

1. Report No. FHWA/TX -88/339-15F		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle The Katy Freeway Transitway, Evaluation of Operations During 1987, The Third Year of Operation				5. Report Date June 1988	
				6. Performing Organization Code	
7. Author(s) Dennis L. Christiansen and Stephen E. Ranft				8. Performing Organization Report No. Research Report 339-15F	
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135				10. Work Unit No.	
				11. Contract or Grant No. Study No. 2-10-84-339	
12. Sponsoring Agency Name and Address Texas State Department of Highways and Public Transportation P.O. Box 5051 Austin, Texas 78763-3135				13. Type of Report and Period Covered Final - September 1983 June 1988	
				14. Sponsoring Agency Code	
15. Supplementary Notes Research performed in cooperation with DOT, FHWA Research Study Title: Improving Urban Mobility Through Application of High-Occupancy Vehicle Priority Treatments					
16. Abstract This report evaluates the operation of the Katy Freeway (I-10) Transitway in Houston, Texas for calendar year 1987. This represents an evaluation of the third year of transitway operation. Two previous reports have documented experiences during the first two years of transitway operation. This research report provides an analysis of trend data related to: 1) operation of the transitway; 2) operation of the freeway mainlanes; 3) combined transitway and freeway data; and 4) data relating to transit usage and operations. In comparing a.m. peak direction data collected at Bunker Hill from before the transitway was implemented to data (combined freeway and transitway) representative of December 1987: 1) peak-hour person movement increased by 93%; 2) peak-hour vehicle occupancy increased by 21%; 3) total peak-period carpool volume increased by 127%; 4) peak-period bus passenger trips increased by 176%; and 5) vehicles parked in corridor park-and-ride lots increased by 138%. A peak-hour measure of effectiveness frequently associated with high-occupancy vehicle projects is passenger-miles/hour (the multiple of passengers times miles per hour). This measure of effectiveness (expressed in 1000's) has increased from a pre-transitway value of 36 to a value of 86 in December 1987, an increase of 139%.					
17. Key Words High-Occupancy Vehicle Lanes, Transitways, Busways, Carpools, HOV Facilities Authorized Vehicle Lanes, Priority Treatment for High-Occupancy Vehicles			18. Distribution Statement No restriction. This document is available to the public through the National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 144	22. Price

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
--------	---------------	-------------	---------	--------

LENGTH

in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km

AREA

in ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha

MASS (weight)

oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t

VOLUME

tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³

TEMPERATURE (exact)

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

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
--------	---------------	-------------	---------	--------

LENGTH

mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi

AREA

cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares (10,000 m ²)	2.5	acres	

MASS (weight)

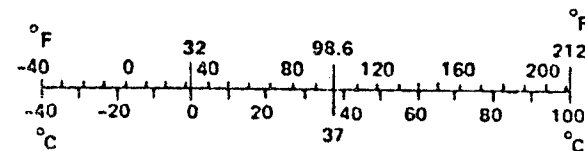
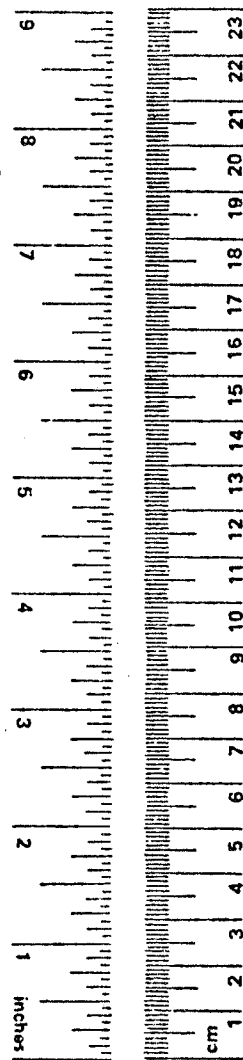
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	

VOLUME

ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	35	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F
----	---------------------	-------------------	------------------------	----



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

**THE KATY FREEWAY TRANSITWAY
EVALUATION OF OPERATIONS DURING 1987
THE THIRD YEAR OF OPERATION**

by

**Dennis L. Christiansen
Research Engineer**

and

**Stephen E. Ranft
Research Associate**

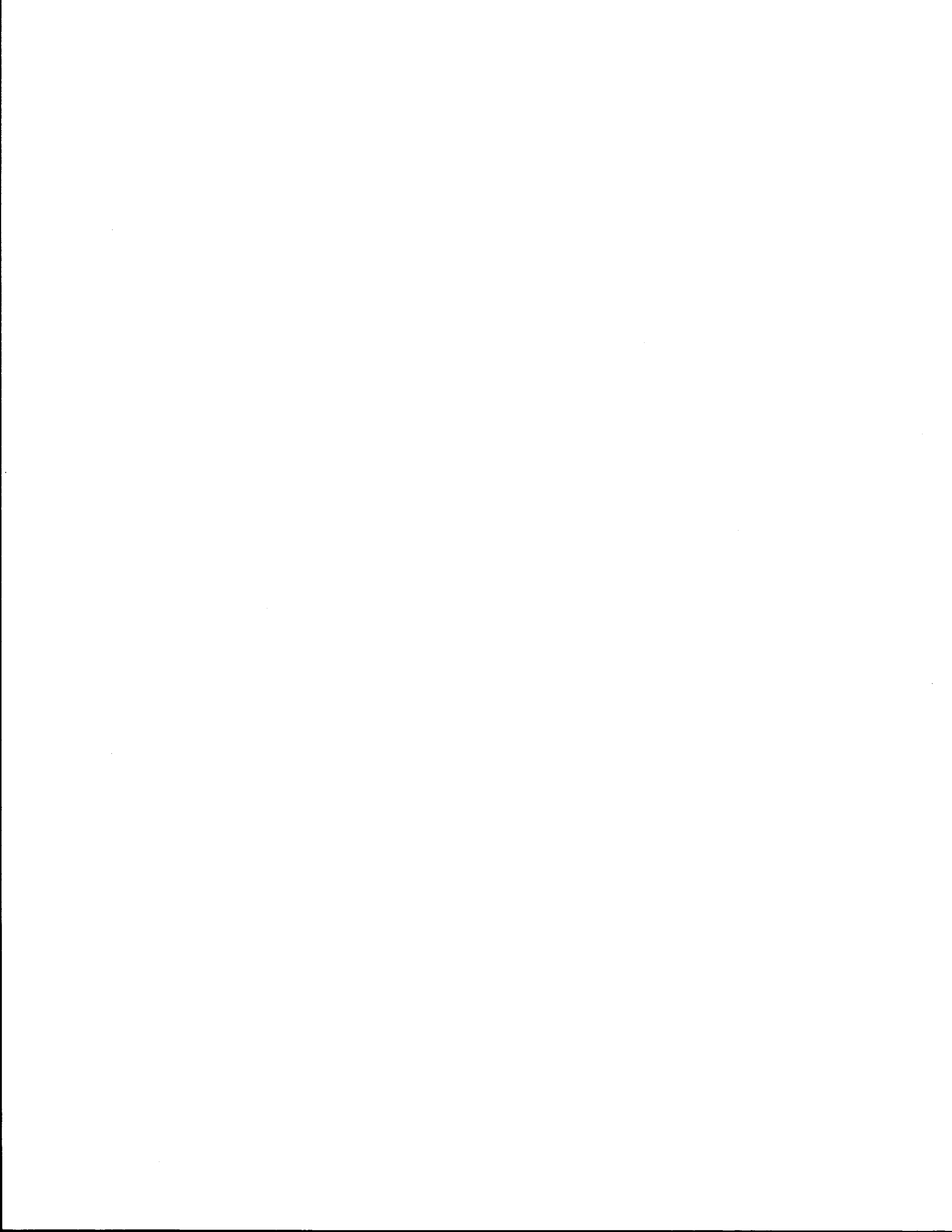
Research Report 339-15F

**Improving Urban Mobility Through Application
of High-Occupancy Vehicle Priority Treatments
Research Study 2-10-84-339**

**Sponsored by
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**

June 1988



ABSTRACT

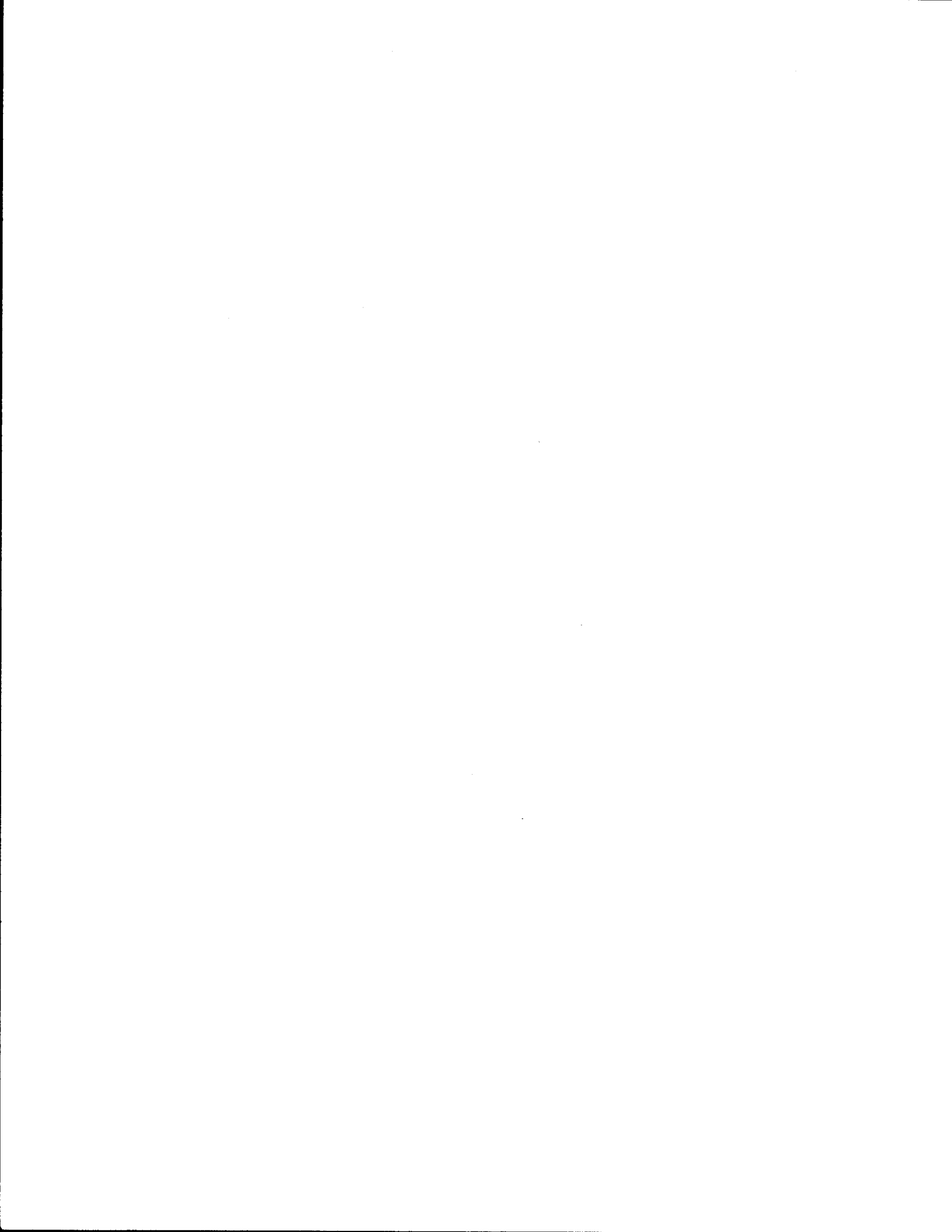
This report evaluates the operation of the Katy Freeway (I-10) Transitway in Houston, Texas for calendar year 1987. This represents an evaluation of the third year of transitway operation. Two previous reports have documented experiences during the first two years of transitway operation.

This research report provides an analysis of trend data related to: 1) operation of the transitway; 2) operation of the freeway mainlanes; 3) combined transitway and freeway data; and 4) data relating to transit usage and operations.

In comparing a.m. peak direction data collected at Bunker Hill from before the transitway was implemented to data (combined freeway and transitway) representative of December 1987: 1) peak-hour person movement increased by 93%; 2) peak-hour vehicle occupancy increased by 21%; 3) total peak-period carpool volume increased by 127%; 4) peak-period bus passenger trips increased by 176%; and 5) vehicles parked in corridor park-and-ride lots increased by 138%.

A peak-hour measure of effectiveness frequently associated with high-occupancy vehicle projects is passenger-miles/hour (the multiple of passengers times miles per hour). This measure of effectiveness (expressed in 1000's) has increased from a pre-transitway value of 36 to a value of 86 in December 1987, an increase of 139%.

Key Words: High-Occupancy Vehicle Lanes, Transitways, Busways, Carpools, HOV Facilities, Authorized Vehicle Lanes, Priority Treatment for High-Occupancy Vehicles



SUMMARY

This report summarizes and evaluates the experience and operations on the Katy Freeway (I-10) Transitway and mainlanes in Houston through December 1987, the third year of transitway operations.

Houston Transitway System

Houston is in the process of developing a 71-mile system of transitways (high-occupancy vehicle lanes) on the freeway system. These transitways are typically located in the freeway median, are 1-lane, reversible, and separated from the general purpose mainlanes by concrete median barriers. The 71-mile system is being implemented at a total cost of approximately \$500 million, and is being funded using state and federal highway dollars as well as federal and local transit monies. As of the end of 1987, 11.5 miles of transitway were operating on the Katy Freeway (I-10), and 9.1 miles were in operation on the North Freeway (I-45N).

Description of the Katy Freeway Transitway

Phase 1 of the Katy Freeway Transitway was opened in October 1984. In June 1987, the transitway was completed as far west as SH 6, a distance of 11.5 miles. Total cost for the operating segment of the transitway is approximately \$32 million, or just less than \$3 million per mile. Three major park-and-ride facilities, with a total of approximately 3600 parking spaces, are located in the corridor.

The priority lane is used by 2+ vehicles. It operates eastbound toward downtown from 5:45 to 11:00 a.m. and operates westbound from 2 to 8 p.m. Daily operations and enforcement are the responsibility of the Metropolitan Transit Authority; the annual operations and enforcement cost is approximately \$300,000.

Transitway and Freeway Mainlane Data

Katy Freeway Transitway

The transitway is currently carrying nearly 18,000 passenger trips per day. In terms of total volume, buses transport approximately 30% of transitway users in 3% of the vehicles; carpools move 66% of the persons in 95% of the vehicles, and vanpools carry 4% of the persons in 2% of the vehicles. A.M. volumes on the transitway are slightly higher than p.m. volumes, although volumes in both peaks have increased markedly over the past year (Table S-1).

Table S-1. Summary of Selected Transitway Data

Data	Representative 12/87 Value	% Change 12/86 to 12/87
Person Volume, Daily	17,897	+25%
A.M. Peak Hour	4,580	+25%
A.M. Peak Period	8,703	+18%
P.M. Peak Hour	3,812	+30%
P.M. Peak Period	8,129	+29%
Vehicle Volume, Daily	5,733	+36%
A.M. Peak Hour	1,469	+28%
A.M. Peak Period	2,788	+21%
P.M. Peak Hour	1,180	+38%
P.M. Peak Period	2,517	+32%
Estimated Transitway Capacity, vph	1,500	---
Transitway Vehicle Occupancy, a.m. peak hour	3.12	-3.4%
Transitway Violation Rates	less than 1%	---

Transitway Safety. The transitway accident rate for the period from 1986 through 1987 was 1.07 accidents per million vehicle miles. This is approximately 80% of the accident rate for the freeway mainlanes during that same time period.

Katy Freeway Mainlanes

The diversion of carpools to the transitway has reduced average occupancy on the freeway mainlanes. However, the increase in vehicular volume has more than offset the decrease in occupancy, resulting in greater person throughput on the mainlanes. The freeway accident rate has not been adversely impacted by implementing the transitway (Table S-2).

Table S-2. Summary of Selected Freeway Mainlane Data

Data ¹	"Representative" Pre-Transitway Value	Representative 12/87 Value	% Change
Person Volume			
A.M. Peak Hour	5,100	5,284	+ 4%
A.M. Peak Period	15,655	17,399	+11%
P.M. Peak Hour	5,657	5,667	0%
P.M. Peak Period	16,873	18,953	+12%
Vehicle Volume			
A.M. Peak Hour	4,043	4,993	+24%
A.M. Peak Period	12,750	15,925	+24%
P.M. Peak Hour	4,266	5,178	+21%
P.M. Peak Period	12,706	17,410	+37%
Vehicle Occupancy (persons/vehicle)			
A.M. Peak Hour	1.26	1.06	-16%
P.M. Peak Hour	1.33	1.09	-18%
Travel Speed (mph)			
A.M. Peak Hour	21.4	22.5	+ 5%
P.M. Peak Hour	25.9	32.8	+27%
Accident Rate (accidents/MVM)	1.69	1.25	-26%

¹Data collected between an off-ramp and an on-ramp at Bunker Hill.

Combined Katy Freeway Mainlane and Katy Transitway Data

In comparing pre-transitway conditions to current conditions, person volume and average vehicle occupancy have increased significantly. Also, there has been a substantial increase in carpooling (Table S-3). Carpooling on the transitway is also proving to be an effective means for serving travel demands to the suburban activity centers.

Table S-3. Combined Freeway Mainlane and Transitway Data

Characteristic Combined Mainlane and Transitway	"Representative" Pre-Transitway Value	Representative 12/87 Value	% Change
Person Volume			
A.M. Peak Hour	5,100	9,864	+93%
P.M. Peak Hour	5,657	9,479	+68%
Vehicle Volume			
A.M. Peak Hour	4,043	6,462	+60%
P.M. Peak Hour	4,266	6,358	+49%
Average Vehicle Occupancy (persons/vehicle)			
A.M. Peak Hour	1.26	1.53	+21%
P.M. Peak Hour	1.33	1.49	+12%
Transitway Travel Time Savings (min.)			
A.M. Peak Hour	---	12	---
P.M. Peak Hour	---	5	---
2+ Carpool Volumes			
A.M. Peak Hour	505	1,630	+223%
P.M. Peak Hour	768	1,518	+98%
Carpools Destined to 3 Suburban Activity Centers (a.m. peak period)	630	1,084	+72%

Increase in Carpooling Due to Transitway. Carpools have increased significantly since the transitway opened (Table S-3). Surveys of carpoolers on the transitway conducted during the a.m. peak period illustrate that most of the carpools using the transitway are "new" carpools. The previous mode of travel for the transitway carpoolers is: drove alone, 52%; carpooled or vanpooled, 33%; rode a bus, 9%; new trip, 6%.

Bus Transit Data

The park-and-ride and transitway service is attracting young, educated white-collar workers. Since the transitway opened, Metro has greatly increased bus service; in spite of that increase, average bus occupancy has also increased (Table S-4).

Table S-4. Summary of Bus Transit Data

Data	"Representative" Pre-Transitway Value	Representative 12/87 Value	% Change
Bus Passengers			
A.M. Peak Hour	336	1,327	+295%
P.M. Peak Hour	297	1,270	+328%
Bus Vehicle Trips			
A.M. Peak Hour	11	38	+245%
P.M. Peak Hour	10	32	+210%
Average Bus Occupancy (persons/bus)			
A.M. Peak Hour	30.5	34.9	+ 14%
P.M. Peak Hour	28.7	39.7	+ 38%
Vehicles Parked at Park-and-Ride Lots	575	1,368	+138%

Comparison of Data, Freeways With and Without Transitways

Tables S-1 through S-4 indicate that significant changes have occurred on the Katy Freeway since the implementation of the transitway. In an attempt to determine how much of that change is the result of providing the transitway, data from the Katy Freeway are compared with similar data from other Houston freeways that do not have transitways (Table S-5). While substantial changes have occurred on the Katy Freeway since the opening of the transitway, this is not the case with freeways that do not have transitways. It appears that provision of the transitway lane is responsible for most of the change that has occurred in the Katy corridor.

Table S-5. Comparison of Measures of Effectiveness, Freeways With (Katy, I-10) and Freeways Without Transitways, Houston

Measure of Effectiveness	Representative 1984 Value	Representative 12/87 Value	% Change
Average A.M. Peak-Hour Vehicle Occupancy			
Freeway w/transitway	1.26	1.53	+21%
Freeway (Gulf) w/o transitway	1.29	1.25	- 3%
A.M. Peak Hour Carpool Volume Change			
Freeway w/ transitway	505	1,630	+223%
Freeway (Gulf) w/o transitway	474	428	-10%
Bus Passengers			
Freeway w/ transitway	900	2,485	+176%
Freeway (Gulf) w/o transitway	1,188	1,111	- 6%
Cars Parked at Park-and-Ride Lots			
Freeway w/ transitway	575	1,368	+138%
Freeway w/o transitway ¹	2,722	3,033	+11%
Facility Per Lane Efficiency ²			
Freeway w/ transitway	36	86	+139%
Freeway (Gulf) w/o transitway	59	42	-29%

¹Combined data for Northwest, Southwest and Gulf Freeways.

