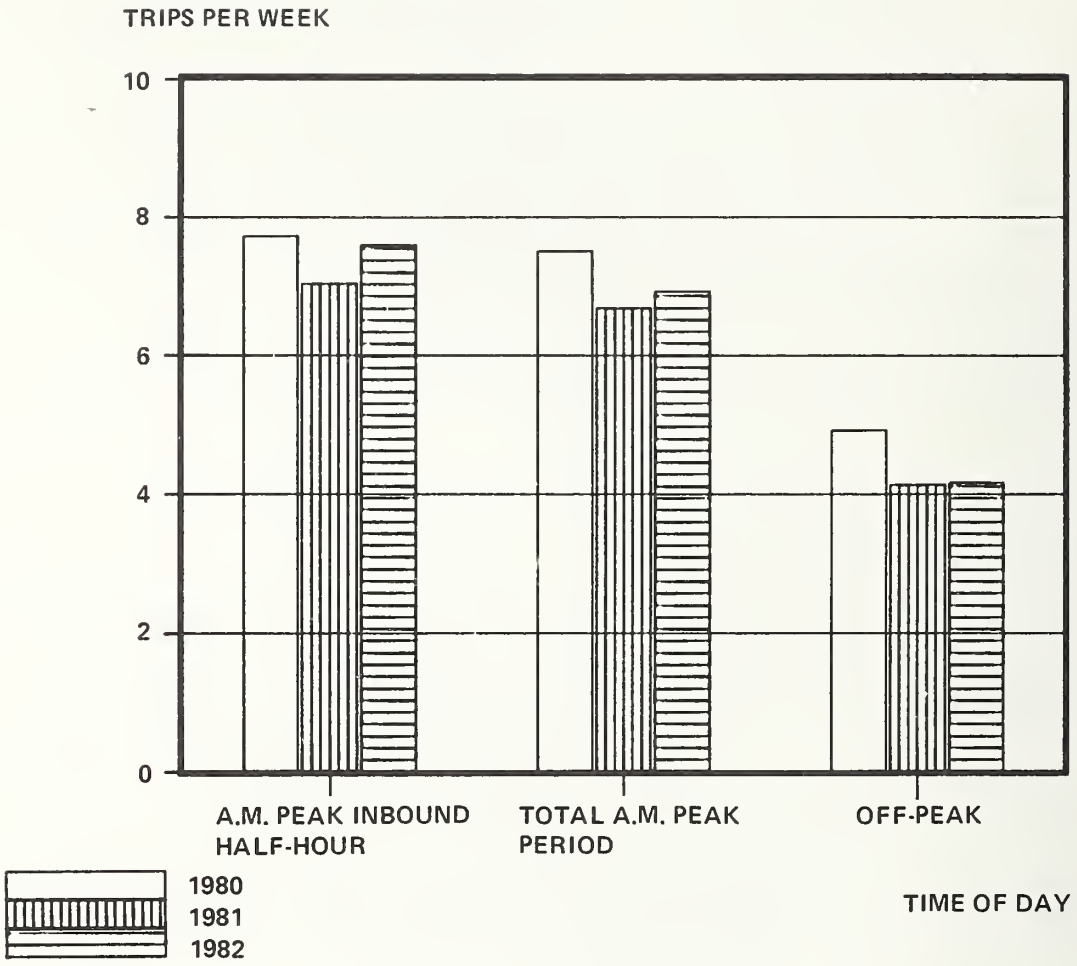
Another specific question related to transit ridership is whether new transit users were generated as a result of the demonstration. Data are not available to address this question directly, but some deductions are possible from the On-Board Survey data. Passholders were asked to indicate how they would have traveled if the pass had not been available. While these data are very scant (see Table 3-3), there is a suggestion that between 10 and 20 percent of pass trips would have been made by some other mode or not made at all. These trips are made either by former transit users who are now making additional trips because they have an unlimited-use pass, or by new transit users. We recognized that new users would have switched to transit because of the availability of the unlimited-use pass (we know that the variable work hours program was not likely to have been a factor). If this is the case, then the new users should be frequent travelers, and we should expect an increase in the average trip frequency of DTA riders. Survey data, however, indicate that overall trip frequency declined over the course of the demonstration. The decline between 1980 and 1982 was statistically very significant (99 percent) during all time periods except the a.m. peak inbound half-hour. The decline in trip frequency is shown in Figure 3-9. This suggests that few new high-frequency riders joined the pool of DTA users as a

TABLE 3-5. IMPACT OF THE DEMONSTRATION ON PEAK HALF-HOUR DEMAND*
(Expressed as a Percentage of Total Daily Demand)

	Inbound	Outbound
1980 Peak Half-Hour Ridership	11.6%	10.8%
1981 Forecast (Based on General Fare Increase)	12.1%	11.1%
1981 Actual	13.2%	9.6%
PHASE ONE CHANGE DUE TO DEMONSTRATION:	+1.1%	-1.5%
[Range of Estimates]	[+1.0 - +1.5%]	[-1.2% - -1.7%]
1982 Forecast (Based on General Fare Increase)	13.3%	9.7%
1982 Actual	12.0%	9.8%
PHASE TWO CHANGE DUE TO DEMONSTRATION:	-1.3%	+0.1%
[Range of Estimates]	[-1.0% - -1.5%]	[-0.1% - +0.3%]

*Midrange estimates; see Appendix D for detailed calculations.

SOURCE: Brown Sheet Survey data and Appendix D.



SOURCE: Derived from On-Board Survey Data.

Figure 3–9. AVERAGE TRIP FREQUENCY OF DTA RIDERS

result of the demonstration, and implies that most of the new transit trips resulting from the pass program are trips made by persons who used transit before the demonstration.

A more detailed examination of these data by market segments (including age, auto ownership, sex, family size, etc.) did not reveal any interesting results. Certainly, trip frequency varies by payment type; these results are discussed in a later subsection. Surveys of employees at ARDC and City Hall did not have large enough samples to address the question of new transit users statistically. While some commuting mode-switching did occur, the significance of the shift was not measurable.

3.3.2 Transit Operations Impacts

The operations of the Duluth Transit Authority appear to have remained largely unaffected by the demonstration project. The DTA did not adjust its schedules in any way to compensate for demand decreases. Table 3-6 shows the number of inbound and outbound daily bus runs operated in each year of the demonstration. The number of peak half-hour inbound bus runs remained nearly constant at 29; had the desired shift of 200 peak half-hour users occurred, this number should have been reduced to about 24.

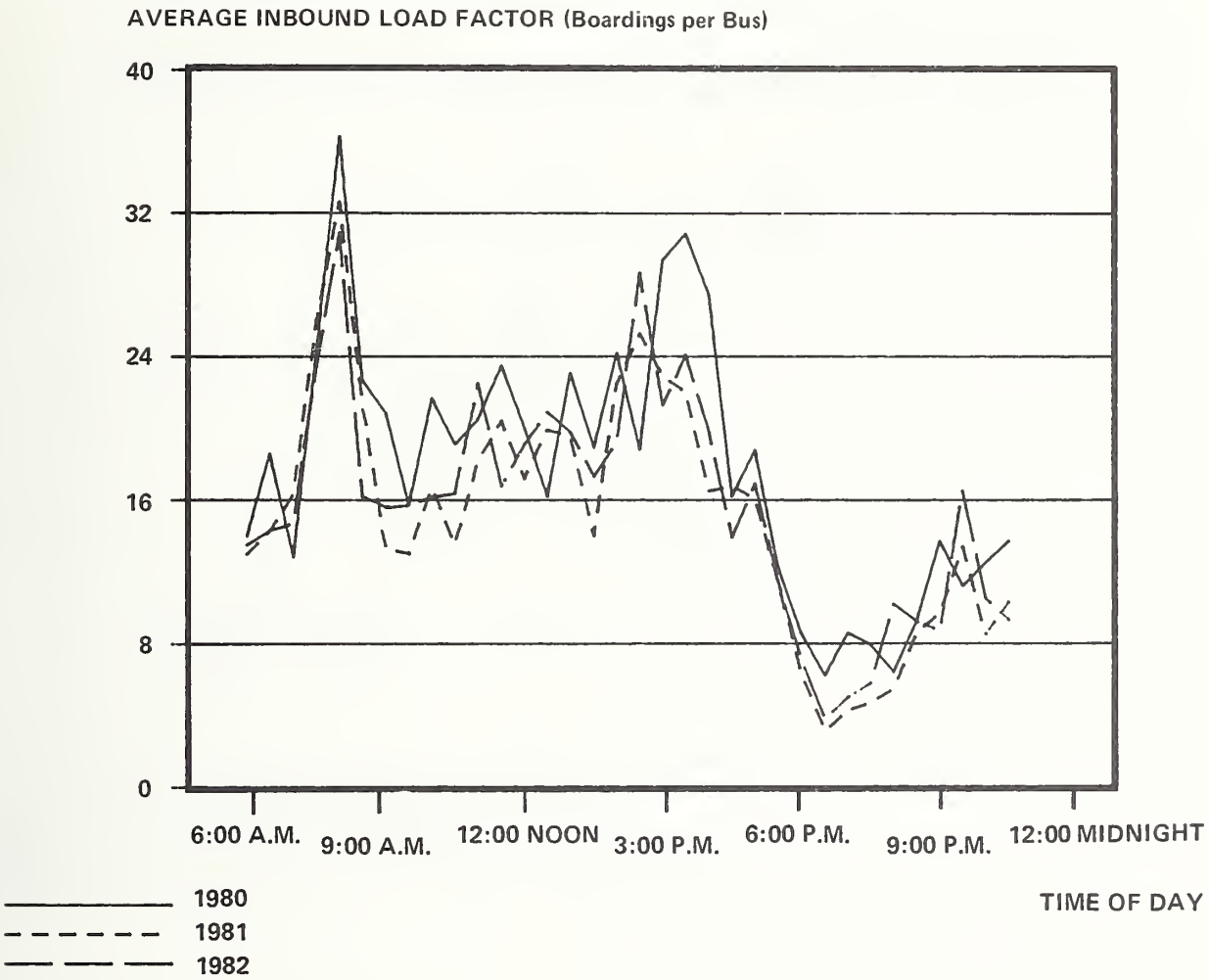
Transit ridership in the two-hour peak periods declined between 1980 and 1982 by 18.7 percent (inbound) and 22.2 percent (outbound). However, the number of bus runs in the two-hour peak was not reduced over this same period. As a result, peak load factors declined. Figures 3-10 and 3-11 show average boardings per bus by half-hour time period for inbound and outbound service, respectively. The drop in this ratio over time is apparent in both Figures. Table 3-7 shows that average a.m. peak half-hour passenger loading decreased from 36.3 passengers per bus in 1980 to 32.6 in 1981 and 30.9 in 1982. Similar decreases occurred in the outbound peak half-hour and in the inbound and outbound two-hour peaks. Total weekday passengers dropped by 17.7 percent between 1980 and 1982; total weekday bus runs decreased by only 3.2 percent over the same time period.

The implication of these data is that the DTA did not attempt to reschedule service to respond to changes in demand. As a result, no measurable reduction took place in vehicle or labor requirements or in system operating costs. The lack of changes in peak-period schedules reflects the half-hour headways that existed prior to the demonstration on many DTA bus routes. These routes were in some cases served by only two or three vehicles, so that the reassignment of a single vehicle could have resulted in peak headways of between 45 minutes and one hour. The DTA considered headways of this magnitude to be inadequate for peak-period service.

TABLE 3-6. ACTUAL DAILY BUS RUNS OPERATED - DULUTH TRANSIT AUTHORITY

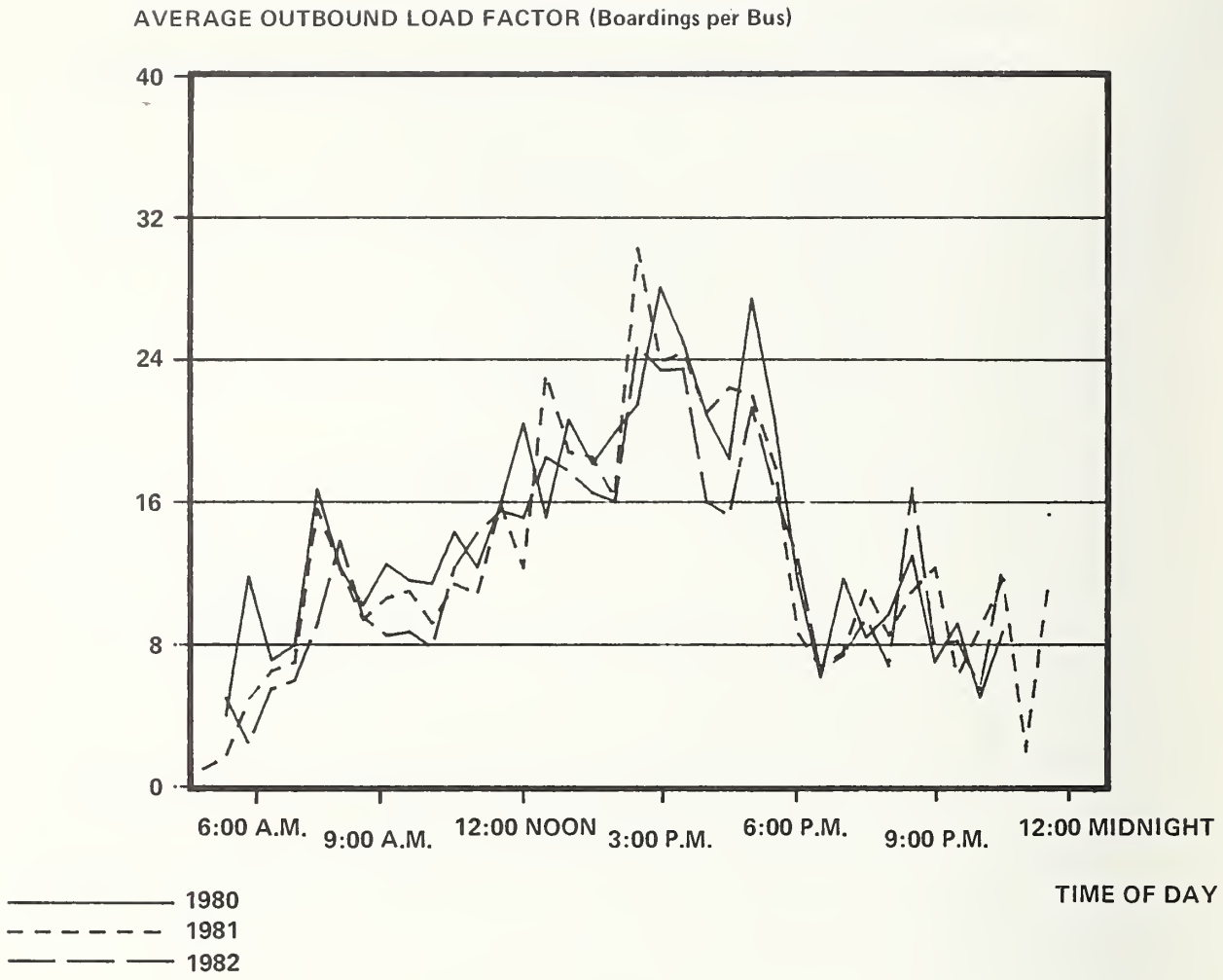
	1980	1981	1982
Inbound			
Total All-Day	492	479	476
Peak Two-Hour	95	95	94
Peak Half-Hour	29	30	29
Outbound			
Total All-Day	496	481	480
Peak Two-Hour	95	96	94
Peak Half-Hour	29	30	29

SOURCE: Brown Sheet data.



SOURCE: Derived from Brown Sheet Survey Data.

Figure 3–10. WEEKDAY INBOUND LOAD FACTORS BY HALF-HOUR TIME PERIOD



SOURCE: Derived from Brown Sheet Survey Data.

Figure 3–11. WEEKDAY OUTBOUND LOAD FACTORS BY HALF-HOUR TIME PERIOD

TABLE 3-7. AVERAGE LOAD FACTORS - DULUTH TRANSIT AUTHORITY
(Boardings per Bus)*

	1980	1981	1982
Inbound			
Peak Half-Hour	36.3	32.6	30.9
Peak Two-Hour	26.6	23.3	21.9
Outbound			
Peak Half-Hour	27.5	22.0	21.3
Peak Two-Hour	22.4	20.8	17.6

*Load factors in this report are actually the total number of boardings divided by the bus capacity, rather than the number of passengers at the peak load point divided by the capacity. Because of the CBD-oriented nature of the DTA route system, few riders deboard outside the CBD, and this approximation is fairly accurate, particularly in the aggregate.

