TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-91/27+484-13		

4. Title and Subtitle	5. Report Date
The Impacts of Carpool Utilization on the Katy Freeway Transitway, 54-Month "After" Evaluation	September 1990
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Diane L. Bullard	Research Report 484-13
9. Performing Organization Name and Address	10. Work Unit No.
Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135	11. Contract or Grant No. Study 2-10-85-484
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Texas State Department of Highways and Public Transportation Transportation Planning Division P.O. Box 5051 Austin, Texas 78763	Interim: September 1984 - September 1990
	14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with DOT, FHWA. Research Study Title: An Evaluation of the Impact of Permitting Carpools to Use the Katy Transitway

16. Abstract

Within the Houston metropolitan area, a major commitment has been made to develop a system of physically separated transitways in the medians of the existing freeway network. These lanes are reserved for the exclusive use of high-occupancy vehicles. Phase 1 of the first completed transitway opened on the Katy Freeway (I-10W) in October 1984. Initially, only authorized buses and vanpools were designated as eligible users of the transitway. To encourage increased vehicular utilization of the facility, carpools were allowed to use the transitway on a test basis beginning in April 1985. This research study, sponsored by the Metropolitan Transit Authority of Harris County and the Texas State Department of Highways and Public Transportation, was initiated in order to conduct a comprehensive analysis of the effects of permitting carpools to use the transitway. This report documents data collected in October 1989, 4.5 years after carpool utilization of the transitway began. This report compares the 1989 data to similar data collected before carpool utilization was permitted (March 1985) and after carpool utilization was permitted (April 1986, October 1987, October 1988). These comparisons address numerous concerns and provide an indication of the effectiveness of allowing carpools onto the transitway.

17. Key Words	18. Distribution Statement
High-Occupancy Vehicle Lanes, Transitways, Busways, Carpools, HOV Facilities, Authorized Vehicle Lanes	No restrictions; this report is available from: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif. (of the report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	82	

Form DOT F 1700.7 (8-69)

THE IMPACTS OF CARPOOL UTILIZATION ON THE KATY FREEWAY TRANSITWAY 54-MONTH "AFTER" EVALUATION

by

Diane L. Bullard
Associate Research Planner

Research Report 484-13

An Evaluation of the Impact of Permitting Carpools to Use the Katy Transitway

Research Study 2-10-85-484

Sponsored by the
Metropolitan Transit Authority of Harris County
and the
Texas State Department of Highways and Public Transportation

In Cooperation with the
U.S. Department of Transportation, Federal Highway Administration

Texas Transportation Institute
The Texas A&M University System
College Station, Texas 77843-3135

September 1990

METRIC (SI*) CONVERSION FACTORS

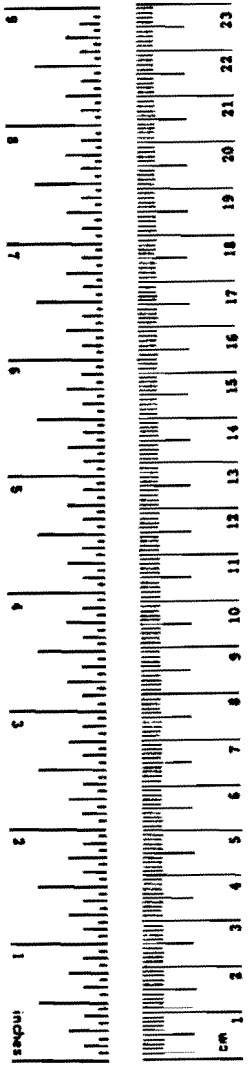
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	centimetres squared	cm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
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mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

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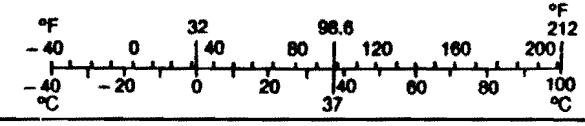

These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

ABSTRACT

Within the Houston metropolitan area, a major commitment has been made to develop a system of physically separated transitways in the medians of the existing freeway network. These lanes are reserved for the exclusive use of high-occupancy vehicles. Phase 1 of the first completed transitway opened on the Katy Freeway (I-10W) in October 1984. Initially, only authorized buses and vanpools were designated as eligible users of the transitway. To encourage increased vehicular utilization of the facility, carpools were allowed to use the transitway on a test basis beginning in April 1985. This research study, sponsored by the Metropolitan Transit Authority of Harris County and the Texas State Department of Highways and Public Transportation, was initiated in order to conduct a comprehensive analysis of the effects of permitting carpools to utilize the transitway. This report documents data collected in October 1989, 4.5 years after carpool utilization of the transitway began. This report compares the 1989 data to similar data collected before carpool utilization was permitted (March 1985) and after carpool utilization was permitted (April 1986, October 1987, October 1988). These comparisons address numerous concerns and provide an indication of the effectiveness of allowing carpools onto the transitway.

Key Words: High-Occupancy Vehicle Lanes, Transitways, Busways, Carpools, HOV Facilities, Authorized Vehicle Lanes

IMPLEMENTATION STATEMENT

Because there is relatively little experience with operating exclusive, reversible, high-occupancy vehicle lanes, many of the operating procedures and strategies being used in Houston are being developed through experience. A major issue that is currently being addressed is determination of the types of vehicles that will be permitted to use these special lanes (known locally as transitways).

This study was specifically undertaken to assist the Metropolitan Transit Authority of Harris County and the Texas State Department of Highways and Public Transportation in the implementation and operation of the transitways. This study, through analyses and comparisons of both "before" and "after" carpool data, assesses the impacts of permitting carpools to utilize the special high-occupancy vehicle lanes.

DISCLAIMER

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SUMMARY

In October 1984, the Katy Transitway was opened to authorized buses and vanpools. To encourage increased vehicular utilization of the facility, authorized 4+ carpools were allowed onto the facility in April 1985. Approximately 6 months later, authorized 3+ carpools were allowed to use the transitway. In August 1986, the occupancy requirement for vehicles was lowered to 2 persons and all authorization requirements were eliminated. By the fall of 1988, a.m. peak hour vehicle volumes on the transitway were approaching (or exceeding) capacity and were beginning to have a negative effect on the operation of the facility. As a result, in October 1988, the minimum occupancy requirement was raised to 3 persons between the hours of 6:45 a.m. and 8:15 a.m. (2-person carpools were still permitted on the lane during all other operating hours).

This report evaluates the impacts of allowing carpools to use the transitway. Data in the report cover the period from April 1985 through October 1989.

Trends in Transitway Utilization

In October 1989, over 7,900 persons used the Katy Transitway during the a.m. peak period; over 9,000 persons used the lane during the p.m. peak period. More than 18,000 persons were transported on the transitway daily; 67% of these persons were moved in carpools. Of those carpoolers, approximately 10% have been attracted from other transitway modes (buses or vans). Carpools comprise approximately 96% of the vehicles using the transitway.

In October 1989, 920 vehicles used the transitway during the a.m. peak hour; 1,266 vehicles traveled the facility during the p.m. peak hour. The p.m. peak hour value is very close to the capacity of the transitway, which is estimated to be approximately 1,500 vehicles per hour. Allowing carpools to use the lane has increased the frequency of transitway vehicle breakdowns; over 95% of the disabled vehicles on the transitway are carpools.

Criteria for Judging the Success of the Carpool Experiment

Prior to allowing carpools onto the transitway, both the Metropolitan Transit Authority of Harris County and the Texas State Department of Highways and Public Transportation agreed upon a set of criteria to use in evaluating the success of the carpool experiment. Each criterion is addressed in this report. Table 6 in the report outlines the criteria and the basis for that evaluation. Each criterion can be rated as "highly successful," "successful," "unsuccessful," or "highly unsuccessful." In the overall evaluation, the individual criterion are weighted, and a numerical value is assigned; "highly successful" is considered to be a 4, with "highly unsuccessful" considered to be a 1. Thus, a 2.5 overall rating would represent a neutral evaluation, midway between "unsuccessful" and "successful."

Data have been collected on 5 separate occasions (April 1986, April 1987, October 1987, October 1988 and October 1989) that permit analyses of the success of the carpool experiment. As carpool volumes have increased on the transitway, so has the success of the carpool experiment increased. In April 1986, the experiment was rated a 2.63 (between "successful" and "unsuccessful"); in April 1987 and October 1987, the experiment was rated a 3.2 and 3.3, respectively (between "successful" and "highly successful"). In October 1988, the experiment was rated a 2.9 (just below "successful"); and in October 1989 it was rated a 3.0 ("successful"). The data for these 5 analyses are summarized in Table S-1. More detailed data for the October 1989 analyses are shown in Table S-2.

The October 1988 42-month "after carpools" evaluation showed that the past success of the carpool experiment had increased the transitway travel times, thereby reducing the overall

Table S-1.
Overall Evaluation of the Katy Transitway Carpool Experiment, 1985-1989

Criterion	Relative Weighting	Conclusion Pertaining to Experiment				
		Apr 1986	Apr 1987	Oct 1987	Oct 1988	Oct 1989
1. Change in Person Movement on the Transitway Directly Attributable to Carpooling	25%	2.5	4	4	4	4
2. Nonuser Perception of Katy Transitway Utilization	30%	1	2	3	3	2
3. Change in Travel Time on the Transitway	20%	4	4	3	1	3
4. Change in Delay to Mixed-Flow Traffic	15%	4	4	4	4	4
5. Increase in Frequency of Transitway Breakdowns	5%	3	1	1	1	1
6. Increase in Authorization and Enforcement Costs	5%	3	3	3	3	3
TOTAL	100%	2.63	3.20	3.30	2.90	3.00

Scoring:
1 = "Highly Unsuccessful"; 2 = "Unsuccessful"; 3 = "Successful"; 4 = "Highly Successful"

Table S-2.
Overall Evaluation of the Katy Transitway Carpool Experiment,
54 Months After Carpools Were Allowed onto the Transitway

Criterion	Relative Weighting	Conclusion Pertaining to Experiment	Relevant Data
1. Change in Person Movement on the Transitway Directly Attributable to Carpooling	25%	"Highly Successful"	Carpools move 61% of the total a.m. peak period person movement and 67% of the total daily person movement.
2. Nonuser Perception of Katy Transitway Utilization	30%	"Unsuccessful"	Less than 40% of the nonusers feel the transitway is sufficiently utilized.
3. Change in Travel Time on the Transitway	20%	"Successful"	Average transitway speeds have decreased by 3 mph.
4. Change in Delay to Mixed-Flow Traffic	15%	"Highly Successful"	Mixed-flow speeds have increased slightly.
5. Increase in Frequency of Transitway Breakdowns	5%	"Highly Unsuccessful"	Approximately 95% of transitway vehicle breakdowns are carpools. Approximately 7 breakdowns occur per week.
6. Increase in Authorization and Enforcement Costs	5%	"Successful"	Marginal increase in costs due to carpools has not been substantial.
TOTAL	100%	"Successful"	

success of the facility. This travel time increase was a result of the vehicular volumes approaching or exceeding the capacity of lane, thereby reducing the travel speeds and trip reliability. The October 1989 54-month evaluation shows that implementing the 3+ carpool occupancy requirement during a portion of the a.m. peak period has lowered the volume of vehicles using the facility. This, in turn, has resulted in improved transitway travel speeds and trip reliability. Consequently, the overall effectiveness of the carpool experiment has also improved.

CHAPTER 1
INTRODUCTION

In an effort to maximize the person-carrying capacity of the major freeway corridors in Houston, an extensive system of high-occupancy vehicle (HOV) lanes is currently being developed in the medians of the city's existing freeway network. Known locally as transitways, the development of these facilities is a joint venture between the Metropolitan Transit Authority of Harris County (METRO) and the Texas State Department of Highways and Public Transportation (SDHPT). Approximately 96 miles of transitways will ultimately be constructed on six of the city's freeways. By the end of 1989, just over 36 miles of transitways on four separate freeways were operational. The intent of the Houston transitway system is to move more people through congested travel corridors in fewer vehicles. This is to be accomplished by offering riders in high-occupancy vehicles access to special, limited access lanes designed to provide both a travel time advantage and travel time reliability over traveling in the regular freeway lanes.

An area of vital importance to the success of the transitway project is the determination of the types of vehicles that will be permitted to use these special lanes. Initially, only authorized buses and 8+ passenger vanpools (truly high-occupancy vehicles) were envisioned to be eligible users of the transitway system. In order to become authorized, vanpools (and later carpools) had to have: 1) certified drivers; 2) valid Texas vehicle inspection stickers no more than six months old; 3) the minimum state insurance coverage; 4) some familiarity with the transitway geometrics before actually driving in the facility; 5) passed a visual inspection of the vehicle by METRO; and 6) valid transitway authorization decals displayed on windshields.

Consequently, when the first transitway opened in October 1984 on the Katy Freeway, its use was limited to authorized buses and 8+ vanpools. Under this operating strategy,

fewer than 150 vehicles per peak period traveled the transitway during its initial months of operation, giving the facility the appearance of being underutilized. To encourage increased utilization of the transitway, authorized 4+ carpools were allowed to begin using the lane on a test basis in April 1985. Although permitting carpools represented a means of increasing the volume of vehicles operating on the transitway, a number of operational concerns were associated with such an action. For example:

- Permitting carpools might simply attract commuters away from buses or vans, thereby moving no more people, but requiring many more vehicles;

- The introduction of carpools might result in vehicle volumes that exceed the capacity of the transitway, thereby adversely affecting the level-of-service that is so essential to successful transitway operation;

- If carpool volumes were restricted sufficiently to maintain a high level-of-service on the transitway, the increase in the number of vehicles using the facility might not be great enough to change the perception that the transitway is underutilized;

- Increased carpool volumes might result in an increase in vehicle breakdowns, thereby reducing the travel time reliability attribute of the transitway; and

- Other safety related concerns might develop.

Because the Katy Transitway was the first of several transitways being implemented in Houston, and the first to permit carpool use, a special study was sponsored by both METRO and the SDHPT to assess the impacts associated with allowing carpools to use the transitway.

As part of this assessment, major data collection efforts have been undertaken on several occasions. The first data collection effort was conducted in March 1985 *before* carpools were allowed to use the transitway. Data were also collected on four separate

occasions *after* the introduction of carpools onto the transitway. Specifically, "after carpools" data were collected in:

- April-July 1986 (approximately one year after carpools were permitted);
- October 1987 (2.5 years after carpools began using the transitway);
- October 1988 (3.5 years after carpools were allowed); and
- October 1989 (4.5 years following the introduction of carpools to the transitway).

In this report, the information collected has been combined and evaluated to identify the effects of the presence of carpools on the operation of the Katy Transitway and Katy Freeway, 54 months (4.5 years) after carpools were first allowed onto the transitway. This study addresses the period from October 29, 1984 through October 13, 1989.

When opened in October 1984, the Katy Transitway extended from Post Oak to Gessner, a distance of 4.7 miles. By October 1989, (following two expansions to the west), the transitway extended from Post Oak to State Highway 6, a total of 11.5 miles. A map of the Katy Transitway (as of October 1989) is shown in Figure 1.

Types of Data Collected

Several different types of data were collected to assist in evaluating the impacts of carpool usage on transitway/freeway operations. TTI has conducted periodic volume counts on the Katy Freeway at Bunker Hill since June 1983 and at Eldridge since September 1985. These manual counts classify vehicles according to type and occupancy and are the source of all vehicular volumes and occupancies used in this report. TTI has also conducted travel time studies on both the Katy Freeway and the Katy Transitway from the transitway's western terminus to the Southern Pacific Railroad (S.P.R.R.) overpass near Washington Avenue. These are used to compare speeds and travel times along the corridor.