²A.M. Peak-Hour, peak-direction passengers multiplied by average operating speed.

A.M. Peak-Hour Measure of Lane Efficiency

In assessing the efficiency of a lane, a measure that is used is the multiple of peak-hour person volume times average vehicle speed. This takes into account both the magnitude of persons transported as well as the speeds at which they are moved.

The efficiency of the Katy Transitway lane is over 5 times that of a general purpose freeway mainlane. Since the transitway was implemented, the overall per lane efficiency on the Katy Freeway has increased by 139% (Table S-6).

Table S-6. A.M. Peak Hour Per Lane Efficiency¹ (passenger-miles per hour), Katy Freeway and Transitway

Roadway	"Representative" Pre-Transitway Value (1000's)	Representative 12/87 Value (1000's)	% Change
Katy Freeway Mainlanes	36	40	+ 11%
Katy Transitway Lane	---	229	---
Combined Katy Freeway Mainlanes and Transitway	36	86 ²	+139%

¹A.M. Peak-Hour, Peak-Direction Lane efficiency equals person volume per lane multiplied by average operating speed.

²This is the multiple of total peak-hour passengers (freeway plus transitway) multiplied by the weighted average speed and divided by 4 lanes.

Mainlane Motorist Acceptance of the Transitway

In order to address the perception that the transitway was underutilized, the type of vehicles allowed onto the transitway has been changed on several occasions. As the volume of vehicles operating on the transitway has increased, so has acceptance of the transitway by motorists in the freeway mainlanes (Table S-7). In the October 1987 survey, 63% of the mainlane motorists stated they felt the transitway was a good transportation improvement.

Table S-7. Perception of the Utilization of the Katy Transitway
By Motorists in the General Freeway Lanes

Measure of Effectiveness	Non Transitway Users			
	3/85 ¹	4/86 ²	4/87 ³	10/87 ³
Transitway A.M. Peak Period Vehicle Volume	138	256	2410	2922
Is the transitway sufficiently utilized?				
Yes	3%	3%	36%	44%
No	90%	92%	55%	42%
Not Sure	7%	5%	9%	14%
Is the transitway a good transportation improvement?				
Yes	41%	36%	56%	63%
No	35%	43%	29%	20%
Not Sure	24%	21%	15%	17%

¹Authorized buses and vanpools (before carpools).

²Authorized buses, vanpools and 3+ carpools.

³2+ vehicles, no authorization.

IMPLEMENTATION STATEMENT

This study was sponsored by the Texas State Department of Highways and Public Transportation as part of an overall effort entitled "Improving Urban Mobility Through Application of High-Occupancy Vehicle Priority Treatments". An objective of this research is to perform a comprehensive "before" and "after" evaluation of the five freeway transitways being implemented in Houston, Texas. An intent of these evaluations is to develop guidelines for planning, designing and operating transitways on Texas freeways.

The first of the completed transitways opened on the Katy Freeway (I-10) in Houston in October 1984. This is the third report prepared as part of this project to evaluate operations on the Katy Transitway and Katy Freeway. This report focuses primarily on data collected during calendar year 1987.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas State Department of Highways and Public Transportation. This report does not constitute a standard, specification, or regulation.



TABLE OF CONTENTS

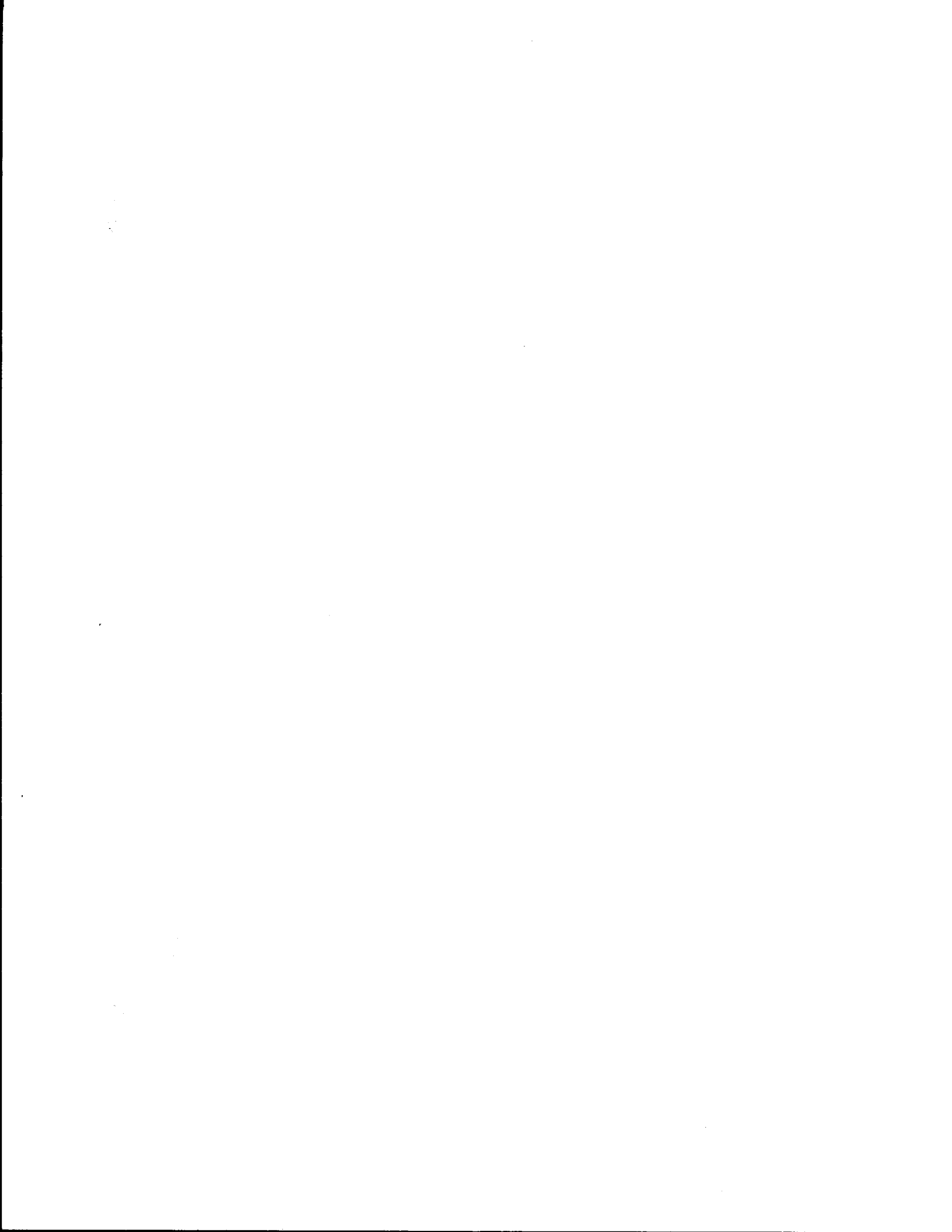
	Page
ABSTRACT	iii
SUMMARY	v
Houston Transitway System	v
Description of Katy Freeway Transitway	v
Transitway and Freeway Mainlane Data	vi
Comparison of Data, Freeways With and Without Transitways ...	ix
A.M. Peak-Hour Measure of Lane Efficiency	x
Mainlane Motorist Acceptance of the Transitway	xi
IMPLEMENTATION STATEMENT	xiii
DISCLAIMER	xiii
I. INTRODUCTION	1
Organization of the Report	1
II. PROJECT DESCRIPTION	5
Proposed Transitway Enhancement	10
Park-and-Ride Facilities	12
Transitway Capital and Operating Costs	12
Data Collection Locations	15
III. TRANSITWAY DATA	19
Vehicles Eligible to Use the Transitway	19
Transitway Person Volumes	21
Transitway Vehicle Volume Data	30
Transitway Vehicle Occupancy	38
Transitway Violation Rate	46
Transitway Vehicle Breakdown Rate	47
Transitway Accident Rate	48
Transitway Lane Measure of Effectiveness	48
Estimated Travel Time Elasticities, Houston Data	49
Summary of Selected Transitway Data	51

TABLE OF CONTENTS (continued)

	Page
IV. DATA RELATING TO FREEWAY MAINLANE OPERATION	53
Characteristics of Freeway Mainlane Motorists	53
Motorist Attitudes Regarding Transitway	55
Freeway Mainlane Person Volumes	56
Freeway Vehicular Volumes	59
Vehicle Occupancy	64
Travel Time and Speed	67
Freeway Accident Rate	70
Freeway Lane Measure of Effectiveness	71
Summary of Selected Freeway Mainlane Data	71
V. COMBINED FREEWAY MAINLANE AND TRANSITWAY DATA	75
Person Volumes	75
Vehicular Volumes	78
Average Vehicle Occupancy	81
Combined Volume and Occupancy Data	85
Carpooling Characteristics	89
Increase in Carpooling Due to Transitway Implementation	91
Travel Time Savings	98
Transitway Mode Split	103
Measure of Efficiency for the Freeway and Transitway	104
Summary, Selected Combined Freeway Mainlane and Transitway Data	104
VI. BUS TRANSIT DATA	109
Ridership Characteristics	109
Bus Passengers and Bus Trips	111
Bus Occupancy	114
Bus Operating Speed	114
Vehicles Parked in Corridor Park-and-Ride Facilities	115
Summary of Transit Data	119
VII. CONCLUSIONS	121
Transitway Impacts	121

TABLE OF CONTENTS (Continued)

	Page
Freeway Impacts	123
Future Issues	123



I. INTRODUCTION

The Houston area is committed to developing approximately 70-miles of transitways within freeway rights-of-way (Figure 1). These facilities are to be constructed on five radial freeways. Phase 1 of the first completed transitway opened on the Katy Freeway (I-10) in October 1984.

The commitment to transitways in Houston is extensive, and the design being used for these facilities is conceptually different from what has been developed elsewhere in the nation. As a consequence, many of the guidelines and standards to be used in developing the transitway system are being learned through experience. Since the Katy Transitway is the first of the transitways to open in completed form, it is being intensively used as a laboratory for the evaluation of design approaches and operating procedures.

Through this research effort, a comprehensive "before" and "after" evaluation of the Katy Transitway is being undertaken; an objective of the research is to use the experience on the Katy Transitway to develop improved guidelines for planning, designing and operating the transitways being provided in Houston.

This report evaluates data related to the transitway and the freeway for calendar year 1987. Two previous reports (Research Reports 339-6 and 339-11) analyzed data for the first two years of transitway operation (October 1984 through 1986).

Organization of the Report

The remainder of this report is comprised of six major sections. The following section provides a description of the transitway as well as presenting construction cost information.

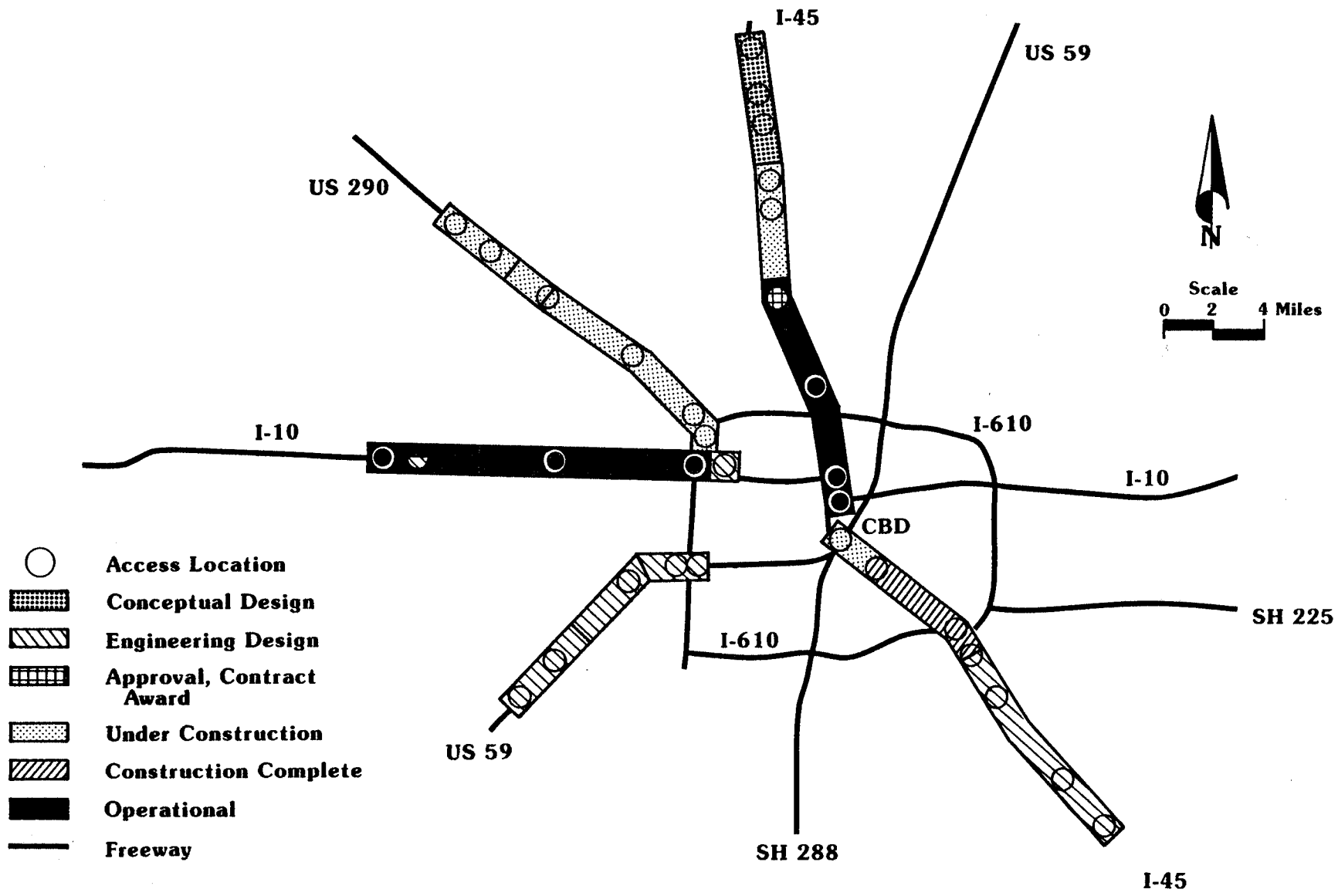
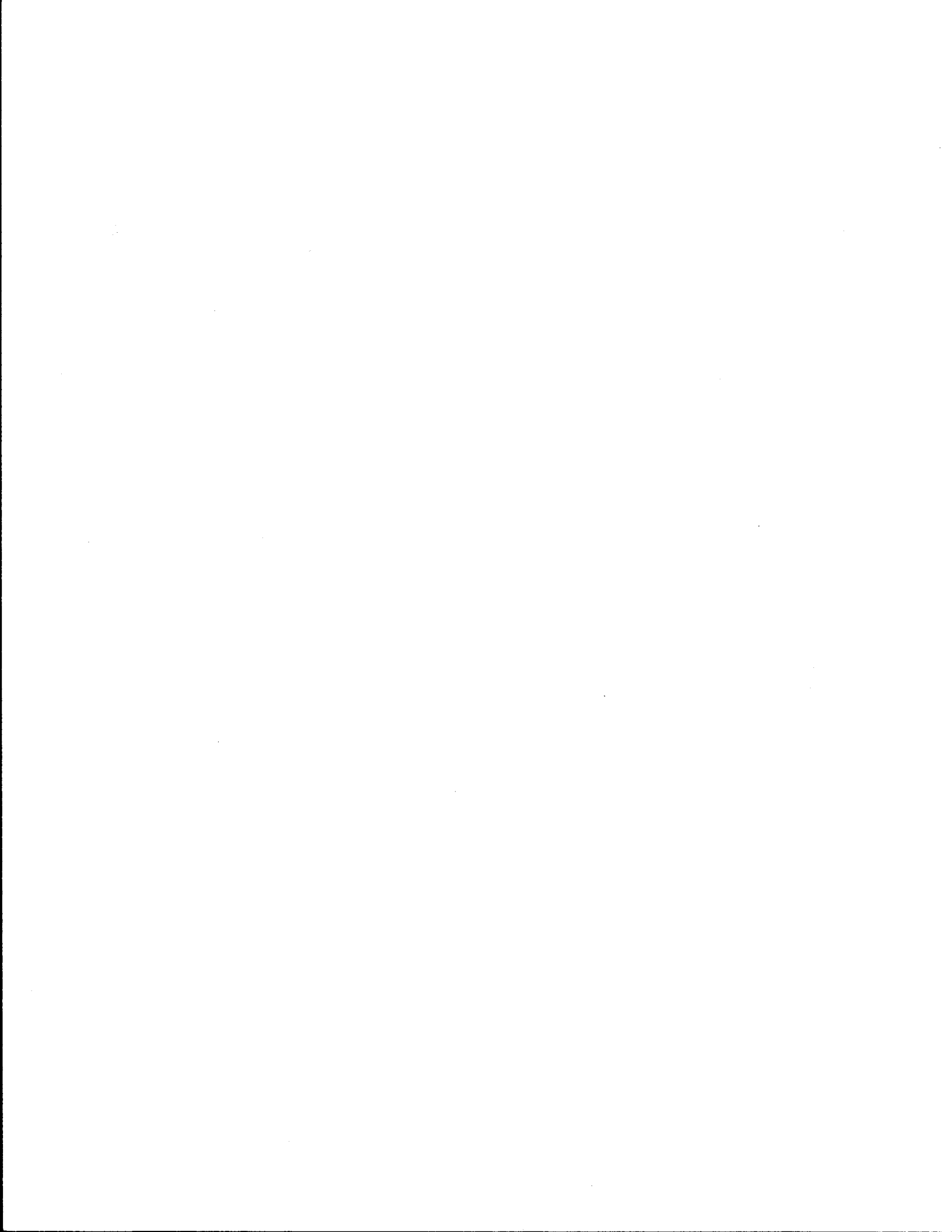


Figure 1. Status of Transitway Development, December 1987

Detailed data have been collected relating to all aspects of travel in the Katy Freeway corridor. Those data are presented and analyzed in four sections as described below.

- Data relating to transitway operations. These data relate to the travel that occurs within the confines of the transitway.
- Data relating to freeway operations. These data relate to the travel that occurs in the mainlanes of the Katy Freeway.
- Combined freeway and transitway data. The transitway data and freeway mainlane data are combined to reflect total travel on the facility.
- Transit data. Data related to transit use and operations are presented in this section.

Finally, a section containing conclusions is presented.



II. PROJECT DESCRIPTION

The Katy Freeway (I-10) is a major interstate highway serving travel demands in the western part of Houston and Harris County (Figure 2). The Katy Freeway is primarily a six-lane freeway, with a section of 8-lane facility near I-610. In 1987, the highest average daily traffic (ADT) on the Katy Freeway was approximately 175,000¹.

The Katy Freeway Transitway was implemented in 3 phases; the first phase (4.7 miles) opened October 29, 1984 between Post Oak and Gessner (Figure 3). On May 2, 1985, the transitway was extended from Gessner to West Belt, resulting in a total of 6.4 miles of transitway. On June 29, 1987, the third phase of the transitway opened; this phase extended the transitway to just west of SH 6, resulting in approximately 11.5 miles of transitway. At present, the Katy Transitway operates inbound toward downtown from 5:45 a.m. to 11:00 a.m.; it operates outbound in the afternoon from 2:00 p.m. to 8:00 p.m. Daily operations and enforcement is handled by the Metropolitan Transit Authority of Harris County.

The cross section of the transitway is typical of the Houston transitway system. The transitway is located in the median of the freeway, is one-way and reversible, and is separated from the general purpose traffic lanes by concrete median barriers (Figure 4). The transitway is typically 19.5 feet wide; this results in sufficient width to permit passing of a stalled vehicle.

Three access/egress locations exist on the 11.5-mile transitway. At the eastern end of the transitway near I-610, an elevated flyover ramp leaves the median of the freeway and ties into an arterial street at the Post Oak and Old Katy Road intersection (Figure 5). At this intersection, vehicles leaving the transitway can either travel south toward Galleria/City Post Oak (a major suburban activity center) or can continue east to re-enter the Katy

¹Count location on I-10 at Silber. Source, Texas Transportation Institute Research Report 484-7.