SOURCE: Derived from Brown Sheet data.

A facet of transit operations that was affected by the demonstration was the manner in which transit riders paid for their trips. The introduction of two new payment mechanisms (the All-Day and Discount passes) resulted in marked shifts in method of payment for trips. At the same time, however, shifts were also taking place in the regular DTA fare structure, including cash and token fares. Therefore, the changes in method of payment reported here are a function of both the demonstration and these external changes.

Table 3-8 shows the method of fare payment during the peak inbound half-hour over the course of the demonstration. In 1981, passes accounted for 8.5 percent of trips, which appear at first glance to have been drawn nearly equally from both the cash and token fare categories. We would normally expect that most passholders would have been drawn from the token fare category under the assumption that most frequent riders have already purchased tokens rather than pay cash. Between 1980 and 1981, however, the token discount (as compared to cash) increased from 12.5 percent to 20 percent. Because of this, some cash users switched to token payment at the same time that some token users switched to passes. As a result, a decrease is evident in both of these fare payment categories.

In 1982, pass payment appeared to drop significantly during peak periods despite the fact that pass sales had been extended to the general public. In fact, during the month of the Phase 2 On-Board Survey, 967 passes were sold, compared to 808 during the month of the Phase 1 On-Board Survey. However, Table 3-6 indicates a drop in pass use from 8.5 percent of half-hour peak inbound trips in 1981 to only 4.7 percent in 1982. This drop in reported pass use in 1982 is likely to be the result of a low survey response rate for passholders in the 1982 On-Board Survey. These passholders had been subjected to numerous surveys over the course of the demonstration, including the Pass Purchaser Survey several months earlier. This possibility is discussed in more detail in Appendix B.

Between the 1981 and 1982 On-Board surveys, the token fare was increased to equal the cash fare. As a result, the balance between cash and token fare payment also shifted significantly in 1982. Cash fares increased and token fares decreased drastically, because convenience was now the only benefit to be derived from the use of tokens.

An examination of method of payment during the bidirectional a.m. peak two-hour period reveals trends very similar to the a.m. peak inbound half-hour. The only apparent increase in pass use occurred on weekends, when passes represented a significantly higher portion of trips in 1982 (7.7 percent) than in 1981 (3.2 percent); (see Table 3-9). One hypothesis that would explain this result recognizes that in 1981 all pass buyers were employees (since passes were only sold through employers). As a result, most pass use occurred on weekdays. In Phase 2, pass sales were opened to the general public, including students or other individuals who were less frequent weekday travelers and more frequent weekend travelers. This could have resulted in an increase in reported weekend pass use coincident with a

TABLE 3-8. DISTRIBUTION OF METHOD OF PAYMENT, PEAK INBOUND HALF-HOUR

	1980	1981	1982
Full Fare Cash	20.3%	15.6%	43.9%
Full Fare Token	58.8	52.2	31.1
All-Day Pass	--	5.0	3.5
Discount Pass	--	3.5	1.2
Other (Discount Cash and Token, DTA Employee Pass, etc.)	20.9	23.7	20.3
Total	100.0%	100.0%	100.0%
Sample Size (n)	532	565	260

SOURCE: Derived from On-Board Survey data.

TABLE 3-9. DISTRIBUTION OF METHOD OF PAYMENT, WEEKEND TRANSIT TRAVEL

	1980	1981	1982
Full Fare-Cash	Not Available	35.9%	49.2%
Full Fare Token		27.8	7.0
All-Day Pass		1.5	4.4
Discount Pass		1.7	3.3
Other (Discount Cash and Token, etc.)		33.1	36.1
Total		100.0%	100.0%
Sample Size (n)		716	547

SOURCE: Derived from On-Board Survey data.

decrease in reported weekday pass use. Conversely, response rates on weekends may not have been as low as on weekdays for passholders. Unfortunately, no data are available to support either hypothesis.

An examination of method of payment by trip purpose showed that pass use levels are slightly higher for work trips (as we would expect, since these are higher-frequency riders), and somewhat lower for non-work trips. There were generally insufficient data to examine smaller trip purpose classifications (school, shopping, medical, etc.).

From the standpoint of DTA operations, fare payment method was not a factor over the course of the demonstration. As mentioned in Chapter 2, new procedures and operating regulations were established to support the pass program, and some confusion developed among drivers with respect to distinguishing All-Day and Discount passes. Otherwise, DTA operations were not affected; no attempt was made to measure reductions in dwell time or other operational characteristics, and there was no evidence that such changes occurred.

3.3.3 DTA Cost and Revenue Impacts

Because the DTA did not implement changes in service as a result of the demonstration, it can be safely assumed that no operating cost savings resulted from the demonstration. The costs of the prepayment component of the demonstration project were estimated by the project staff and are shown in Table 3-10. Total costs for the pass program were approximately $110,440. A total of 17,572 passes were sold during the project, resulting in a per-pass cost for the project of $6.28. The bulk of these costs was for professional labor and advertising. This relatively high figure is consistent with the high cost per pass of the TFP demonstration in Jacksonville, FL.* In that demonstration, total expenditures were approximately $170,000 (including data collection) for total sales of about 10,000 passes, for a net cost of $11.70 per pass. By contrast, per-pass costs for pass programs in other cities range from $0.13 to $1.02, and costs for smaller systems are generally lower than average.**

The pass program also appeared to have a measurable impact on DTA revenues. The average trip frequency of passholders (as measured in the On-Board and Passholder surveys) was consistently higher than the breakeven

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*See Charles River Associates, Jacksonville Transit Fare Prepayment Demonstration: Final Evaluation Report, April 1982.

**See U.S. DOT, The Costs of Transit Fare Prepayment Programs: A Parametric Cost Analysis, prepared by Ecosometrics, Inc., February 1982.

TABLE 3-10. DEMONSTRATION PROGRAM EXPENSES

Description	Total	Pass Program*	Variable Work Hours*	Evaluation and Data Collection*
Support Labor	$ 20,860	$15,020	$ 3,750	$ 2,090
Professional Labor	44,680	32,170	8,030	4,470
Employee Benefits	5,810	4,190	1,040	580
Travel	1,480	740	740	-
Supplies	8,760	7,010	1,750	-
Consultant Services	92,210	-	-	92,210
Other TFP Costs	57,010	51,310	5,700	-
Contingencies	0	-	-	-
Total	$230,810	$110,440	$21,010	$99,350

*Based on allocation estimates by the DTA Project Manager.

SOURCE: Duluth Transit Authority.

pass price (expressed as a multiple of the cost of cash or token fare trips). This by itself would indicate that the DTA is losing money from the pass program, except that some of these trips are new trips that would not have been made had the pass not been available. To account for travel that may have been induced by the pass program, the reported trip frequencies were adjusted by examining how passholders would have traveled if the pass had been unavailable. In May 1981, for example, the average trip frequency of All-Day passholders was 9.28 trips per week, or 40.21 trips per month. Based on On-Board Survey responses, 10.41 of these trips would have been paid for by cash, 26.78 by token, and 3.02 would not have been made by transit had the pass been unavailable. The actual average revenue per passholder was $14.00 (the cost of the All-Day Pass). The alternate revenue would have been calculated as follows:

$$(26.78)(\$0.40) + (10.41)(\$0.50) = \$15.92.$$

Therefore, the revenue loss per All-Day Pass in May 1981 was $1.92. Similar calculations were performed for the Discount Pass, and a second set of calculations was performed for Phase 2, in which pass prices and average trip frequencies of passholders were much higher. In fact, two separate estimates were made for this later time period, one based on trip frequencies reported in the May 1982 On-Board Survey, and one based on trip frequencies reported in the November 1981 Port Pass User Survey. The estimated revenue loss per pass for each time period is shown in Table 3-11. Note that a conservative estimate of revenue loss during Phase 2 indicates a net revenue gain from purchasers of the All-Day Pass. While it is indeed possible that for certain individuals a net revenue gain will occur as a result of purchasing a pass,* it is unlikely that this would be the case on average for all pass purchasers. This result probably stems from an underestimate of actual trip frequency or, more likely, from an overestimate of the number of trips that would not have been made by transit had the pass been unavailable.

Using a midrange estimate of Phase 2 revenue loss, the total revenue loss resulting from pass sales over the two-year demonstration was $43,161, or an average of $2.46 per pass. When combined with the costs to DTA of administering the pass program ($6.28 per pass), the total subsidy provided by the DTA was approximately $8.74 per pass. In comparison, the average pass purchase price over the course of the demonstration was $16.20.

It was originally expected that additional revenue gain might be generated from increased transit travel by non-passholders, as a result of reduced peak congestion. However, this impact was not detected in the data.

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*See L. Doxsey, The Economics of Demand for Transit Passes, U.S. Department of Transportation, Transportation Systems Center, August 1982.

TABLE 3-11. REVENUE LOSS PER TRANSIT PASS

	Time Period		
	Phase 1	Phase 2 (Minimum Estimate)	Phase 3 (Maximum Estimate)
Source of Estimate	On-Board Survey	On-Board Survey	Passholder Survey
Revenue Loss Per All-Day Pass	$1.92	$0.95	$1.18
Revenue Loss Per Discount Pass	$4.65	$1.81	$4.18

SOURCE: Derived from On-Board and Passholder Survey data.

3.4 SUMMARY

Previous subsections have described the detailed findings of the demonstration project evaluation concerning impacts on three organizations or groups: employers, travelers, and the DTA. This subsection summarizes these impacts.

The demonstration project had virtually no impact on employers. Only 1 firm with 30 employees joined the variable work hours program. A total of 135 employees participated in the pass program, most of these selling 10 or fewer passes per month, with no resulting costs or benefits.

Individuals' work hours and times of travel seemed to be unaffected by the demonstration, except at the one firm that adopted variable work hours. While some passholders reported changing their time of travel after buying the pass, there was evidence that the demonstration project was not the principal cause of shifts in time of travel. Pass purchasers were generally frequent travelers who purchased the pass to reduce their travel expense; persons buying the Discount Pass were much less likely to start work during the restricted time period (7:30-8:00 a.m.), but were otherwise very similar to All-Day passholders.

When pass prices were increased in Phase 2, the average trip frequency of passholders increased, as low-end pass users returned to paying a cash or token fare. Trip frequency was the only significant variable distinguishing passholders from cash or token fare transit riders. The demonstration resulted in very little switching of travel modes. Some pass users (who formerly paid cash or tokens) shifted selected trips (principally non-work trips) from automobile or walking; a generous estimate indicates that these additional trips resulted in overall increases in DTA ridership of 0.4 percent and 0.7 percent in 1981 and 1982, respectively. While many passholders stated that they traveled by bus more frequently after buying the pass, the limited before and after data available from employee surveys did not support this claim.

Transit ridership increased by at most about 1.2 percent during peak periods and by a smaller amount during off-peak periods as a result of the demonstration. These impacts were clouded by an overall demand drop of 24.6 percent due to external causes over the course of the project. Demand peaking did not appear to be affected by the project. Few new transit users appear to have been generated by the demonstration. Transit operations were not affected; no changes in service were made to adapt to overall transit demand decreases over time. Changes in method of payment did not appreciably affect transit operations, and there is evidence that drivers remained confused throughout the project concerning the distinction between the Discount and All-Day Port passes. The average cost of operating the pass program was $6.28 per pass sold over the course of the project. The estimated revenue loss from the project (to passholders who traveled frequently enough to recoup their net payment to the DTA) was estimated to be $43,161, or $2.46 per pass sold.

4. CONCLUSIONS AND RECOMMENDATIONS

Although the Duluth Variable Work Hours/Transit Fare Prepayment Demonstration was clearly unsuccessful in alleviating demand peaks and reducing operating costs, many conclusions and recommendations that are transferable to other cities can be made regarding variable work hours programs, differential time-of-day pricing, and transit pass programs. In general, the project indicated that the ability of transit operators to directly control transit demand is limited in a variety of ways. While the demonstration concept was appropriate for the site, and although the DTA project staff was diligent in implementing the incentives that the demonstration entailed, the task of manipulating demand was far more difficult and complex than originally anticipated.

Variable work hours programs are difficult to implement even in an ideal setting in which peaking congestion problems are severe and widely recognized. Even under these circumstances, it is difficult and costly to convince employers to change their fixed schedules despite strong evidence that flexible work schedules can in many cases both improve employee productivity and morale and reduce absenteeism. It is also difficult to achieve a penetration rate (number of employers participating) significant enough to have a perceptible impact on congestion levels.

In Duluth, peak congestion was not perceived as a problem by employers; thus, virtually no interest was generated in the variable work hours component of the project. Even if severe bus system congestion had existed in the peak, the lack of automobile congestion would have reduced employers' perceptions of the severity of the peaking problem. Clearly, variable work hours programs should not be pursued unless there is a strong and widespread perception of congestion caused by peaking in demand. Note that this condition by itself is not sufficient for the implementation of a variable work hours program. If congestion is perceived as severe and widespread, employers must still be convinced that their participation in variable work hours will have a meaningful impact on the problem. And, once employer participation is obtained, extensive coordination must be achieved on a regional basis to insure that peaking problems are not simply shifted temporarily or spatially. This result is likely to hold for transit systems in all types and sizes of cities.

The attempt to utilize differential time-of-day transit pricing for the purpose of reducing peaking of demand in the Duluth demonstration was also unsuccessful, largely because the people affected by differential pricing represented only a small portion of DTA riders (only 10 to 15 percent of those making peak trips used passes). As a result, even if the Discount Pass had caused a major shift in time of travel for passholders, the net impact on total demand would have been small. We conclude, then, that fare prepayment

must have extensive market penetration to successfully implement differential time-of-day pricing using fare prepayment. This result can be generalized for transit systems of all sizes.

The discount price of the off-peak pass seemed only to provide a windfall cash benefit to those individuals who already traveled outside the restricted time interval. As hypothesized in the demonstration plan, the lack of freedom in work schedules did leave some peak users unable to use the Discount Pass. However, the demonstration failed to determine whether or not the financial incentive offered would have been sufficient to shift travelers had their work schedules permitted. Significant revenue loss did occur as a result of the pass program, with most of this loss due to the discounted off-peak pass. Clearly, it would have been better in this case to lengthen the restricted period to minimize the number of riders who were able to take advantage of the discount without changing their travel behavior. This result, however, is peculiar to Duluth and to the characteristics of transit ridership on the DTA system. It is very clear that the time boundaries for peak/off-peak fares must be determined on a site-specific basis.

The pass program itself provided verification of the results of other fare prepayment demonstrations. The principal buyers of passes are individuals whose trip frequency is high and who, therefore, save money by buying the pass. The resulting revenue loss is significant, and resulting ridership increases are small. It is also evident that fare prepayment programs in small transit systems entail very high costs per pass sold, and that the implied subsidy to passholders cannot in most cases be justified.

APPENDIX A. DEMONSTRATION SETTING

A.1. SITE DESCRIPTION

The city of Duluth is located in northeast Minnesota at the western edge of Lake Superior, 140 miles northeast of Minneapolis. Duluth borders the state of Wisconsin and is linked to Superior, Wisconsin across the St. Louis Bay by the Blatnik High Bridge. Since Duluth is situated at the western edge of Lake Superior, the city is the western terminus of the St. Lawrence Seaway (see Figure A-1). The Duluth area was originally visited by the French voyager Sieur Duluth in 1679. A trading post was established in 1792 and the city was officially founded in 1856.

The city of Duluth covers 67.3 square miles of land and had a population of 92,811 in 1980 with a population density of about 1,379 persons per square mile. Between 1960 and 1970, the Duluth population decreased by 5.9 percent compared to a population increase in the United States of 13.3 percent. Between 1970 and 1980, Duluth's population decreased 7.7 percent, while the population of the United States increased by 11.4 percent. A complete list of these and other demographic characteristics of the city of Duluth is provided in Table A-1 and discussed in the next section.

A.2. DEMOGRAPHICS

The median family income in Duluth-Superior for 1970 was $9,313, which was slightly less than the national median family income of $9,586 for the same year (see Table A-1). The median family income for DTA transit riders in 1977 had risen to about $15,000. Of the city's 33,384 households in 1970, 19.4 percent earned less than $5,000 compared to 20.3 percent of the households in the United States. As an indication of the level of transit dependency in Duluth, slightly more than 76 percent of the households owned one or more autos as of 1970.