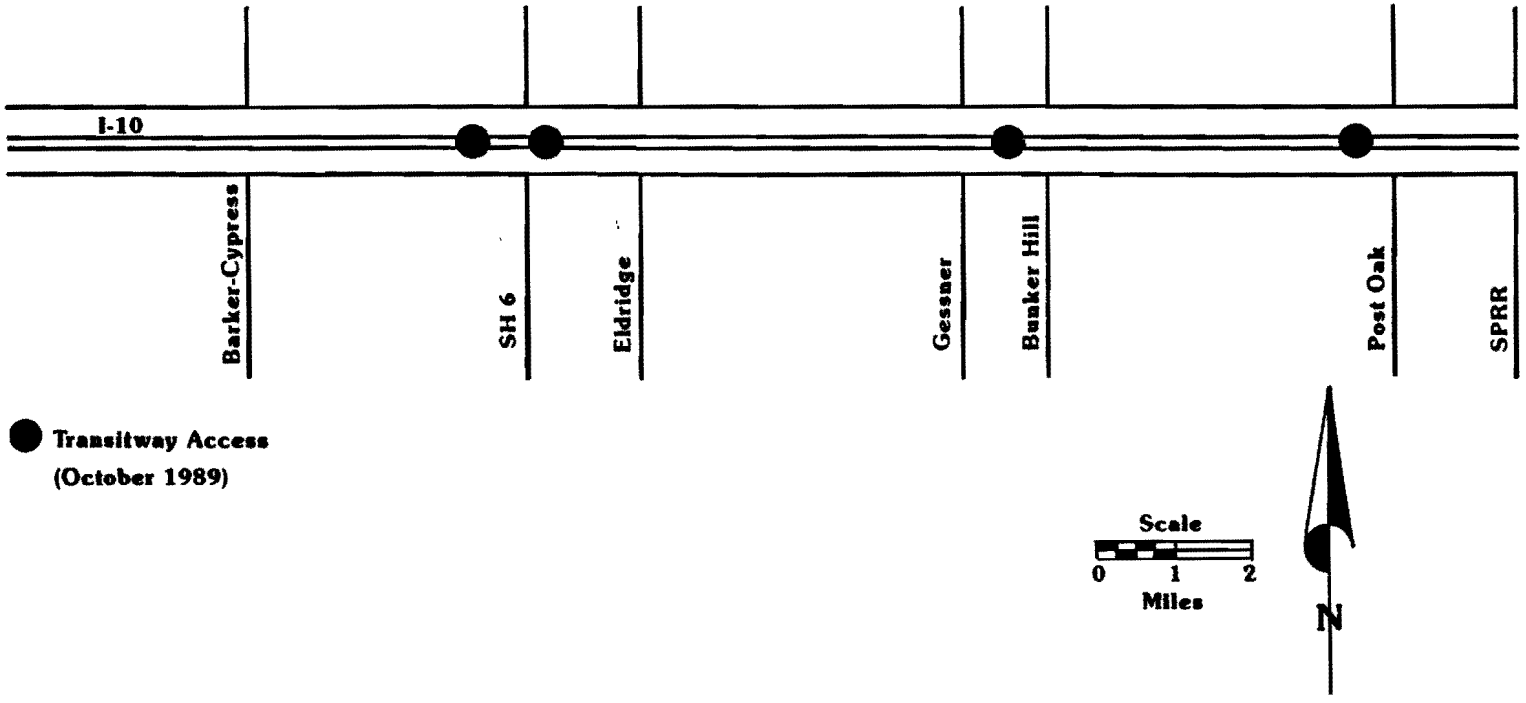


Figure 1. Katy Transitway Corridor

The accident data for the Katy Freeway mainlanes are obtained from the Department of Public Safety, and selected data concerning transitway operations (vehicle breakdowns, violations, etc.) are obtained from METRO.

Previous Research Reports

A number of TTI research reports have addressed carpool utilization of the Katy Transitway (1-14). This report is the thirteenth research report prepared as part of this study. No attempt is made in this report to include all the relevant material presented in the previous reports. Some pertinent data from previous reports are used in this report to draw conclusions concerning the impacts of allowing carpools onto the transitway.

Organization of This Report

Following this introductory chapter, Chapter 2 describes trends in utilization of the Katy Transitway. Chapter 3 restates the criteria to be used in evaluating the "success" of the transitway carpool experiment. Each criterion is addressed individually in Chapters 4 through 9. Conclusions are presented in Chapter 10.

CHAPTER 2
KATY TRANSITWAY UTILIZATION

The Katy Transitway began initial operation on October 29, 1984. Since that date, the transitway has experienced a number of modifications in its geometrics and operations. Significant modifications include those which have affected the transitway length, the types of vehicles permitted to use the facility, and the hours of operation. Table 1 outlines the historical development of the transitway.

Background on the Katy Transitway Carpool Utilization

As stated previously, only authorized buses and 8+ passenger vanpools were allowed to use the Katy Transitway during the first 5 months of operation (October 1984 through March 1985). Although this operating strategy offered the potential to move large numbers of persons, it did not result in moving large volumes of vehicles, and the public developed a perception that the transitway was underutilized. In an effort to address this perception problem, METRO and the SDHPT agreed to permit carpools to use the transitway on a trial basis. Beginning April 1, 1985, authorized automobiles carrying four or more persons could access the lane. The authorization procedures for carpools were identical to those described in Chapter 1 for vanpools. If an authorized carpool had fewer than four persons an any given day due to a carpool member's work schedule, travel, illness or vacation, it was not permitted onto the transitway that day. This carpool definition was structured to ensure maximum passenger occupancy of vehicles traveling on the transitway. Another factor contributing to the 4+ occupancy requirement was a concern that a 3+ carpool designation could possibly generate a sufficient vehicular volume to exceed the capacity of the transitway, creating unacceptable operating conditions.

Table 1.
Katy Transitway Milestone Dates
(October 1984 - October 1989)

Date	Operational Length	Vehicles and Occupancy Requirements to Use Transitway	Operating Hours
10/29/84	Transitway opened from Post Oak to Gessner (4.7 miles)	Authorized buses and 8+ vanpools	M-F: 5:45 a.m. - 9:30 a.m. inbound; 3:30 p.m. - 7:00 p.m. outbound
4/1/85	Same	Authorized buses, vanpools and 4+ carpools; 4+ for authorization and use	Same
5/2/85	Transitway extended from Gessner to West Belt (total length - 6.4 miles)	Same	Same
7/29/85	Same	Authorized buses, vanpools and 4+ carpools; 4+ for authorization and 3+ for use	Same
11/4/85[1]	Same	Authorized buses, vanpools and 3+ carpools; 3+ for authorization and use	Same
8/11/86	Same	All 2+ vehicles; no authorization requirements	M-F: 5:45 a.m. - 11:00 a.m. inbound; 2:00 p.m. - 7:00 p.m. outbound
6/29/87	Transitway extended from West Belt to SH 6 (total length - 11.5 miles)	Same	M-F: 5:45 a.m. - 11:00 a.m. inbound; 2:00 p.m. - 8:00 p.m. outbound
7/25/88	Same	Same	M-F: 4:00 a.m. - 1:00 p.m. inbound; 2:00 p.m. - 10:00 p.m. outbound
10/17/88	Same	All 3+ vehicles, no authorization between 6:45 a.m. and 8:15 a.m. weekdays; 2+ vehicles all other operating hours	Same
10/1/89	Same	Same	M-F: 4:00 a.m. - 1:00 p.m. inbound; 2:00 p.m. - 10:00 p.m. outbound Sat: 4:00 a.m. - 10:00 p.m. outbound Sun: 4:00 a.m. - 10:00 p.m. inbound

[1] *Official date of 3+ authorization; actual 3+ authorization began in 9/85.*

Access locations:

Post Oak - flyover ramp (used from 10/29/84 to present).
Gessner - intermediate slip ramp (used from 10/29/94 to present).
West Belt - terminal slip ramp (used from 5/2/85 to 6/29/87).
Addicks Park-and-Ride - elevated "T" ramp (used from 6/29/87 to present).
SH 6 - terminal slip ramp (used from 6/29/87 to present).

During the first month the Katy Transitway was open to carpools, approximately 30 carpools became authorized to use the facility. However, of these 30 carpools, an average of only 5 carpools actually used the lane during a typical peak period. Although the number of carpools observed using the transitway doubled between April and July 1985, the absolute demand levels remained extremely low. Consequently, effective July 29, 1985, carpools with a minimum of three passengers were permitted access to the transitway; four or more registered passengers were still required to obtain authorization, however. Less than a month after the carpool occupancy requirements were reduced, only nine more carpool trips were being made on the transitway each day.

As a result, a decision was made to reduce the minimum authorization requirement from four persons to three persons. Officially, the authorization of 3+ carpools was not to commence until November 4, 1985. However, as early as September 1985, 3+ carpools were being authorized by METRO and permitted on the transitway. Even with the 3+ designation, however, peak-hour carpool volumes remained less than 100 vehicles per hour and the perception of underutilization remained. Consequently, in August 1986, the minimum passenger requirement for eligible vehicles was lowered to 2 persons and all authorization requirements were eliminated. Following this change, there was an immediate increase in carpool volumes. Carpool volumes continued to climb in 1987 and 1988.

By the fall of 1988, traffic volumes on the transitway during the a.m. peak hour (7:00 a.m. - 8:00 a.m.) increased to levels exceeding 1500 vehicles per hour, normally assumed to the capacity of the facility. This dramatic increase was beginning to have a negative effect on the facility's a.m. inbound operation (lower travel speeds, increased travel times and unreliable travel times). To relieve this peak-hour congestion, the minimum carpool occupancy requirement was raised from 2 to 3 persons between 6:45 a.m. and 8:15 a.m. effective October 17, 1988; 2 person carpools were still permitted on the facility in the mornings before 6:45 a.m. or after 8:15 a.m. and during the entire p.m. operating period.

Trends in Katy Transitway Utilization

Trends in average peak-period utilization of the Katy Transitway are illustrated in Figures 2 through 5. In October 1989, on a daily basis (approximately one year after the a.m. 3+ carpool restriction was implemented), buses accounted for 3% of the vehicles using the transitway and moved 30% of the people (buses had moved 26% of the people in October 1988 just before the 3+ restriction was implemented). In October 1989, vanpools represented 1% of the vehicles on the transitway and carried 3% of the people (unchanged from October 1988), and carpools comprised 96% of the total transitway vehicles and moved 67% of the people (down from 71% in October 1988). Thus, carpools became (and have continued to remain) the dominant mode of transitway person movement since unauthorized 2+ vehicles were allowed to use the transitway.

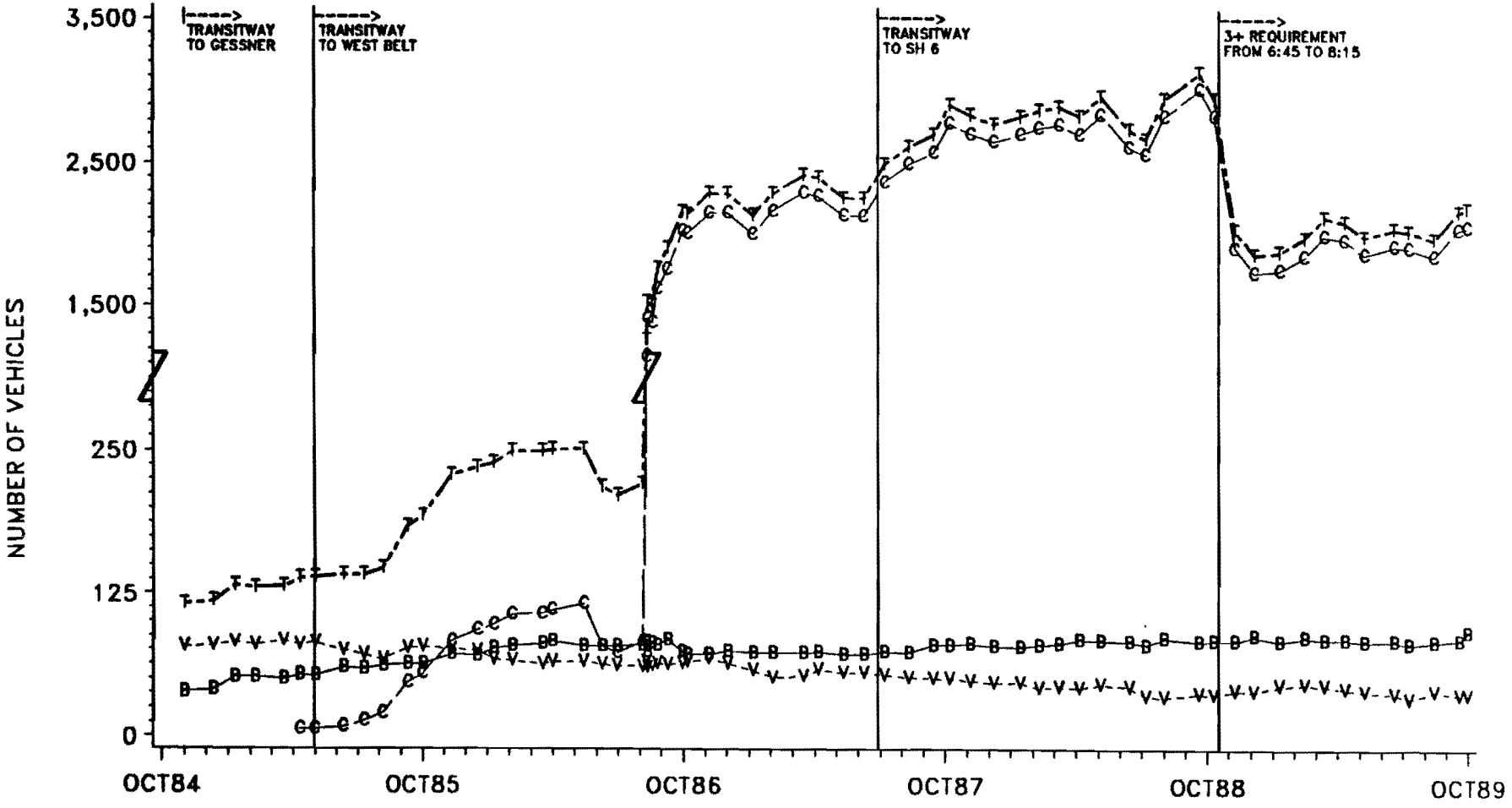
Data pertaining to daily transitway utilization by mode are summarized in Table 2 below.

Table 2.
Trends in Daily Utilization of the Katy Transitway

Transitway Vehicle Type	Volume						Percent Change	
	11/84[1]	3/85[2]	4/86[3]	10/87[4]	10/88[5]	10/89	3/85 to 10/89	10/88 to 10/89
Buses								
Vehicles	78	100	160	156	166	171	+71%	+3%
Passengers	2,860	3,450	4,302	4,685	4,830	5,505	+60%	+14%
Vanpools								
Vehicles	160	170	140	112	79	82	-52%	+4%
Passengers	1,304	1,596	1,180	942	623	653	-59%	+5%
Carpools								
Vehicles	0	0	204	5,466	6,227	5,579	—	-10%
Passengers	0	0	706	11,716	13,042	12,393	—	-5%
Total								
Vehicles	238	270	504	5,734	6,472	5,832	+2060%	+10%
Passengers	4,164	5,046	6,188	17,343	18,495	18,551	+268%	< +1%

[1] *First full month of transitway operation.*
[2] *Month before carpools were allowed onto the transitway.*
[3] *Data from 12-month evaluation report (TTI Research Report 484-3).*
[4] *Data from 30-month evaluation report (TTI Research Report 484-7).*
[5] *Data from 42-month evaluation report (TTI Research Report 484-11).*

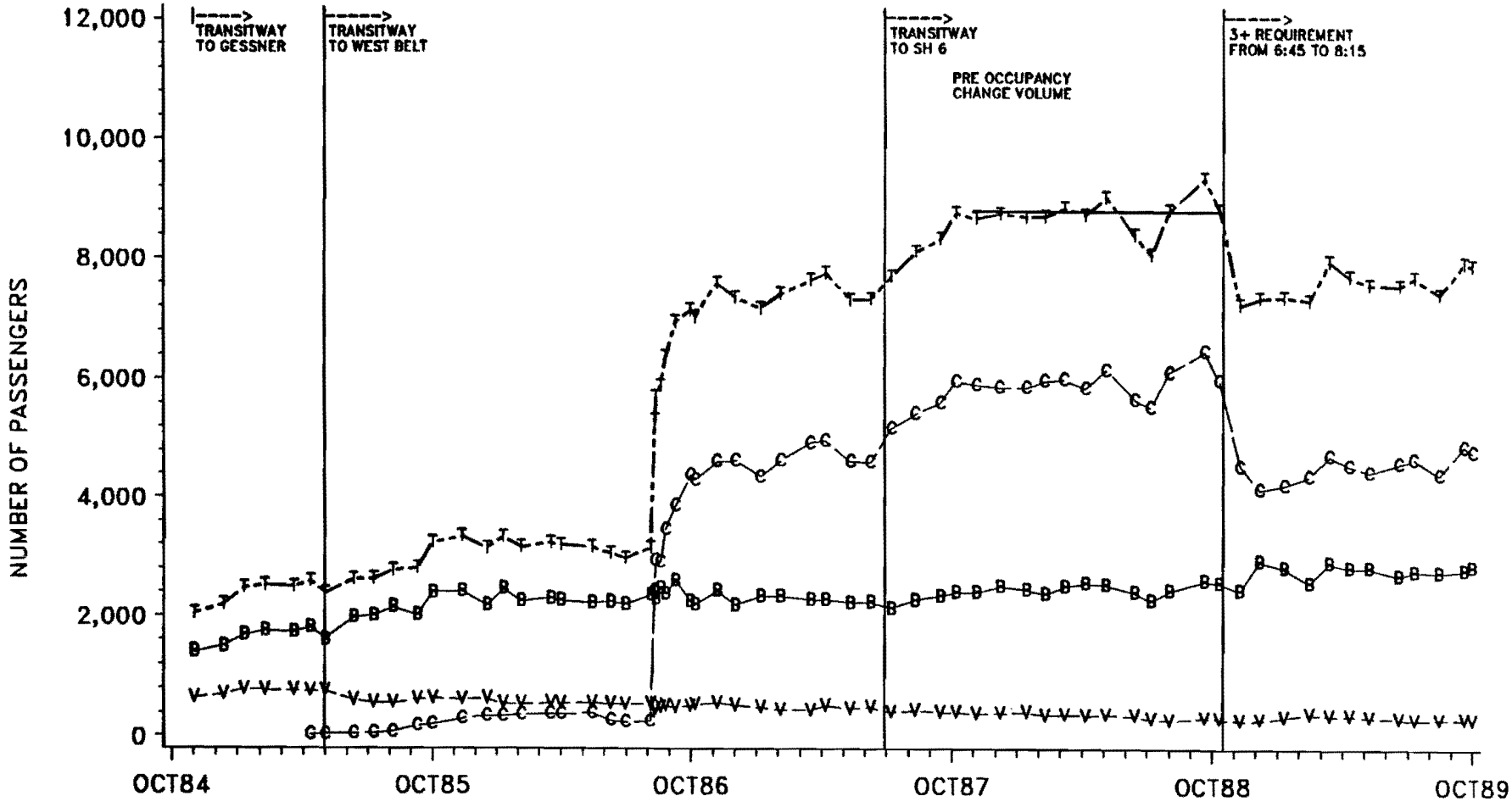
Source: Texas Transportation Institute counts.



KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984
TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985
OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986
TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29,1987
3+ CARPOOL REQUIREMENT FROM 6:45 TO 8:15 A.M. IMPLEMENTED OCTOBER 17, 1988
TRANSITWAY EASTERN EXTENSION (1.17 MI.) OPENED JANUARY 9, 1990
PEAK PERIOD IS 6:00 – 9:30 A.M.
DATA COLLECTED BETWEEN GESSNER AND POST OAK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL HOV VEHICLES
B = TOTAL BUSES
V = TOTAL VANPOOLS
C = TOTAL CARPOOLS

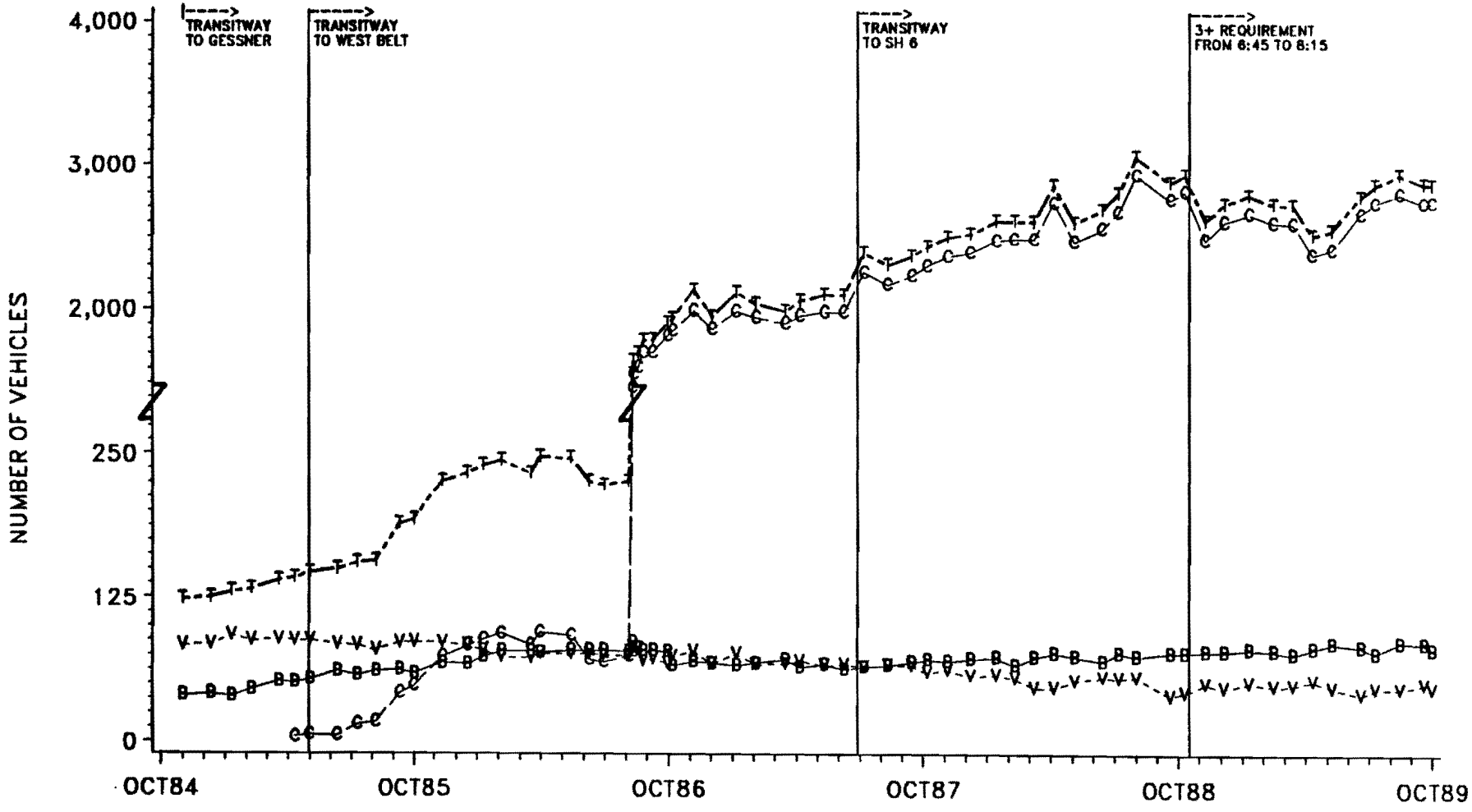
Figure 2. A.M. Peak Period Katy Transitway Vehicle Utilization



KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984
TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985
OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986
TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29,1987
3+ CARPOOL REQUIREMENT FROM 6:45 TO 8:15 A.M. IMPLEMENTED OCTOBER 17, 1988
TRANSITWAY EASTERN EXTENSION (1.17 MI.) OPENED JANUARY 9, 1990
PEAK PERIOD IS 6:00 – 9:30 A.M.
DATA COLLECTED BETWEEN GESSNER AND POST OAK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL HOV PASSENGERS
B = TOTAL BUS PASSENGERS
V = TOTAL VANPOOLERS
C = TOTAL CARPOOLERS

Figure 3. A.M. Peak Period Katy Transitway Person Movement



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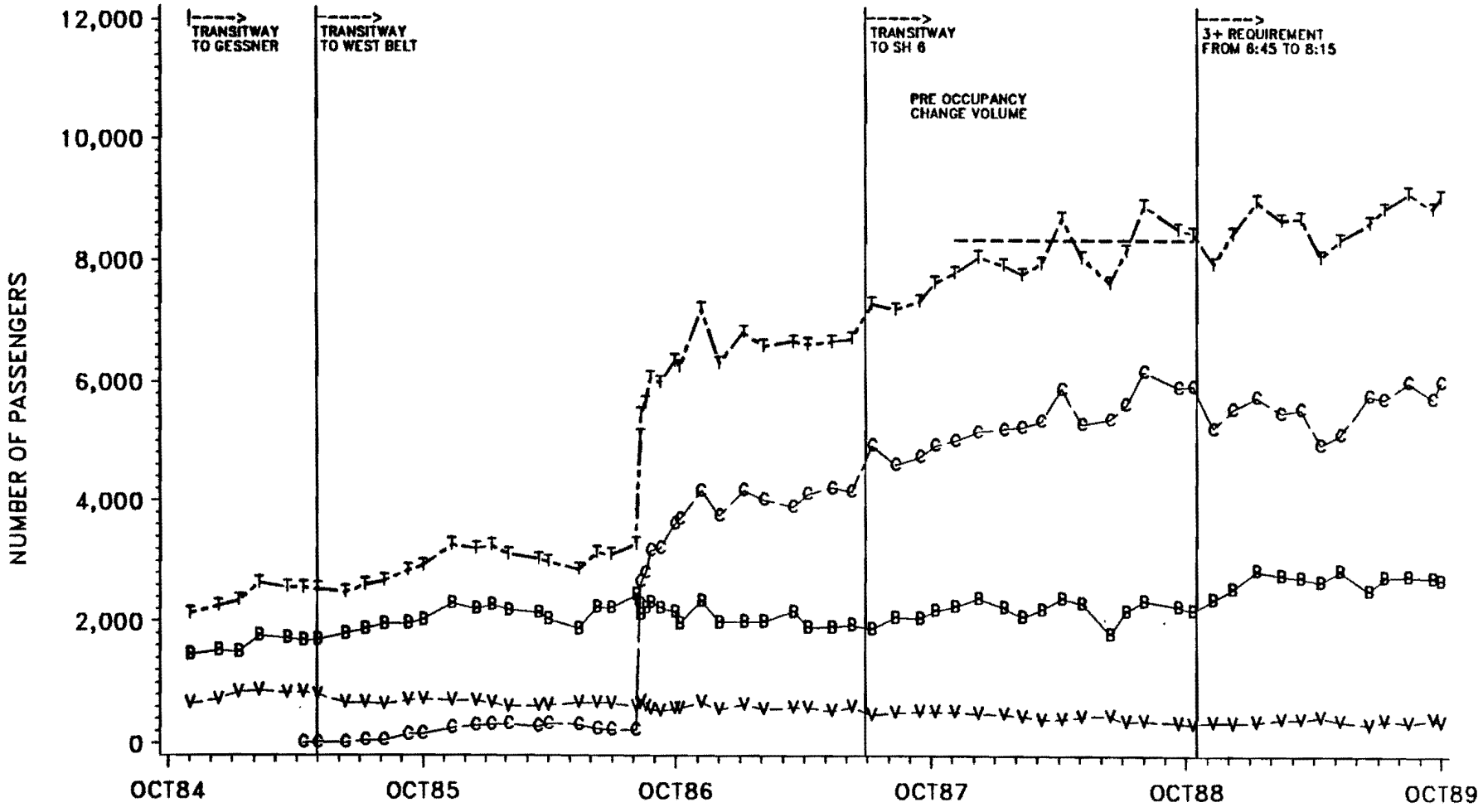
PEAK PERIOD IS 3:30 – 7:00 P.M.
DATA COLLECTED BETWEEN GESSNER AND POST OAK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL HOV VEHICLES
B = TOTAL BUSES
V = TOTAL VANPOOLS
C = TOTAL CARPOOLS

Figure 4. P.M. Peak Period Katy Transitway Vehicle Utilization



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PEAK PERIOD IS 3:30 – 7:00 P.M.
DATA COLLECTED BETWEEN GESSNER AND POST OAK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL HOV PASSENGERS
B = TOTAL BUS PASSENGERS
V = TOTAL VANPOOLERS
C = TOTAL CARPOOLERS

Figure 5. P.M. Peak Period Katy Transitway Person Movement

Since carpools were introduced to the transitway, bus passenger volumes have increased by 40% and vanpool passenger volumes have decreased by 59%. The vanpool decline appears to be more a function of the downturn in the Houston economy than it is the introduction of carpools; this conclusion is supported subsequently where the previous mode of travel is documented for transitway carpoolers.

An overall assessment of trend data in the Katy corridor is shown in Table 3. This table compares conditions in the corridor prior to implementation of the transitway (1984) with conditions in the corridor during 1987, 1988 and 1989. As noted in this table, the transitway has been successful in increasing the total person throughput and average vehicle occupancy even with the a.m. 3+ occupancy restriction.

Carpool Data, Katy Transitway and Selected Other HOV Projects

Trends in peak hour and peak period carpool utilization are shown in Figures 6 and 7. As to be expected, a.m. carpool utilization of the transitway dropped immediately following the implementation of the 3+ occupancy requirement between 6:45 a.m. and 8:15 a.m. (October 17, 1988). Afternoon carpool demand has also declined somewhat since the 3+ occupancy requirement went into effect. This would suggest that some commuters (formerly traveling in 2-person carpools) are no longer carpooling since they cannot use the transitway in both the morning and afternoon. Other 2-person carpools appear to be using the transitway in the afternoons only, as evidenced by the comparatively high afternoon carpool demand.

As illustrated in Figure 8, since the time 2+ carpools were permitted to use the transitway, carpools have consistently represented approximately 95% of the total vehicular volume and between 55% and 70% of the total transitway person volume.

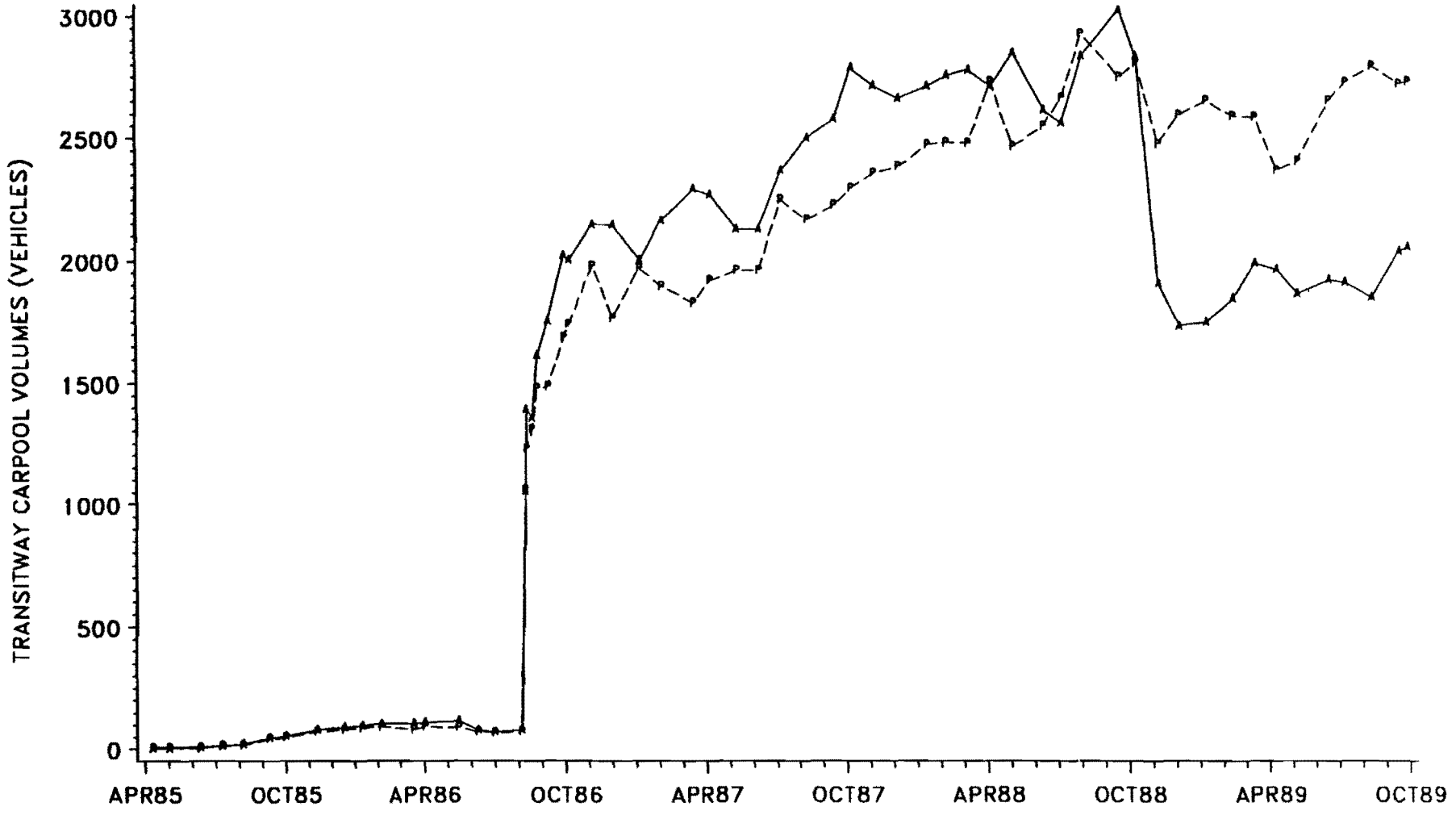
Table 3.
Comparison of Travel Conditions in the Katy Freeway Corridor Prior to Transitway Implementation and in 1987, 1988 and 1989, A.M. Peak Period, Peak Direction

Type of Data	"Representative Value"			
	1981[1]	1987[2]	1988[3]	1989[4]
Transitway Data				
Person Movement				
Peak Hour	—	4,252	4,569	3,316
Peak Period	—	8,369	9,341	7,523
Total Daily	—	16,737	19,078	18,352
Vehicle Volumes				
Peak Hour	—	1,364	1,531	950
Peak Period	—	2,719	3,146	2,155
Accident Rate (Accidents/MVM)	—	0.96	1.06	1.12
Vehicle Breakdowns (VMT/Breakdown)	—	29,000	37,570	34,253
Violation Rate	—	1%	1%	14%
Combined Freeway and Transitway Data				
Person Movement				
Peak Hour	5,100	9,183	8,566	9,446
Peak Period	15,655	23,442	25,102	26,803
Peak-Hour Vehicle Occupancy	1.26	2.55	1.60	1.46
Peak-Period Vehicle Occupancy	1.23	1.38	1.40	1.35
Peak-Period Carpool Vehicle Volume	1,570	3,300	3,541	2,968
Total Peak-Period Vehicle Volume	12,750	16,941	17,985	19,815
Freeway Data				
Peak-Period Freeway Vehicle Volume	12,750	14,222	14,839	17,660
Peak-Period Freeway Person Volume	15,655	15,073	15,761	19,280
Peak-Period Freeway Vehicle Occupancy	1.23	1.06	1.06	1.11
Peak-Period Operating Speed in mph (West Belt to Wirt)	27	27	22	32
Accident Rate (Accidents/MVM)	1.34	1.34	1.22	1.34
Transit Data				
Vehicles Parked in Park-and-Ride Lots	575	1,250	1,530	1,873
Peak-Period Bus Trips	32	90	82	84
Peak-Period Bus Passengers	900	2,400	2,585	2,645

[1] *Represents typical pre-transitway conditions.*
[2] *Represents typical transitway conditions during 2+ carpool operation.*
[3] *Represents typical transitway conditions prior to morning 3+ carpool restriction, September 1988.*
[4] *Represents typical transitway conditions approximately one year after morning 3+ carpool restriction, fall 1989.*