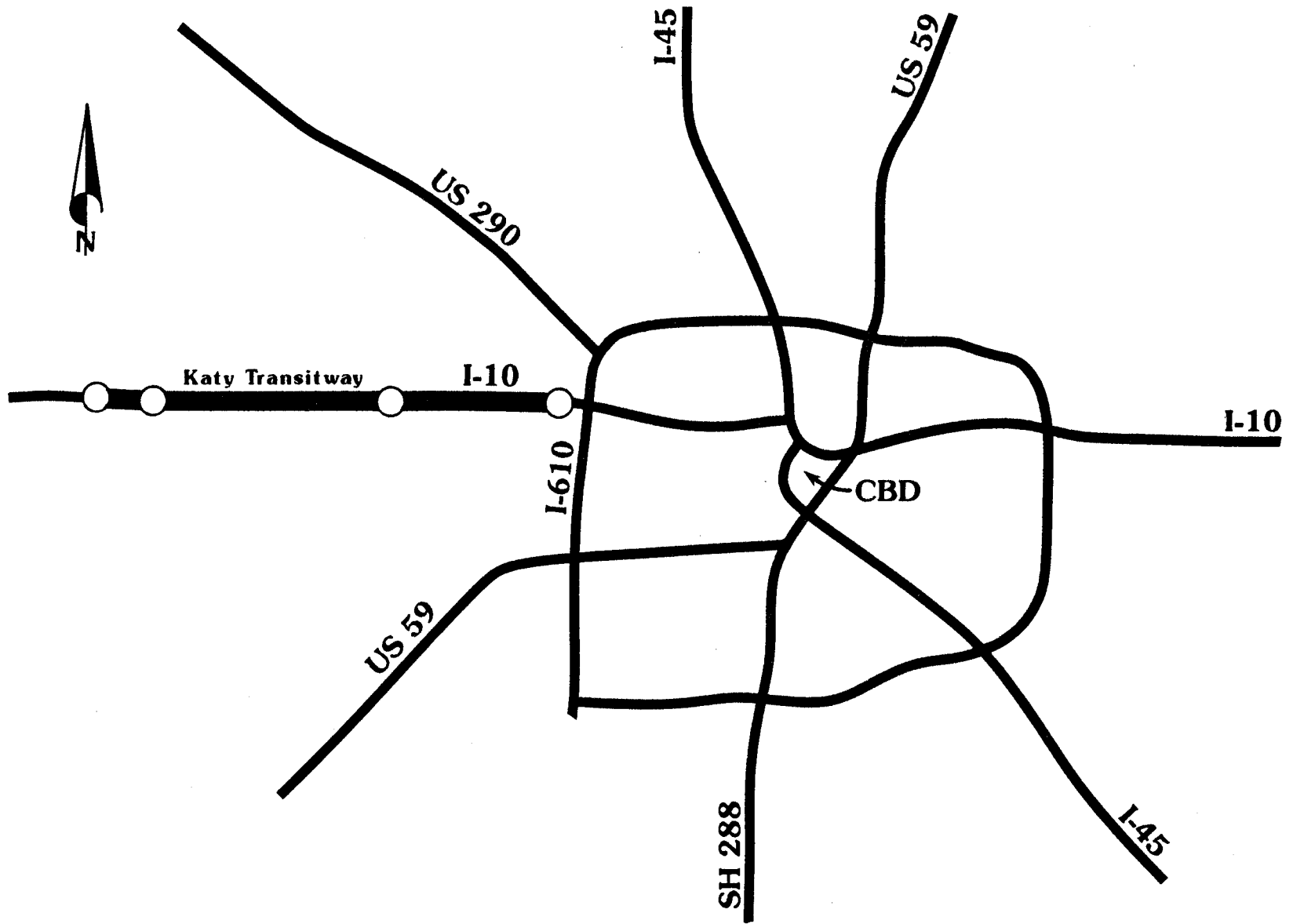


Figure 2. Location of Katy Transitway Corridor

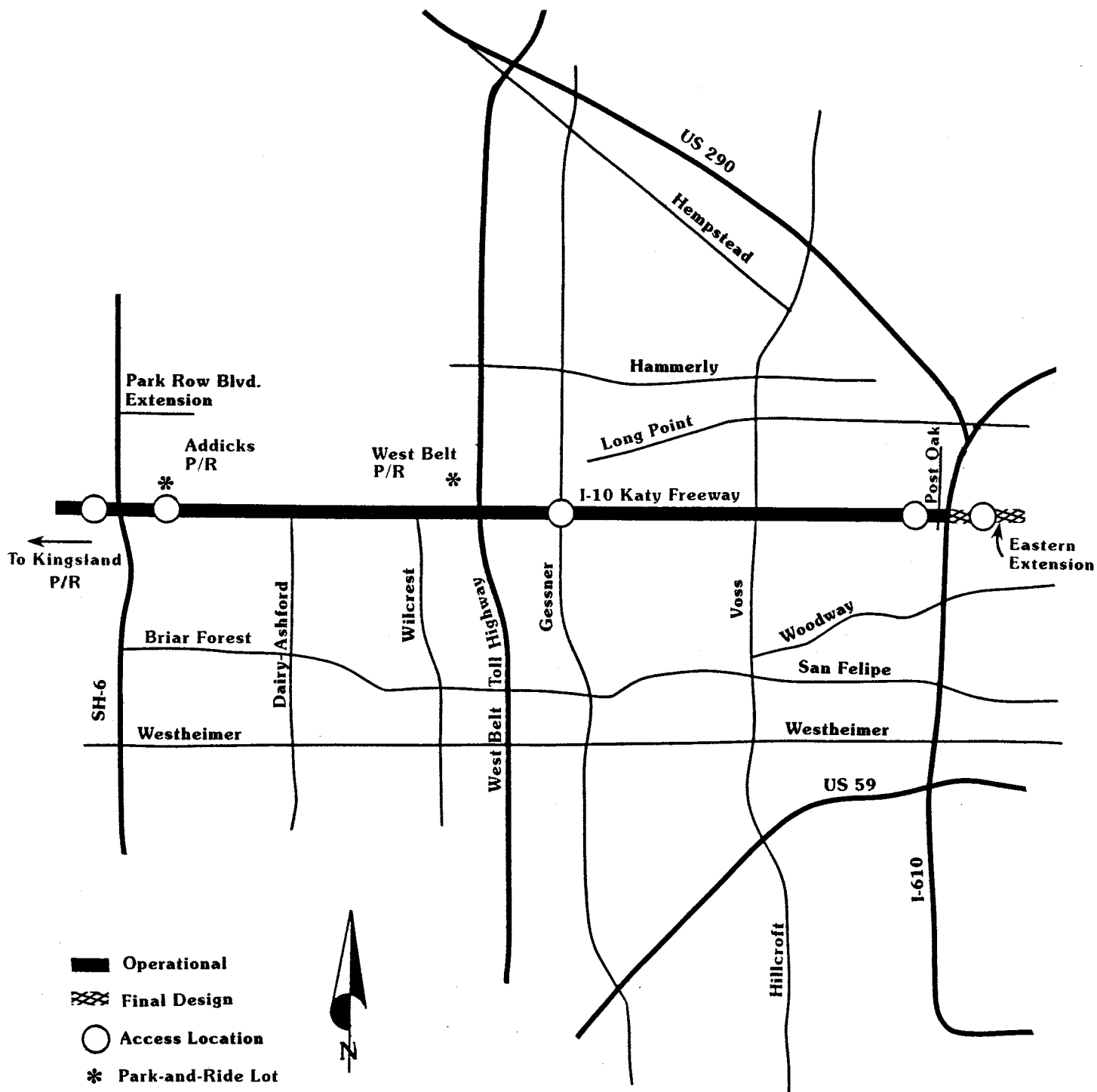
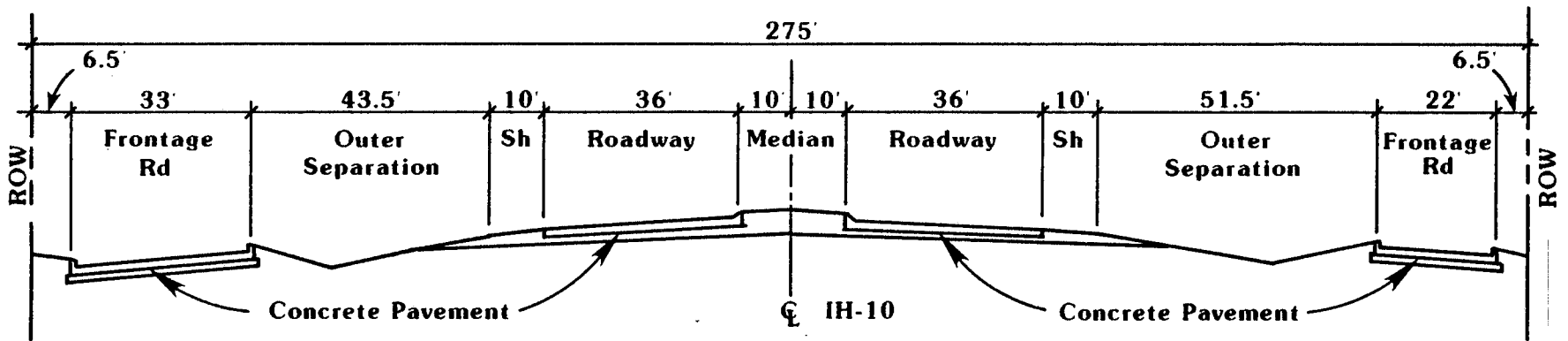
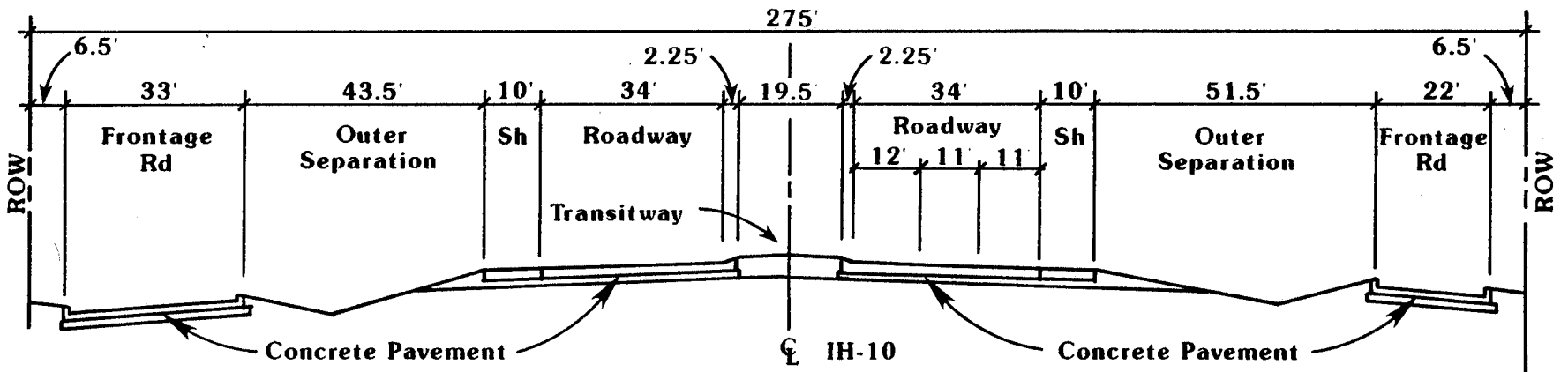


Figure 3. Katy Freeway Transitway



Typical Section Before Transitway Construction

8



Typical Section After Transitway Construction

Figure 4. Typical Sections, Before and After Transitway Construction, Katy Freeway Transitway

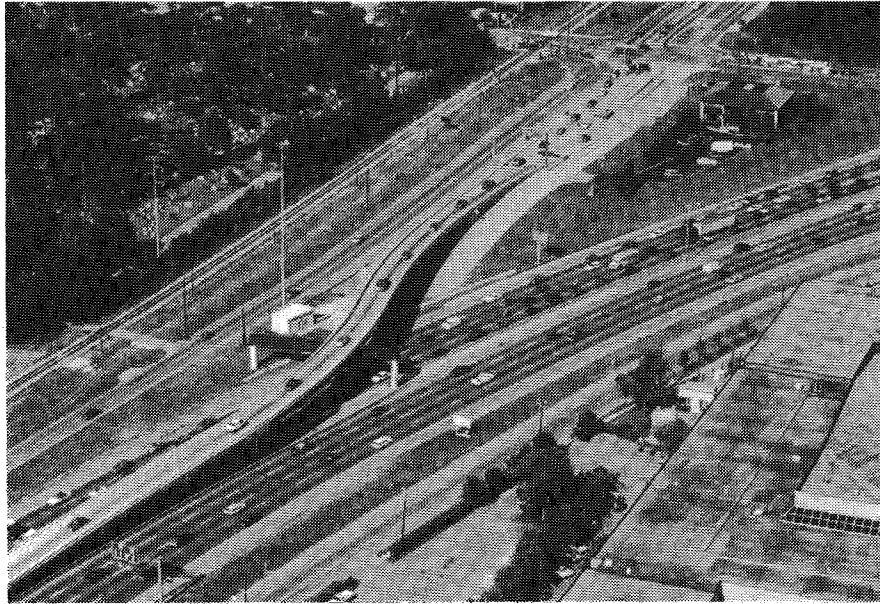


Figure 5. Transitway Flyover Ramp at Eastern Terminus of Katy Transitway

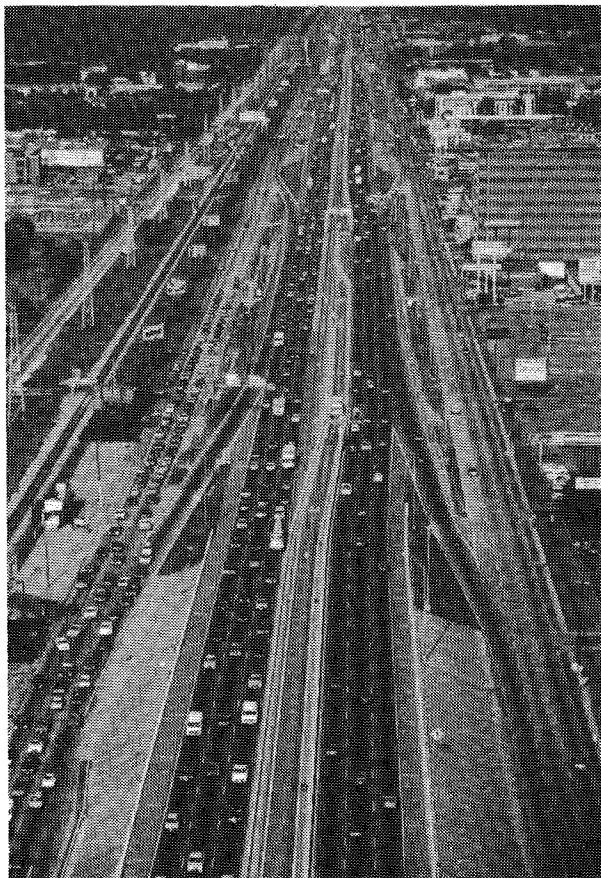


Figure 6. Slip Ramp Transitway Access/Egress in Vicinity of Bunker Hill

Freeway to travel toward the downtown area in the mixed-flow, general purpose lanes.

At the intermediate access/egress location in the vicinity of Bunker Hill, concrete median barrier sections form slip ramps to provide access/egress to the transitway from the inside freeway lanes (Figure 6). At the western terminus, the first of the elevated transitway interchanges to be constructed in Houston has become operational. The transitway becomes elevated in the median of the freeway (Figure 7). Transitway vehicles are able to use either an elevated "T" ramp to access a park-and-ride facility or, to the west of the elevated "T" ramp connection, can access/egress the Katy Freeway general purpose inside freeway lanes at a slip ramp similar to the one located at Bunker Hill. This elevated interchange was opened in June 1987. It is designed so that an elevated ramp can be built in the future to connect to the south side of the freeway; at that time, the "T" interchange will become a 4-way interchange.

Proposed Transitway Enhancement

Presently, at the eastern terminus of the transitway, all transitway traffic passes through the signalized intersection at Old Katy Road and North Post Oak. Vehicles desiring to continue to travel toward downtown must use a section of surface arterial street and re-enter the Katy Freeway east of the I-610 interchange.

Plans have been developed to extend the transitway approximately 1.5 miles to the east. This eastern extension will allow vehicles desiring to travel to/from downtown to access/egress the transitway from the inside freeway lane east of I-610. That HOV traffic will no longer have to travel through the signalized street intersection. The improvement is estimated to cost \$5.5 million and is scheduled to become operational in mid to late 1989.

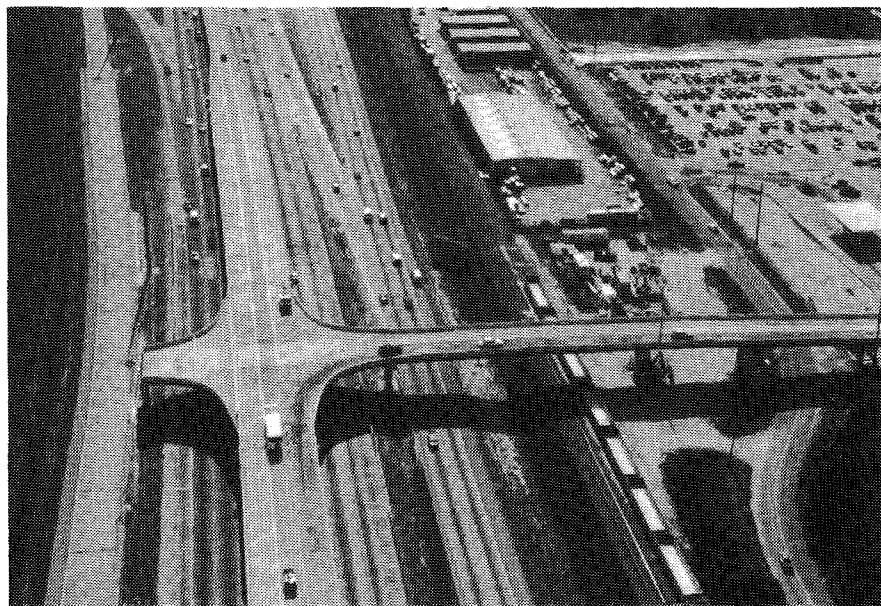
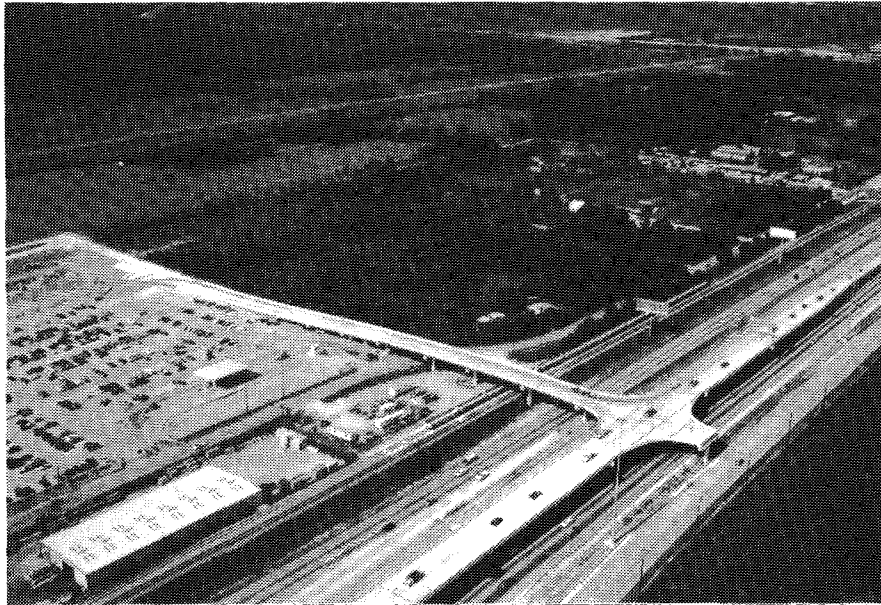


Figure 7. Elevated "T" Ramp Interchange at Western Terminus of Katy Transitway

Park-And-Ride Facilities

Three major park-and-ride facilities exist in the corridor. The Kingsland lot has 1326 spaces (Figure 8). The Addicks lot (Figure 9) is in the process of being expanded. At present, approximately 850 spaces are available at the lot; the number of spaces available at that lot has been reduced for construction of the elevated ramp connection to the transitway. A third lot exists at West Belt (Figure 10); that lot has 1111 spaces. Utilization of these lots is discussed in a subsequent section of this report.

In addition, 3 carpool formation lots exist to the west of the western terminus of the transitway. All of these lots have between 375 and 410 parking spaces, are paved and lighted. Utilization of these lots is discussed subsequently in this report.