The median number of years of schooling in Duluth-Superior for persons 25 years and older in 1970 was 12.3. Approximately 13,477 people or 13.4 percent of Duluth-Superior's 1970 population of 100,578 were over 65 years of age. Of the total population, 0.9 percent was black and 98.5 percent was white. The leading (foreign) country of national origin is Sweden.

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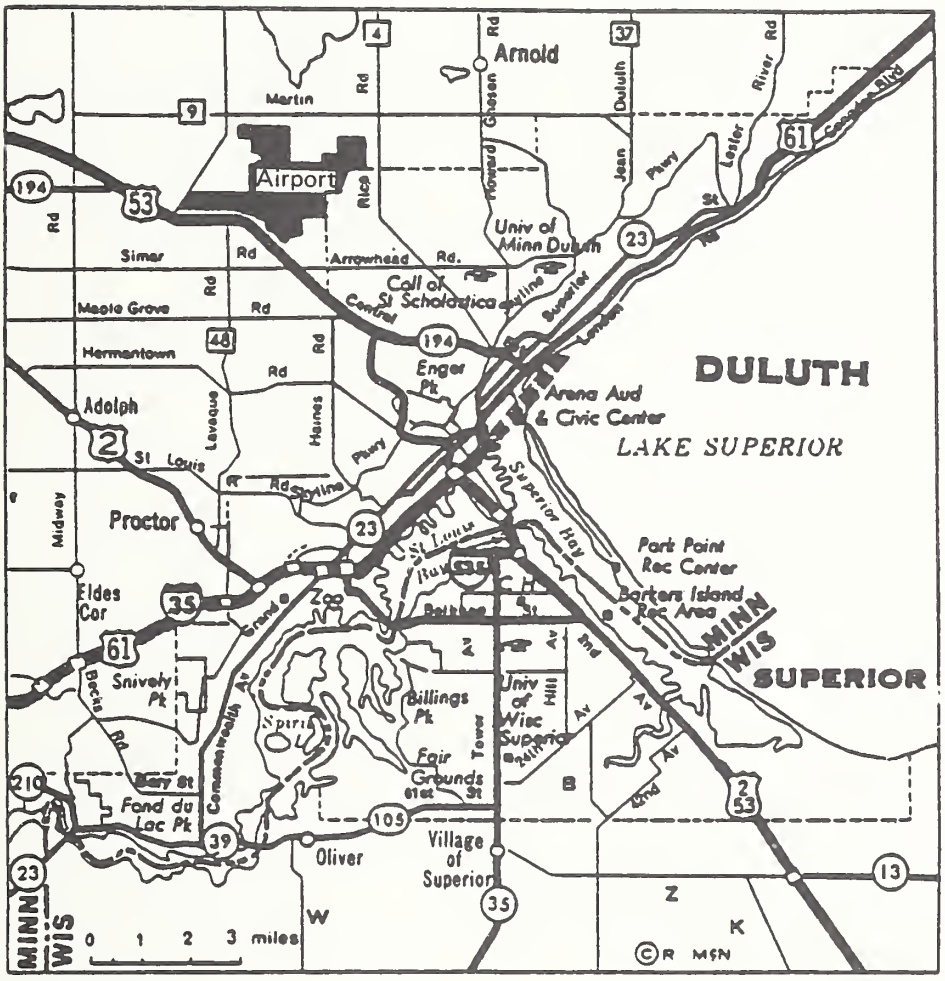
*Large segments of this chapter have been taken from Patrick Mayworm and Armando M. Lago, Demonstration Plan for the Variable Work Hours/Employee Pass Demonstration, Duluth, Minnesota, Ecosometrics Incorporated, December 7, 1979, Draft.



SOURCE: Rand McNally Commercial Atlas and Marketing Guide, 1981.

Figure A–1. DULUTH LOCATION MAP

TABLE A-1. DEMOGRAPHIC CHARACTERISTICS OF DULUTH (1970)

	Characteristics	1970	1980
1.	Population	100,578*	92,811**
2.	Land Area (square miles)	67.3*	
3.	Density (pop./sq. mile)	1,494*	
4.	Median Age (years)	29.8	
5.	Age Distribution		
	Percent below 18	32.2	
	Percent above 64	13.4	
6.	Median Years of Schooling	12.3	
7.	Total Number of Housing Units	34,710**	37,090**
8.	Average Number of Persons per Occupied Housing Unit	3.0	
9.	Percent of Families with Children under 6 Years of Age	25.0	
10.	Percent of Workers Working Outside County of Residence	4.6	
11.	Median Family Income	$9,313	
12.	Income Distribution		
	Percent Below $5,000	19.4	
	Percent Above $15,000	16.8	
13.	Number of Persons in Civilian Labor Force	39,434	
	Females	15,909	

Table continued on following page.

TABLE A-1 (Continued). DEMOGRAPHIC CHARACTERISTICS OF DULUTH (1970)

Characteristics	1970
14. Unemployment Rate (%)	6.0
15. Employment Profile	
% Employment - Manufacturing	16.4
% Employment - Trade	23.5
% Employment - Service	7.5
% Employment - Government	18.3
% Employment - White-Collar	51.4
16. Modal Split	
% Workers Using Public Transit for Work Trip	10.4
17. Growth Rate	
% Change in Population	
1960-1970	-5.9
1970-1978	-7.5
1970-1980	-7.7
18. Ethnic Breakdown	
% Black	.9
% White	98.5
19. Auto Ownership	
% Occupied Housing Units With One or More Autos	76.5
20. Mean Temperature (F)	
January	8.7
July	65.5
21. Mean Precipitation (inches)	28.97
% Possible Sunshine	55
Wind Velocity (mph)	11.7

Table continued on following page.

TABLE A-1 (Continued). DEMOGRAPHIC CHARACTERISTICS OF DULUTH (1970)

Notes:

*Rand McNally Commercial Atlas and Marketing Guide (Chicago: Rand McNally & Co., 1981).

**SOURCE: U.S. Department of Commerce, Bureau of the Census, 1980 Census of Population and Housing (Washington, D.C.: U.S. Department of Commerce, 1981).

SOURCE: Unless otherwise noted, all data are from U.S. Department of Commerce, Bureau of the Census, County and City Data Book, 1972: A Statistical Supplement (Washington, D.C.: U.S. Department of Commerce, 1972).

A.3. CLIMATE

Duluth is located in the northern part of the country and has a rather harsh climate. The winters tend to be long and cold while the summer season is mild and short. The mean temperature in January is 8.7 degrees Fahrenheit with temperatures as low as 30 degrees below zero. In July the mean temperature rises to 65.5 degrees. Mean precipitation is 28.97 inches per year, with an average yearly snowfall of 80 inches. Summer precipitation can range up to 4 inches monthly. The average wind velocity in Duluth is 11.7 miles per hour.

A.4. ECONOMIC BASE

Because the city is the western terminus of the St. Lawrence Seaway and because of its proximity to the grain-producing states of the Midwest, Duluth is a major port for international grain shipments. In addition, Duluth is located near rich iron ore ranges. The major industries in Duluth other than shipping include meat packing, publishing, and electronics manufacturing.

In 1970 the civilian resident labor force in Duluth numbered 39,434 people, 15,909 (40.3 percent) of whom were women.

A breakdown of employment in the Duluth-Superior urbanized area as of January 1977 is shown in Table A-2. The table indicates that the largest employment is in wholesale and retail trade, followed closely by services and government. Table A-3 shows the number of employment sites of different types located in the city of Duluth. These employment sites were to a large extent the target group of the variable work hours program. Table A-4 shows a breakdown of the two largest employment types by size of firm.

A.5. CHARACTERISTICS OF THE DULUTH TRANSPORTATION SYSTEM

A.5.1 Highway

In Duluth the automobile is the primary mode of travel with 95 percent of the average daily unlinked passenger trips being made by auto in 1972* and 76 percent of the households owning one or more cars in 1970 (see Table A-1).

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*Wells Research Company and Control Data Corporation, 1974 National Transportation Report: Urban Data Supplement, Washington, D.C.: U.S. Department of Transportation, May 1974.

TABLE A-2. EMPLOYEES ON NONAGRICULTURAL PAYROLLS IN DULUTH-SUPERIOR

	1979	1981
Contract Construction	2,300	1,800
Manufacturing	7,900	7,300
Transportation and Public Utilities	6,800	6,200
Wholesale and Retail Trade	16,600	15,100
Finance, Insurance, and Real Estate	2,200	2,300
Services	13,100	13,800
Government	12,600	12,100
TOTAL	61,500	58,600

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, May 1982, p. 110.

TABLE A-3. EMPLOYERS IN DULUTH

Type of Employment	1972* Number of Establishments	1977** Number of Establishments
Manufacturing	118	107
Retail Trade	973	834
Wholesale Trade	198	Not Available

SOURCES: *U.S. Department of Commerce, Bureau of the Census, County and City Data Book, 1977: A Statistical Supplement (Washington, D.C.: U.S. Department of Commerce, 1977).

**U.S. Department of Commerce, Bureau of the Census, 1977 Census of Manufacturers and 1977 Census of Retail Trade (Washington, D.C.: U.S. Department of Commerce, 1978).

TABLE A-4. RETAIL ESTABLISHMENTS, AND MANUFACTURERS AND WHOLESALERS BY FIRM SIZE (1978)

Number of Employees	Retail Establishments	Manufacturers and Wholesalers
Fewer Than 8	104	41
8 - 24	76	30
25 - 49	17	12
50 - 99	3	6
100 - 249	2	9
250 - 499	0	5
500 - 999	1	1
1000 - 4999	0	5
TOTAL	203	109

SOURCE: Duluth Transit Authority.

As of 1972, Duluth had a total of 750 miles of highways and streets within the city limits. A more detailed breakdown and classification of the highways is shown in Table A-5.

A.5.2 Transit Service Characteristics*

The Duluth Transit Authority serves principally the cities of Duluth, Minnesota and Superior, Wisconsin. The system also provides service to the village of Proctor and other developing areas outside Duluth's city limits.

Public transportation in Duluth has existed for nearly 100 years. On July 6, 1883, a horse-drawn car on rails began serving Duluth's population of 6,000. The first transit system ran one mile along Superior Street. During the next seven years the system expanded to four miles and in 1890 the first electric street cars replaced the horse-drawn vehicles.

By 1900 the population of Duluth had increased to 52,000 and Superior had 31,000 inhabitants. In that year the Duluth Street Railway Company and the Superior Traction Company were consolidated and reorganized with 74 miles of street car track and a $.05 fare.

The first gasoline-powered bus appeared on Duluth streets in 1924, and in 1931 the first electric trolley bus was put into service. In 1933 the fleet consisted of 110 street cars, 2 electric trolley buses and 9 gasoline buses. Propane buses were introduced in 1951 and discontinued in 1967. The last street car ran in 1939, and the electric trolley operations were discontinued in 1957.

Prior to 1970, the Duluth-Superior community was served by a private bus company, the Duluth-Superior Transit Company (DST). Because of declining ridership and inflationary pressures, the company ceased operation. However, it was determined that providing transit service to the area was vital to its economic and social well-being, and the system was revived as a public body.

DTA is a public authority of the City of Duluth. Its Board of Directors is appointed by the Mayor and approved by the City Council. The Board's responsibilities include the establishment of overall system goals, objectives and standards, and the monitoring of management. Although the DTA Board is accountable for transit policy, the Duluth City Council has the ultimate authority over transit operations through the control of funding, fares, and appointments to the Board.

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*Unless otherwise indicated, all transit ridership data in this section are from Metropolitan Interstate Committee, Duluth-Superior Transit Development Program, 1980-1985, October 1979.

TABLE A-5. HIGHWAY MILEAGE IN DULUTH (1972)

Highway Classification	Total Miles
Interstate	9
Other Principal Arterials	44
Minor Arterials	98
Collectors	105
Local	494
TOTAL	750

SOURCE: Wells Research Company and Control Data Corporation, National Transportation Report, Urban Data Supplement (Washington, D.C.: U.S. Department of Transportation, 1974).

The City of Superior receives bus service on a contract basis. The amount of service contracted for is determined by the Superior City Council, which is the funding authority. Under newly amended Minnesota statutes, Superior will have one voting member on the DTA Board of Directors.

The American Transit Enterprises (ATE) Management & Service Company is directly responsible through ATE Management of Duluth Incorporated to the DTA Board of Directors for the management and operation of the transit system.

Table A-6 summarizes DTA service and ridership from its inception in 1970 to the beginning of the demonstration project in 1979. Service miles and ridership varied widely during the first five years of operation. Between 1975 and 1979, both service and ridership remained relatively constant.

During the ten-year time period, total revenue and revenue per mile rose slowly while total costs and deficits increased greatly as illustrated in Figure A-2. In real terms (constant dollars), revenue per mile dropped by 20 percent between 1970 and 1979, while cost per mile rose by over 40 percent.

Approximately one-third of DTA revenues in 1979 came from passengers in Duluth and one-fourth from Duluth student fares. Another one-fourth of revenues come from services in Superior, Wisconsin (including both students and the general public), while the remaining revenues come from advertising, charter services, and other sources.

The majority of operating subsidies are provided by the Minnesota Department of Transportation (nearly 50 percent), the U.S. Department of Transportation, and the City of Duluth. The Wisconsin DOT and the City of Superior contribute only slightly to making up the total deficit.

The Duluth Transit Authority owns and operates a fleet of 109 buses (Table A-7), including 45 GMC-RTSII buses (equipped with the "kneeling" feature) purchased in February 1979. The average age of the 104 buses in the active fleet (omitting 5 25-year-old buses used only in emergencies) is under 7 years. Essentially, the entire fleet consists of full-sized vehicles with capacities of from 43 to 51 passengers. The fleet remained unchanged throughout the demonstration project.

The DTA operates 37 regular routes (see Figure A-3), of which 31 operate entirely within Duluth, 5 entirely within Superior, and 1 between the two cities. The map in Figure A-4 shows the service area of the DTA. All of the routes in Duluth have one terminus within the CBD. The location of routes through the Duluth CBD is shown in Figure A-5, along with major downtown landmarks. The DTA also operates five commuter-oriented express services leading into the CBD. These routes are shown in Figure A-6. The DTA route structure and schedules remained essentially unchanged throughout the course of the demonstration.