Note: Peak Hour - 7:00 a.m. to 8:00 a.m.
Peak Period - 6:00 a.m. to 9:30 a.m.
MVM = Million Vehicle Miles
VMT = Vehicle Miles Traveled

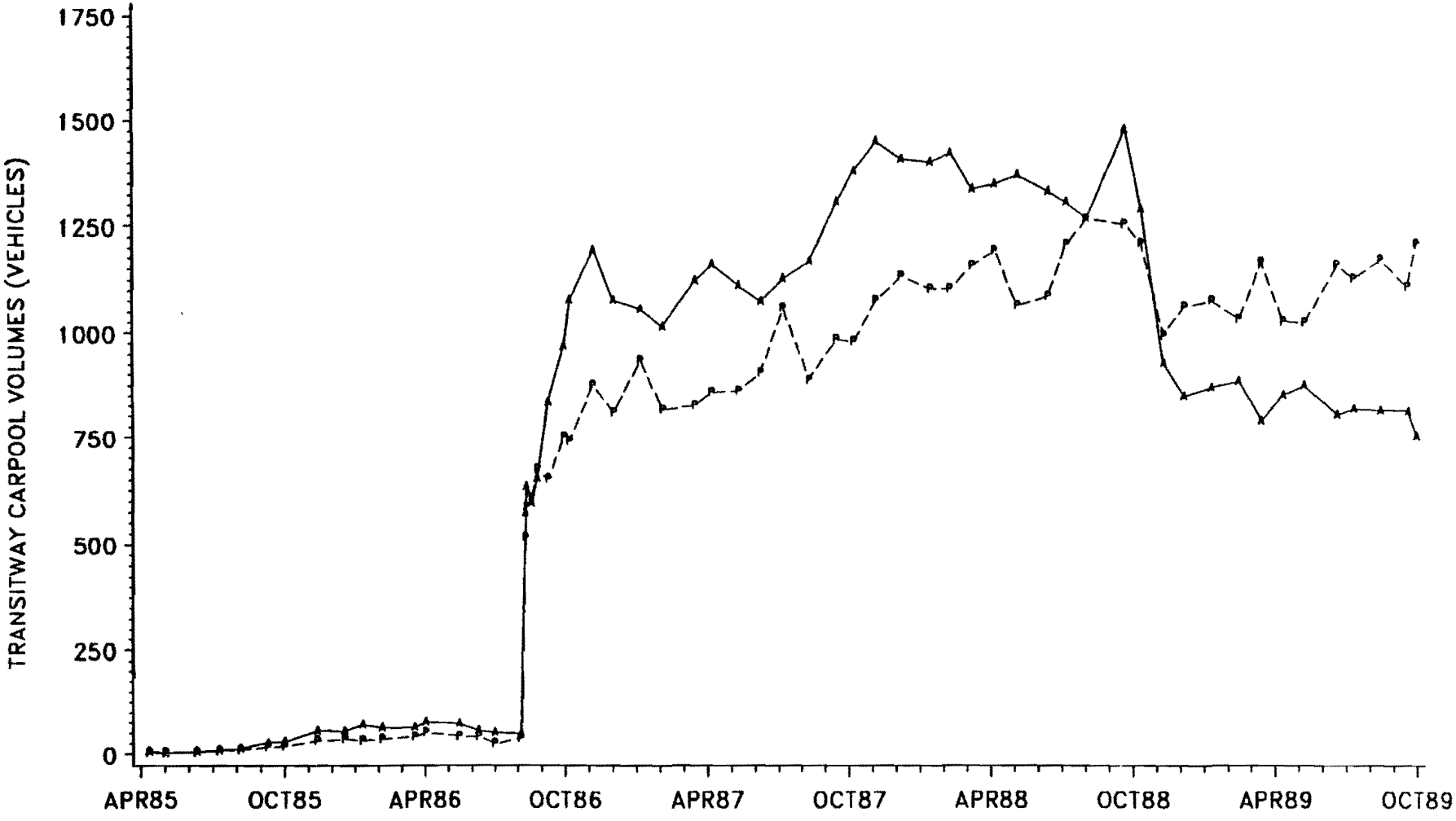
Source: Texas Transportation Institute data collection.



AUTHORIZED 4+ CARPOOLS ALLOWED ON TRANSITWAY, APRIL 1, 1985
AUTHORIZED 3+ CARPOOLS ALLOWED ON TRANSITWAY, SEPTEMBER, 1985
2+ CARPOOLS WITH NO AUTHORIZATION ALLOWED ON TRANSITWAY, AUGUST 1986
3+ CARPOOL REQUIREMENT FROM 6:45 TO 8:15 A.M. IMPLEMENTED OCTOBER 17, 1988
DATA COLLECTED BETWEEN GESSNER AND POST OAK
PEAK PERIOD(S) ARE 6:00–9:30 A.M. & 3:30–7:00 P.M.
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : A = A.M. PEAK PERIOD
P = P.M. PEAK PERIOD

Figure 6. Peak Period Katy Transitway Carpool Utilization



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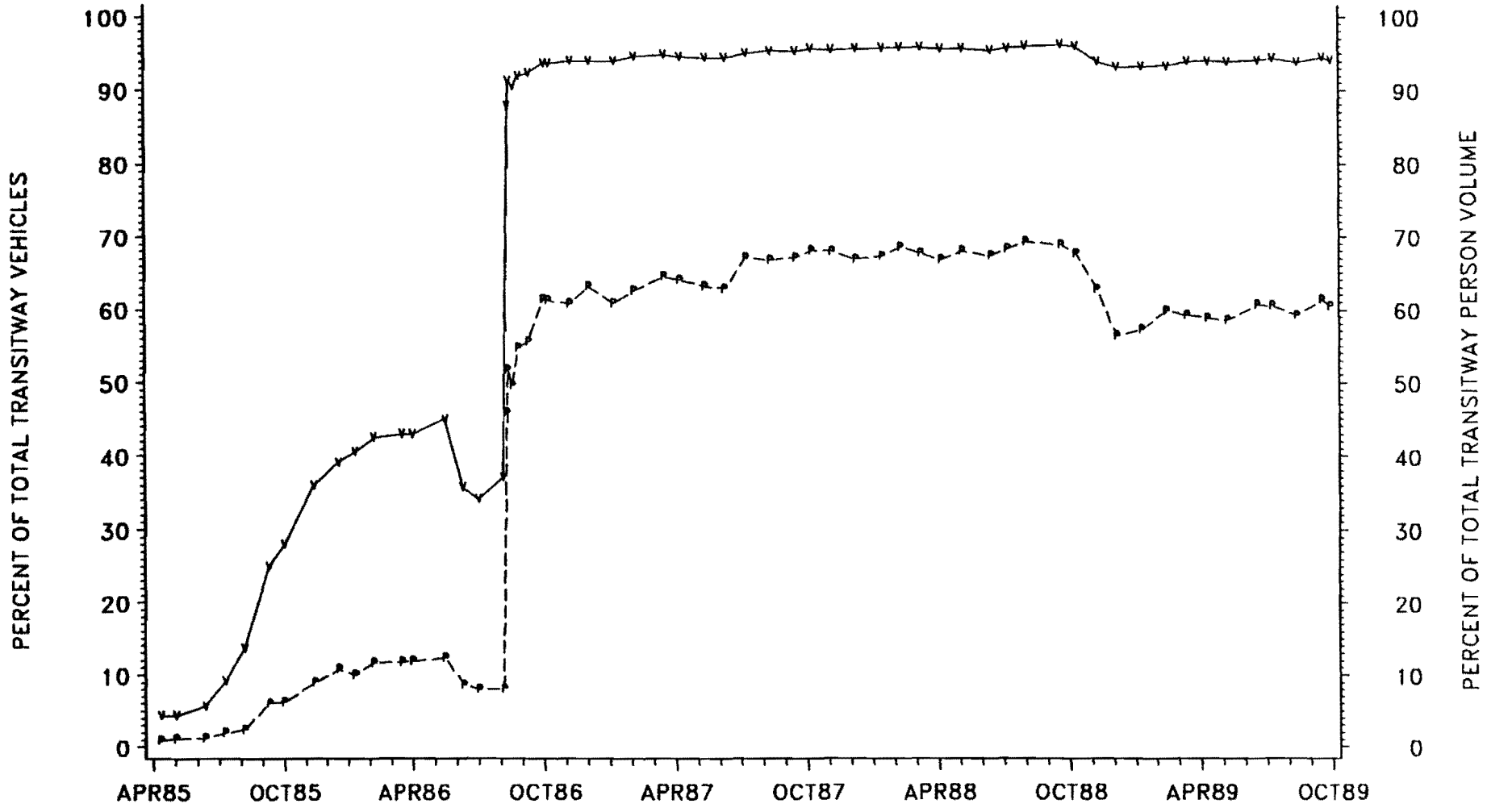
DATA COLLECTED BETWEEN GESSNER AND POST OAK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : A = A.M. PEAK HOUR
P = P.M. PEAK HOUR

Figure 7. Peak Hour Katy Transitway Carpool Utilization



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3+ CARPOOL REQUIREMENT FROM 6:45 TO 8:15 A.M. IMPLEMENTED OCTOBER 17, 1988
DATA COLLECTED BETWEEN GESSNER AND POST OAK 6:00 TO 9:30 A.M.
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : V = TOTAL VEHICLES
P = TOTAL PERSONS

Figure 8. Katy Transitway Carpools as a Percent of Total Transitway Travel, A.M. Peak Period

Peak-Hour Carpool Volumes

Peak-hour carpool volumes for selected freeway HOV lanes in the United States are presented in Table 4. The Katy Transitway, at approximately 1,200 carpools during the p.m. peak hour, is presently one of the better used single-lane HOV facilities.

Table 4.
Carpool Vehicle Volumes on Freeway High Occupancy Vehicle Lanes

HOV Facility	Definition	A.M. Peak Hour Carpool Volume (vph)[1]
Katy Transitway, Houston, TX	2+/3+[2]	a.m. - 862[3] p.m. - 1,214[3]
Shirley (I-395), Washington, D.C. (2 lanes)	3+	2,314
Route 91, Los Angeles, CA	2+	1,294
I-95, Miami, FL	2+	1,300
Route 55, Orange County, CA	2+	1,295
El Monte, Los Angeles, CA	3+	905
I-4 Orlando, FL	2+	900
I-495, Lincoln Tunnel, New York City, NY	buses only	725 buses
I-66, Washington, D.C. (2 lanes)	3+	618
I-5 Seattle, WA	2+/3+[4]	466
US 101, San Francisco, CA	2+	376
SR 520, Seattle WA	3+	210

[1] Includes autos in HOV lane in violation of HOV occupancy requirements.
[2] 3+ between 6:45 a.m. and 8:15 a.m. weekdays; 2+ during all other operating hours.
[3] October 1989 carpool volumes.
[4] Different segments of the I-5 HOV lane have different occupancy requirements.
Source: TTI Analyses, TTI Research Report 925-1, "A Description of High-Occupancy Vehicle Facilities in North America," and 1985 survey of HOV projects.

The high peak hour volumes experienced on some HOV lanes have made it necessary to determine an appropriate capacity level. A consensus of the agencies involved in operating freeway HOV lanes is that the capacity of these lanes is somewhere in the range of 1,000 to 1,500 vehicles per hour per lane (TTI Research Report 484-3). As evaluated in TTI Research Report 484-6, it appears that 1,500 vehicles per hour is representative of the capacity of the Katy Transitway.

By the fall of 1988, a.m. peak-hour transitway volumes were approaching and sometimes exceeding 1,500 vehicles per hour, resulting in lower transitway travel speeds, increased travel times and unreliable travel times. Consequently, the morning 3+ occupancy requirements was implemented, and vehicular demand has been reduced to a level of below capacity. Detailed analysis of the impacts of this change are presented in TTI Research Reports 1146-1 and 1146-2.

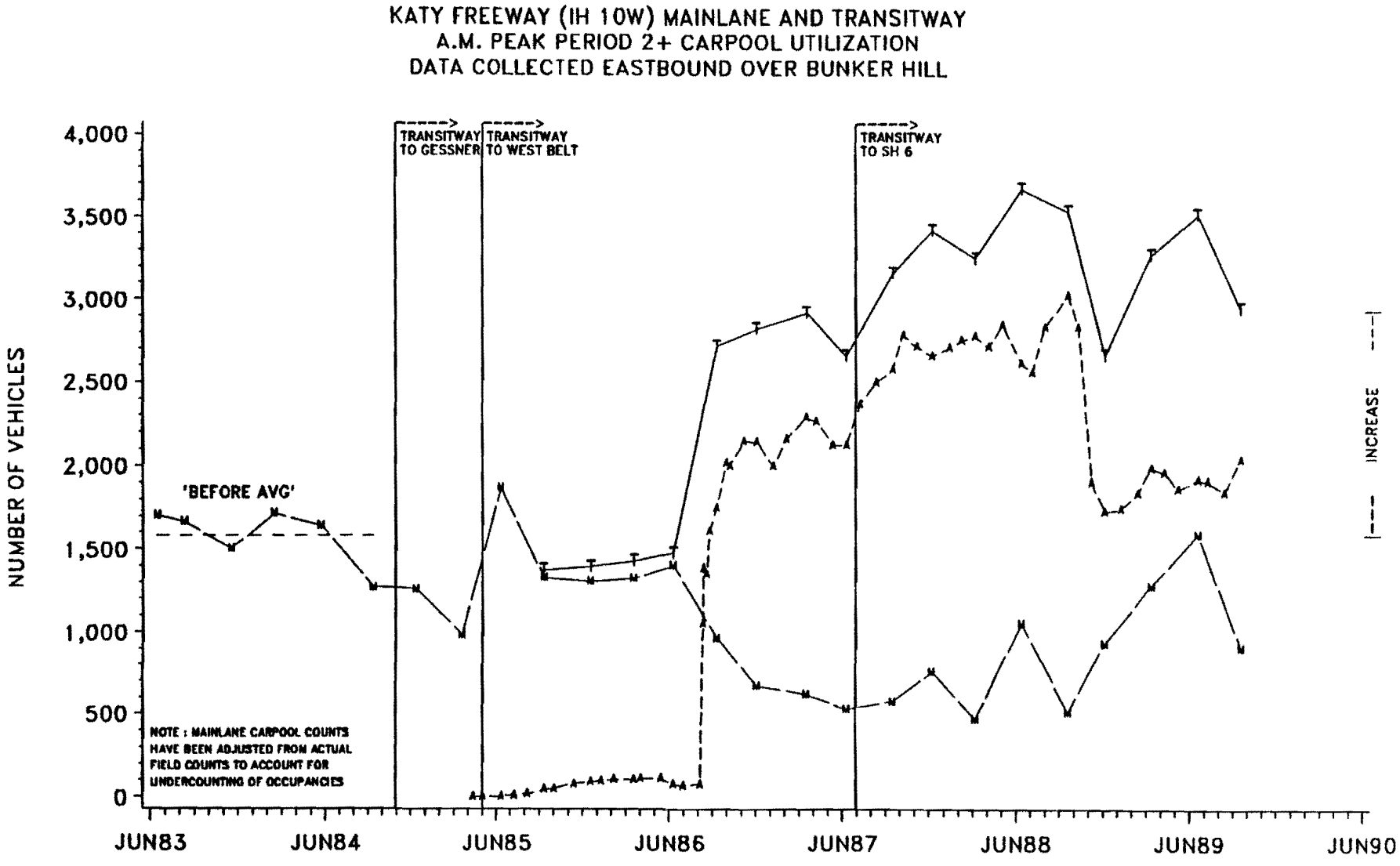
Increase in Carpooling Due to Transitway Implementation

Typically, allowing carpools to use an HOV facility results in an increase in the total volume of carpools on the freeway. Following the introduction of 2+ carpools, this has also occurred on the Katy Transitway.

Extensive carpool data have been collected on the Katy Freeway since 1983. Some of these data are summarized in Figures 9 and 10. It appears that, particularly since carpools were allowed onto the transitway, the increase in carpooling has at least been similar to that experienced on other projects shown in Table 5.

The data in Table 5 indicate that, a year after implementation of the 3+ restriction during a portion of the morning peak period, carpooling on the Katy Freeway in the a.m. peak period has increased 89% since the inception of the transitway.

Surveys were conducted in March 1987, October 1987, November 1988 and October 1989 to determine the origin of carpools. These analyses are summarized in Figure 11. It is apparent that perhaps as much as 62% of the carpools using the transitway are "new" carpools (sum of previous mode being either "drove alone" or "did not make trip").