Transitway Capital and Operating Costs

Capital Cost

The 11.5-mile transitway has been developed at a total cost of approximately \$32 million, or less than \$3 million per mile. Of the cost, approximately 6% was funded by UMTA Section 3 or Section 5 monies; 85% was funded from local Metro transit dollars; and 9% was funded by the State Department of Highways and Public Transportation. The elements of the total cost are summarized in Table 1.



Figure 8. Kingsland Park-and-Ride Lot, Katy Freeway Corridor



Figure 9. Addicks Park-and-Ride Lot, Katy Freeway Corridor



Figure 9. Addicks Park-and-Ride Lot, Katy Freeway Corridor (Continued)

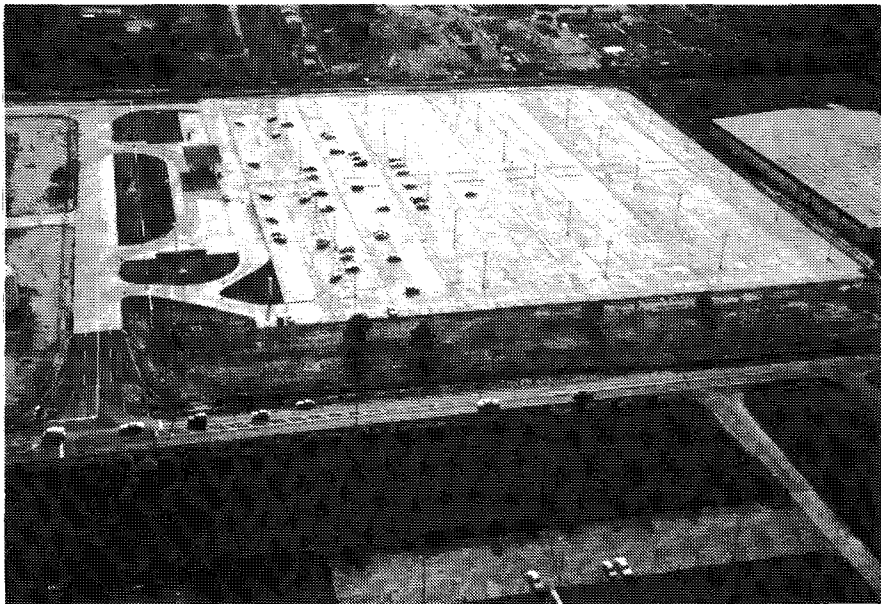


Figure 10. West Belt Park-and-Ride Lot, Katy Freeway Corridor

Table 1. Estimated Capital Cost of the Katy Freeway Transitway

Cost Component	Estimated Cost (\$ millions)
<u>Post Oak to SH 6, 11.5 miles</u>	
Transitway in Freeway Median	\$19.215
Elevated Interchange at Addicks	\$ 5.874
Surveillance, Control and Communication	<u>\$ 6.631</u>
Sub-Total	\$31.720
<u>Committed or Completed Enhancements</u>	
Expansion of Addicks Park-and-Ride Lot	\$ 6.254
Eastern 1.5-mile Extension	<u>\$ 5.466</u>
Sub-Total	\$11.720
<u>Other Possible Improvements</u>	
Inner Katy Connector	\$ 5.256
Ramp Improvements for Carpools	\$ 1.235
Relocate Gessner Ramp	\$ 0.439
South Ramp at Addicks	\$ 0.222
Operating Development and Misc.	<u>\$ 4.587</u>
Sub-Total	<u>\$11.739</u>
TOTAL (13.0 miles)	\$55.179

Source: Metropolitan Transit Authority of Harris County

Operating Cost

Metro is responsible for day-to-day operations of both the North and Katy Transitways. The cost of operating both these facilities is estimated by Metro to be \$50,000 per month (\$25,000 per facility). This includes costs for both operational and enforcement staffs as well as vehicle maintenance.

Data Collection Locations

As part of the evaluation of the Katy Transitway, pertinent data have been collected on a regular basis since June 1983. Much of these data, such as travel time and speed, relate to the entire length of the transitway.

Freeway data are routinely collected at the following two locations (Figure 11).

- Eldridge. A location just east of the western terminus of the transitway. The transitway opened to this location in June 1987. Since the transitway only operated to this location for half of 1987, only limited Eldridge data are included in this report. Expanded data from Eldridge will be included in subsequent reports.
- Bunker Hill. A location just east of the intermediate transitway access/egress point at Bunker Hill. The transitway opened to this location in October 1984.

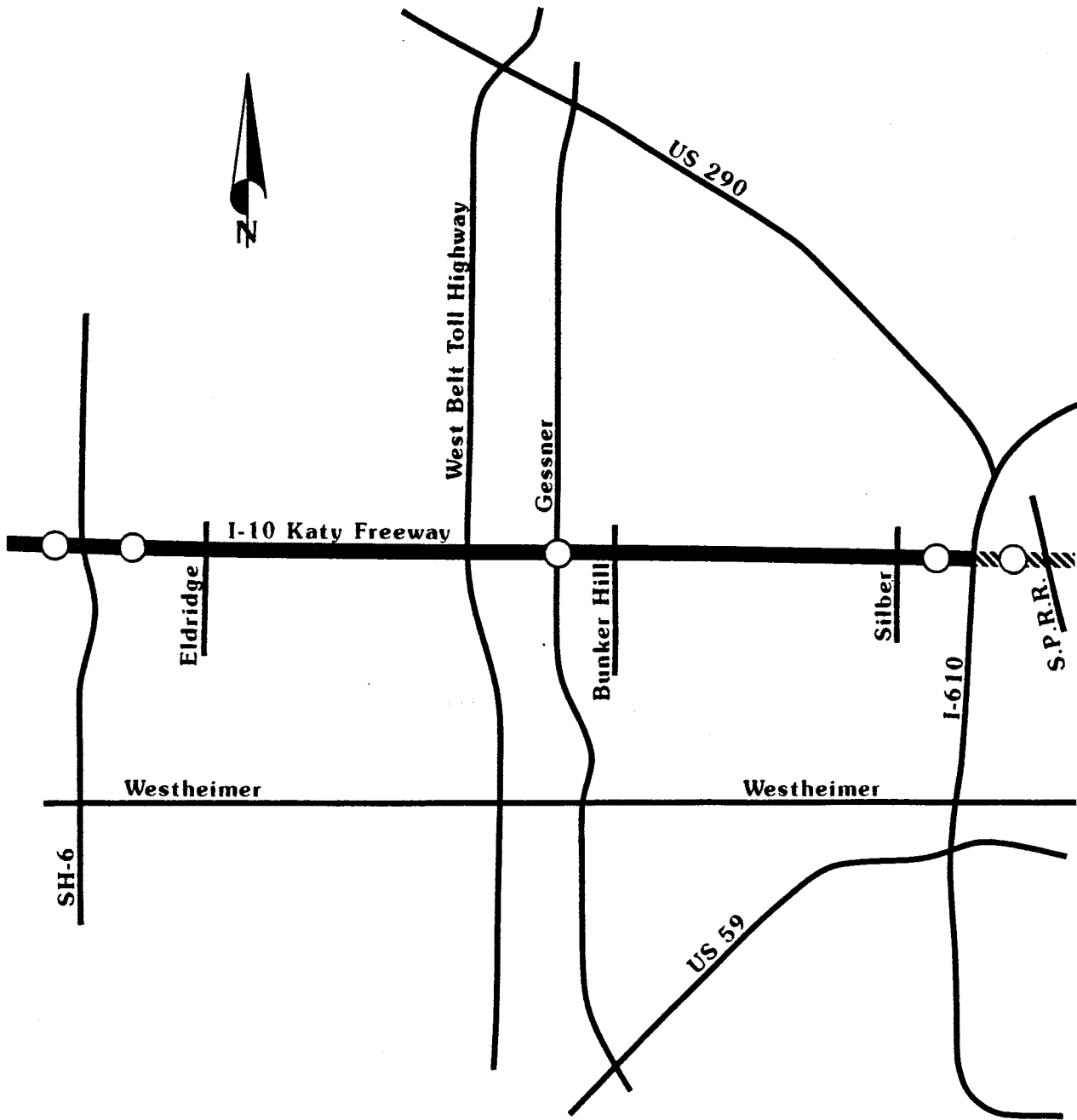
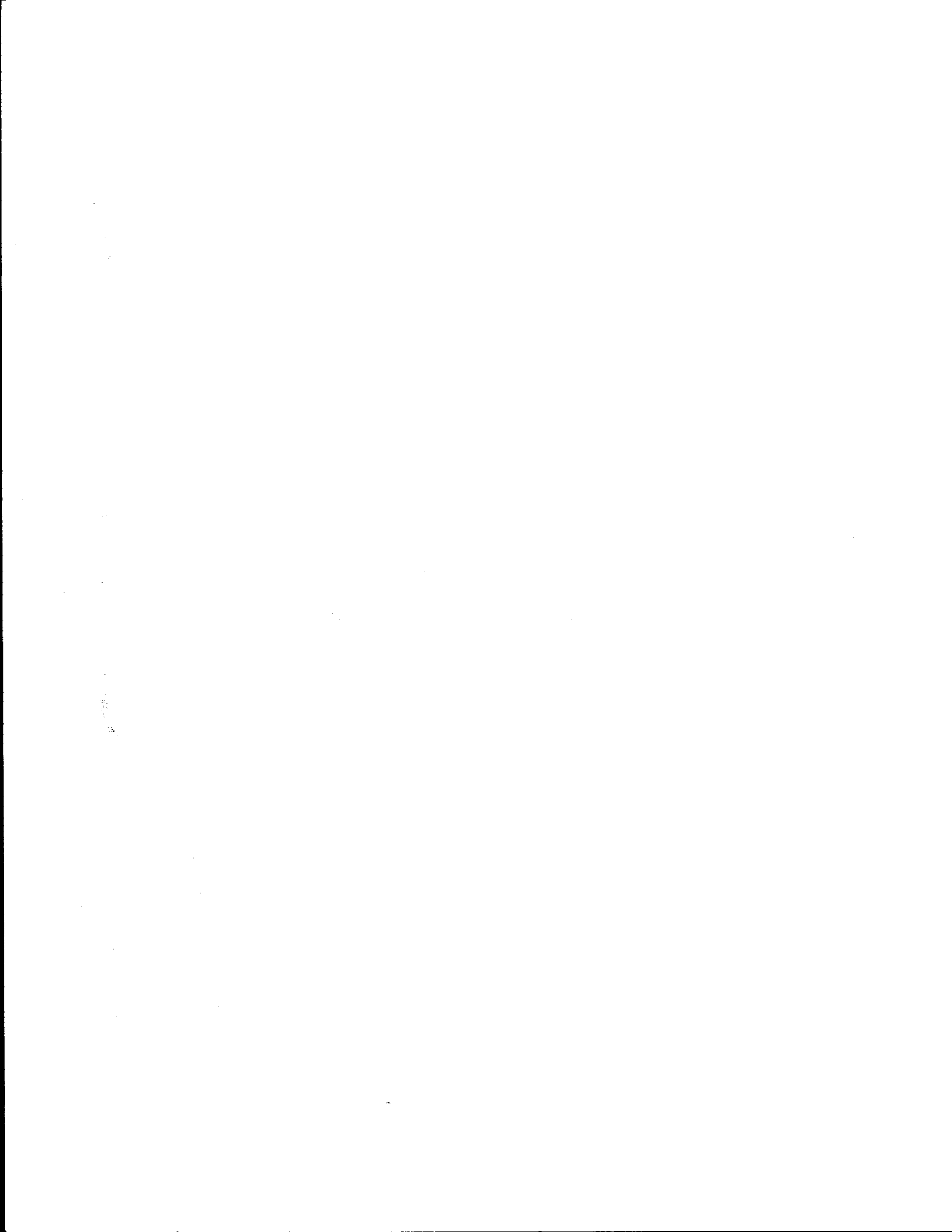


Figure 11. Location of Major Data Collection Sites on Katy Transitway



III. TRANSITWAY DATA

This section presents and evaluates data that relate to operation and use of the transitway. Subsequent sections of this report assess data that pertain to the freeway mainlanes as well as combined data for the transitway and the mainlanes.

Vehicles Eligible to Use the Transitway

At present, 2+ vehicles are allowed to use the transitway. There are no authorization procedures. However, the definition of what vehicles are allowed onto the transitway has changed on several occasions.

The Katy Freeway Transitway opened October 29, 1984. At the time it opened, buses and vanpools were the only authorized users. This procedure was patterned after that which had been used in operating the North Freeway contraflow lane. The authorization process was administered by Metro and involved several considerations, including driver instruction, vehicle inspection, certain minimum insurance requirements, and a minimum number of registered occupants. Vehicles using the lane had permits affixed to their windshields, and drivers had special licenses.

In order to increase the volume of vehicles using the transitway and to address the perception that it was underutilized, a decision was made by Metro and the State Department of Highways and Public Transportation to begin, on a trial basis, to allow carpools to use the priority facility beginning April 1, 1985.

Transitway carpool utilization was initially restricted to authorized automobiles carrying four or more persons. In order to become authorized, carpools had to have: 1) certified drivers; 2) valid Texas vehicle insurance coverage; 4) some familiarity with the transitway geometrics before actually driving in the facility; and 5) passed a visual inspection

of the vehicle by Metro. If an authorized carpool had fewer than four persons on any 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 travelling within the Katy Transitway. The concern that a 3+ carpool designation could possibly generate a sufficient vehicular volume to exceed the capacity of the transitway and create unacceptable operating conditions also contributed to the decision to initially restrict authorization to 4+ carpools.

Approximately 30 carpools were authorized to use the transitway in April 1985. However, of these 30 carpools, an average of only 5 carpools actually chose to use the lane during a typical peak period. By July 1985, the number of carpools observed using the transitway had only doubled, and absolute demand levels remained extremely low. Consequently, effective July 29, 1985, carpools were permitted to enter the transitway with a minimum of three passengers, although four or more registered passengers were still required to obtain authorization. Less than a month after occupancy requirements were reduced for carpools, only nine more carpool trips were being made on the transitway each day. Consequently, further consideration was given to reducing the authorization requirement to a minimum of only three registered occupants. Officially, the authorization of 3+ carpools was not to commence until November 4, 1985. However, as early as September, 1985, 3+ carpools had begun to be authorized by Metro and were allowed to travel through the Katy Transitway.

Even with the 3+ designation, peak-hour carpool volumes remained less than 100 vph. A perception continued to exist that the transitway was underutilized. As a consequence, on August 11, 1986, all authorization procedures were eliminated, and the eligible carpool definition was reduced to 2+. As shown subsequently, this caused a significant increase in transitway carpool volumes and acceptance of the transitway by non transitway users. The chronology of vehicles allowed to use the transitway is summarized in Table 2.

Table 2. Changes Over Time in Vehicles Allowed to Use Katy Freeway Transitway

Date	Event or Vehicles Allowed	Comment
October 29, 1984	Buses, authorized vanpools (minimum of 8 persons registered; minimum of 6 riders)	Transitway Opened from Post Oak to Gessner Drive (4.7 miles)
April 1, 1985	Buses, authorized vanpools and authorized 4+ carpools	
May 2, 1985		Transitway extended to West Belt Drive (total length, 6.4 miles)
July 29, 1985	Buses, authorized vanpools and authorized 4+ carpools with 3 passengers	Authorization of carpools still required at least 4 persons
September 1985	Buses, authorized vanpools and authorized carpools (some 3+ carpools were allowed)	Metro authorized some 3+ carpools
November 4, 1985	Buses, authorized vanpools and authorized 3+ carpools	Official date for authorized 3+ carpools
August 11, 1986	Vehicles with 2 or more persons except large trucks and motorcycles	No authorization is required to use transitway
June 29, 1987		Transitway extended to SH 6 (total length, 11.5 miles)

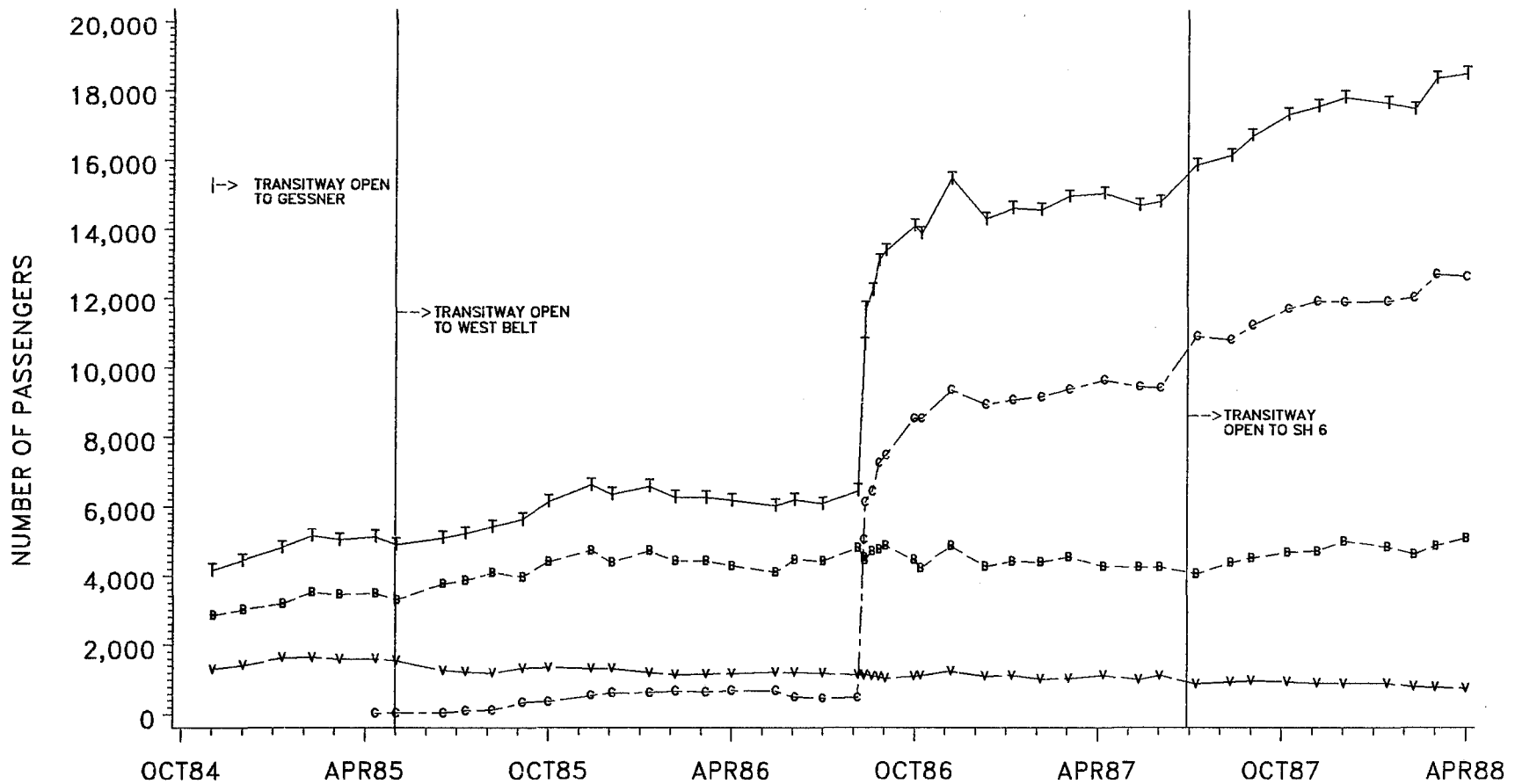
Transitway Person Volumes

Daily Person Movement

Trends in daily person movement are shown in Figure 12. Daily person movement includes both the a.m. (6-9:30) and the p.m. (3:30 to 7) periods plus the off-peak operating hours (the transitway operates from 5:45 to 11:00 a.m., and from 2:00 to 8:00 p.m.).

Between December 1986 and December 1987, daily use of the transitway increased by 24.6%, or nearly 2% per month. Between December 1985 and December 1987, utilization increased by 182%. Of the total daily person

KATY FREEWAY (IH 10W) TRANSITWAY
TOTAL DAILY TRANISTWAY PERSON 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
 DATA COLLECTED OVER BUNKER HILL
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

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

FIGURE 12

movement at the end of 1987, 67% was in carpools, 5% was in vanpools, and 28% was in buses. Daily person movement, as measured at Bunker Hill, was 17,897; as measured at Eldridge, it was 10,227.

A.M. Operating Period

Data are presented for the peak-hour and the peak period. At Bunker-Hill, during the a.m. operating period (5:45 a.m. to 11:00 a.m.), just over 375 persons are moved outside of the peak period (6:00 to 9:30 a.m.).