TABLE A-6. DULUTH TRANSIT AUTHORITY OPERATING AND REVENUE STATISTICS

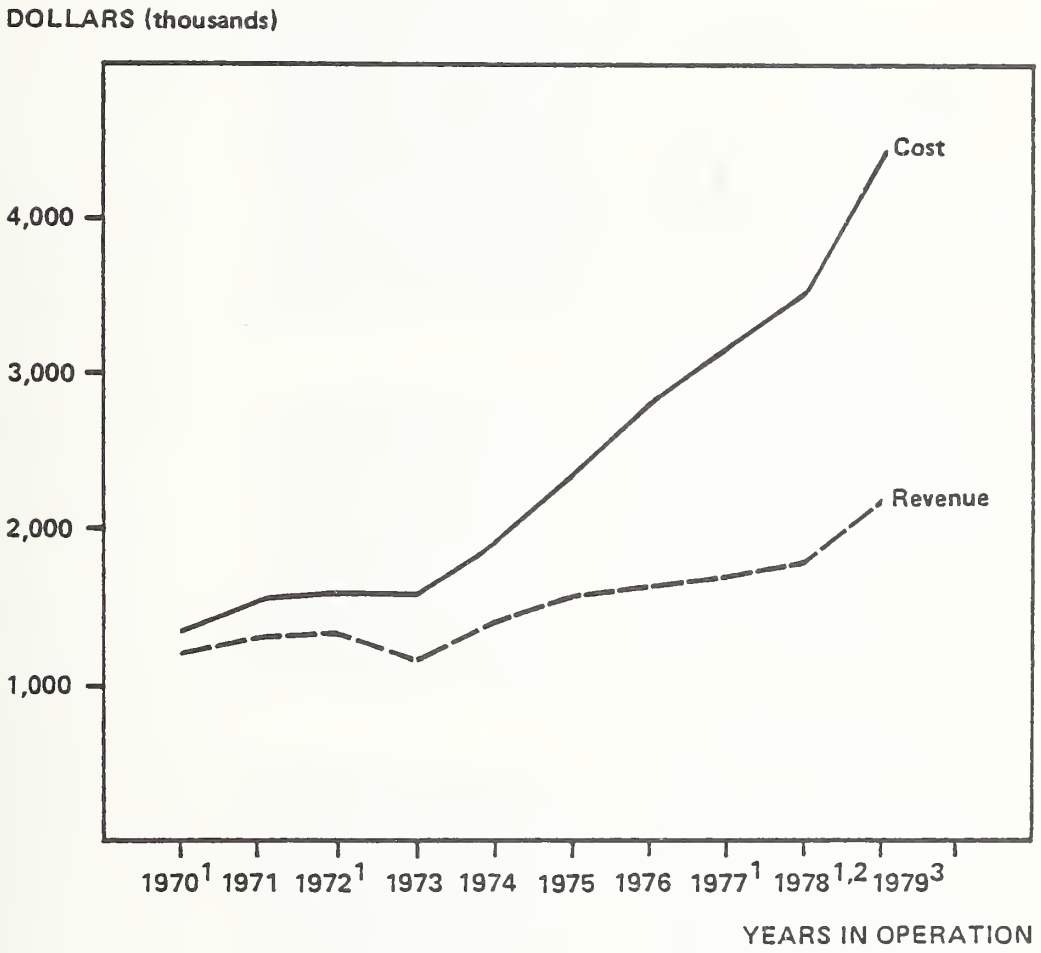
Year	Total Miles	Total Passengers	Total Cost	Total Revenue	Deficit	Cost Per Mile	Revenue Per Mile
1970*	1,896,749	4,818,813	$1,351,768	$1,224,245	$ 127,523	$ .71	$ .65
1971	1,994,692	5,206,281	1,562,724	1,336,030	226,694	.78	.67
1972*	1,828,794	4,340,061	1,596,403	1,360,508	235,895	.81	.74
1973	1,649,392	3,650,362	1,564,497	1,182,988	381,509	.95	.72
1974	1,790,016	4,407,191	1,915,201	1,416,661	498,540	1.07	.79
1975	2,015,968	5,378,028	2,347,429	1,598,824	757,605	1.16	.79
1976	1,958,100	5,584,755	2,831,167	1,646,447	1,184,720	1.45	.84
1977*	2,181,180	5,564,833	3,161,013	1,705,543	1,455,470	1.45	.78
1978* **	2,068,668	5,554,180	3,503,520	1,779,597	1,723,923	1.69	.86
1979	2,278,265	7,034,457	4,448,610	2,409,262	2,039,348	1.95	1.06
1980	2,293,469	6,791,950	5,418,534	2,674,453	2,744,081	2.36	1.17

*Less than 12 full months of service due to a one-month strike by DTA drivers.

**Unaudited results.

+Projected for 1979.

SOURCE: Metropolitan Interstate Committee, Duluth-Superior Transit Development Program, 1980-1985, October 1979, p. I-6; and DTA staff.



1 Less than 12 full months of service
2 Unaudited results
3 1978 estimates for 1979

SOURCE: Table A–6 of this report.

Figure A–2. DULUTH TRANSIT AUTHORITY SYSTEM COSTS AND REVENUES

TABLE A-7. COMPOSITION OF THE DULUTH TRANSIT AUTHORITY BUS FLEET (AUGUST 1982)

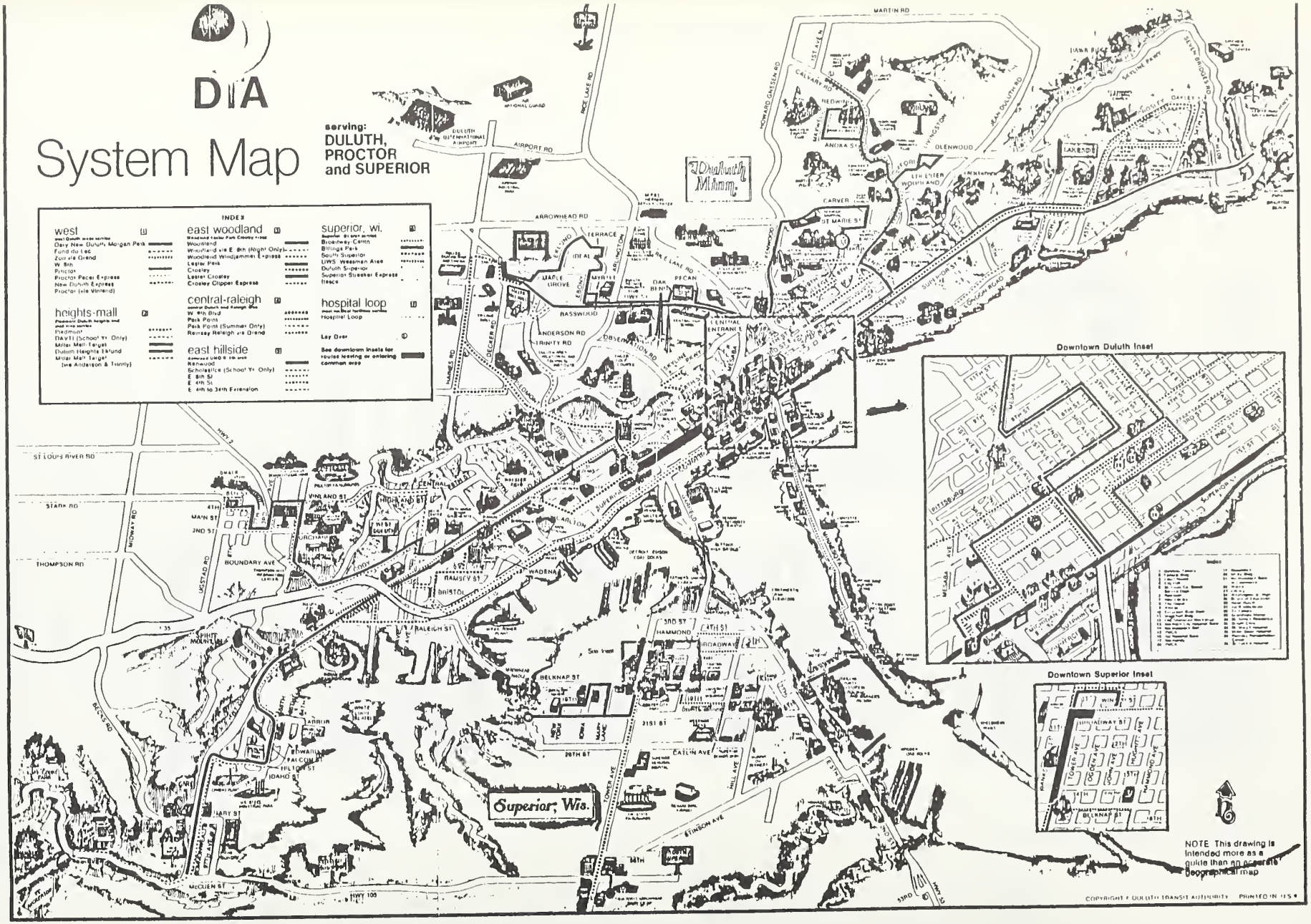
Bus Model Year	Seating Capacity				Total Number of Buses
	19	43	45	51	
1954-1955				5	5*
1962				1	1
1963				5	5
1970	3		30		33
1975			20		20
1979		45			45
TOTAL	3	45	50	11	109

*The five 1954-1955 buses are for emergency use only.

SOURCE: Duluth Transit Authority.

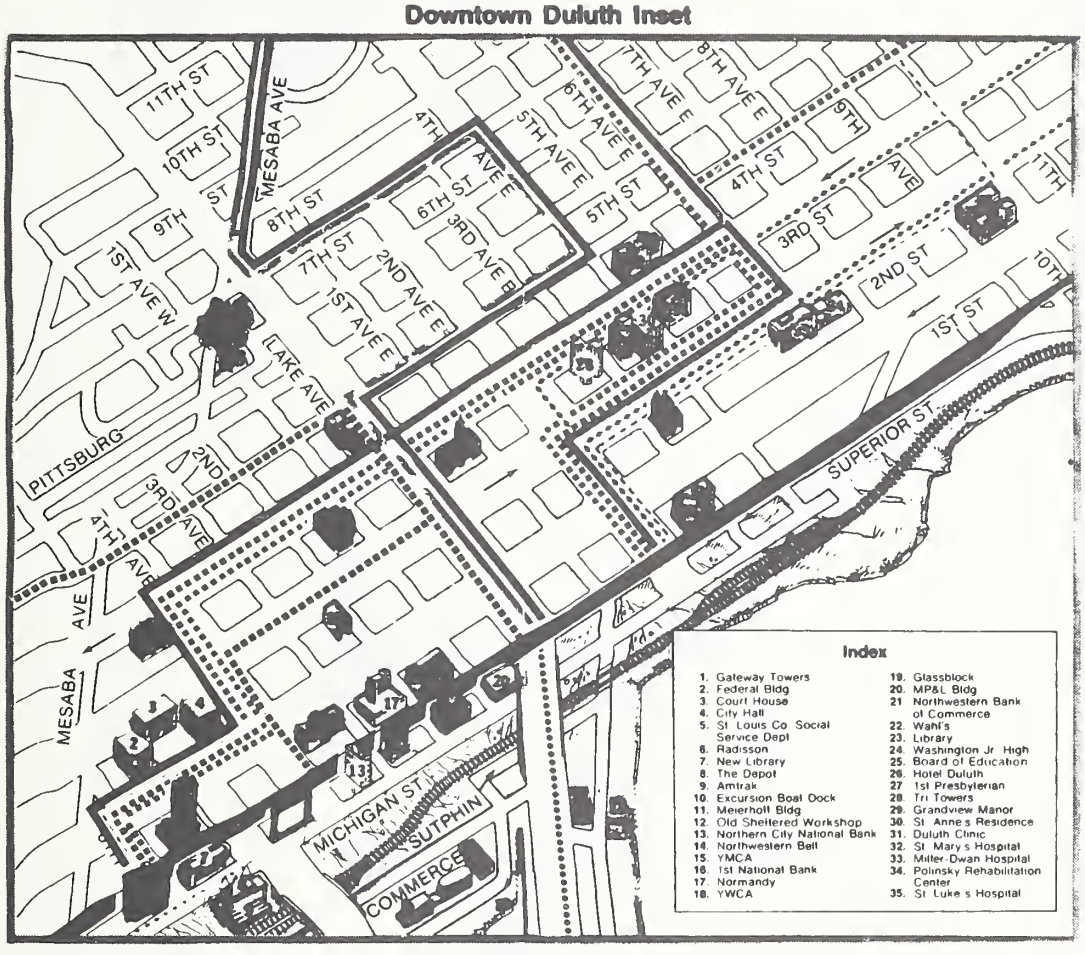
SOURCE: Duluth Transit Authority.

Figure A–3. DULUTH TRANSIT AUTHORITY SERVICES AND ROUTES



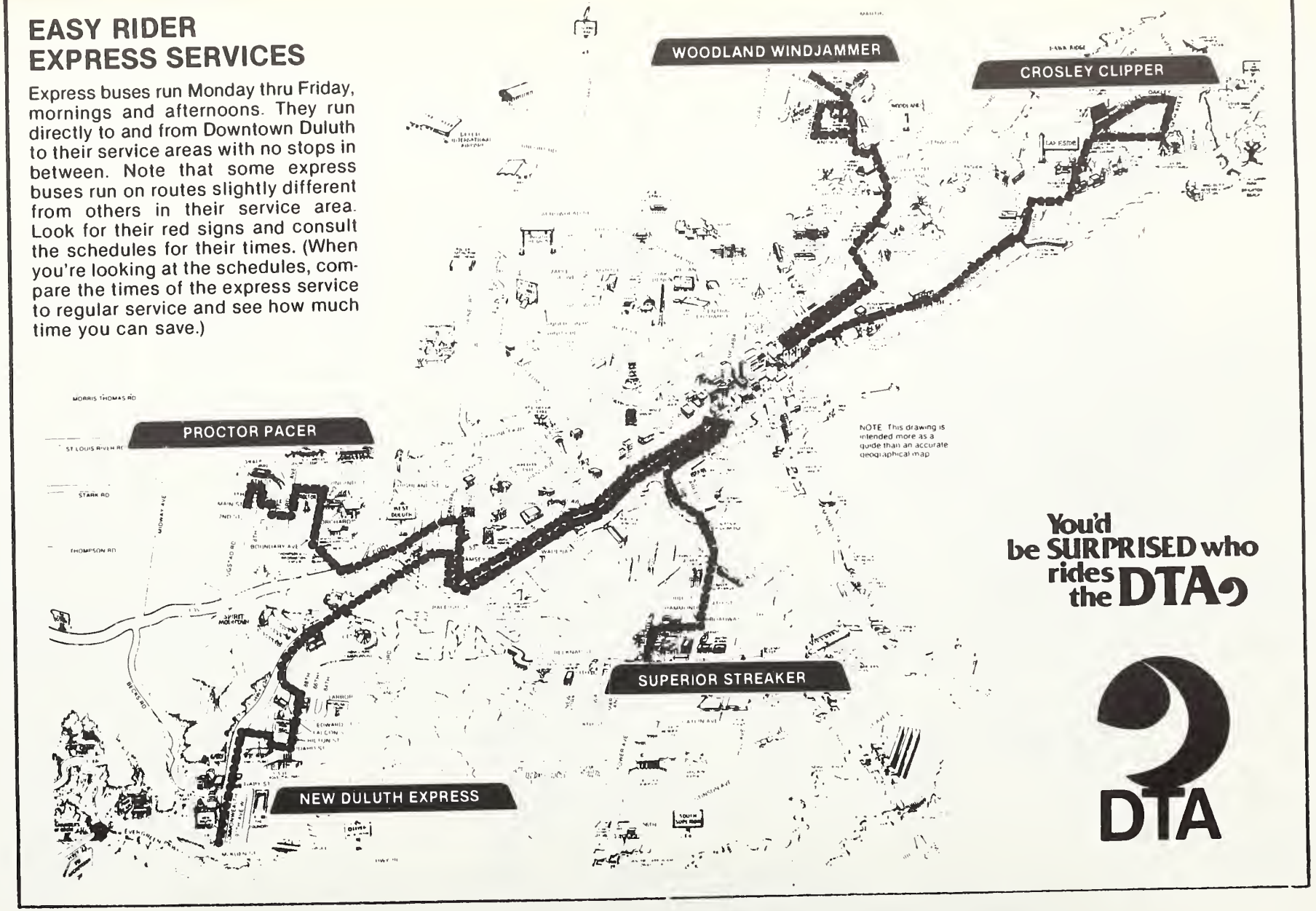
SOURCE: Duluth Transit Authority.

Figure A–4. DULUTH TRANSIT AUTHORITY ROUTE MAP



SOURCE: Duluth Transit Authority.

Figure A–5. DULUTH TRANSIT AUTHORITY ROUTES IN DOWNTOWN DULUTH



SOURCE: Duluth Transit Authority.

Figure A–6. DULUTH TRANSIT AUTHORITY EXPRESS SERVICES

The DTA fare structure that was in effect at the start of the demonstration project is shown in Figure A-7. The regular adult cash fare was $0.40, but single-ride tokens could be purchased in bulk for $0.35 each. Seniors and handicapped persons paid one-half of the regular cash and token fares during off-peak periods and on weekends.

A.5.3. Ridership Characteristics

Approximately 445,146 non-truck trips were made within the metropolitan area on a daily basis in 1977.* Of these, 5.5 percent, or 24,500 trips, were made by mass transit.** This proportion has not changed significantly in recent years. Transit accounts for approximately 15 to 20 percent of all person trips to the Duluth and Superior central business districts (CBDs). Thirty-five percent of all work trips and 20 percent of all shopping trips to the CBDs are made by bus.