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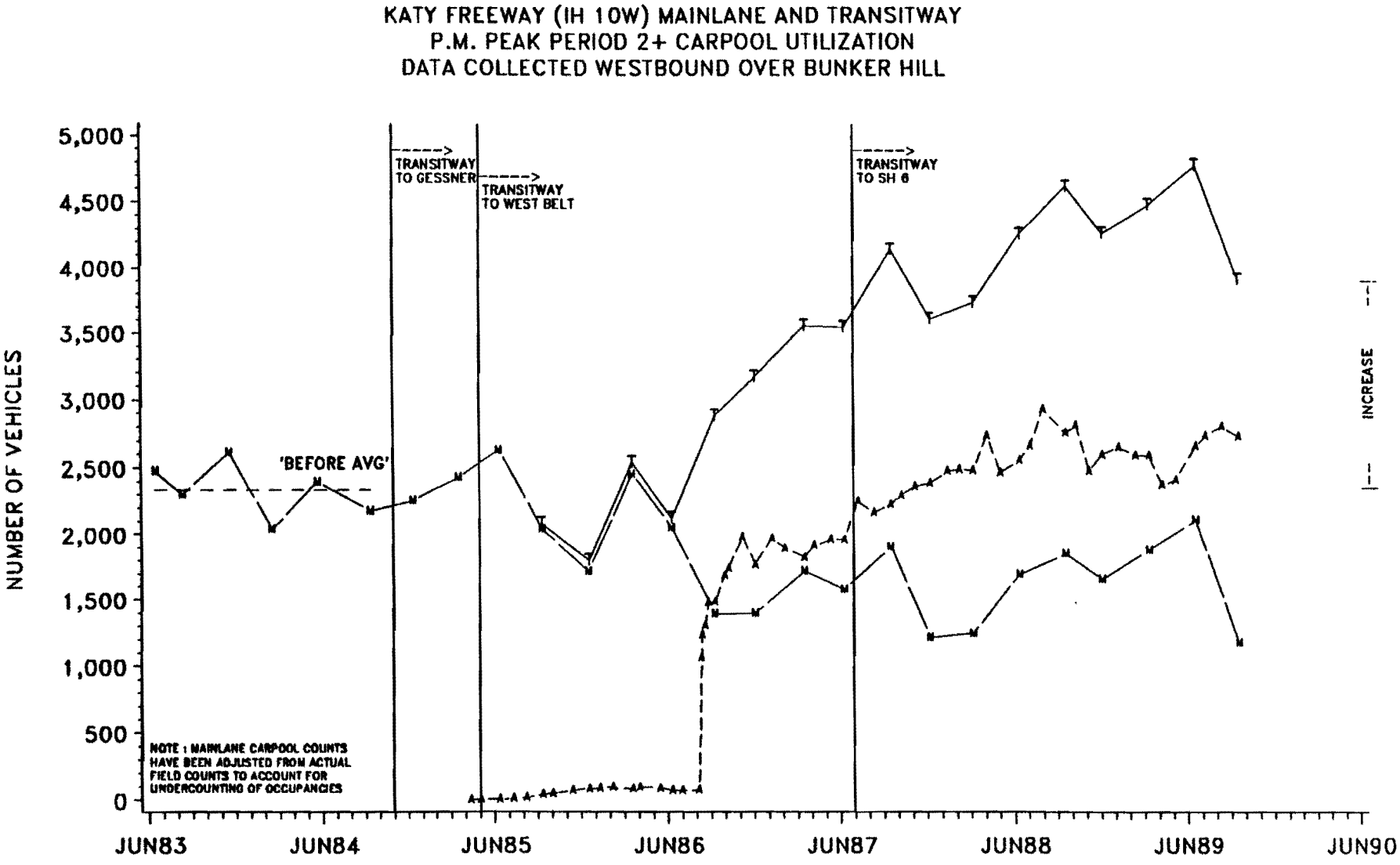
PEAK PERIOD IS 6:00 – 9:30 AM
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL 2+ CARPOOLS
A = TOTAL TRANSITWAY 2+ CARPOOLS
M = TOTAL MAINLANE 2+ CARPOOLS

Figure 9. Increases in Carpooling in the A.M. Peak Period



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PEAK PERIOD IS 3:30 – 7:00 PM
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL 2+ CARPOOLS
A = TOTAL TRANSITWAY 2+ CARPOOLS
M = TOTAL MAINLANE 2+ CARPOOLS

Figure 10. Increases in Carpooling in the P.M. Peak Period

Table 5.
Estimated Increases in Carpool Volumes Due to HOV Lane Implementation

HOV Facility	Carpool Volume Before HOV Lane	Carpool Volume After HOV Lane[1]	Percent Change
Katy Transitway, Houston (1983-1989)			
a.m. peak period (6:00-9:30 a.m.)	1,570	2,968[2]	+89%
El Monte, Los Angeles (1976-1985)			
a.m. peak period	670	2,166	+323%
Route 91, Los Angeles (4 mo. in 1985)			
p.m. peak hour	1,000	1,350	+35%
Route 55, Orange County (1984-1986)			
a.m. peak period	1,341	1,916	+43%
p.m. peak period	1,925	2,473	+28%
I-95 Miami (1976-1984)			
a.m. peak period	2,185	2,714	+24%
Shirley Highway, Washington, D.C. (1974-1980)			
a.m. peak period	272	3,723	+1269%
I-93, Boston (1974-1980)			
a.m. peak period	315	1,224	+289%
Banfield Freeway, Portland, Oregon			
a.m. peak period	106	518	+389%
Moanalua Freeway (1974-1982)			
a.m. peak period	600	1,750	+192%

[1] *Freeway plus HOV lane volume.*
[2] *3+ vehicles between 6:45 a.m. and 8:15 a.m.; 2+ vehicles during all other operating hours.*

Sources: TTI Analyses, ITE 1985 Survey of Operating HOV Projects, and "Study of Current and Planned High-Occupancy Vehicle Lane Use: Performance and Prospects," by Frank Southworth and Fred Westbrook, 1985.

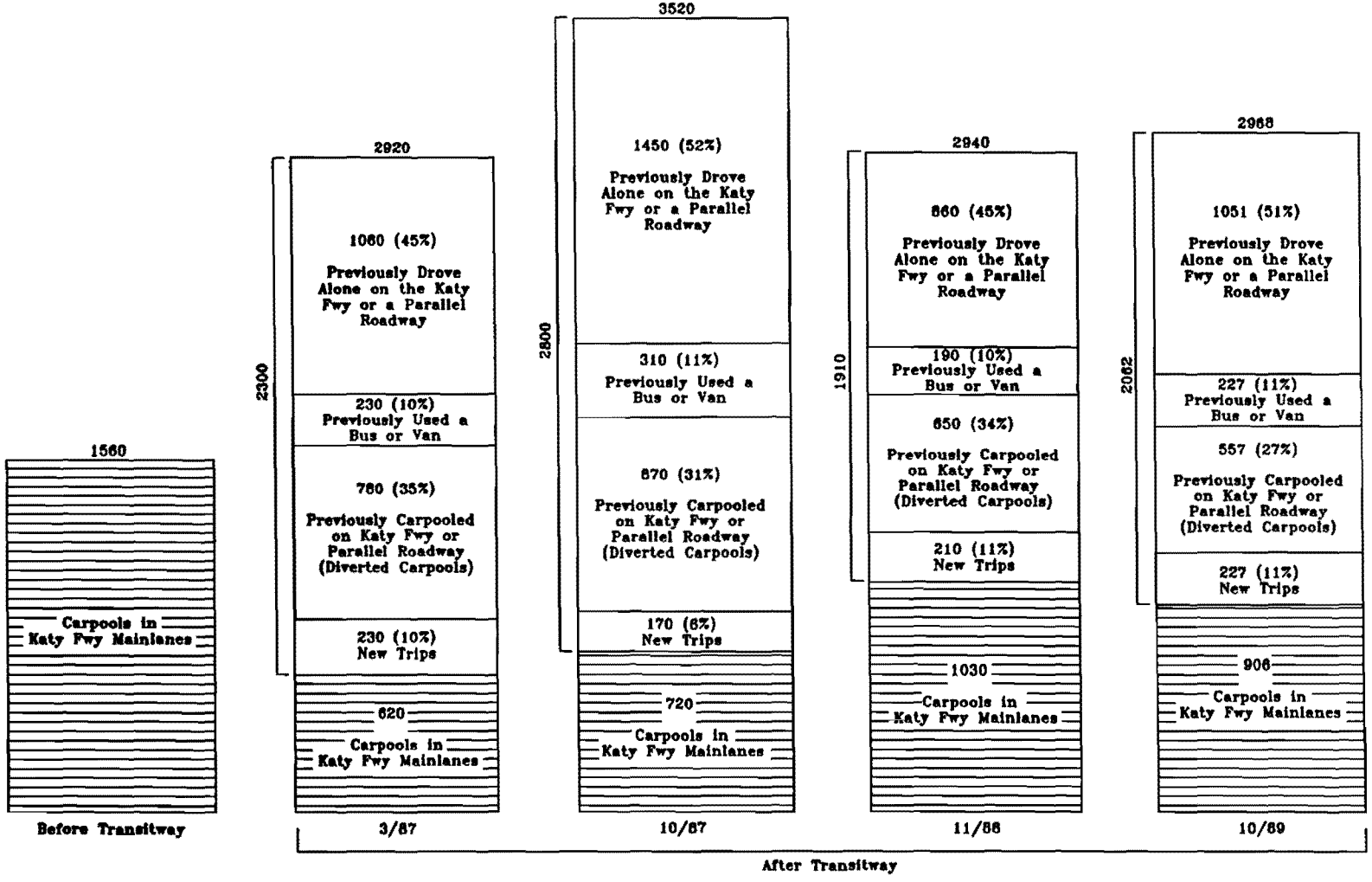

Figure 11. A.M. Peak Period Carpool Volumes (Freeway + Transitway) Before and Afte

CHAPTER 3
CRITERIA FOR EVALUATING THE SUCCESS OF THE TRANSITWAY CARPOOL EXPERIMENT

Carpool utilization of the Katy Transitway was initiated as an experiment which would be evaluated periodically to determine whether or not the project has been successful. Prior to allowing carpools on the transitway, METRO and the SDHPT identified the general criteria that would be used to evaluate the success of the carpool experiment. Those criteria, as developed and presented in TTI Research Report 484-1, are repeated in Table 6. Throughout the duration of the experiment, data collection efforts in the Katy corridor have been oriented to obtain information that can be used to quantify the criteria shown in Table 6.

The criteria, and the relative performance of the Katy Transitway carpool experiment with regard to the criteria, are addressed individually in subsequent chapters of this report. Included in this presentation are relevant data from:

- The 12-month "after carpools" evaluation conducted in April 1986 (when transitway use was limited to authorized buses, vanpools and 3+ carpools);
- The 30-month "after carpools" evaluation conducted in October 1987 (when the transitway was open to all 2+ vehicles with no authorization);
- The 42-month "after carpools" evaluation conducted in October 1988 (just prior to implementing the 3+ carpool occupancy requirement from 6:45-8:15 a.m.); and
- The 54-month "after carpools" evaluation conducted in October 1989 (approximately one year after the 3+ carpool passenger requirement went into effect).

Table 6.
Criteria for Judging the Success of the Katy Transitway Carpool Experiment

Proposed Evaluation Factor	Relative Weighting	Resulting Impact
1. Change in person movement on the Katy Transitway directly attributable to carpooling	25%	Highly Successful: Total transitway person movement increases by at least 20% due to carpooling. Successful: Person movement increases by between 5% and 20%. Unsuccessful: Person movement remains essentially unchanged (0% to 5% increase). Highly Unsuccessful: Person movement decreases.
2. Nonuser perception of Katy Transitway utilization	30%	Highly Successful: At least 70% of nonusers respond that transitway is sufficiently utilized. Successful: Between 50% and 70% of nonusers respond that transitway is sufficiently utilized. Unsuccessful: Between 50% and 70% of nonusers respond that transitway is not sufficiently utilized. Highly Unsuccessful: More than 70% of nonusers respond that transitway is not sufficiently utilized.
3. Change in average travel time on the Katy Transitway	20%	Highly Successful: No change. Successful: Average travel speed decreases by no more than 3 mph. Unsuccessful: Average travel speed decreases by between 3 mph and 6 mph. Highly Unsuccessful: Average travel speed decreases by more than 6 mph.
4. Change in person delay to mixed-flow traffic	15%	Highly Successful: No change or a decrease in total delay. Successful: Delay increases by less than 5%. Unsuccessful: Delay increases by 5% to 10%. Highly Unsuccessful: Delay increases by more than 10%.
5. Increase in frequency of breakdowns on the Katy Transitway	5%	Highly Successful: None. Successful: Increases by less than 5%. Unsuccessful: Increases by between 5% and 15%. Highly Unsuccessful: Increases by more than 15%.
6. Increase in authorization and enforcement costs	5%	Values developed by METRO. Authorization has been eliminated.

Note: In this table, Items 1, 3 and 4 indirectly address change in total corridor delay; Item 5 indirectly addresses trip reliability.

CHAPTER 4
PERSON MOVEMENT IMPACTS OF CARPOOLING

One of the main reasons for permitting carpools to use the Katy Transitway was to increase the volume of persons moved on the facility. As shown previously in Table 2, carpools are presently carrying the majority of persons on the transitway.

Carpool Component

The percentage of persons moved on the transitway, by vehicle type, is presented in Table 7. As this table indicates, the carpool component of total person movement has increased significantly over time, particularly since 2+ unauthorized carpools were allowed onto the transitway. As might be expected, the percentage of persons moved in transitway carpools has dropped somewhat since the 3+ occupancy requirement went into effect.

At first glance, these data appear to indicate that, as of October 1989, allowing carpools onto the transitway has effectively increased person movement by 153% in the a.m. peak period and by 197% in the p.m. peak period. Such conclusions, however, do not take into consideration the fact that some of the carpoolers traveled in buses or vans on transitway prior to carpooling. In fact, approximately 10% of the current carpoolers were attracted from other transitway modes (Table 8); these trips do not represent a net increase in person movement due to carpooling. Therefore, in October 1989, carpooling actually increased a.m. peak period person movement by about 121%, and p.m. peak period person movement by 148%. The average increase in person movement on the transitway is assumed to be approximately 135% for both the a.m. and p.m.

Table 7.
Person Movement on the Katy Transitway

Time Period	Bus		Vanpool		Carpool		Total
	Volume	Percent	Volume	Percent	Volume	Percent	
A.M. Eastbound							
Peak Hour							
April 1986	980	61%	377	23%	261	16%	1,618
April 1987	1,025	27%	256	7%	2,531	66%	3,812
October 1987	1,200	28%	195	4%	2,965	68%	4,360
October 1988	1,215	32%	240	6%	2,375	62%	3,830
October 1989	1,340	38%	163	5%	1,965	57%	3,468
Peak Period							
April 1986	2,270	71%	548	17%	378	12%	3,196
April 1987	2,300	30%	534	7%	4,960	63%	7,794
October 1987	2,405	27%	400	5%	5,956	68%	8,761
October 1988	2,540	29%	298	3%	5,961	68%	8,799
October 1989	2,820	36%	285	3%	4,808	61%	7,913
P.M. Westbound							
Peak Hour							
April 1986	670	56%	366	30%	166	14%	1,202
April 1987	1,065	35%	212	7%	1,804	58%	3,081
October 1987	1,175	34%	185	5%	2,083	61%	3,443
October 1988	1,195	31%	92	3%	2,543	66%	3,830
October 1989	1,430	35%	81	2%	2,613	63%	4,124
Peak Period							
April 1986	2,032	68%	632	21%	328	11%	2,992
April 1987	1,895	29%	596	9%	4,113	62%	6,604
October 1987	2,175	29%	521	7%	4,925	64%	7,621
October 1988	2,180	26%	325	4%	5,921	70%	8,426
October 1989	2,685	30%	368	4%	6,025	66%	9,078

Note: April 1986 - authorized 3+ carpools were allowed to use the transitway.
April 1987, October 1987 and October 1988 - 2+ carpools with no authorization were allowed on the transitway.
October 1989 - transitway restricted to 3+ carpools (no authorization) between 6:45 a.m. and 8:15 a.m., 2+ carpools (no authorization) allowed during all other operating hours.
Peak Periods - 6:00 a.m. to 9:30 a.m. and 3:30 p.m. to 7:00 p.m.
Peak Hour - peak hour for vehicle volumes.

Table 8.
Prior Use of the Transitway by Carpoolers

Did You Use the Transitway Before Carpooling	Carpool Survey Date					
	10/85	4/86	4/87	10/87	11/88	10/89
Yes, Bus	3%	7%	7%	8%	6%	8%
Yes, Van	2%	7%	2%	1%	1%	2%
No	95%	86%	91%	91%	93%	90%

Conclusion Pertaining to Evaluation Criterion

The increase in transitway person movement resulting from carpool utilization is the first criterion established for evaluating the success of the Katy Transitway carpool experiment (Table 6). Table 9 summarizes the application of the data to this criterion. As of October 1989, in terms of this evaluation criterion, the carpool experiment is judged to be "highly successful."

Table 9.
Transitway Person Movement Impacts of Carpooling,
Criterion for Assessing the Success of the Katy Transitway Carpool Experiment

Date of Evaluation	A.M. Peak Period Carpool Person Volume	Estimated % Increase in Transitway Person Movement	Rating of Criterion (See Table 6)
4/86	378	10%	"Successful"
4/87	4,960	135%	"Highly Successful"
10/87	5,956	150%	"Highly Successful"
10/88	5,961	180%	"Highly Successful"
10/89	4,808	135%	"Highly Successful"

CHAPTER 5
PERCEPTION OF TRANSITWAY UTILIZATION

One of the primary reasons for allowing carpools on the Katy Transitway was to make the facility appear better utilized to the general public. Permitting carpools has significantly increased the volume of vehicles using the transitway. In fact, the number of vehicles using the transitway during the a.m. peak period has risen from 138 in March 1985 to 2,186 by October 1989. The effect of this increased volume of vehicles on the perception of transitway utilization has been noticeable; it is evident that a relationship does exist between vehicular utilization of the transitway and the perception that the transitway is sufficiently utilized.