A.M. Peak Hour. The a.m. peak hour is usually from 7:00 a.m. to 8:00 a.m. At Bunker Hill, 4580 persons were moved on the transitway in December 1987 (Figure 13). This represents a 25% increase over the volume in December 1986, a 162% increase of the volume in December 1985, and a 374% increase over the volume in December 1984. Of the volume at Bunker Hill at the end of 1987, 29% were moved in buses, 3% were moved in vans, and the remaining 68% were moved in carpools. In December 1987, 2905 persons were moved on the transitway at Eldridge.

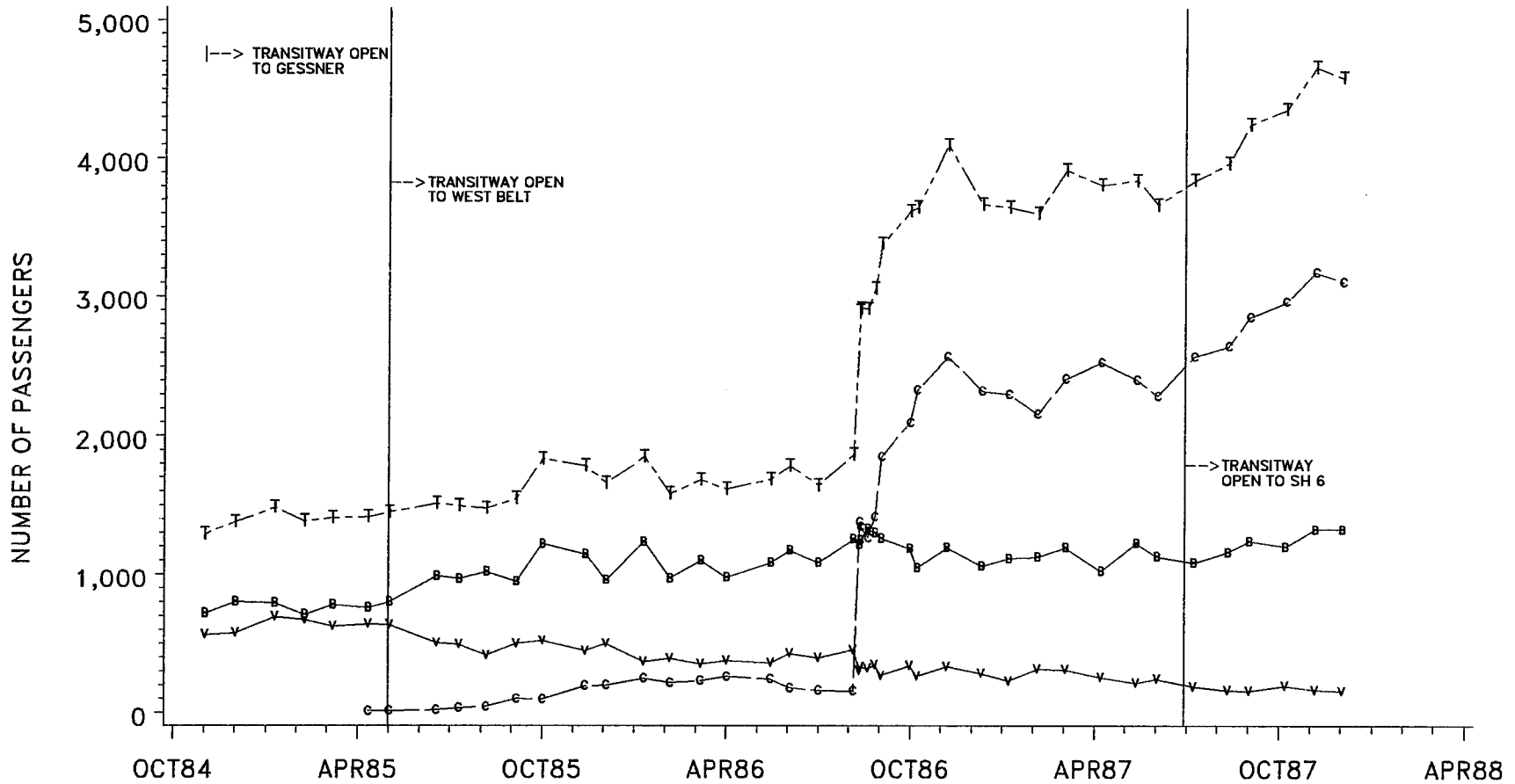
A.M. Peak Period. The a.m. peak period is defined from 6:00 a.m. to 9:30 a.m. At Bunker Hill, 8703 persons were moved on transitway in December 1987 (Figure 14). This represents an 18% increase over the volume in December 1986, a 177% increase over the volume in December 1985, and a 428% increase over the volume in December 1984. Of the volume at Bunker Hill at the end of 1987, 29% was in buses, 4% was in vanpools, and 67% was in carpools; these percentages are nearly identical to the peak hour. In December 1987, 5330 persons were moved on the transitway at Eldridge.

P.M. Operating Period

Data are presented for the peak hour and the peak period. At Bunker Hill, during the p.m. operating period (2:00 p.m. to 8:00 p.m.), 687 persons use the transitway outside of the peak period (3:30 p.m. to 7:00 p.m.).

KATY FREEWAY (IH 10W) TRANSITWAY
A.M. PEAK HOUR TRANSITWAY PERSON MOVEMENT

24



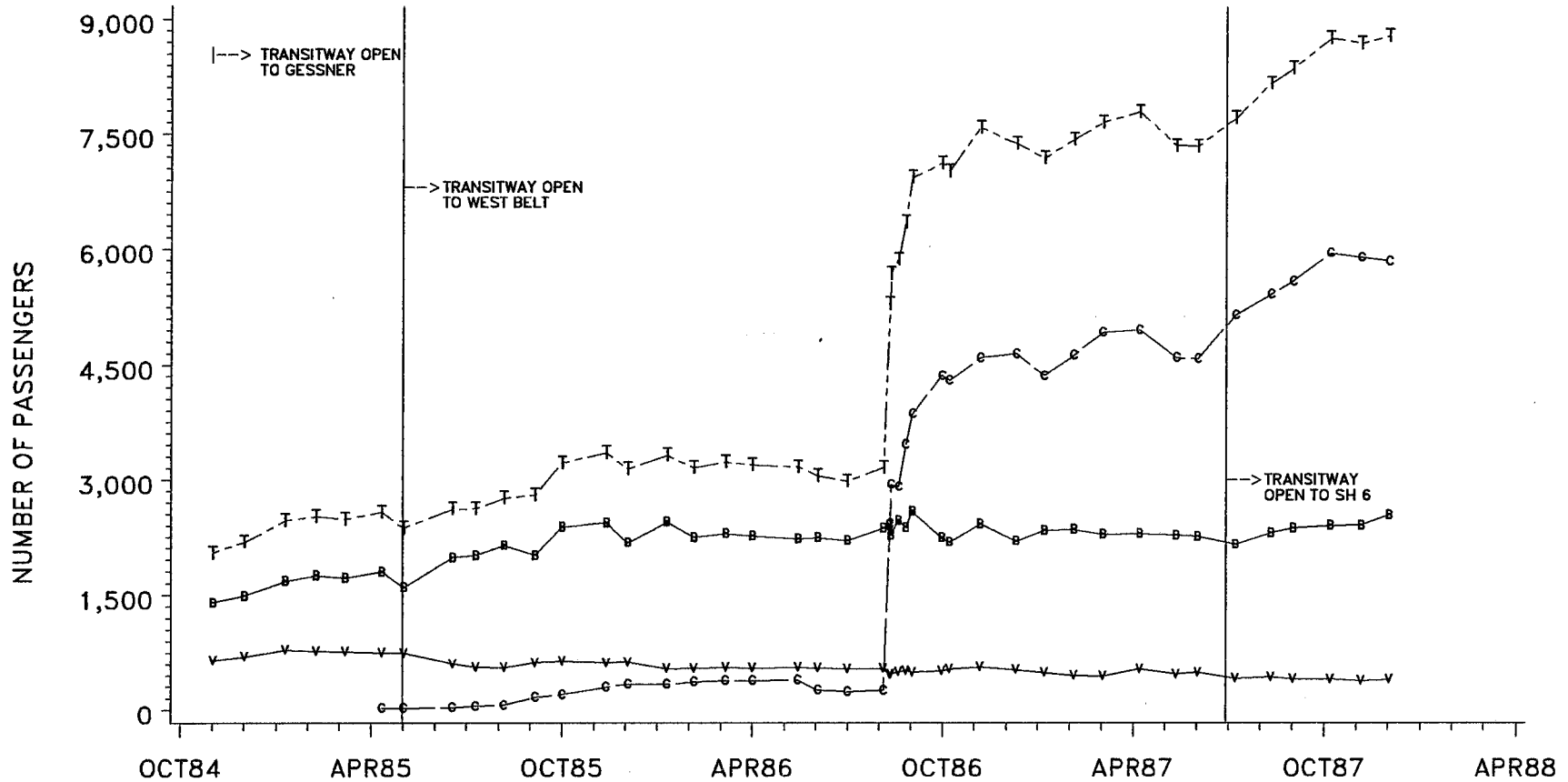
KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987
 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 13

KATY FREEWAY (IH 10W) TRANSITWAY
A.M. PEAK PERIOD TRANSITWAY PERSON MOVEMENT

25



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
 PEAK PERIOD IS 5:45 - 9:30 AM
 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 14

In general, p.m. volumes are slightly lower than a.m. volumes. In the p.m. at Bunker Hill, the peak-hour volume is 83% of the a.m. peak-hour volume, and the peak period is 93% of the a.m. peak-period volume.

P.M. Peak Hour. The p.m. peak hour is usually from 5:00 p.m. to 6:00 p.m. At Bunker Hill, 3812 persons were moved on the transitway in December 1987 (Figure 15). This represents a 30% increase over the volume in December 1986, a 208% increase over the volume in December 1985, and a 281% increase over the volume in December 1984. Of the volume at Bunker Hill at the end of 1987, 33% was in buses, 4% was in vans, and 63% was in carpools. In December 1987, 2171 persons were moved on the transitway at Eldridge.

P.M. Peak Period. The p.m. peak period is defined from 3:30 p.m. to 7:00 p.m. At Bunker Hill, 8129 persons were moved on the transitway in December 1987 (Figure 16). This represents a 29% increase over the volume in December 1986, a 153% increase over the volume in December 1985, and a 338% increase over the volume in December 1984. Of the volume at Bunker Hill at the end of 1987, 30% was in buses, 6% was in vans, and 64% was in carpools. In December 1987, 4454 persons were moved on the transitway at Eldridge.

Summary, Increases in Transitway Person Movement

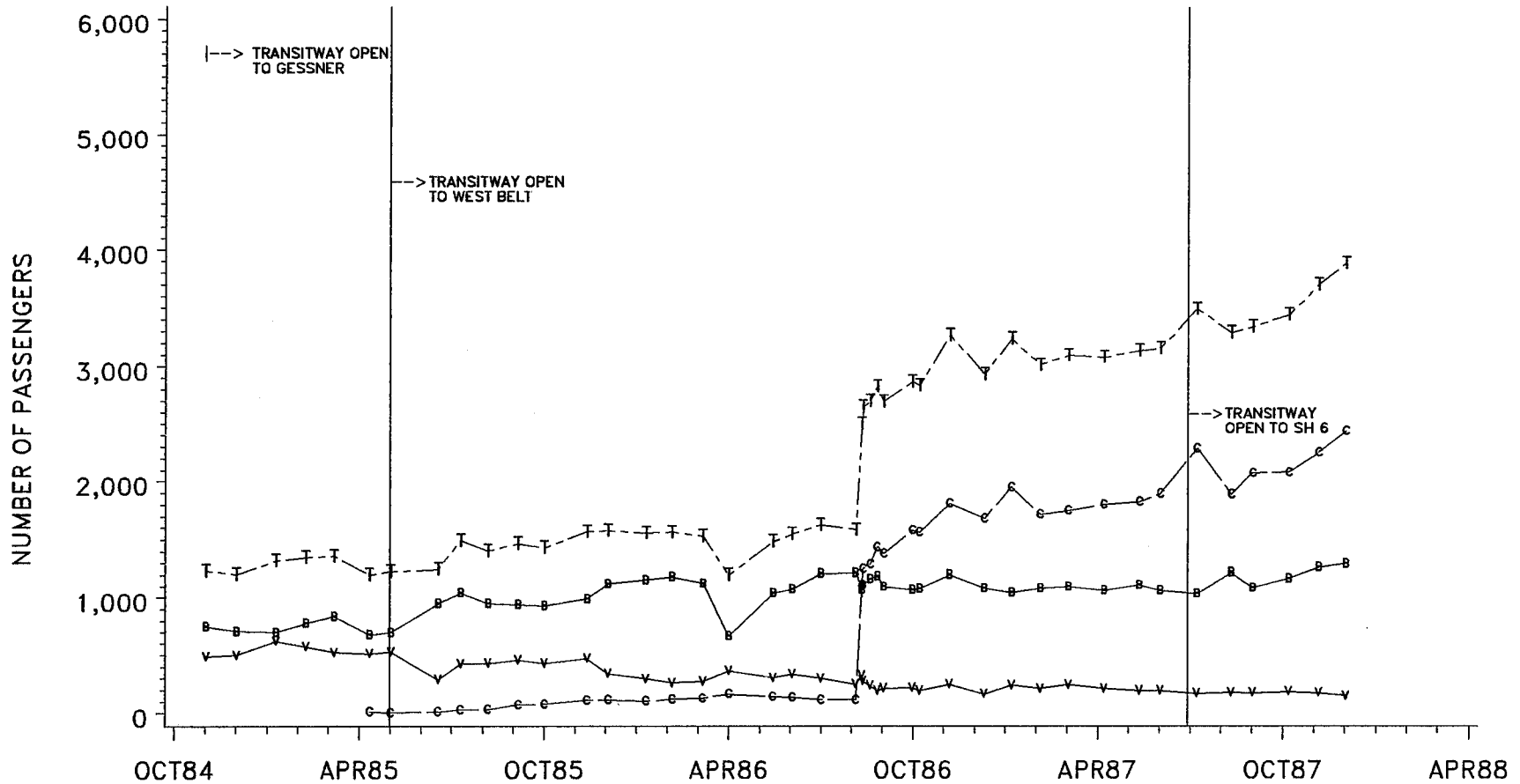
Table 3 summarizes the increases in transitway person movement that have been experienced between December 1984 and December 1987.

Table 3. Increase in Transitway Person Movement, December 1984 through December 1987 (measured at Bunker Hill)

Time Period	December 1987 Person Volume	Percent Increase		
		12/84-12/87	12/85-12/87	12/86-12/87
Daily Passengers	17,897	+410%	+182%	+ 25%
A.M. Peak Hour	4,580	+374%	+162%	+ 25%
A.M. Peak Period	8,703	+428%	+177%	+ 18%
P.M. Peak Hour	3,812	+281%	+208%	+ 30%
P.M. Peak Period	8,129	+338%	+153%	+ 29%

KATY FREEWAY (IH 10W) TRANSITWAY
P.M. PEAK HOUR TRANSITWAY PERSON MOVEMENT

27



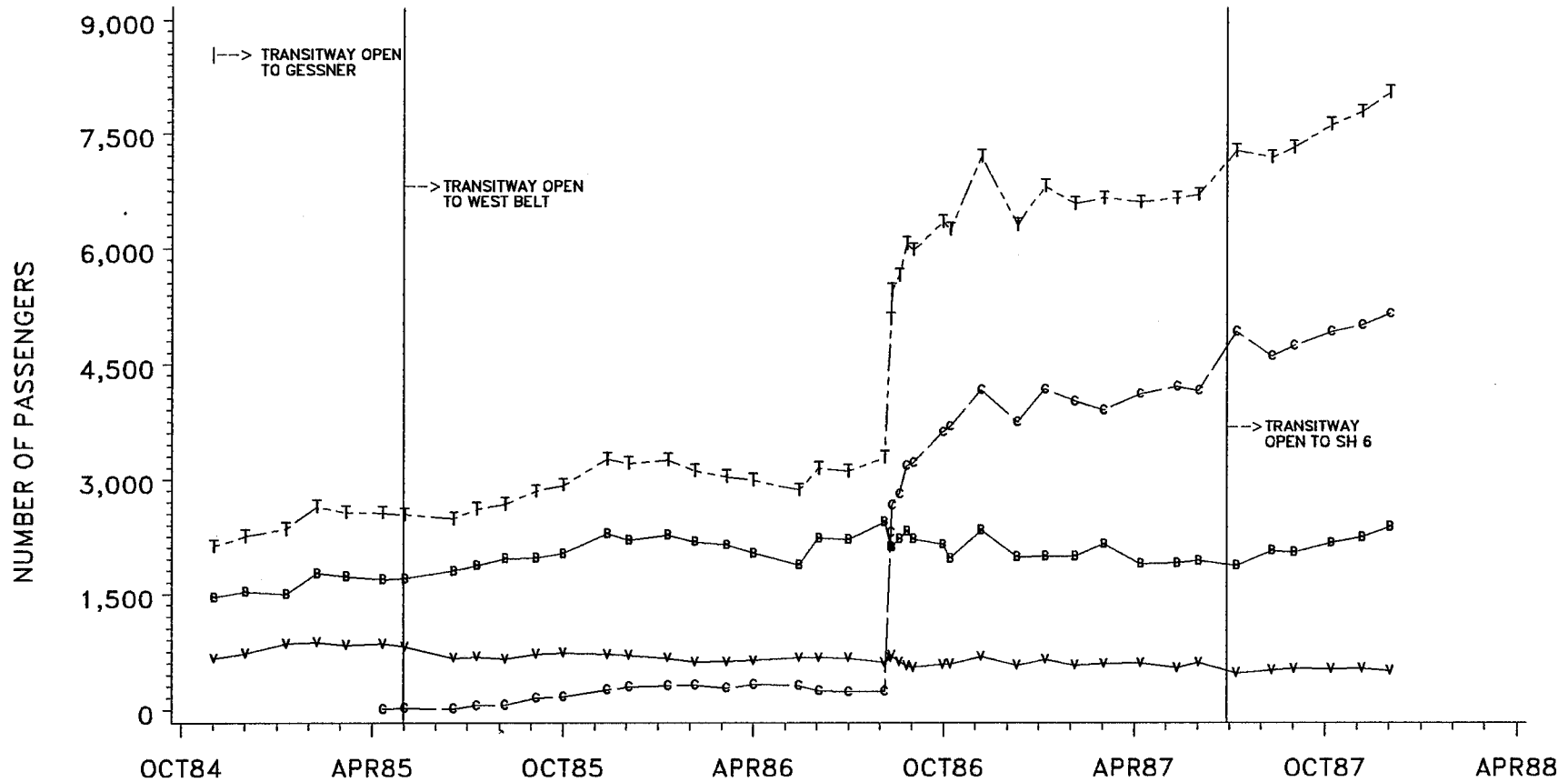
KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987
 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 15

KATY FREEWAY (IH 10W) TRANSITWAY
P.M. PEAK PERIOD TRANSITWAY PERSON MOVEMENT

28



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
 PEAK PERIOD IS 3:30 - 7:00 PM
 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 16

Comparison to Other HOV Projects

Utilization of the Katy Transitway is compared to other HOV projects in Table 4. The Katy HOV facility has developed into a relatively well used HOV lane.

Table 4. A.M. Person Movement for Selected HOV Facilities

HOV Facility	Eligible Vehicles	A.M. Person Movement
Lincoln Tunnel, N.J. Rte. 495	Buses	65,600
Shirley Highway, Washington, D.C.	4+ Carpools	27,000
I-66, Washington, D.C.	3+ Carpools	16,800
Rte. 55, Orange County, CA.	2+ Carpools	12,400
San Bernardino, Los Angeles	2+ Carpools	12,200
Rte. 91, Los Angeles	3+ Carpools	10,500
KATY, Houston	2+ Carpools	9,081
East Patway, Pittsburgh	Buses	8,600
U.S. 101, San Francisco	3+ Carpools	7,400
North, Houston	Buses and Vans	7,200
Rte. 520, Seattle	3+ Carpools	5,100
South Patway, Pittsburgh	Buses	4,500

Sources: Houston data for 12/87, Texas Transportation Institute
 Los Angeles data for 7/86, Caltrans
 All other data for 1985, ITE Report IR-050, "The Effectiveness of High-Occupancy Vehicle Facilities", 1988.

In relation to other successful HOV projects, the growth in person movement over time on the Katy Transitway has been relatively high (Table 5). Person volume on the Katy Transitway is continuing to increase.