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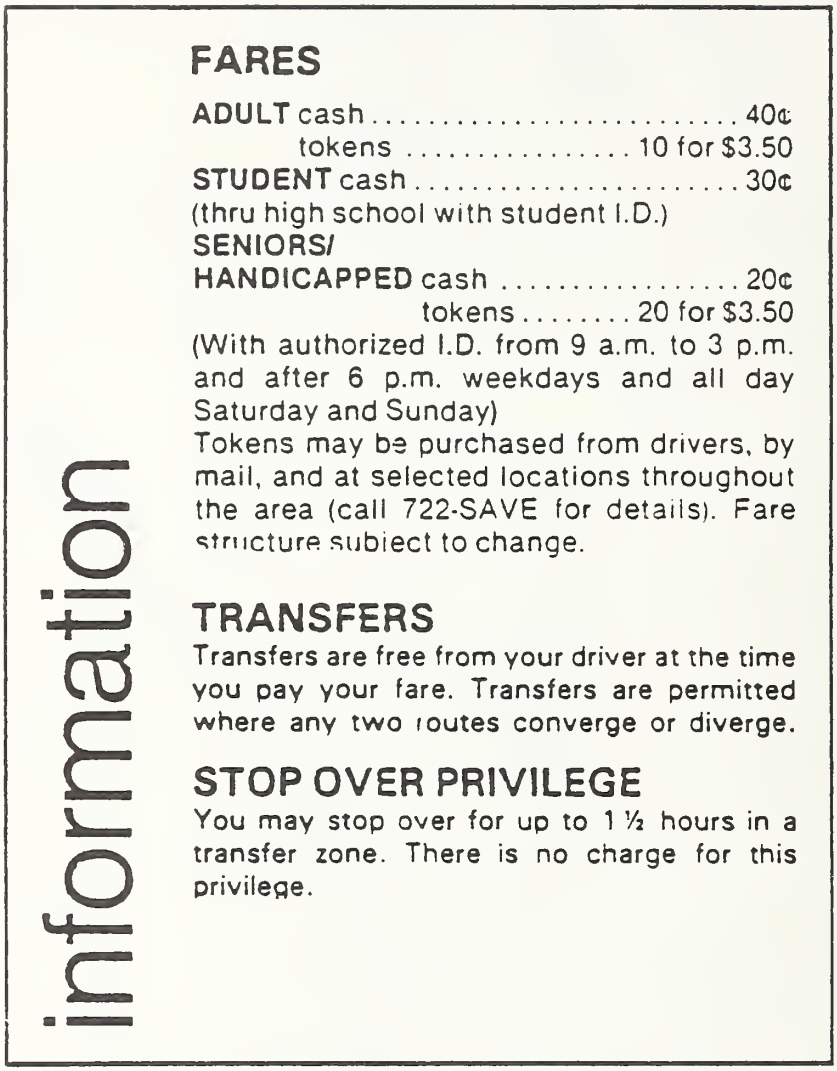
*Metropolitan Interstate Committee, Long Range Transportation Element, November 1977, p. II-3.

**Duluth Transit Authority ridership data.



SOURCE: Duluth Transit Authority.

Figure A–7. DULUTH TRANSIT AUTHORITY FARE STRUCTURE (November 1980)

APPENDIX B. DATA COLLECTION PROCEDURES AND ANALYSIS METHODOLOGY

This appendix first describes the types of data that were used in evaluating the Duluth Variable Work Hours/Transit Fare Prepayment Demonstration. The second section examines response rates to the various surveys that were used in the evaluation (copies of the surveys are provided in Appendix C). The third section discusses the survey analysis methodology, and the fourth and final section outlines the statistical tests that were used in identifying significant evaluation results.

B.1 DATA COLLECTION ITEMS

A total of eight different data sources were used in the Duluth evaluation:

a. On-Board Surveys -- Self-administered short surveys of DTA riders distributed on transit vehicles during the pre-demonstration phase, Phase 1, and Phase 2. Sampling was weighted heavily toward the a.m. peak period, the time period of greatest interest in this study. Survey questionnaires were designed by CRA; the survey was implemented by ARDC (the data collection subcontractor).

b. Brown Sheet Ridership Counts -- Complete counts of the number of riders on every run of every route of the DTA system. This count was performed three times (pre-demonstration, Phase 1, Phase 2) and yielded data on average weekday, Saturday, and Sunday ridership. Brown Sheet procedures were developed and implemented by ARDC.

c. Employee Survey and Travel Diaries -- Before and after surveys of employees performed at two sites as described in Chapter 2 of this report. These lengthy self-administered surveys were intended to measure changes in work schedules and associated changes in travel schedules resulting from the project. Before and after surveys were linked by Social Security numbers to yield panel data. A detailed self-administered one-week travel diary was executed to provide more explicit data on day-to-day variability in work and travel schedules; these data were not used in the evaluation because data analysis results from the main employee survey did not suggest that analyzing diary data would be cost-effective in terms of identifying demonstration impacts. The survey was designed by CRA and implemented by the DTA project staff.

d. Pass Purchaser Survey -- A blanket self-administered survey of all pass purchasers in Phase 2 of the demonstration intended to identify travel characteristics of these riders. Surveys were distributed with the November 1981 passes at the point of sale. The survey was designed by CRA and implemented by DTA project staff.

e. Transit Operator Statistics -- Data on DTA ridership, revenue, costs, schedules, and fares for 12 months preceding and throughout the demonstration. These data were compiled by the DTA.

f. Log of Employer Activities -- A log of all employers contacted during the course of the demonstration and the extent of their participation in the program. This log included participation in variable work hours, levels of pass sales, and pass distribution procedures and costs. This information was compiled by the DTA project staff.

g. Log of Demonstration Activities -- A record of the timing and cost of all demonstration activities such as marketing and promotion, advertising, employer solicitation, pass distribution, survey implementation, and project planning. This information was compiled by the DTA project staff.

h. Site Characteristics -- Data on the economic climate in Duluth used to measure the impact of external factors on DTA operations and transit riding. Monthly economic indicators were tabulated for the 12 months preceding and throughout the demonstration. Data were compiled by the DTA project staff and ARDC from a variety of sources.

B.2 SURVEY RESPONSE RATES

Response rates for the Pass Purchaser, Employee, and On-Board surveys are shown in Table B-1. Response rates for the self-administered Pass Purchaser and Employee surveys were very high. Unfortunately, accurate data were not kept concerning the number of On-Board surveys distributed or the number of passengers on buses that were surveyed in each phase of the evaluation. Estimated response rates in 1980 and 1981 were approximately 50 percent. Sample size in 1981 was increased significantly in 1981 compared to that of 1980, resulting in greater numbers of completed surveys. The principal purpose of this increase between 1980 and 1981 was to yield better coverage of afternoon peak and evening time periods, which were barely surveyed in 1980. In 1982, there was a marked drop in response rates,

TABLE B-1. SURVEY RESPONSE RATES

Survey/Time Period	Number Distributed	Number Completed	Response Rate
Pass Purchaser Survey: (748 Passholders)	722	450	62.3%
Employee Surveys			
ARDC Pre-Demonstration:	30	30	100.0%*
Phase 1:	28	27	96.4%*
City Hall Pre-Demonstration:	502	426	84.9%
Phase 1:	500**	320	64.0%
On-Board Surveys			
1980 Weekday a.m. Peak:	N.A.	1070	--
Weekday Other:	N.A.	828	--
Weekend:	N.A.	387	--
1981 Weekday a.m. Peak:	N.A.	1525	--
Weekday Other:	N.A.	1288	--
Weekend:	N.A.	727	--
1982 Weekday a.m. Peak:	N.A.	719	--
Weekday Other:	N.A.	1334	--
Weekend:	N.A.	547	--

Notes: N.A. = Not Available (see text).

*ARDC was the data collection subcontractor for the demonstration project, explaining this unusually high rate of response.

**Estimated.

as surveyors noted a significant increase in refusals. This dropoff was particularly severe in the a.m. peak period, in which total responses dropped by over 50 percent from 1981 levels. Survey saturation probably explains this occurrence. The 1980 and 1981 surveys yielded usable data from 29.7 percent and 48.6 percent of riders, respectively (as well as 55.3 percent and 62.8 percent of inbound peak half-hour riders, respectively). Therefore, a majority of 1982 peak riders had already responded to one or both of the 1980 and 1981 surveys, and were, thus, likely to decline the third and final On-Board Survey. Disaggregate data on response rates by payment method, age, sex, or other variables are not available for any of the survey instruments. It is possible, however, to hypothesize that Phase 2 passholders were less likely to participate in the third and final On-Board Survey because they had been exposed not only to the two previous On-Board surveys, but the Port Pass Purchaser Survey as well. This would explain the drop in pass use from 1981 to 1982 measured by the On-Board Survey, which was inconsistent with overall increases in pass sales (and in passholder trip frequency) between the two survey months (see Chapter 3).

B.3 DATA ANALYSIS METHODOLOGY

Because the Passholder and Employee surveys were distributed to all members of the relevant population, data analysis was straightforward. The On-Board Survey, however, involved sampling the population of DTA riders at rates that varied throughout the day. Sampling was heaviest during the a.m. peak period and much lighter throughout the rest of the day. This could have resulted in the development of biased estimates of socioeconomic or behavioral parameters. In addition, the On-Board Survey (like all On-Board surveys) oversampled frequent transit travelers. Therefore, a weighting procedure was applied to correct for sampling bias. Sample weights for each time period were determined by the ratio of number of passengers riding in that interval (as determined from the Brown Sheet Survey) to the number of surveys completed in that interval. Time intervals were generally one-half hour or one hour in length. These weights were applied to all On-Board surveys before any analysis was performed. In analyzing the travel behavior of transit users (as opposed to characteristics of transit trips), another weighting factor equal to the inverse of the individual's trip frequency was applied; this weighting factor corrects for the oversampling of frequent riders.* The use of these two simple weighting procedures provided unbiased data on travel behavior.

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*See L. Doxsey, Respondent Trip Frequency Bias in On-Board Surveys, U.S. Department of Transportation, Transportation Systems Center, May 1982.

One complication introduced by this weighting procedure was the estimation of standard errors for variables of interest. These standard errors were needed in order to perform statistical tests on the data (see Section B.4). A computer program was written to calculate these weighted standard errors of parameter estimates. The standard errors of means and proportions for a stratified sample are weighted averages of the standard errors of each strata in the sample, as follows:

$$\text{s.e.}\ (\bar{x}_{strat}) = \frac{1}{N} \sqrt{\Sigma \frac{N_i^2 S_i^2}{n_i}}$$

$$\text{s.e.}\ (\bar{P}_{strat}) = \frac{1}{N} \sqrt{\Sigma \frac{N_i^2 P_i(1-P_i)}{n_i}}$$

where:

$\text{s.e.}\ (\bar{x}_{strat})$ = the standard error of the mean for a stratified sample;

$\text{s.e.}\ (P_{strat})$ = the standard error of a proportion for a stratified sample;

N = the total population size;

N_i = the population size of stratum i;

S_i = the standard error of the sample in stratum i;

P_i = the relevant proportion in the sample for stratum i; and

n_i = the size of the sample in stratum i.

B.4 STATISTICAL TESTS OF SIGNIFICANCE*

Throughout this report, comparisons are made between the travel-related and socioeconomic characteristics of different groups of individuals. These comparisons are based on the use of a variety of statistical tests. The

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*For a detailed explanation of the use of statistical tests and application of confidence intervals, see Hubert M. Blalock, Social Statistics, McGraw Hill, 1972; or any other elementary statistics text.

principal statistical tests used in this report were the difference of means and difference of proportions tests, which compare the mean value and proportion of a parameter for independent samples. The difference of means test calculates a t-statistic as follows:

$$t = \frac{X_1 - X_2}{\sqrt{\frac{S_1^2}{n_1 - 1} + \frac{S_2^2}{n_2 - 1}}}$$

where:

X_1 and X_2 = mean value of the parameter for Samples 1 and 2;

S_1 and S_2 = sample parameter standard errors; and

n_1 and n_2 = size of Samples 1 and 2.

The difference of proportions test calculates a Z-statistic as follows:

$$Z = \frac{P_1 - P_2}{\sqrt{P'(1-P') \frac{n_1 + n_2}{n_1 n_2}}}$$

where:

$P' = \frac{P_1 n_1 + P_2 n_2}{n_1 + n_2}$ = the weighted average value of the proportion; and

P_1 and P_2 = the parameter proportion of Samples 1 and 2, respectively.

Throughout this report, results or comparisons are identified as significant if they are accepted at the 95 percent confidence level (t- or Z-statistic greater than or equal to 1.96 for two-tailed test or 1.65 for a one-tailed test with relatively large samples). Results identified as "very significant" cannot be rejected even at the 99 percent confidence level (t- or Z-statistic greater than or equal to 2.58 for a two-tailed test or 2.33 for a one-tailed test with relatively large samples). Any results for which the confidence interval is less than 95 percent are noted in the text. The statistical results in the report are based on correlations; multivariate statistical techniques were not used to produce any of the information contained in the report.

APPENDIX C. DATA COLLECTION INSTRUMENTS

C–1. BROWN SHEET DATA COLLECTION FORM

KENWOOD

ON - OFF PASSENGER CHECK

TRIP SEQUENCE					
ROUTE-BLOCK-BUS NUMBER					
OBSERVER					
WEATHER					
DAY-DATE					
SCHEDULED TIME	Lv.	Arr.	Lv.	Arr.	Arr.
ACTUAL TIME	Lv.	Arr.	Lv.	Arr.	Lv.
STREETS	OUTBOUND	INBOUND	OUTBOUND	INBOUND	OUTBOUND
	ON OFF	ON OFF	ON OFF	ON OFF	ON OFF
Arrowhead Rd.					
TIME POINT					
KENWOOD-UMD continues					
Arrowhead Rd.& Warren Ave.					
Dodge Ave.					
Brainerd Ave.					
Valhalla Ave.					
#845					
#701					
#522					
Woodhaven Ave.					
Carver Abe.					
Carver Ave.&Halsey St./					
Brookline St.					
St. Marie St.					
St.Marie St. & Midway Dr.					
Bayview Ave.					
Oakland Ave.					
Kirby Center - UMD					
TIME POINT					
ACTUAL TIME	Arr.	Lv.	Arr.	Lv.	Arr.
SCHEDULED TIME	Arr.	Lv.	Arr.	Lv.	Arr.
	OUTBOUND	INBOUND	OUTBOUND	INBOUND	OUTBOUND
TOTAL ON-OFF					
TOTAL OUT					
TOTAL IN					
TOTAL TRIP					

REMARKS:

C–2. EMPLOYEE SURVEY FORMS

Employer ☐☐☐ (1–3)
Survey ☐☐☐☐ (4–7) 01 (8–9)

C–2.1. PRE-DEMONSTRATION EMPLOYEE SURVEY (Distributed at ARDC and City Hall)

PART I: TRAVEL & ACTIVITY QUESTIONS

PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT YESTERDAY'S TRIP TO WORK. (If you were not at work yesterday for some reason, please answer these questions for the last day you were at work.)

OFFICE USE ONLY

1. How did you get to work yesterday? ☐ (10)
1__Drove alone
2__Drove myself and others
3__Someone drove me
4__Took the bus
5__Walked
6__Other (please specify) _____

2. If you rode the bus to work yesterday, how did you pay for the trip? ☐ (11)
1__40¢ Cash
2__35¢ Adult token
3__20¢ Cash
4__17½¢ Senior or handicapped token
5__Other (please specify) _____

2a. Does your employer pay part of the cost of riding the bus to work? ☐ (12)
1__Yes (How much?_____)
2__No

3. If you rode in a car with other people, please indicate how many others were in the car with you in each of the following categories:
__Number of co-workers ☐ (13)
__Number of family or household members (other than yourself) ☐ (14)
__Number of neighbors ☐ (15)
__Number of others ☐ (16)

4. If you drove to work yesterday, how much did it cost to park your car, van, or light truck? ☐☐☐ (17–19)
$_____

4a. Check if applicable: ☐ (20)
1__Employer provides a free parking space
2__Employer pays part of your parking cost

5. What time did you leave for work yesterday? ☐☐☐☐ (21–24)
____:____a.m./p.m.

6. What time did you arrive at work yesterday? ☐☐☐☐ (25–28)
____:____a.m./p.m.

7. How did you get home from work yesterday? ☐ (29)
1__Drove alone
2__Drove myself and others
3__Someone drove me
4__Took the bus
5__Walked
6__Other (please specify) _____

8. If you rode the bus home from work yesterday, how did you pay for the trip? ☐ (30)
1__40¢ Cash
2__35¢ Adult token
3__20¢ Cash
4__17½¢ Senior or handicapped token
5__Other (please specify) _____

9. If you rode home from work in a car with other people, please indicate how many others were in the car with you in each of the following categories:
__Number of co-workers ☐ (31)
__Number of family or household members (other than yourself) ☐ (32)
__Number of neighbors ☐ (33)
__Number of others ☐ (34)

10. What time did you leave work yesterday? ☐☐☐☐ (35–38)
____:____a.m./p.m.

11. What time did you arrive home yesterday? ☐☐☐☐ (39–42)
____:____a.m./p.m.

OFFICE USE ONLY

12. Did you stop anywhere on the way home from work yesterday? ☐ (43)
__Yes, I did some shopping ☐ (44)
__Yes, I gave someone a ride ☐ (45)
__Yes, I went out to eat ☐ (46)
__Yes (other, please specify_____)
__No

13. During the work day yesterday, did you leave the building in which you work at any time? ☐ (47)
__Yes, on business ☐ (48)
__Yes, to go out to eat ☐ (49)
__Yes, to go shopping ☐ (50)
__Yes, for other reasons (please specify_____)
__No, I never left the building in which I work

14. If you did leave work during the day yesterday, how did you travel? ☐ (51)
__By auto (how many people in car?_____) ☐ (52)
__Free bus ride (DASH card) ☐ (53)
__Regular bus ride (cash or token) ☐ (54)
__Walk ☐ (55)
__Other (please specify_____)

PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT YOUR GENERAL TRAVEL BEHAVIOR.