The perceptions of transitway utilization are based on TTI surveys of both transitway users and nonusers. These surveys were performed in March 1985, April 1986, October 1987, November 1988 and October 1989.

As to be expected, there is a significant difference in the perception of transitway utilization between the transitway users and nonusers. As noted in Table 10, the majority (74% to 85%) of the transitway users surveyed in October 1989 felt the facility is sufficiently utilized.

However, the majority of commuters traveling in the Katy Freeway general purpose lanes (persons who may not perceive they are directly benefitting from the transitway) did not agree; 53% of the freeway motorists surveyed in October 1989 felt the transitway was not sufficiently utilized (Table 11). Nevertheless, as transitway volumes have increased, so has the acceptance of the lane by freeway motorists; 66% of the motorists now feel the transitway is a good transportation improvement (Table 11).

Table 10.
Perception of Katy Transitway Utilization by Transitway Users

Is the Transitway Sufficiently Utilized?	Survey Date					
	3/85[1]	4/86[2]	4/87[3]	10/87[3]	11/88[4]	10/89[4]
Transitway Transit Users						
Yes	49%	66%	—	77%	72%	85%
No	33%	14%	—	7%	8%	5%
Not sure	18%	20%	—	16%	20%	10%
Transitway Vanpoolers						
Yes	30%	41%	—	—	47%	74%
No	51%	34%	—	—	27%	13%
Not sure	19%	25%	—	—	26%	13%
Transitway Carpoolers						
Yes	—	45%	82%	—	43%	77%
No	—	32%	9%	—	43%	14%
Not sure	—	23%	9%	—	14%	9%
Transitway A.M. Peak Period Vehicle Volume[5]	138	256	2,410	2,854	2,032	2,186

[1] *Authorized buses and vanpools (before carpools were allowed).*
[2] *Authorized buses, vanpools and 3+ carpools.*
[3] *2+ vehicles, no authorization.*
[4] *3+ vehicles, no authorization between 6:45 a.m. and 8:15 a.m.; 2+ vehicles, no authorization at all other times.*
[5] *Vehicle volumes present on transitway during months surveys were performed.*

Table 11.
Perception of Katy Transitway Utilization by Motorists in the General Freeway Lanes (Non Transitway Users)

Measure of Effectiveness	Survey Date					
	3/85[1]	4/86[2]	4/87[3]	10/87[3]	11/88[4]	10/89[4]
Is the Transitway Sufficiently Utilized?						
Yes	3%	3%	36%	44%	31%	30%
No	90%	92%	55%	42%	55%	53%
Not sure	7%	5%	9%	14%	14%	17%
Is the Transitway a Good Transportation Improvement?						
Yes	41%	36%	56%	63%	64%	66%
No	35%	43%	29%	20%	22%	20%
Not sure	24%	21%	15%	17%	14%	14%
Transitway A.M. Peak Period Vehicle Volume[5]	138	256	2,412	2,854	2,032	2,186

[1] *Authorized buses and vanpools (before carpools were allowed)*
[2] *Authorized buses, vanpools and 3+ carpools*
[3] *2+ vehicles, no authorization*
[4] *3+ vehicles, no authorization between 6:45 a.m. and 8:15 a.m.; 2+ vehicles, no authorization at all other times*
[5] *Vehicle volumes present on transitway during months surveys were performed.*

Conclusion Pertaining to Evaluation Criterion

In evaluating the success of the Katy Transitway carpool experiment, the nonuser perception of transitway was the single most important criterion (Table 6). Table 12 summarizes the application of the nonuser perception findings to this criterion. As of October 1989, in terms of perceived transitway utilization, the experiment is judged to be "unsuccessful."

Table 12.
Perception of Katy Transitway Utilization,
Criterion for Assessing the Success of the Katy Transitway Carpool Experiment

Date of Evaluation	A.M. Peak Period Transitway Vehicle Volume	% Motorists in General Purpose Lanes Who Feel Transitway is Sufficiently Utilized[1]	Rating of Criterion (See Table 6)
4/86	256	6%	"Highly Unsuccessful"
4/87	2,412	40%	"Unsuccessful"
10/87	2,854	51%	"Successful"
10/88	2,922	51%[2]	"Successful"
10/89	2,186	38%	"Unsuccessful"

[1] *This represents the sum of those responding the transitway is sufficiently utilized plus one-half of those stating they were "not sure." See Table 11 for data breakdown.*

[2] *For the 42-month "after carpools" evaluation, the October 1987 survey responses were assumed to represent October 1988 conditions (before the 3+ carpool operating restriction went into effect between 6:45 a.m. and 8:15 a.m.).*

CHAPTER 6
CHANGE IN AVERAGE TRAVEL TIME ON THE TRANSITWAY

While allowing carpools represented a means to increase the volume of vehicles operating on the transitway, a number of concerns were associated with such an action. For example, permitting carpools might result in vehicle volumes that exceed the capacity of the transitway, thereby adversely affecting operating speeds on the facility. Any decrease in transitway speed would reduce both the transitway travel time savings and the trip time reliability. This, in turn, would reduce the attractiveness of the transitway.

Transitway Average Travel Speeds

The average travel speed (space mean speed) was calculated for each bus using the Katy Transitway. Bus speeds were then used to estimate the transitway speeds of vanpools and carpools, as bus flow rates during peak periods were high; buses ran at average headways of two minutes. The average of peak period a.m. and p.m. travel speeds of all buses using the transitway when no carpools were allowed is compared to the same average travel speeds in 1986, 1987, 1988 and 1989 when carpools were present (Table 13).

Table 13.
Average Travel Speed (mph) for Vehicles on the Katy Transitway

Vehicle Type	3/85[1]	5/86[2]	11/87[3]	10/88[3]	10/89[4]
Bus	52	56	52	45	49
Van	56	57	NA	NA	NA
Carpool	–	56	NA	NA	NA

[1] *Authorized buses and vanpools (prior to carpool implementation)*
[2] *Authorized buses, vanpools and 4+ carpools*
[3] *2+ vehicles, no authorization*
[4] *3+ vehicles, no authorization 6:45-8:15 a.m., 2+ vehicles, no authorization at all other times.*

Notes: Speeds represent average of a.m. and p.m. peak period speeds based on travel time runs between SH 6 and the S.P.R.R. overpass (13.3 miles). Transitway speeds for 4:00, 5:00 and 6:00 p.m. were measured in October 1988.
NA = speed not available. Bus speeds are assumed to estimate all transitway speeds.

The average travel speeds of vehicles traveling on the Katy Transitway in 1986 and 1987 were at "pre-carpool" base condition levels or higher. By October 1988, however, the average recorded transitway travel speed of 45 mph was 7 mph less than the 52 mph "pre-carpool" base condition. Figure 12 illustrates the hourly changes in the a.m. travel speed since carpools began using the transitway. The drop in peak hour travel speeds occurring in 1988 (as evident in this figure) was one of the factors that led to the implementation of the 3+ carpool occupancy requirement between 6:45 a.m. and 8:15 a.m. in late October 1988.

The drop in average travel speed was the result of vehicular volumes approaching, and sometimes exceeding, the capacity of the transitway and also from delay encountered at the eastern transitway terminus. Once the 3+ operating restriction went into effect, however, vehicular volumes on the transitway declined and the average transitway travel speed subsequently improved; by October 1989, the average of a.m. and p.m. peak period travel speeds increased to 49 mph.

Conclusion Pertaining to Evaluation Criterion

The change in transitway operating speed is the third criterion developed for use in evaluating the success of the Katy Transitway carpool experiment (Table 6). The 42-month "after carpools" evaluation (TTI Research Report 484-11) found that, in 1988, transitway speeds had decreased significantly. Therefore, this criterion was considered to be "highly unsuccessful."

As shown in Table 14, the October 1989 average travel speed (after the implementation of the 3+ a.m. operating restriction) is only 3 mph less than the 1985 base condition speed. As a result, this criterion is rated "successful" for October 1989.

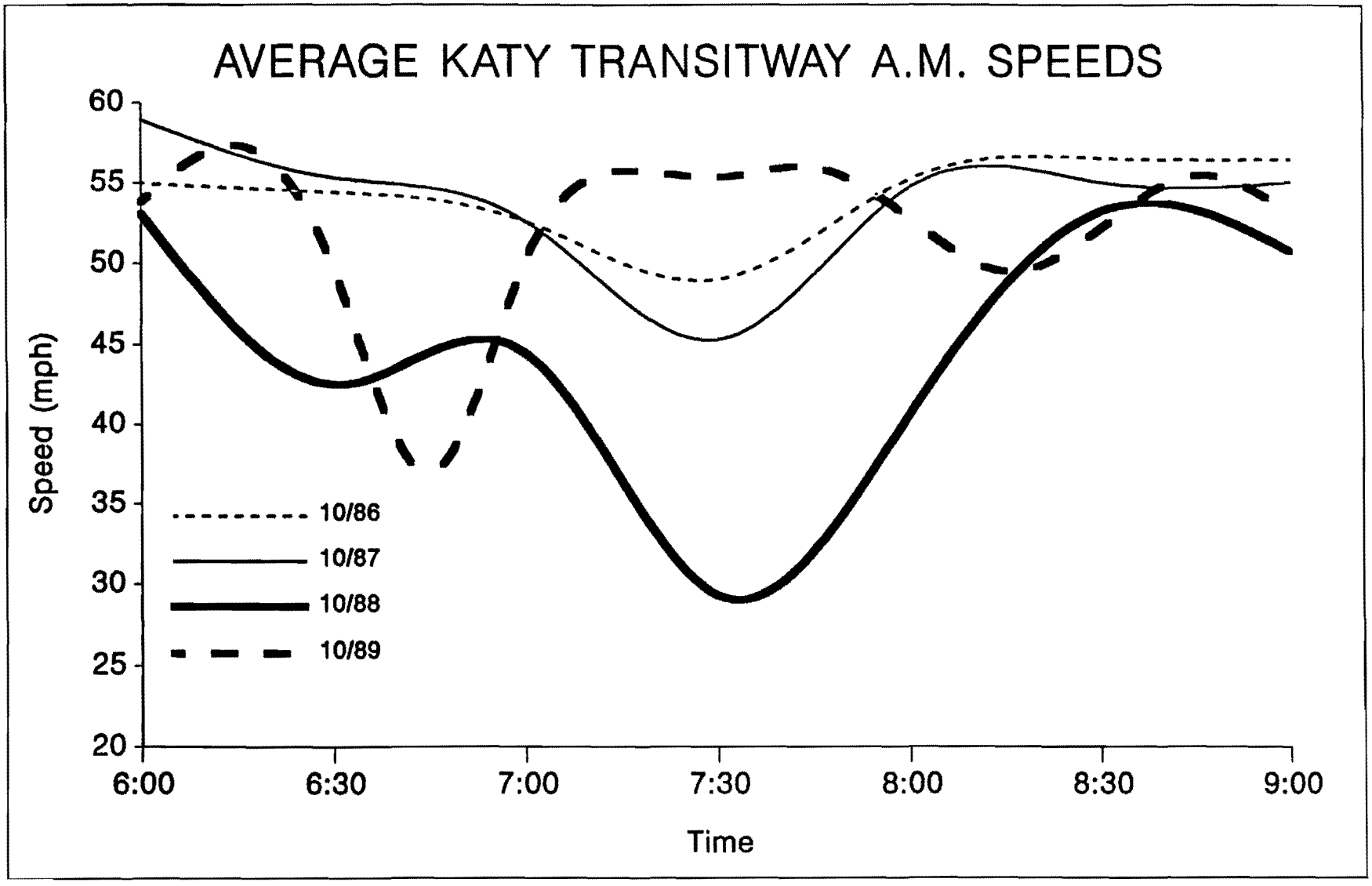

Figure 12. A.M. Average Transitway Running Speeds from Western Terminus to Post Oak Intersection

Table 14.
Change in Average Bus Travel Speed on the Transitway,
Criterion for Assessing the Success of the Katy Transitway Carpool Experiment

Date of Evaluation	Average Transitway Speed (mph)	Rating of Criterion (See Table 6)
3/85	52	Base Condition
5/86	56	"Highly Successful"
11/87	52	"Highly Successful"
10/88	45	"Highly Unsuccessful"
10/89	49	"Successful"

CHAPTER 7
MIXED-FLOW TRAFFIC LANES

It is possible that permitting carpools to use the Katy Transitway could have either a positive or a negative effect on speeds and operation in the Katy Freeway mixed-flow lanes. For example, if substantial carpool volumes use the transitway, freeway mainlane volumes could decrease, which might improve operations. Conversely, the location of the access/egress points to the transitway are not necessarily optimal; large volumes of vehicles entering or exiting the transitway (particularly at Gessner) could result in a deterioration of the level-of-service on the mainlanes.

Freeway Average Travel Speeds

In October 1989, travel time studies were conducted on the Katy Freeway mainlanes at 30-minute intervals between the SH 6 interchange and the Southern Pacific Railroad (S.P.R.R.) overpass east of Washington Avenue, a distance of approximately 13 miles. The results of these travel time studies were compared to similar studies performed in 1985, 1986, 1987 and 1988 using the study sections shown in Table 15.

Table 15.
Section Limits for Travel Times Runs on the Katy Transitway

Section Number A.M. Designation	Section Number P.M. Designation	Limits of Section
1	3	SH 6 to Gessner access Ramps (6.4 mi.)
2	2	Gessner access ramps to transitway eastern terminus at Post Oak (4.7 mi.)
3	1	Post Oak to the S.P.R.R. overpass of I-10 (2.2 mi.)

A.M. Peak Period

Eastbound floating car travel times were conducted over the 13 mile study length on the Katy Freeway, and the average speeds for the three study lengths were calculated. The results of these travel time runs are presented in Table 16. The travel speeds for each freeway section were then averaged for each time period. The 1989 data, presented in Figure 13 and Table 16, can be directly compared to previous travel speed data.

Table 16.
A.M. Average Speeds (mph) on the Eastbound Katy Freeway Mainlanes

Time	3/85	11/87	10/88	10/89
Section 1 - A.M.				
6:00	54	56	61	58
6:30	32	33	28	36
7:00	22	24	24	23
7:30	18	22	17	18
8:00	32	37	19	18
8:30	37	48	44	34
9:00	–	50	59	60
Section 2 - A.M.				
6:00	55	56	59	54
6:30	39	34	37	42
7:00	28	26	26	30
7:30	21	22	21	27
8:00	26	28	23	35
8:30	28	31	29	37
9:00	–	50	36	54
Section 3 - A.M.				
6:00	55	55	59	57
6:30	36	55	54	59
7:00	27	55	56	59
7:30	21	55	57	58
8:00	32	55	55	55
8:30	35	57	57	61
9:00	–	55	59	60
Total Length - A.M.				
6:00	55	56	60	57
6:30	36	36	33	40
7:00	27	28	28	28
7:30	21	24	20	23
8:00	32	34	23	25
8:30	35	40	38	38
9:00	–	50	48	58

The travel time profile shown in Figure 13 indicates that 1989 freeway travel speeds between 6:00 and 9:00 a.m. have generally improved since 1988. It is also interesting to note

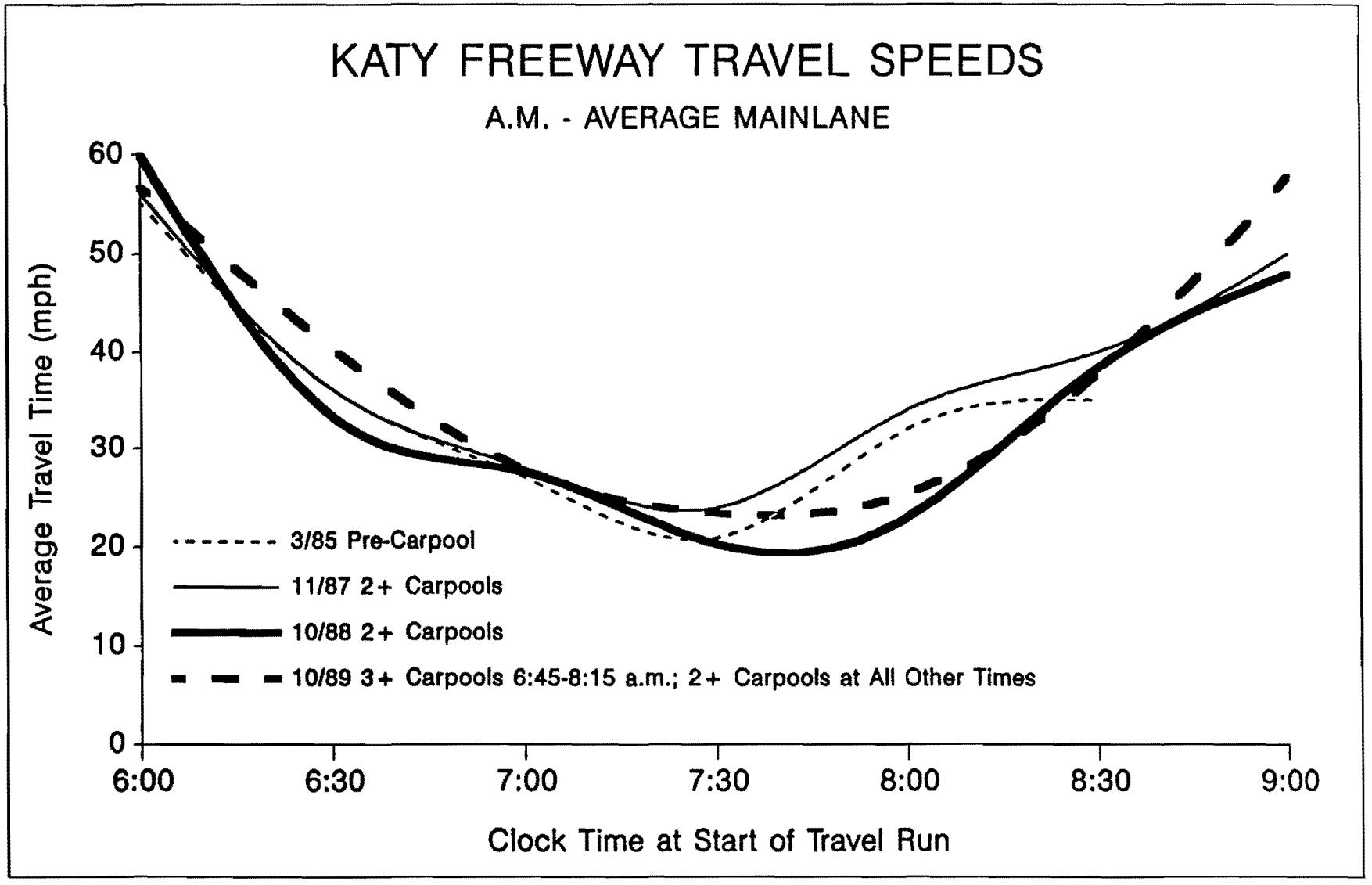

Figure 13. Katy Freeway Average Mainlane Travel Speeds, A.M. Eastbound, SH 6 to S.P.R.R. Overpass

that 1989 freeway travel speeds between 6:00 a.m. and 7:30 a.m. have also improved since 1985.