Table 5. Growth Rates in Person Movement During First 3 Years of Operation on Selected Major High-Occupancy Vehicle Projects

Project and Time Period A.M. Peak Period	3-Year Growth (Percent)
Katy Transitway, Houston ¹ 12/84-12/87	+428%
El Monte Busway, Los Angeles 1973-1976	+370%
North Contraflow Lane, Houston 1979-1982	+243%
Shirley Highway, Washington, D.C. 1970-1973	+200%

¹The Katy growth rate is somewhat overstated in that the 12/84 volume is used for the first year value (only 2 months after opening). For the other projects, the first year value represents 6 months into operation.

Transitway Vehicle Volume Data

Vehicle movement on the transitway increased dramatically when 2+ carpools were allowed onto the facility and authorization requirements were eliminated. The impacts of the authorization process on transitway utilization are reviewed in Research Report 484-6¹.

Transitway "Capacity"

For a transitway to be successful, it must be able to offer a relatively high operating speed as well as a reliable trip time. These necessary characteristics of a transitway place limits on the maximum volume of vehicles that can be allowed to use the priority facility. Based on analyses¹ performed on the Katy Transitway, it is estimated that the

¹"Options for Managing Traffic Volumes and Speeds on the Katy Transitway." Texas Transportation Institute Research Report 484-6, September 1987.

"capacity" of the Katy Transitway is essentially 1500 vph. This is consistent with the observed capacities for other high-occupancy vehicle lane projects.²

Daily Vehicle Volumes

Trends in daily volume data are shown in Figure 17. In December 1987, of the 5733 daily vehicles using the transitway at Bunker Hill, 3% were buses, 2% were vans, and 95% were carpools.

A.M. Operating Period

Data are presented for the peak hour and the peak period. At Bunker Hill, during the a.m. operating period (5:45 a.m. to 11:00 a.m.), approximately 150 vehicles use the transitway outside of the peak period (6:00 a.m. to 9:30 a.m.).

A.M. Peak Hour. The a.m. peak hour is usually from 7:00 a.m. to 8:00 a.m. At Bunker Hill, a peak-hour vehicle volume of 1469 occurred in December 1987 (Figure 18); 96% of those vehicles were carpools. At Eldridge in December 1987, the peak-hour vehicle volume was 1008.

A.M. Peak Period. The a.m. peak period is defined from 6:00 a.m. to 9:30 a.m. At Bunker Hill, the peak-period vehicle volume in December 1987 was 2788 (Figure 19); 95% of those vehicles were carpools. At Eldridge in December 1987, the peak-period vehicle volume was 1797.

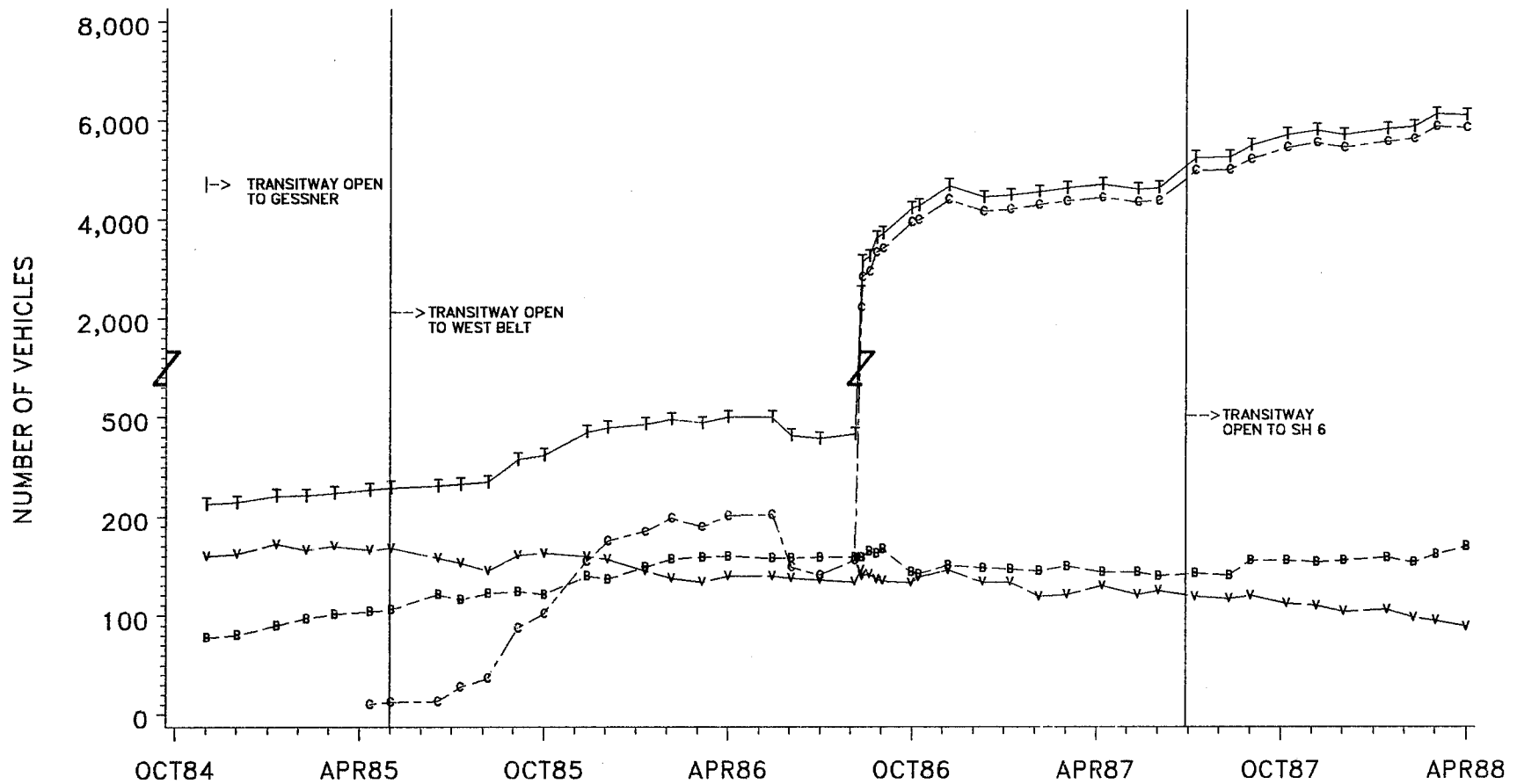
P.M. Operating Period

Data are presented for the peak hour and the peak period. At Bunker Hill, during the p.m. operating period (2:00 p.m. to 8:00 p.m.),

²"The Effectiveness of High-Occupancy Vehicle Facilities". Institute of Transportation Engineers report IR-050, 1988.

KATY FREEWAY (IH 10W) TRANSITWAY
TOTAL DAILY TRANSITWAY VEHICLE UTILIZATION

32



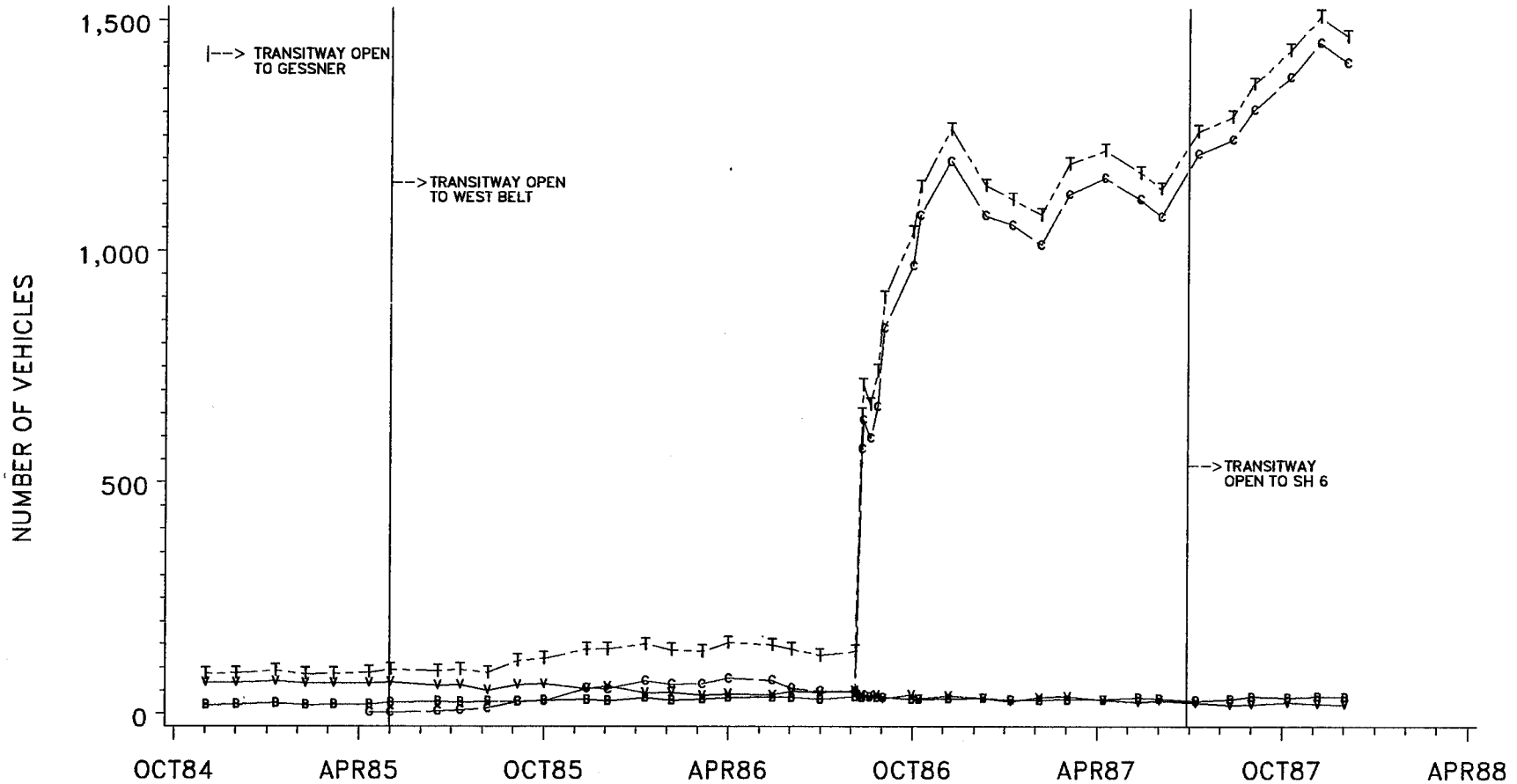
KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987
 DATA COLLECTED OVER BUNKER HILL
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

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

FIGURE 17

KATY FREEWAY (IH 10W) TRANSITWAY
A.M. PEAK HOUR TRANSITWAY VEHICLE UTILIZATION

33



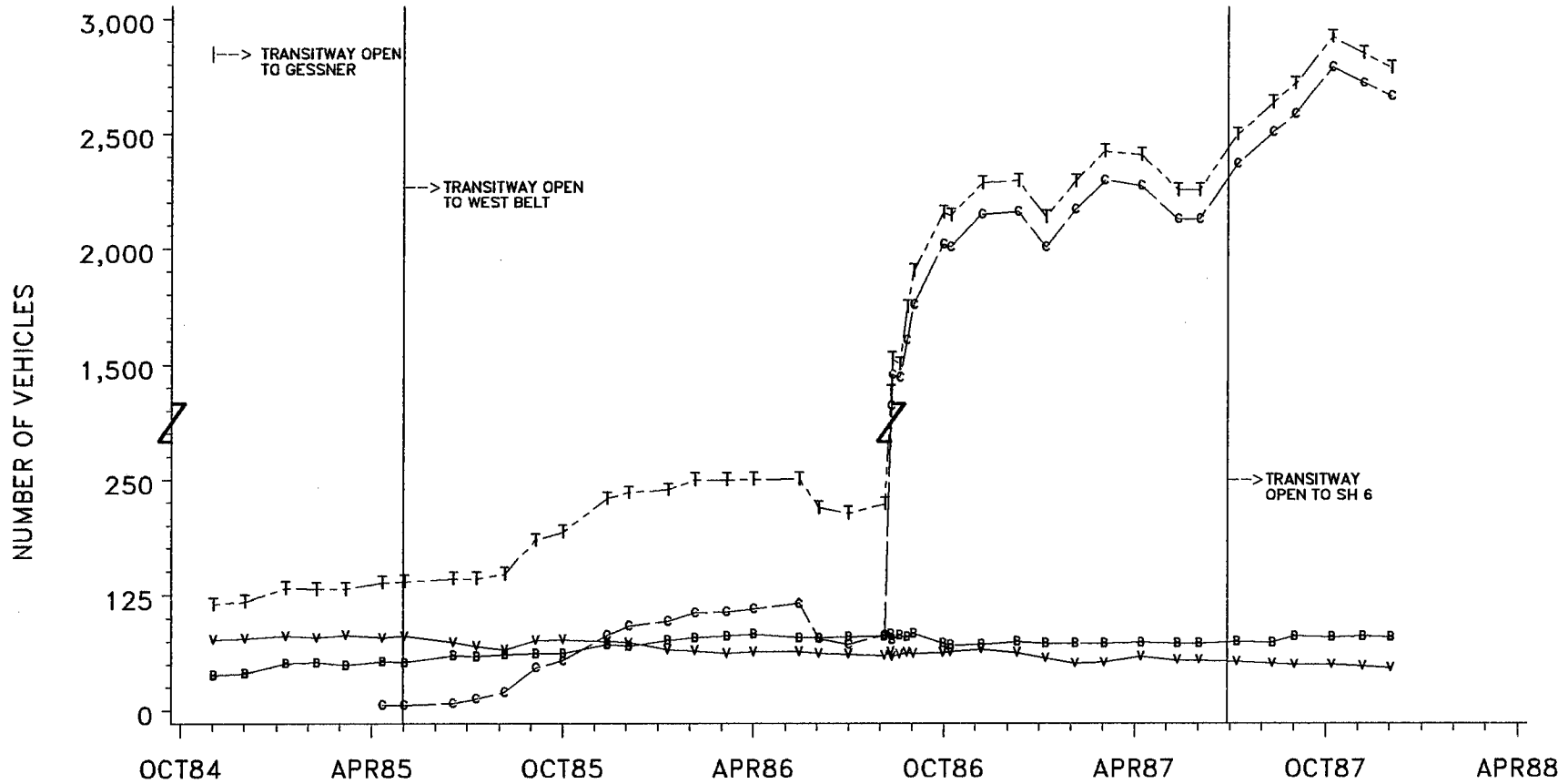
KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987
 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 18

KATY FREEWAY (IH 10W) TRANSITWAY
A.M. PEAK PERIOD TRANSITWAY VEHICLE UTILIZATION

34



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
 PEAK PERIOD IS 5:45 - 9:30 AM
 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 19

approximately 280 vehicles use the transitway outside of the peak period (3:30 p.m. to 7:00 p.m.).

P.M. Peak Hour. The p.m. peak hour is usually from 5:00 p.m. to 6:00 p.m. At Bunker Hill, a peak-hour vehicle volume of 1180 occurred in December 1987 (Figure 20); 96% of those vehicles were carpools. At Eldridge in December 1987, the peak-hour vehicle volume was 708%.

P.M. Peak Period. The p.m. peak period is defined from 3:30 to 7:00 p.m. At Bunker Hill, the peak-period volume in December 1987 was 2517 (Figure 21); 95% of those vehicles were carpools. At Eldridge in December 1987, the peak-period volume was 1506.

Access/Egress Patterns

During the a.m., vehicles can enter the transitway from west of SH 6, from the Addicks park-and-ride facility, or from the slip ramp at Gessner. In terms of total vehicle volume, the entry patterns are generally as shown below.

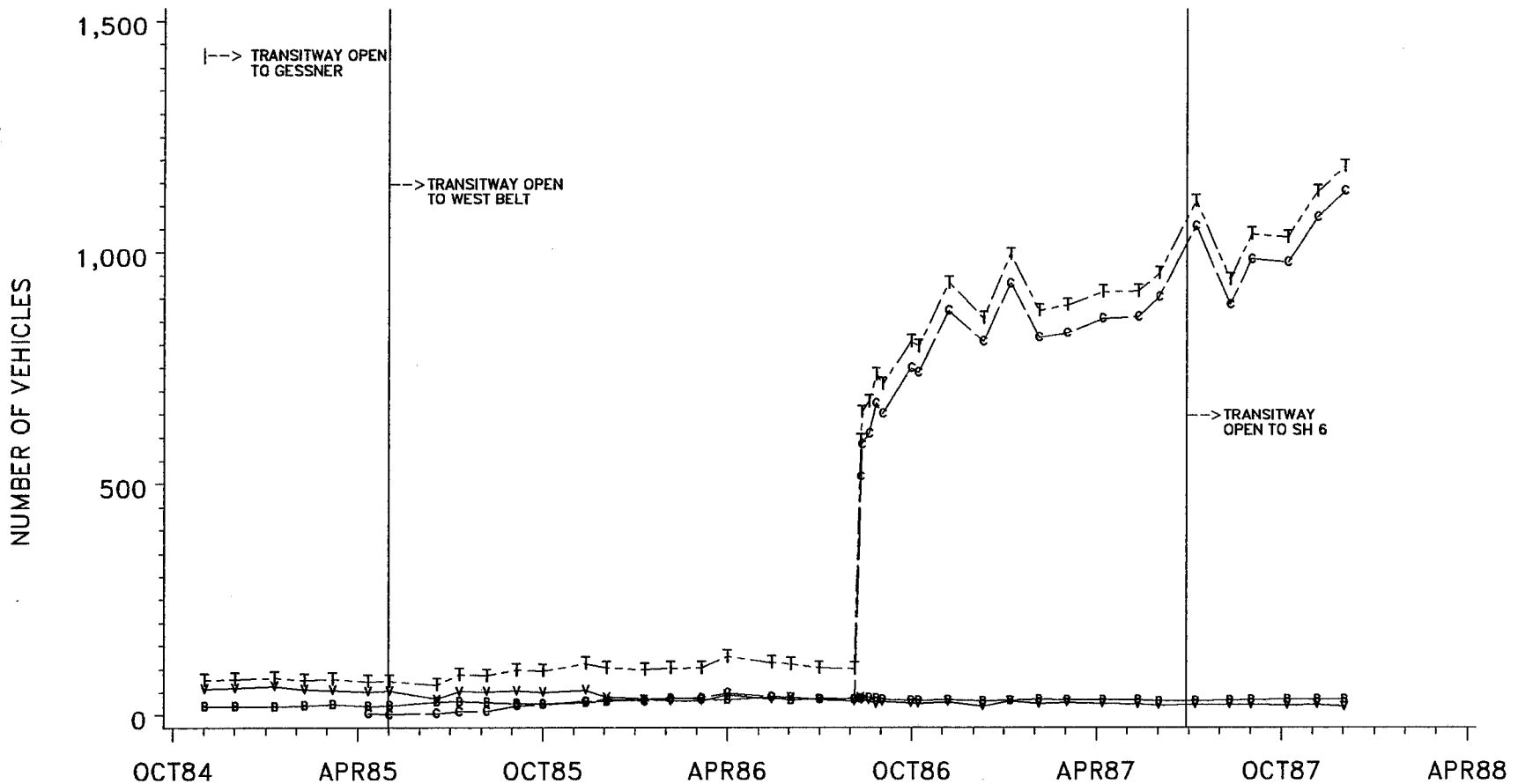
- Enter from west of SH 6: 35%
- Enter from Addicks park-and-ride: 30%
- Enter from Gessner: 35%

During the p.m., all vehicles enter the transitway through the Post Oak intersection. Those vehicles can exit the transitway at Gessner, at the Addicks park-and-ride lot, or west of SH 6. In terms of total vehicle volume, the exit patterns are generally as shown below.