☐☐☐ (1–3) ☐☐☐☐ (4–7) 02 (8–9)

15. If you have a carpool involving nonhousehold members, which of the following best describes your arrangement? ☐ (10)
1__Driving is shared by all carpool members
2__Driving is shared by some carpool members
3__One person drives all the time

16. How often and how many household members, including children, travel with you for at least part of your trip to work? ☐☐ (11–12)
_____Members. _____times a week

17. How often and how many household members, including children, travel with you for at least part of your trip home from work? ☐☐ (13–14)
_____Members, _____times a week

18. Do you generally have a car available to get to and from work each day? ☐ (15) ☐ (18) ☐ (17)
1__Yes, as a driver, _____days per week
1__Yes, as a passenger, _____days per week
2__No

19. Do you ever need to use your own personal car for work during the day or to make trips during lunch time? ☐☐ (18–19)
1__Yes (How many days per week?_____)
2__No

20. How many miles is your one-way trip from home to work?_____ ☐☐ (20–21)

21. How far is your home from the nearest bus stop? ☐ (22)
1__0-3 blocks
2__3-6 blocks
3__More than 6 blocks
4__Don't know

22. In general, how many days per week do you use the bus to get to work:
In the summer?_____ In the winter?_____ ☐☐ (23–24)

23. Do you ever use the bus for purposes other than going to or from work? ☐☐ (25–28)
1__Yes, _____times per month
2__No

FINALLY, PLEASE ANSWER THE FOLLOWING GENERAL QUESTIONS.

OFFICE USE ONLY

24. What type of job do you have?
- 1__Administrative/clerical
- 2__Professional/technical
- 3__Skilled/unskilled labor
- 4__Sales
- 5__Other (please specify_____)

25. Are your scheduled working hours during the winter the same from day to day?
- 1__Yes, I work from _____:_____a.m./p.m. to _____:_____a.m./p.m., _____days per week
- 2__No, I work irregular hours (please specify: _____)

25a. If your summer working hours are different from those listed above, are your summer hours the same from day to day?
- 1__Yes, my summer hours are _____:_____a.m./p.m. to _____:_____a.m./p.m., _____days per week.
- 2__No, my summer hours vary from day to day (please specify: _____)
- 3__I have no special summer hours

26. What time do you usually arrive at work?
_____:_____a.m./p.m.

27. Which of these statements apply to you:
- __I nearly always arrive at work at the same time
- __I arrive ten minutes earlier than usual once a week or more
- __I arrive ten minutes earlier than usual around 2-4 times per month
- __I arrive ten minutes later than usual once a week or more
- __I arrive ten minutes later than usual around 2-4 times per month

28. How often do problems arise that make it impossible for you to get to work on time?
- 1__Often (once a week or more)
- 2__Sometimes (2 or 3 times a month)
- 3__Seldom (less than twice a month)

29. Ideally, at what time of day would you like to start work?
In the summer? _____:_____a.m./p.m.
In the winter? _____:_____a.m./p.m.
__I don't care when I start work.

30. How frequently do you work overtime or stay at work more than 30 minutes later than usual?
- 1__Never
- 2__Rarely—about once a month
- 3__Sometimes—between two and four times per month
- 4__Often—once a week or more

31. How many persons are in your household, including yourself?_____

32. How many licensed drivers are in your household, including yourself?_____

33. How many full-time workers are in your household, including yourself?_____

34. How many part-time workers are in your household, including yourself?_____

35. If there are other workers in your household, what time does each of them typically leave for work?
- 1__They leave for work at: ____:____a.m./p.m.
  ____:____a.m./p.m.
  ____:____a.m./p.m.
- 2__I'm not sure
- 3__There are no other workers in my household

36. How many children are in your household in the following age groups:
__less than 5 years old
__5 to 13 years old
__14 to 18 years old

37. If you have children in school, what time does each of them typically leave for school?
- 1__They leave for school at: ____:____a.m./p.m.
  ____:____a.m./p.m.
  ____:____a.m./p.m.
- 2__I'm not sure
- 3__I have no school-age children

38. What year were you born?_____

39. What is the total annual income of your household?
- 1__less than $10,000
- 2__$10,000 - $14,999
- 3__$15,000 - $19,999
- 4__$20,000 - $24,999
- 5__$25,000 - $29,999
- 6__$30,000 - $39,999
- 7__$40,000 or over

40. Are you:
- 1__Female
- 2__Male

41. A year from now we will ask you to fill out another survey form. By answering this question you will help us make sure our results next year are comparable to this year. However, to protect your confidentiality, please fill in *only the last four digits* of your Social Security number:

X X X / X X / ☐ ☐ ☐ ☐

Thank you very much for answering these survey questions. Your assistance will help the Duluth Transit Authority to provide better service to you and to the public. Please keep this form where you work until it is collected from you in a few days by the person who delivered it to you.

We would also appreciate your participation in an optional portion of this survey. The attached sheets ask you to list all the trips and journeys you make over the next seven days.

IF YOU FILL OUT THE OPTIONAL PORTION OF THIS SURVEY, THE DTA WILL GIVE YOU TWO FREE MOVIE PASSES TO THANK YOU FOR YOUR ASSISTANCE.

FILL OUT THIS OPTIONAL PORTION OF THE SURVEY AND THE DULUTH TRANSIT AUTHORITY WILL GIVE YOU TWO FREE MOVIE PASSES!

PART II: TRAVEL DIARY

This diary has been designed as a record of ALL TRIPS or JOURNEYS that you happen to make on a day-to-day basis. You should use it to record the details of EACH TRIP that you make on EACH DAY. ALL TRIPS for which you ventured from your house should be included, whether made by you alone or in the company of others, regardless of how far you traveled, for what purpose you traveled, or by what method you traveled. A SEPARATE LINE should be used for EACH successive TRIP, a SEPARATE SHEET for EACH successive DAY. Extra sheets are provided in case you need them. After seven days, please place the log record sheets in the attached envelope and return them to the designated person. We will then give you your *free* movie passes.

If you want to participate and receive your *free* movie passes, but have some questions about the survey or the instructions printed below, please call Linda Zemotel at the Duluth Transit Authority at 722-4426. She will be glad to assist you.

1. Record ALL TRIPS made EACH DAY in FULL DETAIL. Each log sheet has a day of the week printed in the upper right-hand corner, along with a space for you to fill in the date. On each of the next seven days, simply use the log sheet marked with the correct day of the week. If there is not enough room on one sheet for all the trips you take in one day, use one of the spare blank sheets (record the correct date on the blank sheet).

   A TRIP is defined as a one-way journey for which you leave your house (or place from which you start) to go to some place for ANY PURPOSE by ANY METHOD of TRAVEL. Examples of typical TRIPS follow:

   a) A journey from your home to the place where you work.

   b) A journey from the place where you work to your home.

   c) A journey on foot from your home to the home of a friend to visit.

   d) A journey from the home of your friend in your friend's car to the grocery store.

   e) A journey from the grocery store on foot to a restaurant to have lunch.

   f) A journey from the restaurant back to home in your friend's car.

   g) A journey to take the dog for a walk after dinner and return home.

   You should include any trip, large or small, for which you must go out of doors. You should also remember that your trips must all "fit together," so that you do not appear to go some place and not come back.

2. For EACH TRIP, record the following information:

   a) WHERE YOU WENT — describe the PLACE you are going to and its LOCATION. A good description might be Home, Church, or Home of a Friend. Try to be as specific as possible in describing where you went.

   b) TIME YOU LEFT — record the TIME your journey to this place BEGAN as accurately as you remember.

   c) HOW LONG IT TOOK — record how much TIME the journey took as accurately as you can.

   d) REASON FOR MAKING TRIP — Every trip is made for some PURPOSE, even if it is just for recreation or to accompany or take someone else. Try to describe that reason as COMPLETELY as possible. If you went to a SINGLE PLACE but did SEVERAL THINGS there, try to describe ALL the things. For example, you could have gone to a shopping mall to cash a check, have your eyeglasses fixed, and shop for a gift. A GOOD trip record will show that you did ALL these things.

   e) METHOD OF TRAVEL — this is the PRINCIPAL way by which you traveled on your trip. If you WALKED to the bus stop and then took the BUS downtown, BUS would be your principal method of travel. If on a particular trip you traveled by more than one METHOD and are not sure which was the PRINCIPAL METHOD OF TRAVEL, record EACH method. A trip on which you WALKED is as important as one in which you DROVE. If you travel some place in an automobile, be sure to indicate whether you were the DRIVER or PASSENGER. Always record enough information so that you are sure your record shows what really happened.

An example of a completed travel log sheet is attached to these instructions. Also, for your convenience. we present a large list of typical REASONS for TRAVEL and METHODS of TRAVEL.

Once again, when you finish filling out the trip diary for seven days, give it back to the designated person and we will give you *two free movie passes!*

THANK YOU FOR YOUR HELP

TYPICAL METHODS AND REASONS FOR TRAVEL

Examples of Methods of Travel

Walk

Auto — driver (also pickup, van, motorcycle)

Auto — passenger (also pickup, van, motorcycle)

Taxi

Public Bus (DTA)

Bicycle

Examples of Reasons for Travel

Return Home

Work

School

Shopping
- groceries
- convenience store
- clothing, furniture, or other
- window shop

Automobile-Related
- gas station
- take car to garage

Personal Business
- bank
- hairdresser/barber
- look for job
- funeral home
- club meeting
- post office
- laundromat

Medical
- see doctor or dentist
- visit medical clinic

Visit Friends or Relatives
- at home
- in hospital

Religious Activity
- attend church services
- attend church function

Entertainment
- movie, concert, play
- sports event
- flower show or exhibit
- play cards, bingo

Recreation
- visit park
- picnic
- play sports
- pleasure walk or drive
- walk dog

Eat Meal
- restaurant
- fast food

Provide Service or Company
- drive someone to or from a place
- accompany someone else on a trip

TRAVEL DIARY

Day: _____

Employer: _____

Date: _____/_____/ 80

Survey: _____

WHERE DID YOU START YOUR FIRST TRIP TODAY? _____

Trip No.	Where did you go next?	What time did you start this trip?	How long did the trip take?	For what reason did you go?	By what means did you travel?
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					

C–2.2. PHASE 1 EMPLOYEE SURVEY FOR FIRMS WITH FLEXTIME (Distributed at ARDC)

PART I: TRAVEL & ACTIVITY QUESTIONS

PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT YESTERDAY'S TRIP TO WORK. (If you were not at work yesterday for some reason, please answer these questions for the last day you were at work.)

1 — 3

— — — 7

0 1
2 3

1. How did you get to work yesterday? 10
   1 ___ Drove alone
   2 ___ Drove myself and others
   3 ___ Someone drove me
   4 ___ Took the bus
   5 ___ Walked
   6 ___ Other (please specify) _____

2. If you rode the bus to work yesterday, how did you pay for the trip? 11
   1 ___ 50¢ Cash
   2 ___ 50¢ Adult Token
   3 ___ 25¢ Cash
   4 ___ 25¢ Senior or handicapped token
   5 ___ All day Port Pass
   6 ___ Discount Port Pass
   7 ___ Other (please specify) _____

   2a. Does your employer pay part of the cost of riding the bus to work? 12
   1 ___ Yes (How much?_____)
   2 ___ No

3. If you rode in a car with other people, please indicate how many others were in the car with you in each of the following categories:
   ___ Number of co-workers 13
   ___ Number of family or household members (other than yourself)
   ___ Number of neighbors
   ___ Number of others 15

4. If you drove to work yesterday, how much did it cost to park your car, van, or light truck?
   $_____ — — — 17

   4a. Check if applicable: 18
   ___ Employer provides a free parking space
   ___ Employer pays part of your parking cost
   ___ Park free on the street

5. What time did you leave for work yesterday?
   ___:___ a.m./p.m. 21 — — 24

6. What time did you arrive at work yesterday?
   ___:___ a.m./p.m. 25 — — 28

7. How did you get home from work yesterday? 29
   1 ___ Drove alone
   2 ___ Drove myself and others
   3 ___ Someone drove me
   4 ___ Took the bus
   5 ___ Walked
   6 ___ Other (please specify) _____

8. If you rode the bus home from work yesterday, how did you pay for the trip? 30
   1 ___ 50¢ Cash
   2 ___ 50¢ Adult Token
   3 ___ 25¢ Cash
   4 ___ 25¢ Senior or handicapped token
   5 ___ All day Port Pass
   6 ___ Discount Port Pass
   7 ___ Other (please specify) _____

9. If you rode home from work in a car with other people, please indicate how many others were in the car with you in each of the following categories:
   ___ Number of co-workers 31
   ___ Number of family or household members (other than yourself) 32
   ___ Number of neighbors 33
   ___ Number of others 34

10. What time did you leave work yesterday?
    ___:___ a.m./p.m. 35 — — 38

11. What time did you arrive home yesterday?
    ___:___ a.m./p.m. 39 — — 42

12. Did you stop anywhere on the way home from work yesterday? (Check all that apply) 43
    ___ Yes, I did some shopping
    ___ Yes, I gave someone a ride
    ___ Yes, I went out to eat
    ___ Yes (other, please specify _____) 46
    ___ No

13. During the work day yesterday, did you leave the building in which you work at any time? (Check all that apply) 47
    ___ Yes, on business
    ___ Yes, to go out to eat
    ___ Yes, to go shopping
    ___ Yes, for other reasons (please specify _____) 50
    ___ No, I never left the building in which I work

14. If you did leave work during the day yesterday, how did you travel?
___By auto (how many people in car? ____)
___By bus (cash or token)
___By bus (DASH Card)
___By bus (Port Pass)
___Walk
___Other (please specify_____)

PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT YOUR GENERAL TRAVEL BEHAVIOR.

15. If you have a carpool involving nonhousehold members, which of the following best describes your arrangement?
1 ___Driving is shared by all carpool members
2 ___Driving is shared by some carpool members
3 ___One person drives all the time

16. How often and how many household members, including children, travel with you for at least part of your trip to work?
____ Members, ____ times a week

17. How often and how many household members, including children, travel with you for at least part of your trip home from work?
____ Members, ____ times a week

18. Do you generally have a car available to get to and from work each day?
1 ___Yes, as a driver, ____ days per week
2 ___Yes, as a passenger, ____ days per week
3 ___No

19. Do you ever need to use your own personal car for work during the day or to make trips during lunch time?
1 ___Yes (How many days per week? ____)
2 ___No

20. How many miles is your one-way trip from home to work? _____

21. How far is your home from the nearest bus stop?
1 ___0-3 blocks
2 ___3-6 blocks
3 ___More than 6 blocks
4 ___Don't know

22. In general, how many days per week do you use the bus to get to work:
In the summer? ____ In the winter? ____

23. Do you ever use the bus for purposes other than going to or from work?
1 ___Yes, ____ times per month
2 ___No

IF YOU HAVE EVER BOUGHT A DTA PORT PASS, PLEASE ANSWER THE FOLLOWING QUESTIONS. OTHERWISE, PLEASE SKIP TO QUESTION #29.