Average travel time and average speeds for freeway and transitway traffic are shown for both two-and three-hour periods in Table 17. These values represent travel times over the entire study length from SH 6 to the S.P.R.R. overpass. In general, average travel times for both the Katy Transitway and Katy Freeway traffic are lower in 1989 and average speeds for both are higher in 1989 than in 1985.

Table 17.
Eastbound A.M. Travel Times and Average Speeds,
Katy Freeway Mainlanes and Transitway

Time Period	Average Travel Time (minutes) 3/85	11/87	10/88	10/89	% Change 85-89
3-Hour Period, 6:00-9:00 a.m.					
Non Transitway Traffic	26.5	22.0	26.9	25.2	-5%
Transitway Traffic	21.2	16.6	19.0	17.0	-20%
2-Hour Period, 6:30-8:30 a.m.					
Non Transitway Traffic	30.6	26.4	31.8	29.0	-5%
Transitway Traffic	23.5	17.4	20.9	17.5	-26%
Time Period	**Average Speed (mph) 3/85**	**11/87**	**10/88**	**10/89**	**% Change 85-89**
3-Hour Period, 6:00-9:00 a.m.					
Non Transitway Traffic	30	36	30	32	+7%
Transitway Traffic	37	48	42	48	+28%
2-Hour Period, 6:30-8:30 a.m.					
Non Transitway Traffic	26	30	25	28	+8%
Transitway Traffic	34	46	38	46	+35%

Note: Travel times and speeds for freeway and transitway are from SH 6 to S.P.R.R. Overpass.

P.M. Peak Period

The westbound Katy Freeway speeds are presented by section in Table 18 and compared to the previous years' studies in Table 19. Average travel speeds for 1989 are compared to 1985, 1987 and 1988 conditions in Figure 14.

Table 18.
P.M. Average Speeds (mph) on the Westbound Katy Freeway Mainlanes

Time	3/85	11/87	10/88	10/89
Section 1 - P.M.				
3:00	55	–	–	62
3:30	57	–	55	58
4:00	55	60	57	29
4:30	54	56	38	47
5:00	46	54	54	61
5:30	49	51	46	49
6:00	50	55	55	45
6:30	–	57	55	58
7:00	–	59	–	61
Section 2 - P.M.				
3:00	66	–	–	59
3:30	54	–	55	57
4:00	60	44	42	33
4:30	34	46	34	29
5:00	24	34	30	25
5:30	19	25	24	21
6:00	32	31	28	26
6:30	–	38	38	37
7:00	–	49	–	44
Section 3 - P.M.				
3:00	61	–	–	59
3:30	52	-	59	56
4:00	56	52	59	58
4:30	41	55	53	53
5:00	32	54	52	53
5:30	27	37	52	42
6:00	42	32	56	55
6:30	–	37	59	58
7:00	–	56	–	59
Total Length - P.M.				
3:00	61	–	–	60
3:30	52	–	57	57
4:00	56	52	51	40
4:30	41	52	42	40
5:00	32	45	41	38
5:30	27	35	36	31
6:00	42	38	41	38
6:30	–	44	49	47
7:00	–	55	–	53

Table 19.
Westbound P.M. Travel Times and Average Speeds,
Katy Freeway Mainlanes and Transitway

Time Period	Average Travel Time (minutes) 3/85	11/87	10/88	10/89	% Change 85-89
3-Hour Period, 4:00-7:00 p.m.					
Non Transitway Traffic	21.3	18.0	18.7	21.1	-0.9%
Transitway Traffic	16.3	17.3	17.3	16.2	-0.6%
2-Hour Period, 5:00-7:00 p.m.					
Non Transitway Traffic	24.7	19.3	19.4	21.2	-14%
Transitway Traffic	16.6	17.5	18.0	16.4	-1%
Time Period	**Average Speed (mph) 3/85**	**11/87**	**10/88**	**10/89**	**% Change 85-89**
3-Hour Period, 4:00-7:00 p.m.					
Non Transitway Traffic	37	44	43	38	+3%
Transitway Traffic	49	46	46	50	+2%
2-Hour Period, 5:00-7:00 p.m.					
Non Transitway Traffic	32	41	41	38	+19%
Transitway Traffic	48	45	44	49	+2%

Note: Travel times and speeds for freeway and transitway are from S.P.R.R. Overpass to SH 6.

Freeway Mainlane Volumes

Volume counts (from loop detectors installed in the Katy Freeway mainlanes at the Silber overpass and at the Gessner overpass) were taken in October 1989. The ADT, a.m. peak period, and p.m. peak period counts for 1985 through 1989 are shown in Table 20. In general, eastbound traffic volumes observed at the Silber overpass decreased from 1988 levels, while traffic volumes at the Gessner overpass increased.

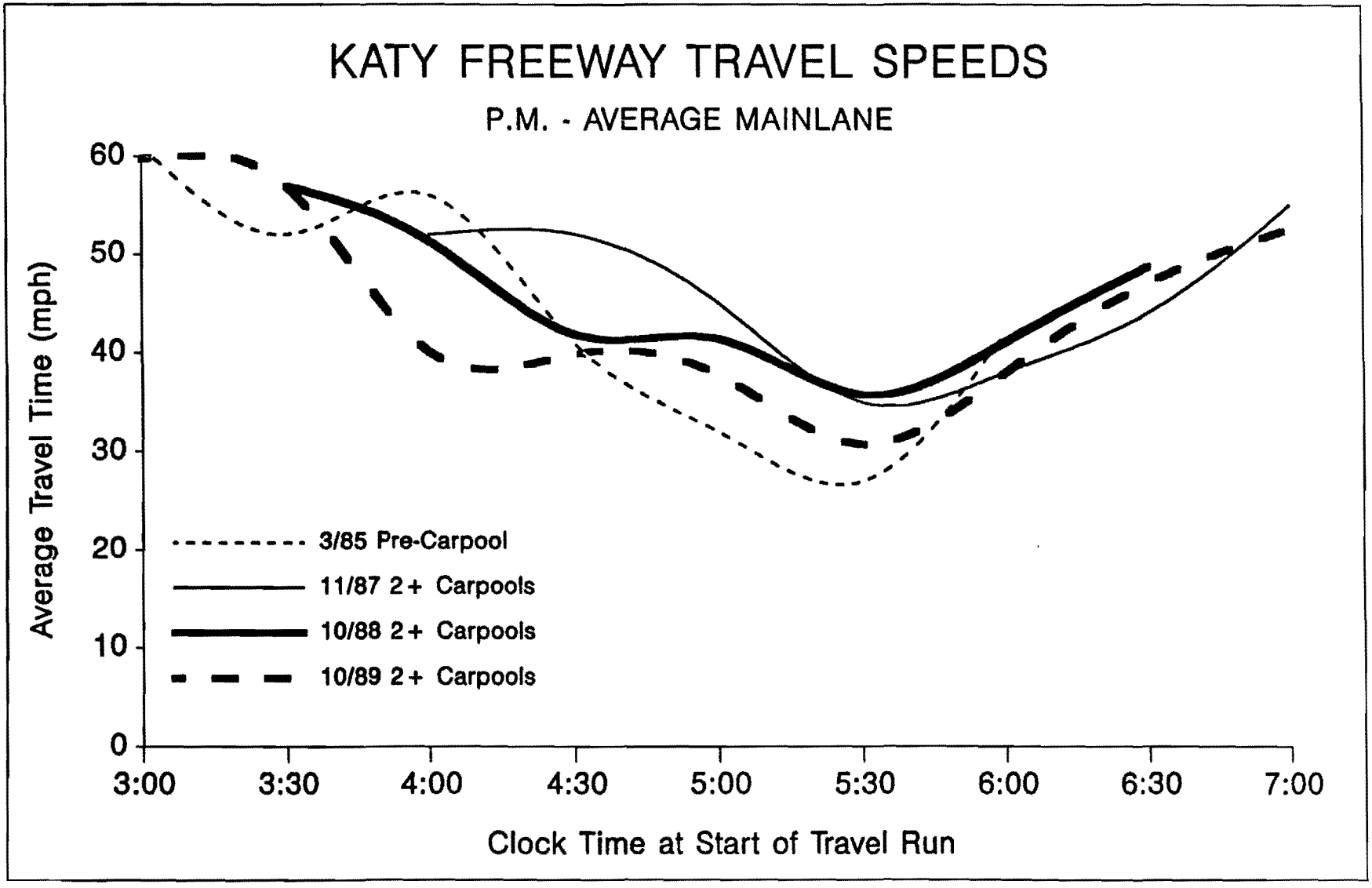

Figure 14. Katy Freeway Average Mainlane Travel Speeds, P.M. Westbound, S.P.R.R. Overpass to SH 6

Table 20.
Traffic Volumes, Katy Freeway Mainlanes

Eastbound Direction Location and Time	3/85	8/86	10/87	10/88[1]	10/89	% Change 88-89
Silber Overpass - 4 Lanes						
ADT	90,325	89,507	87,730	92,588	87,857	-5.1%
6:30-9:30 a.m.	20,589	19,445	20,783	21,270	20,295	-4.6%
3:30-6:30 p.m.	16,406	16,296	16,662	17,722	16,848	-4.9%
Peak Hour	7,295	7,113	7,200	7,425	7,163	-3.5%
Gessner Overpass - 3 Lanes						
ADT	70,069	69,250	64,064	71,647	73,186	+2.1%
6:30-9:30 a.m.	15,263	15,528	13,448	13,771	13,697	-0.5%
3:30-6:30 p.m.	13,547	12,717	12,972	14,734	15,340	+4.1%
Peak Hour	5,526	5,523	5,127	5,444	5,485	+0.8%
Westbound Direction Location and Time	**3/85**	**8/86**	**10/87**	**10/88**	**10/89**	**% Change 88-89**
Silber Overpass - 4 Lanes						
ADT	86,978	87,622	85,690	89,787		
6:30-9:30 a.m.	14,395	13,864	13,973	14,868	*Data not*	—
3:30-6:30 p.m.	17,539	17,692	18,535	18,211	*available.*[2]	—
Peak Hour	6,368	6,278	6,426	6,497		
Gessner Overpass - 3 Lanes						
ADT	70,919	69,965	69,147	75,199	78,255	+4.1%
6:30-9:30 a.m.	12,130	11,432	11,375	12,476	12,654	+1.4%
3:30-6:30 p.m.	14,270	12,835	16,911	17,322	17,278	-0.3%
Peak Hour	4,985	4,933	5,886	6,041	5,923	-2.0%

[1] *Volume represents average of Tuesday through Thursday.*
[2] *Data not available - loop detectors not accessible because of construction.*
Note: Peak Hour - Eastbound direction for a.m. period, westbound direction for p.m. period.

Travel Time Savings

Desirably, the transitway will result in travel time savings for both the transitway users and the freeway users. Transitway users can reduce travel time by utilizing the transitway to avoid congestion delays in the freeway mainlanes. When commuters change travel modes and begin using the transitway, the number of vehicles on the freeway mainlanes may be reduced, which could then result in a travel time savings for freeway users as well.

Travel time saved by the transitway traffic is calculated by comparing the freeway mainlane travel time to the transitway travel time at the same time period, and determining the number of vehicles and persons using the transitway during the same time period. The number of vehicles, by type and occupancy rate, were determined from independent surveys taken at the same time as the travel times. In Table 21, the eastbound direction from SH 6 to the Gessner

access ramp is analyzed. During all time periods, the travel time for the transitway traffic is less than or equal to the freeway travel time, and the results are positive savings. In Table 22, for the section from Gessner to the S.P.R.R. overpass, the early morning data indicate that transitway users lose time because of the delays at the Post Oak terminus and the route followed to re-enter the Katy Freeway mainlanes. Thus, the travel time savings are negative during the early hours. However, the fact that commuters use the transitway during these periods indicates that the trip time reliability can offset some losses in travel time savings.

Table 21.
Eastbound A.M. Travel Time Savings for Katy Transitway Traffic, SH 6 to Gessner Entrance, October 1989

Time of Day	Average Travel Time		Time Saved by Transitway (minutes)	Transitway Volumes				Travel Time Saved (person minutes)
	Non Transitway (minutes)	Transitway (minutes)		Buses	Vans	Carpools	Persons	
6:00 a.m.	6.7	6.7	0.0	6	10	290	869	0
6:30 a.m.	11.0	7.0	4.0	12	6	497	1,546	6,184
7:00 a.m.	17.5	7.1	10.4	13	5	137	785	8,164
7:30 a.m.	21.6	6.6	15.0	8	4	126	614	9,210
8:00 a.m.	21.5	6.9	14.6	8	3	198	665	9,709
8:30 a.m.	11.5	6.4	5.1	2	0	124	290	1,479
3 Hour Total, 6:00-9:00 a.m.			7.3	49	28	1,372	4,769	34,744
2 Hour Total, 6:30-8:30 a.m.			9.2	41	18	958	3,610	33,267

Table 22.
Eastbound A.M. Travel Time Savings for Katy Transitway Traffic, Gessner Entrance to S.P.R.R. Overpass, October 1989

Time of Day	Average Travel Time		Time Saved by Transitway (minutes)	Transitway Volumes				Travel Time Saved (person minutes)
	Non Transitway (minutes)	Transitway (minutes)		Buses	Vans	Carpools	Persons	
6:00 a.m.	7.6	9.7	-2.1	6	9	147	573	-1,203
6:30 a.m.	9.0	10.6	-1.6	14	12	549	1,781	-2,850
7:00 a.m.	11.7	11.1	0.6	24	8	313	1,687	1,012
7:30 a.m.	13.0	9.0	4.0	22	2	275	1,590	6,360
8:00 a.m.	10.4	9.7	0.7	13	3	293	1,046	732
8:30 a.m.	9.9	9.8	0.1	10	0	344	891	89
3 Hour Total, 6:00-9:00 a.m.			0.6	89	34	1,921	7,568	4,540
2 Hour Total, 6:30-8:30 a.m.			0.9	73	25	1,430	6,104	5,254

Total Time Saved = 34,744 + 4,540 = 39,284 Person Minutes (6:00-9:00 a.m.).
Total Time Saved = 33,267 + 5,254 = 38,521 Person Minutes (6:30-8:30 a.m.).

The total time saved by transitway users is determined from figures in Tables 21 and 22 and shown in Table 23. During the morning peak period, the total time saved by transitway users was over 39,000 person-minutes (over 650 person-hours). Table 23 also provides similar data for 1985, 1987 and 1988. Table 23 shows that the total travel time saved continued to increase with time from 1985 through 1988, but decreased in 1989. The decrease in 1989 is due to fewer persons being moved on the transitway in the mornings after the 3+ carpool operating restriction went into effect.