- Exit at Gessner: 40%
- Exit to Addicks park-and-ride lot: 20%
- Exit west of SH 6: 40%

KATY FREEWAY (IH 10W) TRANSITWAY
P.M. PEAK HOUR TRANSITWAY VEHICLE UTILIZATION

96

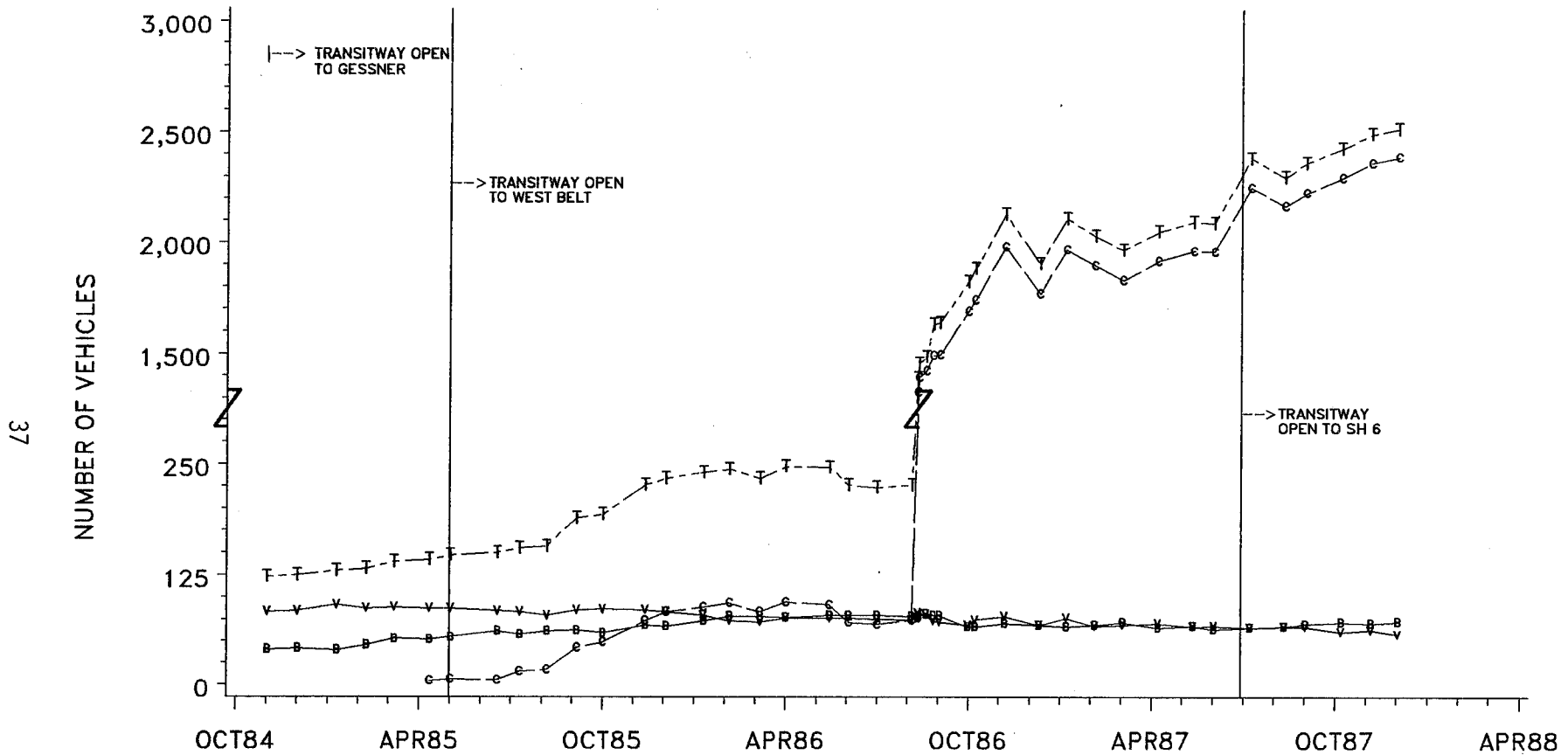


KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987
 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 20

KATY FREEWAY (IH 10W) TRANSITWAY
P.M. PEAK PERIOD 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
 PEAK PERIOD IS 3:30 - 7:00 PM
 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 21

Peaking Characteristics

Distinctive peaking characteristics do occur on the transitway. In the a.m., carpool volumes are highest between 7:00 and 7:45 (Figure 22), while vanpool volumes peak sharply at 6:45 (Figure 23). Buses are scheduled more evenly, and volumes are relatively constant from 6:45 and 8:00 (Figure 24).

In the p.m., carpools peak at 5:15 p.m. (Figure 25), while vanpools peak at 4:30 p.m. (Figure 26). Bus volumes peak at 5:30 (Figure 27). The peaking in bus volumes in the p.m. results from the queueing that develops on the approach to the Post Oak intersection.

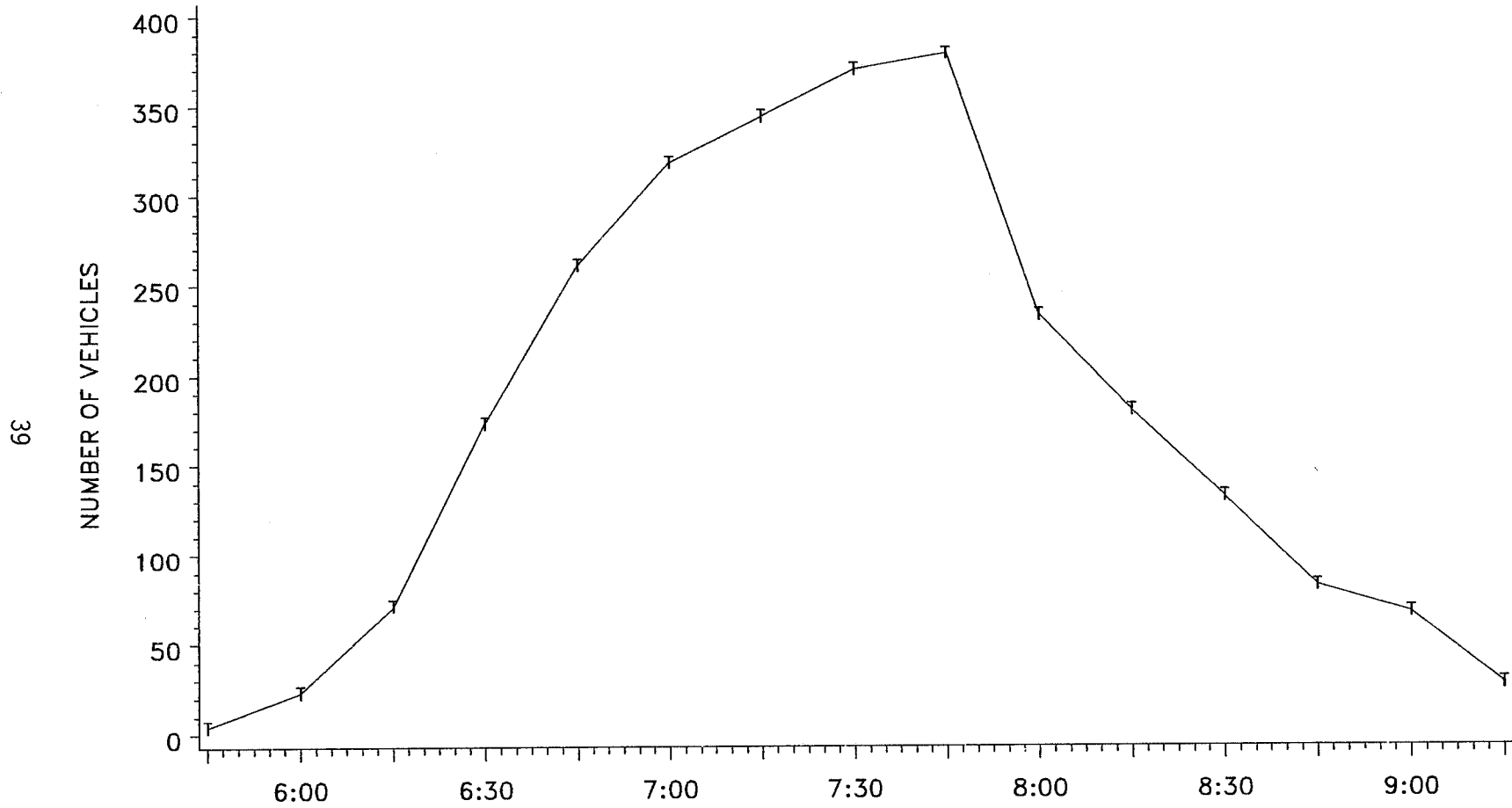
Transitway Vehicle Occupancy

As the definition of carpools eligible to use the transitway has been lowered, average occupancy on the transitway has also been reduced (Figure 28). Average transitway occupancy, by vehicle type for December 1987, is summarized in Table 6.

Table 6. Average Vehicle Occupancy, Katy Transitway, December 1987

Time Period and Vehicle Type	Occupancy
Daily, all vehicles	3.11
A.M. Peak Hour, all vehicles	3.12
Buses	34.92
Vanpools	7.85
Carpools	2.20
A.M. Peak Period, all vehicles	3.12
Buses	30.30
Vanpools	8.59
Carpools	2.20
P.M. Peak Hour, all vehicles	3.25
Buses	39.69
Vanpools	8.28
Carpools	2.15
P.M. Peak Period, all vehicles	3.25
Buses	34.38
Vanpools	8.79
Carpools	2.16

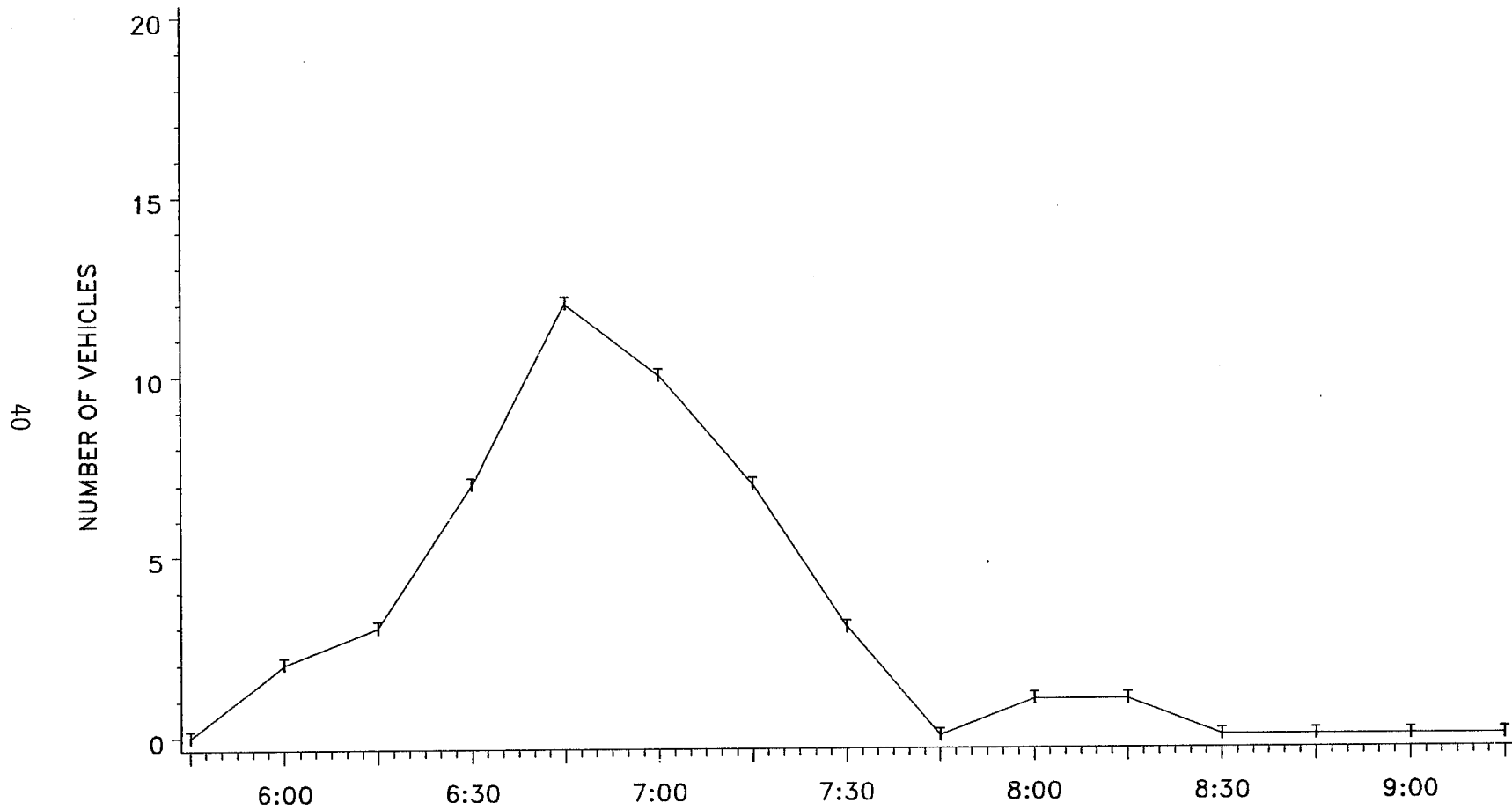
KATY FREEWAY (IH 10W) TRANSITWAY
A.M. PEAK PERIOD CARPOOL UTILIZATION



DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION
DATA COLLECTED DECEMBER, 1987
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 22

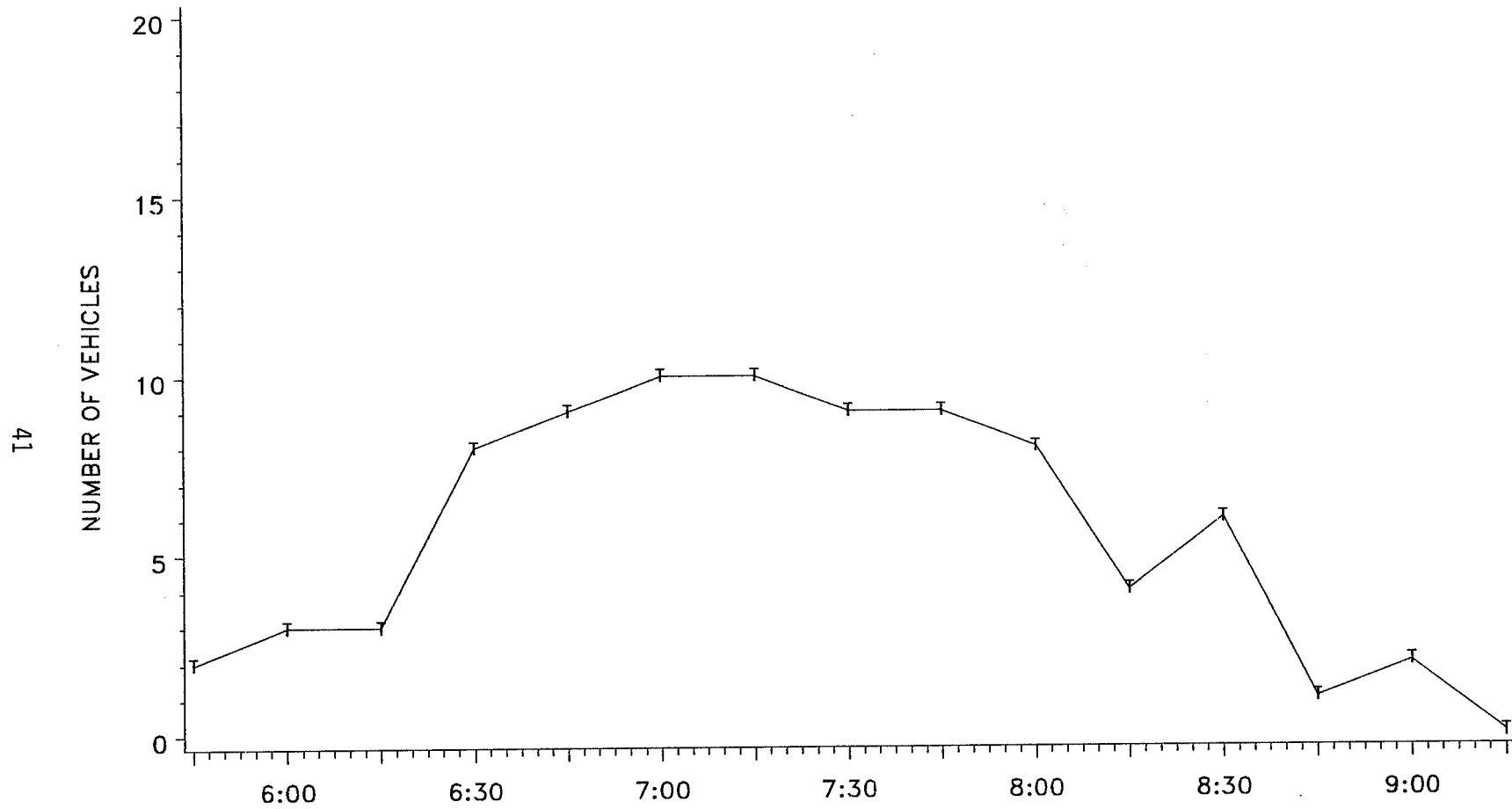
KATY FREEWAY (IH 10W) TRANSITWAY
A.M. PEAK PERIOD VANPOOL UTILIZATION



DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION
DATA COLLECTED DECEMBER, 1987
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 23

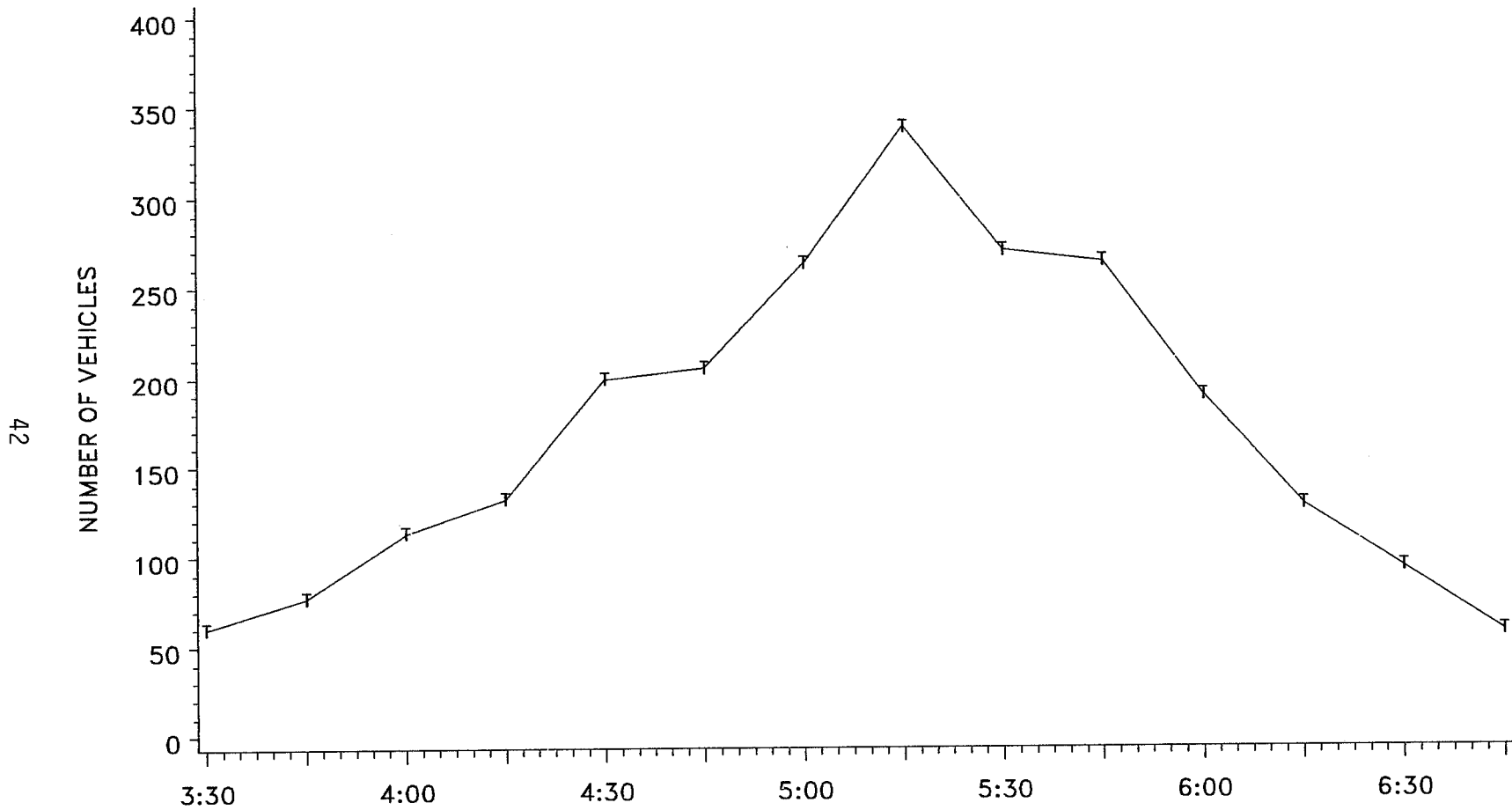
KATY FREEWAY (IH 10W) TRANSITWAY
A.M. PEAK PERIOD BUS UTILIZATION



DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION
DATA COLLECTED DECEMBER, 1987
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 24