24. Please indicate which Port Pass you purchased in each month listed below:

	All-Day Port Pass (1)	Discount Port Pass (2)	I Did Not Buy a Pass (3)
November 1980			
December 1980			
January 1981			
February 1981			
March 1981			
April 1981			
May 1981			
June 1981			
July 1981			
August 1981			

25. What was your most important reason for buying the Port Pass?
1 ___The Port Pass is cheaper than cash or tokens
2 ___The Port Pass is more convenient to use than cash or tokens
3 ___Other (please specify _____)

26. Do you plan to continue buying a Port Pass each month?
1 ___Yes
2 ___No -- Why not? _____

27. Since you started buying the Port Pass, do you ride the bus more, less, or the same ...

	More Often (1)	Less Often (2)	The Same (3)
to go to and from work?			
to make other trips on weekdays?			
to travel on weekends?			

28. If you purchase a Discount Port Pass, do you travel to and from work earlier or later than you did before you had a pass?

	Earlier (1)	Later (2)	Same Time (3)
I travel to work			
I leave work			

PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT FLEXTIME AND YOUR WORK SCHEDULE.

29. Since flextime was introduced, to what extent have you changed your day-to-day work schedule for each of the following reasons:

	No change in work schedule	I occasionally work different hours	I changed the time I generally start or leave work	
To coordinate family activities	1	2	3	27
To schedule medical or personal appointments				28
To participate in outside activities				29

30. If you have changed the way you generally go to work as a result of flextime, please indicate how you got to work before and after flextime came into effect. 30, 31

Before:	After:
1 ___ Carpool	1 ___ Carpool
2 ___ Auto (drive alone)	2 ___ Auto (drive alone)
3 ___ Bus	3 ___ Bus
4 ___ Other (please specify) ___(_____)	4 ___ Other (please specify) ___(_____)

31. If you have changed the way you generally go home from work as a result of flextime, please indicate how you got home from work before and after flextime came into effect. 32, 33

Before:	After:
1 ___ Carpool	1 ___ Carpool
2 ___ Auto (drive alone)	2 ___ Auto (drive alone)
3 ___ Bus	3 ___ Bus
4 ___ Other (please specify) ___(_____)	4 ___ Other (please specify) ___(_____)

32. What has been the effect of flextime on your average travel time to work? 34, 35 36
1 ___ Increased by ___ minutes
2 ___ No effect
3 ___ Decreased by ___ minutes
4 ___ Do not know

33. What has been the effect of flextime on your average travel time home from work? 37, — 39
1 ___ Increased by ___ minutes
2 ___ No effect
3 ___ Decreased by ___ minutes
4 ___ Do not know

34. What has been the effect of flextime on the length of time you spend working each day? 41, — 42
1 ___ Increased by ___ minutes
2 ___ No effect
3 ___ Decreased by ___ minutes
4 ___ Do not know

35. What time do you usually arrive at work? 43 — — 46
___:___ a.m./p.m.

36. Which of these statements apply to you (check all that apply): 47
___ I nearly always arrive at work at the same time
___ I arrive ten minutes earlier than usual once a week or more
___ I arrive ten minutes earlier than usual 2 to 4 times per month
___ I arrive ten minutes later than usual once a week or more
___ I arrive ten minutes later than usual around 2 to 4 time per month 51

FINALLY, PLEASE ANSWER THE FOLLOWING GENERAL QUESTIONS:

37. What type of job do you have? 53 54
1 ___ Administrative/clerical
2 ___ Professional/technical
3 ___ Skilled/unskilled labor
4 ___ Sales
5 ___ Other (please specify_____) 56

38. How many persons are in your household, including yourself? ____ 57 58

39. How many licensed drivers are in your household, including yourself? ____ 59 60

40. How many full-time workers are in your household, including yourself? ____ 61 62

41. How many part-time workers are in your household, including yourself? ____ 63 64

42. If there are other workers in your household, what time does each of them typically leave for work?

19

1 ___ They leave for work at ___:___ a.m./p.m. 20 — — — 23
at ___:___ a.m./p.m. 24 — — — 27
at ___:___ a.m./p.m. 28 — — — 31

2 ___ I'm not sure — — — —

3 ___ There are no other workers in my household

43. How many children are in your household in the following age groups:

___ Less than 5 years old 32
___ 5 to 13 years old
___ 14 to 18 years old 34

44. If you have children in school, what time does each of them typically leave for school? 35

1 ___ They leave for school at ___:___ a.m./p.m. 36 — — — 39
at ___:___ a.m./p.m. 40 — — — 43
at ___:___ a.m./p.m. 44 — — — 47

2 ___ I'm not sure — — — —

3 ___ I have no school-age children.

45. What year were you born?_____

46. What is the total annual income of your household?

1 ___ less than $11,000
2 ___ $11,000 to $21,999
3 ___ $22,000 to $32,999
4 ___ $33,000 or over

47. Are you:

1 ___ female 51
2 ___ male

48. A year ago we asked you to fill out a similar survey form. By answering this question you will help us make sure our results this year are comparable to last year. However, to protect your confidentiality, please fill in only the last four digits of your Social Security number.

(X)(X)(X) / (X)(X) / ( )( )( )

52 — — 55

C–2.3. PHASE 1 EMPLOYEE SURVEY FOR FIRMS WITHOUT FLEXTIME (Distributed at City Hall)

PART I: TRAVEL & ACTIVITY QUESTIONS

PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT YESTERDAY'S TRIP TO WORK. (If you were not at work yesterday for some reason, please answer these questions for the last day you were at work.)

1 — 3

— — — 7

0 1
2 9

1. How did you get to work yesterday? 10
   1 ___ Drove alone
   2 ___ Drove myself and others
   3 ___ Someone drove me
   4 ___ Took the bus
   5 ___ Walked
   6 ___ Other (please specify) _____

2. If you rode the bus to work yesterday, how did you pay for the trip? 11
   1 ___ 50¢ Cash
   2 ___ 50¢ Adult Token
   3 ___ 25¢ Cash
   4 ___ 25¢ Senior or handicapped token
   5 ___ All day Port Pass
   6 ___ Discount Port Pass
   7 ___ Other (please specify) _____

   2a. Does your employer pay part of the cost of riding the bus to work? 12
   1 ___ Yes (How much?_____)
   2 ___ No

3. If you rode in a car with other people, please indicate how many others were in the car with you in each of the following categories:
   ___ Number of co-workers — 13
   ___ Number of family or household members (other than yourself) —
   ___ Number of neighbors
   ___ Number of others — 16

4. If you drove to work yesterday, how much did it cost to park your car, van, or light truck?
   $_____ 17 — 19

   4a. Check if applicable: 20
   1 ___ Employer provides a free parking space
   2 ___ Employer pays part of your parking cost
   3 ___ Park free on the street

5. What time did you leave for work yesterday?
   ___:___ a.m./p.m. 21 — — 24

6. What time did you arrive at work yesterday?
   ___:___ a.m./p.m. 25 — — 28

7. How did you get home from work yesterday? 29
   1 ___ Drove alone
   2 ___ Drove myself and others
   3 ___ Someone drove me
   4 ___ Took the bus
   5 ___ Walked
   6 ___ Other (please specify) _____

8. If you rode the bus home from work yesterday, how did you pay for the trip? 30
   1 ___ 50¢ Cash
   2 ___ 50¢ Adult Token
   3 ___ 25¢ Cash
   4 ___ 25¢ Senior or handicapped token
   5 ___ All day Port Pass
   6 ___ Discount Port Pass
   7 ___ Other (please specify) _____

9. If you rode home from work in a car with other people, please indicate how many others were in the car with you in each of the following categories:
   ___ Number of co-workers — 31
   ___ Number of family or household members (other than yourself) — 32
   ___ Number of neighbors — 33
   ___ Number of others — 34

10. What time did you leave work yesterday?
    ___:___ a.m./p.m. 35 — — 38

11. What time did you arrive home yesterday?
    ___:___ a.m./p.m. 39 — — 42

12. Did you stop anywhere on the way home from work yesterday? (Check all that apply)
    ___ Yes, I did some shopping — 43
    ___ Yes, I gave someone a ride —
    ___ Yes, I went out to eat —
    ___ Yes (other, please specify _____) — 46
    ___ No

13. During the work day yesterday, did you leave the building in which you work at any time? (Check all that apply)
    ___ Yes, on business — 47
    ___ Yes, to go out to eat —
    ___ Yes, to go shopping —
    ___ Yes, for other reasons (please specify _____) — 50
    ___ No, I never left the building in which I work

14. If you did leave work during the day yesterday, how did you travel?
___By auto (how many people in car? ____)
___By bus (cash or token)
___By bus (DASH Card)
___By bus (Port Pass)
___Walk
___Other (please specify_____)

PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT YOUR GENERAL TRAVEL BEHAVIOR.

15. If you have a carpool involving nonhousehold members, which of the following best describes your arrangement?
1 ___Driving is shared by all carpool members
2 ___Driving is shared by some carpool members
3 ___One person drives all the time

16. How often and how many household members, including children, travel with you for at least part of your trip to work?
____ Members, ____ times a week

17. How often and how many household members, including children, travel with you for at least part of your trip home from work?
____ Members, ____ times a week

18. Do you generally have a car available to get to and from work each day?
1 ___Yes, as a driver, ____ days per week
2 ___Yes, as a passenger, ____ days per week
3 ___No

19. Do you ever need to use your own personal car for work during the day or to make trips during lunch time?
1 ___Yes (How many days per week? ____)
2 ___No

20. How many miles is your one-way trip from home to work? _____

21. How far is your home from the nearest bus stop?
1 ___0-3 blocks
2 ___3-6 blocks
3 ___More than 6 blocks
4 ___Don't know

22. In general, how many days per week do you use the bus to get to work:
In the summer? ____ In the winter? ____

23. Do you ever use the bus for purposes other than going to or from work?
1 ___Yes, ____ times per month
2 ___No

IF YOU HAVE EVER BOUGHT A DTA PORT PASS, PLEASE ANSWER THE FOLLOWING QUESTIONS. OTHERWISE, PLEASE SKIP TO QUESTION #29.

24. Please indicate which Port Pass you purchased in each month listed below:

	All-Day Port Pass	Discount Port Pass	I Did Not Buy a Pass
	1	2	3
November 1980			
December 1980			
January 1981			
February 1981			
March 1981			
April 1981			
May 1981			
June 1981			
July 1981			
August 1981			

25. What was your most important reason for buying the Port Pass?
1 ___The Port Pass is cheaper than cash or tokens
2 ___The Port Pass is more convenient to use than cash or tokens
3 ___Other (please specify _____)

26. Do you plan to continue buying a Port Pass each month?
1 ___Yes
2 ___No -- Why not? _____

27. Since you started buying the Port Pass, do you ride the bus more, less, or the same ...

	More Often	Less Often	The Same
	1	2	3
to go to and from work?			
to make other trips on weekdays?			
to travel on weekends?			

28. Do you travel to and from work earlier or later than you did before you had a pass?

	Earlier	Later	Same Time
	1	2	3
I travel to work			
I leave work			

PLEASE ANSWER THE FOLLOWING QUESTIONS ABOUT YOUR WORK SCHEDULE.

29. Are your scheduled working hours the same from day to day?
    1 ___Yes, I work from ___:___a.m./p.m. to ___:___a.m./p.m., ___days per week
    2 ___No, I work irregular hours (please specify _____)

30. Do you have any choice in scheduling your work start time?
    1 ___I have no regular scheduled start time
    2 ___My start time is set by my employer or supervisor
    3 ___I am able to select my work start time (please explain: _____)

31. Are you free to vary your work start time from day to day?
    1 ___Yes, I am allowed to arrive as late as I want, as long as I work the correct number of hours each day.
    2 ___Yes, I am allowed to arrive anytime within 10 or 15 minutes of the scheduled time
    3 ___No, I am required to arrive strictly according to my work schedule

32. Is your work schedule the same as it was a year ago?
    1 ___Yes
    2 ___No (please explain:_____)

33. Do you work in the same office as you did a year ago?
    1 ___Yes
    2 ___No

34. What time do you usually arrive at work?
    ___:___ a.m./p.m.

35. Which of these statements apply to you (check all that apply):
    ___I nearly always arrive at work at the same time
    ___I arrive ten minutes earlier than usual once a week or more
    ___I arrive ten minutes earlier than usual 2 to 4 times per month
    ___I arrive ten minutes later than usual once a week or more
    ___I arrive ten minutes later than usual around 2 to 4 time per month

FINALLY, PLEASE ANSWER THE FOLLOWING GENERAL QUESTIONS:

36. What type of job do you have?
    1 ___Administrative/clerical
    2 ___Professional/technical
    3 ___Skilled/unskilled labor
    4 ___Sales
    5 ___Other (please specify_____)

37. How many persons are in your household, including yourself? ____

38. How many licensed drivers are in your household, including yourself? ____

39. How many full-time workers are in your household, including yourself? ____

40. How many part-time workers are in your household, including yourself? ____

41. If there are other workers in your household, what time does each of them typically leave for work?
    1 ___They leave for work at ___:___a.m./p.m.
      at ___:___a.m./p.m.
      at ___:___a.m./p.m.
    2 ___I'm not sure
    3 ___There are no other workers in my household

42. How many children are in your household in the following age groups:
    ___Less than 5 years old
    ___5 to 13 years old
    ___14 to 18 years old

43. If you have children in school, what time does each of them typically leave for school? 35

1 ___ They leave for school at ___:___ a.m./p.m. 36 — — — — 39
at ___:___ a.m./p.m. 41 — — — — 43
at ___:___ a.m./p.m. 44 — — — — 47

2 ___ I'm not sure

3 ___ I have no school-age children.

44. What year were you born?_____ 48 49

45. What is the total annual income of your household? 50

1 ___ less than $11,000
2 ___ $11,000 to $21,999
3 ___ $22,000 to $32,999
4 ___ $33,000 or over

46. Are you: 51

1 ___ female
2 ___ male

47. A year ago we asked you to fill out a similar survey form. By answering this question you will help us make sure our results this year are comparable to last year. However, to protect your confidentiality, please fill in only the last four digits of your Social Security number.

(X)(X)(X) / (X)(X) / ( )( )( )( ) 52 — — 55

C–3. ON-BOARD SURVEY FORMS

MAY WE ASK YOUR HELP in answering a few questions?

1. How did you pay your fare?

___ 40¢ cash
___ 35¢ adult token
___ student fare or student pass
___ 20¢ cash
___ 17½¢ senior or handicapped token
___ DTA pass

2. Does this trip begin or end at home?

___ Yes, it begins at home
___ Yes, it ends at home
___ No

C–3.1. 1980 PRE-DEMONSTRATION ON-BOARD SURVEY

3. What is the purpose of this trip?

___ Going to or from work

What are your normal working hours? _____ to _____

___ Going to or from school
___ Going to or from shopping
___ Going to or from a personal business or medical appointment
___ Going to or from a social visit, eating, or recreation
___ Other

4. How many automobiles (including light trucks and vans) are owned and operated by members of your household?

___ None
___ One
___ Two
___ Three
___ Four or more

5. Did you have access to an automobile for this trip?

___ Yes, as the driver
___ Yes, as a passenger
___ No

6. How many days last week did you take the bus to work? _____

7. How many days last week did you take the bus home from work? _____

8. In addition, how many one-way bus trips did you make last week for purposes other than going to or from work? _____

9. Are you: ___ Female ___ Male

10. What is your birthdate (Month/Day/Year): _____/_____/_____

11. What is the total annual income of your household?

___ Less than $9,999 ___ $15,000 to $19,999 ___ $25,000 to $29,999
___ $10,000 to $14,999 ___ $20,000 to $24,999 ___ $30,000 and over

THANK YOU FOR RIDING THE DTA! If you have additional comments, please put them on the back of this form. Please return the form to the assistant at the front of the bus.

C–3.2. 1981 PHASE 1 PASSHOLDER ON-BOARD SURVEY

MAY WE ASK YOUR HELP in answering a few questions?