Table 23.
Total Travel Time Savings for Eastbound Katy Transitway Traffic

Time of Day	5/85	11/87	10/88	10/89
Time Saved by Transitway (minutes)[1]				
6:00 a.m.	-1.2	-0.9	-1.7	-2.1
6:30 a.m.	4.0	3.1	3.7	1.9
7:00 a.m.	9.4	4.8	8.9	5.4
7:30 a.m.	11.4	6.1	6.6	9.8
8:00 a.m.	7.8	4.8	6.0	10.0
8:30 a.m.	3.7	2.3	4.2	1.8
3 Hour Total, 6:00-9:00 a.m.	6.8	4.4	5.9	5.2
2 Hour Total, 6:30-8:30 a.m.	8.0	4.8	6.5	6.3
Transitway Person Volume				
6:00 a.m.	242	387	391	573
6:30 a.m.	532	1,540	1,703	1,781
7:00 a.m.	646	2,346	2,127	1,687
7:30 a.m.	384	2,320	1,922	1,590
8:00 a.m.	426	1,198	1,540	1,046
8:30 a.m.	150	600	706	891
3 Hour Total, 6:00-9:00 a.m.	2,380	8,391	8,389	7,568
2 Hour Total, 6:30-8:30 a.m.	1,988	7,404	7,292	6,104
Travel Time Saved (person-minutes)				
6:00 a.m.	-299	-361	-660	-1,203
6:30 a.m.	2,123	4,840	6,367	3,334
7:00 a.m.	6,061	11,157	19,005	9,176
7:30 a.m.	4,372	14,057	12,732	15,570
8:00 a.m.	3,329	5,735	9,204	10,441
8:30 a.m.	558	1,400	2,964	1,568
3 Hour Total, 6:00-9:00 a.m.	16,144	36,828	49,612	39,284
2 Hour Total, 6:30-8:30 a.m.	15,885	35,789	47,308	38,521

[1] *Time saved by transitway (minutes) was calculated, and rounded to tenths, by dividing "person-minutes" by "person volume."*

Similar calculations for the afternoon peak period are presented in Tables 24, 25 and 26. The data in these tables indicate dramatic improvements in the time saved by transitway users

in the afternoon. During the afternoon peak period, the total time saved by transitway users in 1989 was over 40,000 person-minutes (as compared to approximately 8,000 person-minutes in 1988 -- about a 500% increase).

Table 24.
Westbound P.M. Travel Time Savings for Katy Transitway Traffic, S.P.R.R. Overpass to Gessner Exit, October 1989

Time of Day	Average Travel Time		Time Saved by Transitway (minutes)	Transitway Volumes				Travel Time Saved (person minutes)
	Non Transitway (minutes)	Transitway (minutes)		Buses	Vans	Carpools	Persons	
4:00 p.m.	13.4	9.2	4.2	6	16	338	1,107	4,649
4:30 p.m.	13.0	9.2	3.8	16	11	425	1,580	6,004
5:00 p.m.	14.1	9.4	4.7	16	6	600	1,981	9,311
5:30 p.m.	17.1	11.9	5.2	24	6	614	2,143	11,144
6:00 p.m.	14.3	9.7	4.6	9	2	364	1,109	5,101
6:30 p.m.	10.3	8.8	1.5	5	0	213	611	917
3 Hour Total, 4:00-7:00 p.m.			4.4	76	41	2,554	8,531	37,126
2 Hour Total, 5:00-7:00 p.m.			4.7	54	14	1,791	5,844	26,473

Table 25.
Westbound P.M. Travel Time Savings for Katy Transitway Traffic, Gessner Exit to SH 6, October 1989

Time of Day	Average Travel Time		Time Saved by Transitway (minutes)	Transitway Volumes				Travel Time Saved (person minutes)
	Non Transitway (minutes)	Transitway (minutes)		Buses	Vans	Carpools	Persons	
4:00 p.m.	6.6	6.6	0.0	5	14	219	758	0
4:30 p.m.	7.3	6.9	0.4	6	4	178	627	251
5:00 p.m.	7.3	6.6	0.7	12	3	268	996	697
5:30 p.m.	9.1	7.0	2.1	10	3	301	1,006	2,113
6:00 p.m.	6.9	6.8	0.1	9	3	259	870	87
6:30 p.m.	6.8	6.4	0.4	2	0	143	348	139
3 Hour Total, 4:00-7:00 p.m.			0.7	44	27	1,368	4,605	3,287
2 Hour Total, 5:00-7:00 p.m.			0.9	33	9	971	3,220	3,036

Total Time Saved = 37,126 + 3,287 = 40,413 Person Minutes (4:00-7:00 p.m.).
Total Time Saved = 26,473 + 3,036 = 29,509 Person Minutes (5:00-7:00 p.m.).

Table 26.
Total Travel Time Savings for Westbound Katy Transitway Traffic

Time of Day	5/85	11/87	10/88[1]	10/89
Time Saved by Transitway (minutes)[2]				
3:30 p.m.	-0.9	-0.9	—	—
4:00 p.m.	-0.1	-0.9	-0.3	3.9
4:30 p.m.	5.5	-1.8	6.4	3.9
5:00 p.m.	10.3	-0.5	-0.1	5.1
5:30 p.m.	12.2	3.1	-0.7	6.2
6:00 p.m.	2.0	4.5	4.3	4.7
6:30 p.m.	—	—	2.6	1.7
3 Hour Total, 4:00-7:00 p.m.	5.5	1.0	1.9	4.8
2 Hour Total, 5:00-7:00 p.m.	7.0	2.2	1.1	5.0
Transitway Person Volume				
3:30 p.m.	278	407	—	—
4:00 p.m.	412	1,024	1,011	1,107
4:30 p.m.	654	1,435	1,566	1,580
5:00 p.m.	496	1,632	1,907	1,981
5:30 p.m.	364	1,909	1,844	2,143
6:00 p.m.	180	898	1,023	1,109
6:30 p.m.	—	—	563	611
3 Hour Total, 4:00-7:00 p.m.	2,384	7,380	7,914	8,531
2 Hour Total, 5:00-7:00 p.m.	1,926	4,921	5,337	5,844
Travel Time Saved (person-minutes)				
3:30 p.m.	-246	-366	—	—
4:00 p.m.	-30	-937	-142	4,649
4:30 p.m.	3,576	-2,646	4,829	6,255
5:00 p.m.	5,110	-831	-48	10,008
5:30 p.m.	4,436	5,880	-838	13,257
6:00 p.m.	366	4,363	3,499	5,188
6:30 p.m.	—	—	930	1,056
3 Hour Total, 4:00-7:00 p.m.	13,212	7,044	8,231	40,413
2 Hour Total, 5:00-7:00 p.m.	13,488	10,627	3,543	29,509

[1] *The 4:00, 5:00 and 6:00 p.m. transitway travel times were measured in November 1988, as October 1988 travel times were not available for these time periods.*

[2] *Time saved by transitway (minutes) was calculated, and rounded to tenths, by dividing "person-minutes" by "person volume."*

The change in travel time for freeway users is also a concern. A comparison of freeway mainlane travel times in 1989 was made with similar data for 1985. Tables 27 and 28 use the travel time saved, the freeway occupancy rate from Table 3 (1.11 persons per vehicle), and the volume count at Gessner (assumed as an average flow rate for the 13 miles) to calculate the vehicle-minutes of travel time saved. Tables 27 and 28 indicate that there are significant travel time savings for freeway users during both the morning and afternoon peak periods. The

average of the a.m. and p.m. travel time savings for freeway users is used as the evaluation criterion for this chapter of the report.

Table 27.
Eastbound A.M. Travel Time Savings for Katy Non Transitway Traffic,
SH 6 to S.P.R.R. Overpass, October 1989

Time of Day	Non Transitway 1985 (minutes)	Non Transitway 1989 (minutes)	Time Saved 1985-1989 (minutes)	Vehicle Volume at Gessner[1] (vehicles)	Total Time Saved (person-minutes)
6:00 a.m.	13.8	14.3	-0.5	2,656	-1,474
6:30 a.m.	21.5	20.0	1.5	2,609	4,344
7:00 a.m.	30.2	29.2	1.0	2,210	2,453
7:30 a.m.	38.2	34.6	3.6	1,769	7,069
8:00 a.m.	32.7	31.9	0.8	1,940	1,723
8:30 a.m.	24.4	21.4	3.0	2,535	8,442
3 Hour Total, 6:00-9:00 a.m.			1.5	13,719	22,557
2 Hour Total, 6:30-8:30 a.m.			1.7	8,528	15,589

[1] *Average of Tuesday through Thursday volume.*

Table 28.
Westbound P.M. Travel Time Savings for Katy Non Transitway Traffic,
S.P.R.R. Overpass to SH 6, October 1989

Time of Day	Non Transitway 1985 (minutes)	Non Transitway 1989 (minutes)	Time Saved 1985-1989 (minutes)	Vehicle Volume at Gessner[1] (vehicles)	Total Time Saved (person-minutes)
4:00 p.m.	14.5	20.0	-5.5	2,555	-15,598
4:30 p.m.	19.6	20.3	-0.7	2,633	-2,046
5:00 p.m.	27.2	21.4	5.8	2,765	17,801
5:30 p.m.	30.3	26.2	4.1	2,574	11,714
6:00 p.m.	23.2	21.2	2.0	2,242	4,977
6:30 p.m.	—	17.1	—	2,090	—
3 Hour Total, 4:00-7:00 p.m.			1.1	14,859	16,848
2 Hour Total, 5:00-7:00 p.m.			2.9	9,671	34,492

[1] *Average of Tuesday through Thursday volume.*

Conclusion Pertaining to Evaluation Criterion

Changes in freeway speeds and travel times are the fourth criterion for evaluating the success of the Katy Transitway carpool experiment (Table 6). Table 29 indicates the results of the evaluation of the mixed-flow lanes. In terms of this evaluation factor or measure of effectiveness, the carpool experiment is considered "highly successful" in that freeway speeds

have actually improved. It is recognized that factors other than the transitway may have had a major impact on the fact that freeway speeds have improved.

Table 29.
Change in Person Delay to Mixed-Flow Traffic,
Criterion for Assessing the Success of the Katy Transitway Carpool Experiment

Date of Evaluation	Total Travel Time Saved (person-minutes)		Rating of Criterion (See Table 6)
	a.m.	p.m.	
9/86	19,485	23,102	"Highly Successful"
11/87	55,623	66,245	"Highly Successful"
10/88	-395	59,737	"Highly Successful"
10/89	22,557	16,848	"Highly Successful"

[1] *Based on average of a.m. and p.m. total travel time saved.*

CHAPTER 8
TRANSITWAY VEHICLE BREAKDOWN DATA

One of the concerns associated with permitting carpools to use the Katy Transitway has been that such an action would result in an increase in the frequency of vehicle breakdowns; if those breakdowns blocked the lane, transitway trip reliability would be adversely affected.

METRO operating data was obtained and analyzed for the period from October 29, 1984 through October 13, 1989. These data are summarized in Table 30.

Since carpools represent 96% of the vehicles, allowing carpools to use the transitway has greatly increased the number of vehicle breakdowns that occur. Carpools represent 95% of all disabled vehicles on the transitway since the time 2+ carpools began using the facility. The carpool breakdown rate between October 1988 and October 1989 (approximately 1 per 31,000 vehicle-miles of travel) is actually less than that which would exist if only buses used the facility (a breakdown rate of approximately 1 per 20,000 vehicle-miles of travel).

Conclusion Pertaining to Evaluation Criterion

An increase in the frequency of vehicle breakdowns on the Katy Transitway was the fifth evaluation criterion. The criterion was evaluated as follows: "Highly Successful," no increase; "Successful," less than a 5% increase; "Unsuccessful," increase by 5% to 15%; "Highly Unsuccessful," increase by over 15%.

Table 30.
Vehicle Breakdown Rates, Katy Transitway

Vehicle Group	10/29/84 to 10/13/89[1]	4/1/85 to 10/13/89[2]	8/11/86 to 10/13/89[3]	10/17/88 to 10/13/89[4]
Number of Disabled Vehicles				
Buses	81	78	42	18
Vans	13	13	8	0
Carpools	981	980	963	355
Total	1,075	1,071	1,013	373
Disabled Vehicles per Week	4.15	4.54	6.14	7.17
Number of Towed Vehicles				
Buses	22	22	14	5
Vans	7	7	6	0
Carpools	645	644	635	138
Total	674	673	655	243
Vehicle Miles of Travel (VMT)				
Buses	1,294,849	1,251,143	985,056	356,361
Vans	1,084,671	1,003,483	691,448	206,796
Carpools	33,493,360	33,493,360	33,164,376	11,167,264
Total	35,872,880	35,747,986	34,840,880	11,630,421
VMT Per Disabled Vehicle				
VMT/Disabled Bus	15,986	16,040	23,454	19,798
VMT/Disabled Van	83,436	77,191	86,431	———
VMT/Disabled Carpool	34,142	34,177	34,439	31,175
VMT/Disabled Vehicle, Total	33,370	33,378	34,394	31,181
VMT Per Towed Vehicle				
VMT/Towed Bus	58,857	56,870	70,361	71,272
VMT/Towed Van	154,953	143,355	115,241	———
VMT/Towed Carpool	51,928	52,008	52,227	80,198
VMT/Towed Vehicle, Total	53,224	53,117	53,192	47,862

[1] *Operating period from inception of the transitway*
[2] *Operating period from when 4+ authorized carpools were allowed onto the transitway*
[3] *Operating period from when unauthorized 2+ vehicles were allowed onto the transitway*
[4] *Operating period since use of transitway was restricted to 3+ vehicles between 6:45 a.m. and 8:15 a.m.*

Note: Towed vehicles are a subset of disabled vehicles

The data suggest that the total breakdowns have increased substantially due to carpool utilization of the transitway; this equates to "highly unsuccessful." Even though carpool breakdowns generally do not physically block the lane, their frequency (roughly one per day) does create reliability concerns and requires frequent use of the METRO emergency crews. As a result, the findings for this criterion appear warranted.

CHAPTER 9
AUTHORIZATION AND ENFORCEMENT COSTS

The decision to allow carpools on the Katy Transitway could have increased costs for both enforcement and vehicle authorization. However, in August 1986, all authorization requirements were (at least temporarily) eliminated on the transitway. As a result, authorization costs were also eliminated and, at this time, are no longer an issue.

Increase in Enforcement Costs

The Director of Transportation Programs for METRO was requested to address this issue. Her response is summarized below.

Currently, METRO does not have permanent enforcement stations on the Katy or North Transitway. The officers assigned to the lanes use a roving patrol or stationary enforcement mode as the situation dictates. Currently, there is a minimum of one officer assigned to each lane which does not represent an increase or decrease in enforcement costs.

Introduction of carpools to the Katy Transitway has resulted in an increase in traffic violations and vehicle breakdowns; however, operating costs have not been significantly affected at this time.

Conclusion Pertaining to Evaluation Criterion

Experience has shown that, at least to date, the transitway can be operated without authorization; thus, authorization costs have been eliminated.

It appears that the marginal effect on enforcement due to transitway carpool utilization has been minimal. In regard to this criterion, the Katy Transitway carpool experiment is judged to be "successful." This is the same conclusion found in the 30- and 42-month evaluation reports (TTI Research Reports 484-7 and 484-11).

CHAPTER 10
CONCLUSIONS

The evaluation of the individual criterion for the 54-month "after carpools" evaluation is summarized in Table 31. Based on that observation, as of October 1989, the Katy Transitway carpool experiment is judged to be "successful." If numerical values are assigned to the possible outcomes (with "highly successful" = 4; "successful" = 3; "unsuccessful" = 2; and "highly unsuccessful" = 1), the weighted value for the carpool experiment is 3. The criteria related to transitway person movement and mixed-flow traffic delay were rated as "highly successful" and the criteria related to transitway travel time and enforcement costs were rated as "successful." The criteria rated as "unsuccessful" or "highly unsuccessful" included nonuser perception of transitway utilization and transitway breakdowns.

Table 31.
Overall Evaluation of the Katy Transitway Carpool Experiment, 54 Months After Carpools Were Allowed onto the Transitway

Criterion	Relative Weighting	Conclusion Pertaining to Experiment	Relevant Data
1. Change in Person Movement on the Transitway Directly Attributable to Carpooling	25%	"Highly Successful"	Carpools move 61% of total a.m. peak period person movement and 67% of the total daily person movement.
2. Nonuser Perception of Katy Transitway Utilization	30%	"Unsuccessful"	Less than 40% of the nonusers feel the transitway is sufficiently utilized.
3. Change in Travel Time on the Transitway	20%	"Successful"	Average transitway speeds have decreased by 3 mph.
4. Change in Delay to Mixed-Flow Traffic	15%	"Highly Successful"	Mixed-flow speeds have increased slightly.
5. Increase in Frequency of Transitway Breakdowns	5%	"Highly Unsuccessful"	Approximately 95% of transitway vehicle breakdowns are carpools. Approximately 7 breakdowns occur per week.
6. Increase in Authorization and Enforcement Costs	5%	"Successful"	Marginal increase in costs due to carpools has not been substantial.
TOTAL	100%	"Successful"	

Since the introduction of carpools, the Katy Transitway has maintained at least a minimal level of success (defined as a rating greater than 2.5). Since the introduction of the 2+ vehicle occupancy requirement with no authorization procedures, the transitway has maintained a rating at or near the "successful" level (3.0±). The trends in transitway success are shown in Table 32.

Table 32.
Overall Evaluation of the Katy Transitway Carpool Experiment, 1985-1989

Criterion	Relative Weighting	Conclusion Pertaining to Experiment				
		Apr 1986	Apr 1987	Oct 1987	Oct 1988	Oct 1989
1. Change in Person Movement on the Transitway Directly Attributable to Carpooling	25%	2.5	4	4	4	4
2. Nonuser Perception of Katy Transitway Utilization	30%	1	2	3	3	2
3. Change in Travel Time on the Transitway	20%	4	4	3	1	3
4. Change in Delay to Mixed-Flow Traffic	15%	4	4	4	4	4
5. Increase in Frequency of Transitway Breakdowns	5%	3	1	1	1	1
6. Increase in Authorization and Enforcement Costs	5%	3	3	3	3	3
TOTAL	100%	2.63	3.20	3.30	2.90	3.00

Scoring:
1 = "Highly Unsuccessful"
2 = "Unsuccessful"
3 = "Successful"
4 = "Highly Successful"

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