Woodland
OUT/TA
6:55 a.m. / 2nd (W)

1. How did you pay your fare?
   _____ All-Day Port Pass
   _____ Discount Port Pass

2. Does this trip begin or end at home?
   _____ yes, it begins at home
   _____ yes, it ends at home
   _____ no

3. What is the purpose of this trip?
   _____ going to or from work - what are your normal working hours?
   _____:_____ to _____:_____
   _____ going to or from school
   _____ going to or from shopping
   _____ going to or from a personal business or medical appointment
   _____ going to or from a social visit, eating, or recreation
   _____ other

4. Did you have access to an automobile for this trip?
   _____ yes, as a driver
   _____ yes, as a passenger
   _____ no

5. If you didn't have a Port Pass, how would you have made this trip?
   _____ by bus - cash fare _____ by car _____ I would not have made
   _____ by bus - token fare _____ by foot this particular trip

6. How many <u>days</u> last week did you take the bus <u>to</u> work? _____

7. How many <u>days</u> last week did you take the bus home <u>from</u> work? _____

8. In addition, how many <u>one-way bus trips</u> did you make last week for purposes <u>other</u> than going to or from work? _____ trips

9. What is your single most important reason for buying Port Pass? (check only one)
   _____ It's more convenient because I don't have to carry cash or tokens.
   _____ It's cheaper because I ride the bus so frequently.
   _____ It's cheaper because the cash and token fares went up.
   _____ other (specify) _____

10. How many automobiles (including light trucks and vans) are owned and operated by members of your household? _____ number of automobiles

11. Are you: _____ female _____ male?

12. In what year were you born? _____

13. What is the total annual income of your household?
   _____ less than $10,000 _____ $20,000 to $29,999
   _____ $10,000 to $19,999 _____ $30,000 and over

THANK YOU FOR RIDING THE DTA! If you have additional comments, please put them on the back of this form. Please return this form to the assistant at the front of the bus.

South Shore
IN/SAT
12:00 / 14th FT

MAY WE ASK YOUR HELP in answering a few questions?

1. How did you pay your fare?
   _____ 50¢ cash
   _____ 40¢ adult token
   _____ 20¢ senior or handicapped token
   _____ 25¢ cash
   _____ student fare or pass
   _____ DTA Employee pass

2. Does this trip begin or end at home?
   _____ yes, it begins at home
   _____ yes, it ends at home
   _____ no

3. What is the purpose of this trip?
   _____ going to or from work – what are your normal working hours?
   _____:_____ to _____:_____
   _____ going to or from school
   _____ going to or from shopping
   _____ going to or from a personal business or medical appointment
   _____ going to or from a social visit, eating, or recreation
   _____ other

4. Did you have access to an automobile for this trip?
   _____ yes, as a driver
   _____ yes, as a passenger
   _____ no

5. How many days last week did you take the bus to work? _____

6. How many days last week did you take the bus home from work? _____

7. In addition, how many one-way bus trips did you make last week for purposes other than going to or from work? _____ trips

8. How many automobiles (including light trucks and vans) are owned and operated by members of your household? _____ number of automobiles

9. Are you: _____ female _____ male?

10. In what year were you born? _____

11. What is the total annual income of your household?
    _____ less than $10,000
    _____ $10,000 to $19,999
    _____ $20,000 to $29,999
    _____ $30,000 and over

12. If you would be willing to help us further by taking part in a telephone survey, please fill in the following information:

    Telephone number: _____
    Best time to call: _____ Morning
    _____ Afternoon
    _____ Evening
    For whom should we ask: _____

THANK YOU FOR RIDING THE DTA! If you have additional comments, please put them on the back of this form. Please return the form to the assistant at the front of the bus.

C–3.4. 1982 PHASE 2 PASSHOLDER ON-BOARD SURVEY

MAY WE ASK YOUR HELP IN ANSWERING A FEW QUESTIONS?

1. How did you pay your fare?
   _____ All-Day Port Pass
   _____ Discount Port Pass

2. Does this trip begin or end at home?
   _____ Yes, it begins at home
   _____ Yes, it ends at home
   _____ No

3. What is the purpose of this trip?
   _____ going to or from work
   _____ going to or from school
   _____ going to or from shopping
   _____ going to or from personal business or medical appointment
   _____ going to or from a social visit, eating or visiting
   _____ other (specify)_____

4. Did you have access to an automobile for this trip?
   _____ yes, as driver
   _____ yes, as passenger
   _____ no

5. If you did not have a Port Pass, how would you have made this trip?
   _____ by bus - cash fare
   _____ by bus - token fare
   _____ by car
   _____ by foot
   _____ I would not have made this particular trip

6. How many <u>days</u> last week did you take the bus to work? _____

7. How many days last week did you take the bus home from work? _____

8. What are your normal working hours? ____:____ a.m./p.m. to ____:____a.m/p.m.
   _____ I am not regularly employed

9. In addition, how many <u>one way bus trips</u> did you make last week for purposes <u>other</u> than going to or from work? _____

10. What is your single most important reason for buying a Port Pass? (check one only)
    _____ It's more convenient because I don't have to carry cash or tokens
    _____ It's cheaper because I ride the bus so frequently
    _____ Other (specify)_____

11. How many automobiles (including light trucks and vans) are owned and operated by members of your household? _____ number of automobiles

12. Are you: _____ female _____male

13. In what year were you born? _____

14. What is the total annual income of your household?
    _____ less than $10,000
    _____ $10,000 to $19,999
    _____ $20,000 to $29,999
    _____ $30,000 and over

THANK YOU FOR RIDING THE DTA! If you have additional comments, please put them on the back of this form. Please return this form to the assistant at the front of the bus.

MAY WE ASK YOUR HELP IN ANSWERING A FEW QUESTIONS?

1. How did you pay your fare?
   _____ 50¢ cash
   _____ 50¢ adult token
   _____ 25¢ senior or handicapped token
   _____ 25¢ cash
   _____ student fare or pass
   _____ DTA employee pass

2. Does this trip begin or end at home?
   _____ yes, it begins at home
   _____ yes, it ends at home
   _____ no

3. What is the purpose of this trip?
   _____ going to or from work
   _____ going to or from school
   _____ going to or from shopping
   _____ going to or from a personal business or medical appointment
   _____ going to or from a social visit, eating, or recreation
   _____ other (specify)_____

4. Did you have access to an automobile for this trip?
   _____ yes, as driver
   _____ yes, as passenger
   _____ no

5. How many <u>days</u> last week did you take the bus <u>to</u> work? _____

6. How many <u>days</u> last week did you take the bus home from work? _____

7. What are your normal working hours? ____:____a.m./p.m. to ____:____a.m./p.m.
   _____ I am not regularly employed

8. In addition, how many <u>one-way bus trips</u> did you make last week for purposes other than going to or from work? _____ trips

9. How many automobiles (including light trucks and vans) are owned and operated by members of your household? _____ number of automobiles

10. Have you heard of the DTA monthly transit pass called the Port Pass?
    _____ no
    _____ yes - have you ever purchased one? _____ yes _____ no

11. Why didn't you purchase a Port Pass this month?
    _____ too expensive
    _____ too complicated
    _____ I don't ride the bus often enough
    _____ other (specify)_____

12. Are you: _____ female _____ male

13. In what year were you born? _____

14. What is the annual income of your household?
    _____ less than $10,000
    _____ $10,000 to $19,999
    _____ $20,000 to $29,999
    _____ $30,000 and over

THANK YOU FOR RIDING THE DTA! If you have additional comments, please put them on the back of this form. Please return this form to the assistant at the front of the bus.

THANK YOU for buying the Port Pass and for riding the DTA! You can help us to provide you with better service by completing this short questionnaire and returning it to us. You can drop the completed form off at the DTA Normandy Travel Center or mail it back in the enclosed postage-paid envelope. Thank you in advance for your help! 1 – 3

1. How many days each week do you ride the bus to work?
   _____ days per week

4

2. How many days each week do you ride the bus home from work? _____ days per week

5

3. Do you ever ride the bus for purposes other than going to or from work?

6, – 8

1 _____ yes - _____ times per week, or
_____ times per month
2 _____ no

4. Please indicate which Port Pass you purchased in each month listed below:

	All-Day Port Pass 1	Discount Port Pass 2	I Did Not Buy A Pass 3	9
November 1981				
October 1981				
September 1981				
August 1981				
July 1981				
June 1981				
May 1981				
April 1981				
March 1981				
February 1981				
January 1981				
December 1980				
November 1980				20

5. What was your most important reason for buying the Port Pass?

21

1 _____ The Port Pass is cheaper than cash or tokens.
2 _____ The Port Pass is more convenient to use than cash or tokens.
3 _____ Other (please specify _____)

6. Do you plan to continue buying a Port Pass each month?

22

1 _____ yes
2 _____ no - why? _____

7. Since you started buying the Port Pass, do you ride the bus more, less or the same ...

	More Often	Less Often	The Same	
to go to and from work?	1 ____	2 ____	3 ____	23 ___
to make other trips on weekdays?	____	____	____	___
to travel on weekends?	____	____	____	25 ___

8. Do you generally have a car available to get to and from work each day?

1 ____ yes, as a driver - ____ days per week
2 ____ yes, as a passenger - ____ days per week
3 ____ no

26 27 ___,___

9. What are your official working hours?

___:___a.m./p.m. to ___:___a.m./p.m.

28 ___ ___ ___ 31
32 ___ ___ ___ 35

10. What time do you usually leave home and arrive at work each day?

I leave home at ___:___a.m./p.m. and arrive at work at ___:___a.m./p.m.

36 ___ ___ ___ 39
40 ___ ___ ___ 43

11. What time do you usually leave work and arrive home each day?

I leave work at ___:___a.m./p.m. and arrive home at ___:___a.m./p.m.

44 ___ ___ ___ 47
48 ___ ___ ___ 51

12. Do you travel to and from work earlier or later than you did before you had a pass?

	Earlier	Later	Same Time	
I travel to work	1 ____	2 ____	3 ____	52 ___
I leave work	____	____	____	53 ___

13. What bus routes do you normally ride to and from work?

54 ___ 55 ___
56 ___ 57 ___
58 ___ 59 ___

_____

_____

14. What type of job do you have?

60 ___

1 ____ administrative/clerical
2 ____ professional/technical
3 ____ skilled/unskilled labor
4 ____ sales
5 ____ other (please specify _____)

15. How many persons are in your household, including yourself? _____ 61 62

16. How many licensed drivers are in your household, including yourself? _____ 63 64

17. How many full-time workers are in your household, including yourself? _____ 65 66

18. How many part-time workers are in your household, including yourself? _____ 67 68

19. How many children are in your household in the following age groups:

_____ less than 5 years old 69
_____ 5 to 13 years old
_____ 14 to 18 years old 71

20. In what year were you born? _____ 72 73

21. What is the total annual income of your household? 74

1 _____ less than $11,000
2 _____ $11,000 to $21,999
3 _____ $22,000 to $32,999
4 _____ $33,000 or over

22. Are you: 1 _____ male 2 _____ female 75

APPENDIX D. CALCULATIONS OF CHANGES IN TRANSIT RIDERSHIP PEAKING

This appendix provides a detailed explanation of the way in which changes in peaking attributable to the demonstration project were calculated. It is assumed that some of the change in peaking that occurred over the course of the demonstration resulted from fare increases external to the demonstration. Between 1980 and 1981, cash fares increased 25 percent and token fares increased by 14.3 percent (see Table 2-1). Weighting these fare increases by the proportion of riders using each payment method prior to the increase yields an estimate of the net fare increase. These calculations are shown for both peak and off-peak periods in Table D-1. The table also shows similar calculations for the fare change that took place between 1981 and 1982. Because limited data were available for the outbound p.m. peak, it was assumed that the method of payment distribution (and therefore the weighted average fare change) for outbound trips was a mirror image of the inbound distribution.

Using the fare increase data and making assumptions about peak and off-peak fare elasticities, it is possible to calculate the change in peaking of transit ridership that is attributable to the fare increases. Table D-2 illustrates these calculations for 1981 for three different levels of fare elasticity. Note that for any particular set of assumed elasticities, the resulting peaking factors are highly insensitive to errors in the fare change as calculated in Table D-1. Therefore, any sampling or measurement error in the distribution of method of payment is overwhelmed by the elasticity assumptions that are selected from Table D-2. Projected shifts in peaking for 1982 are calculated in an identical fashion and are shown in Table D-3. In the text of this report and in Table 3-5, the second set of estimates has been used to measure the impact of the demonstration on peaking. The effect of using different elasticity assumptions is to change the impact of the demonstration on peaking by ±0.4 percent or less in all cases. Of course, the results in Table 3-5 are subject to an assumption that the overall demand drop of 24.6 percent that occurred over the course of the demonstration did not by itself affect peaking of demand. This assumption is at best a fairly poor one; the shifts in peaking attributable to the external change in aggregate demand as a result of the economic downturn in Duluth may easily have overwhelmed the small changes that appear to result from the demonstration.

TABLE D-1. FARE INCREASES EXPERIENCED BY TIME OF DAY

1980-1981 Payment Method	Percent Using Payment Method in 1980	Change in Fare (1980-1981)	Net Fare Change (1980-1981)
Peak Inbound (n=713)			
Cash	27.6%	+25%	
Tokens	72.4%	+14.3%	+17.3%
All-Day Pass	---		
Discount Pass	---		
Other Inbound (n=479)			
Cash	54.9%	+25%	
Tokens	45.1%	+14.3%	+20.2%
All-Day Pass	---		
Discount Pass	---		

1981-1982 Payment Method	Percent Using Payment Method in 1981	Change in Fare (1981-1982)	Net Fare Change (1981-1982)
Peak Inbound (n=984)			
Cash	25.7%	0%	
Tokens	57.0%	+25%	+22.9%
All-Day Pass	7.0%	+42.9%	
Discount Pass	10.3%	+54.5%	
Other Inbound (n=675)			
Cash	50.8%	0%	
Tokens	43.3%	+25%	+13.9%
All-Day Pass	1.4%	+42.9%	
Discount Pass	4.5%	+54.5%	

SOURCE: Derived from On-Board Survey data.

TABLE D-2. PROJECTED SHIFTS IN PEAKING: 1980 TO 1981

	Base Number of Riders	Fare Change (%)	Forecast Number of Riders		
			Estimate #1*	Estimate #2**	Estimate #3+
Peak Half-Hour Inbound	1,053	+17.3%	1,017	1,017	1,035
Other Peak Inbound	1,475	+17.3%	1,424	1,424	1,449
Off-Peak Inbound	6,517	+20.2%	6,254	5,990	5,990
Peak Half-Hour Inbound Ridership as a Percentage of Total Inbound Ridership	11.6%		11.7%	12.1%	12.2%
Peak Half-Hour Outbound	825	+17.3%++	797	797	811
Other Peak Outbound	1,301	+17.3%	1,257	1,257	1,278
Off-Peak Outbound	5,549	+20.2%	5,325	5,100	5,100
Peak Half-Hour Outbound Ridership as a Percentage of Total Outbound Ridership	10.7%		10.8%	11.1%	11.3%

*Assuming peak and off-peak fare elasticities of -0.2.
**Assuming peak fare elasticity of -0.2, off-peak fare elasticity of -0.4.
+Assuming peak fare elasticity of -0.1, off-peak fare elasticity of -0.4.
++Because insufficient data are available on p.m. outbound peak method of payment, weighted average fare increases are assumed to be identical to the a.m. inbound peak.

SOURCE: Derived from Brown Sheet Survey data and Table D-1.

TABLE D-3. PROJECTED SHIFTS IN PEAKING: 1981 TO 1982

	Base Number of Riders	Fare Change (%)	Forecast Number of Riders Estimate #1*	Estimate #2**	Estimate #3+
Peak Half-Hour Inbound	977	+22.9%	932	932	955
Other Peak Inbound	1,241	+22.9%	1,184	1,184	1,213
Off-Peak Inbound	5,174	+13.9%	5,030	4,886	4,886
Peak Half-Hour Inbound Ridership as a Percentage of Total Inbound Ridership	13.2%		13.0%	13.3%	13.5%
Peak Half-Hour Outbound	659	+22.9%++	629	629	644
Other Peak Outbound	1,341	+22.9%	1,280	1,280	1,310
Off-Peak Outbound	4,844	+13.9%	4,709	4,575	4,575
Peak Half-Hour Outbound Ridership as a Percentage of Total Outbound Ridership	9.6%		9.5%	9.7%	9.9%

*Assuming peak and off-peak fare elasticities of -0.2.
**Assuming peak fare elasticity of -0.2, off-peak fare elasticity of -0.4.
+Assuming peak fare elasticity of -0.1, off-peak fare elasticity of -0.4.
++Because insufficient data are available on p.m. outbound peak method of payment, weighted average fare increases are assumed to be identical to the a.m. inbound peak.

SOURCE: Derived from Brown Sheet Survey data and Table D-1.

APPENDIX E. REPORT OF INVENTIONS

The work performed under this contract, while leading to no new inventions, has provided useful information and insights that can be used to develop, implement, and evaluate variable work hours and transit fare prepayment programs.

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