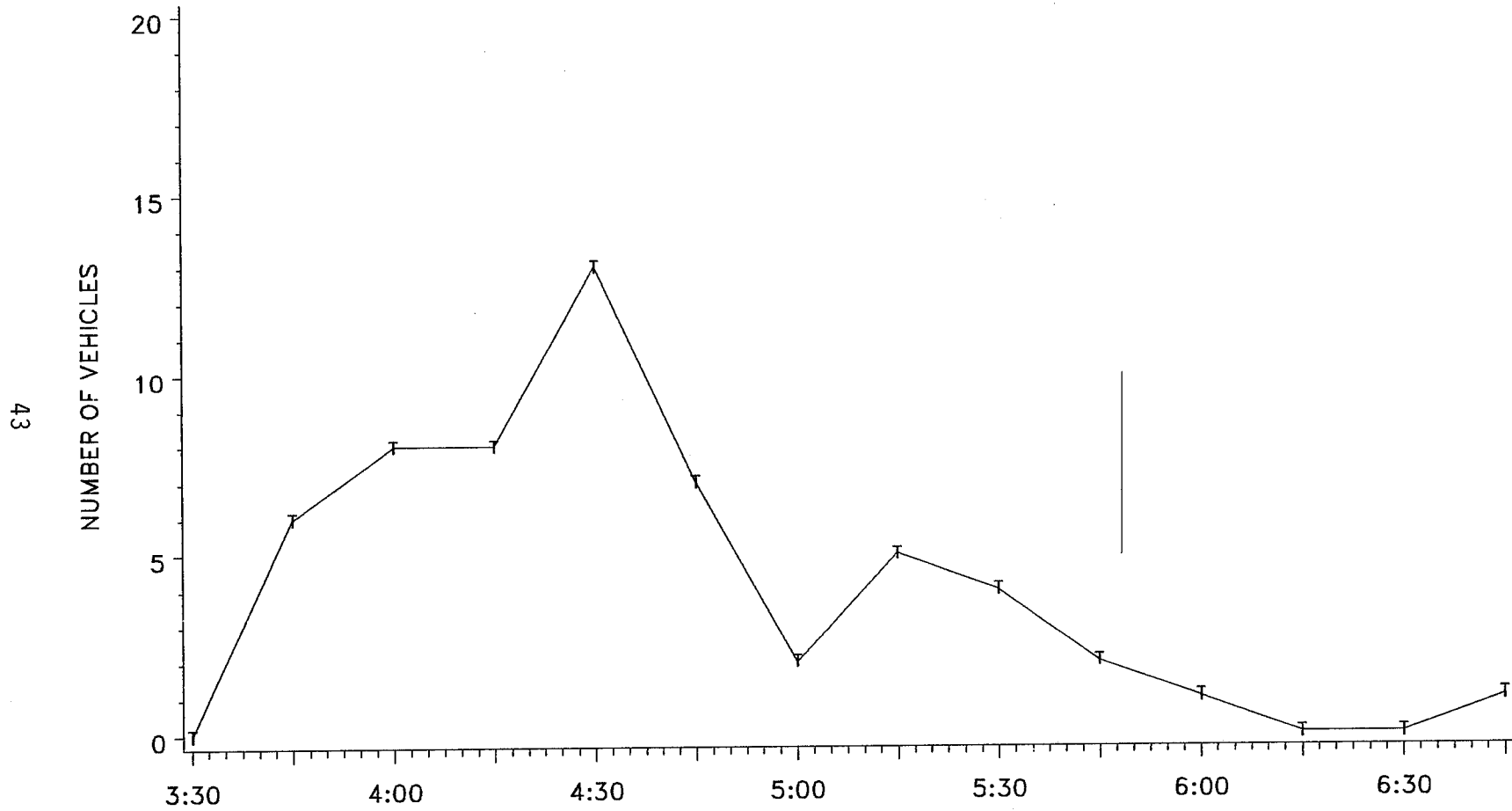
KATY FREEWAY (IH 10W) TRANSITWAY
P.M. PEAK PERIOD CARPOOL UTILIZATION



DATA COLLECTED WESTBOUND OVER BUNKER HILL, 3 LANE SECTION
DATA COLLECTED DECEMBER, 1987
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 25

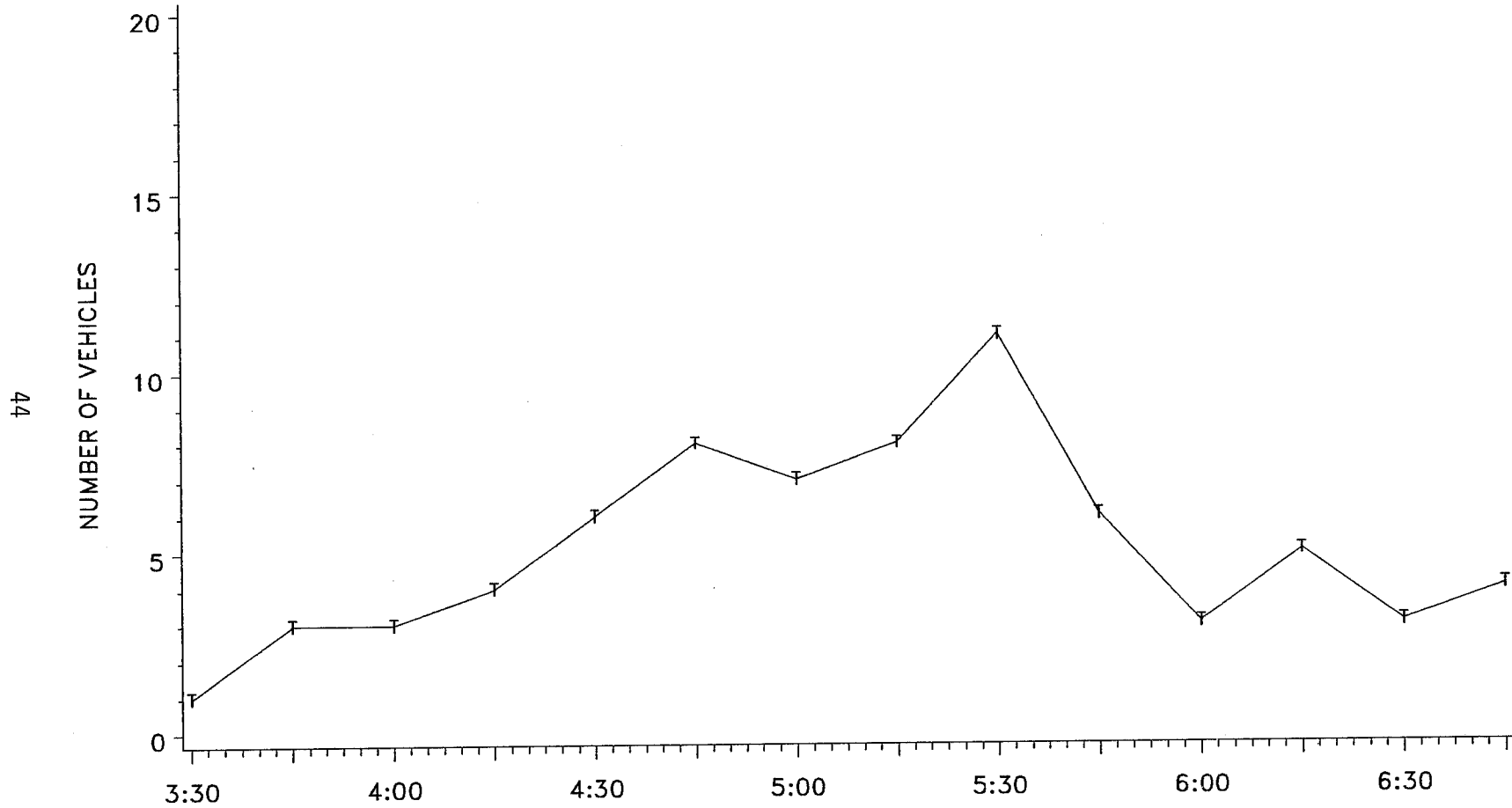
KATY FREEWAY (IH 10W) TRANSITWAY
P.M. PEAK PERIOD VANPOOL UTILIZATION



DATA COLLECTED WESTBOUND OVER BUNKER HILL, 3 LANE SECTION
DATA COLLECTED DECEMBER, 1987
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 26

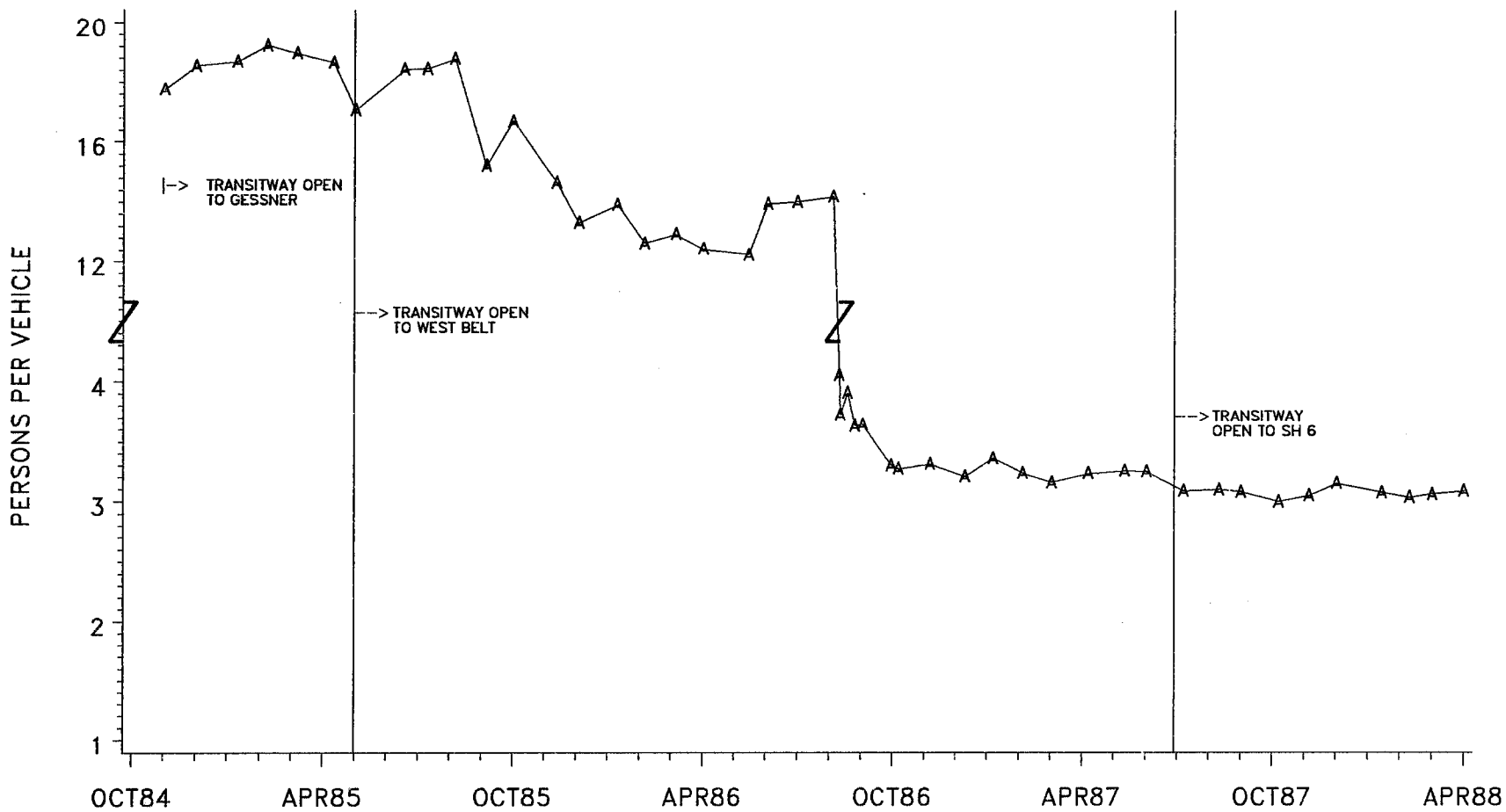
KATY FREEWAY (IH 10W) TRANSITWAY
P.M. PEAK PERIOD BUS UTILIZATION



DATA COLLECTED WESTBOUND OVER BUNKER HILL, 3 LANE SECTION
DATA COLLECTED DECEMBER, 1987
SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 27

KATY FREEWAY (IH 10W) TRANSITWAY
A.M. PEAK PERIOD TRANSITWAY AVERAGE OCCUPANCY



45

4+ CARPOOLS ALLOWED ONTO TRANSITWAY 4/85
3+ CARPOOLS ALLOWED ONTO TRANSITWAY 9/85
2+ CARPOOLS ALLOWED ONTO TRANSITWAY 8/86
DATA COLLECTED OVER BUNKER HILL
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : A = A.M. PEAK PERIOD OCCUPANCY

FIGURE 28

In comparison to pre-transitway conditions, average bus occupancy has increased in both the a.m. and p.m. operating periods (Table 7).

Table 7. Average Bus Occupancy (Persons/Bus) Katy Freeway Corridor

Time Period	Representative Pre-Transitway Value	Representative 12/87 Value	Percent Change
A.M. Peak Hour	30.52	34.92	+14.4%
A.M. Peak Period	28.13	30.30	+ 7.8%
P.M. Peak Hour	28.74	39.69	+38.1%
P.M. Peak Period	30.07	34.38	+14.3%

Note: Occupancy as measured at Bunker Hill.

Transitway Violation Rate

The design of the transitway provides limited opportunities for access and egress. In addition, the transitway is regularly patrolled by Metro police. The result is an extremely low violation rate.

Metro maintains records of the volume of unauthorized vehicles on the transitway. Since Metro personnel are not always present during all operating hours, this count data may be somewhat low.

In the morning, unauthorized vehicles would not be identified by transitway police until they exit the lane at Post Oak. In the afternoon, unauthorized vehicles must pass the enforcement station to enter the lane. As expected, the number of unauthorized vehicles reported on the transitway in the afternoon is much lower than in the morning.

During a typical week in 1987, 20 unauthorized vehicles were reported using the lane; 70% of these unauthorized vehicles were during the a.m. operating period.

Given the volume of vehicles using the transitway and using the Metro reported volume of unauthorized vehicles, the violation rate is in the range of 0.1%. As indicated previously, this is probably a low estimate of the actual violation rate.

Transitway Vehicle Breakdown Data

The transitway is an enclosed environment and is operated on a daily basis by Metro. As a result, reliable data are available pertaining to vehicle breakdown rates.

During an average week in 1987, 5.0 vehicles became disabled on the transitway, or roughly one every other peak period. Approximately two-thirds of the disabled vehicles required towing.

A summary of vehicle breakdown data for the Katy Transitway is shown in Table 8.

Table 8. Estimated Vehicle Breakdown Rates, Katy Transitway

Vehicle Group	Time Period		
	10/29/84-12/30/87 ¹	4/1/85-12/30/87 ²	8/11/86-12/30/87 ³
No. of Disabled Vehicles, Total	362	358	306
Buses	53	49	14
Vans	12	12	5
Carpools	297	297	287
No. of Towed Vehicles, Total	221	221	206
Buses	14	14	6
Vans	5	5	4
Carpools	202	202	196
VMT ⁴ Per Disabled Vehicle, Total	29,500	29,400	31,600
Buses	12,200	12,200	22,200
Vans	53,800	46,500	48,300
Carpools	31,500	31,500	31,800
VMT ⁴ Per Towed Vehicle, Total	48,200	47,600	46,900
Buses	46,200	42,900	51,800
Vans	129,000	111,600	60,300
Carpools	46,400	46,400	46,500

Note: Towed vehicles are a subset of disabled vehicles.

¹Operating period from the inception of the transitway.

²Operating period from when carpools allowed onto transitway.

³Operating period since unauthorized 2+ carpools allowed onto transitway.

⁴Vehicle-miles of travel.

Transitway Accident Rate

A total of 16 transitway-related accidents have been reported between January 1985 and December 1987. Not all of these accidents directly involved vehicles using the transitway. Some involved other vehicles that were in accidents related to the transitway such as: 1) non transitway vehicle hitting a crash cushion or barrier in the vicinity of a transitway access/egress location; or 2) non transitway vehicle hitting the concrete barrier and flipping into the transitway. Of the reported accidents since January 1985, 13 have directly involved transitway vehicles.

A summary of estimated accident rates is shown in Table 9. The overall accident rate for the transitway is less than the accident rate for the freeway.

Table 9. Estimated Accident Rates, Katy Freeway Transitway

Time Period	No. of Accidents	Est. Vehicle Miles of Travel (millions)	Est. Accident Rate (accident/MVM)
1985	2	0.482	4.14
1986	3	3.170	0.95
1987	11	9.956	1.10
1986 and 1987	14	13.126	1.07
1985 thru 1987	16	13.608	1.18

Source of number of accidents: Metropolitan Transit Authority.

Transitway Lane Measure of Effectiveness

In assessing the relative efficiency of a transitway lane, a measure that has frequently been used is the multiple of peak-hour passengers times average operating speed. For the peak hour, this is generally expressed as passenger-miles/hour (passengers times mi/hr.).

For the Katy Transitway in December 1987, this value (expressed in 1000's) is estimated to be 229 (4580 passengers times 50 mph). As shown subsequently in this report, this value is over five times the efficiency of a mixed-flow lane on the Katy Freeway.

In comparison to other major HOV projects in the nation, the Katy Transitway is also relatively successful (Table 10) in terms of this measure of effectiveness.

Table 10. Measure of Effectiveness for Major HOV Projects in the United States

City and Project	Passenger-miles per hour ¹ (1000's)
New York City, N.J. Route 495	1040
Washington, D.C., Shirley Highway	480
Los Angeles, San Bernardino Busway	360
Washington, D.C., I-66	330
HOUSTON, KATY TRANSITWAY	229
San Francisco, US 101	210
Los Angeles, Route 55	200
Houston, North Transitway	196
Los Angeles, Route 91	180
Pittsburgh, East Busway	180
Miami, I-95	130
Pittsburgh, South Busway	80

¹This represents the multiple of peak hour passengers times operating speed.

Source: Houston data, Texas Transportation Institute.
Other U.S. Data, "The Effectiveness of High-Occupancy Vehicle Facilities", Institute of Transportation Engineers 1985 Survey of operating HOV projects.

Estimated Travel Time Elasticities, Houston Data

Travel time elasticity is commonly used as a means of estimating the travel demand impacts of changing travel time. This elasticity can be defined as shown below.

% Change in Ridership
% Change in Travel Time

This is a relatively simple, sketch planning approach for estimating demand impacts. However, Houston data are beginning to define a relatively consistent elasticity value from experience on the Katy and North Transitways. These data are summarized in Table 11. As a general "rule of thumb" an elasticity of between -0.4 and -0.5 appears appropriate; that suggests that each 10% reduction in travel time will result in a 4% to 5% increase in ridership.

Table 11. Estimated Travel Time Elasticities for Houston Transitways

Improvement	% Change in Travel Time	% Change in Ridership	Estimated Elasticity
1. Concurrent Flow Lane Extension to North Authorized Vehicle Lane ¹	-22%	+10%	-0.45
2. Extension of Katy Transitway From Gessner to West Belt ¹	-21%	+ 8%	-0.38
3. Extension of Katy Transitway from West Belt to SH 6 ²	-31%	+15%	-0.48
"Representative" Value, Houston	-10%	+4.5%	-0.45

¹Analysis documented in "Assessment of alternative Transitway improvements, FM 1960 to Downtown Houston", Prepared for Metro by Texas Transportation Institute, 1986.

²For the extension to SH 6 (which opened in June 1987) data are analyzed for the period from January 1987 through January 1988. Trend line data suggest that, without the extension, a.m. peak period ridership in January 1988 would have been 7800; actual ridership was 8700, an increase of 900. Approximately 5800 persons entered the transitway from west of Gessner in June 1987. Thus, the percent increase in ridership was approximately 15%. The extension of the transitway to SH 6 increased the length of the transitway by approximately 80%; this reduced total travel time from SH 6 to Post Oak by approximately 31%.

Summary of Selected Transitway Data

A summary of selected data describing the operation of the transitway is provided in Table 12. The facility is used by 2+ person vehicles. It operates inbound from 5:45 a.m. to 11:00 a.m. and outbound from 2:00 p.m. to 8:00 p.m.

Table 12. Summary of Selected Katy Transitway Data

Data	Value	% Change 1986-1987
Person Movement, Daily	17,897	+25%
A.M. Peak Hour	4,580	+25%
A.M. Peak Period	8,703	+18%
P.M. Peak Hour	3,812	+30%
P.M. Peak Period	8,129	+29%
Vehicle Volume, Daily	5,733	+36%
A.M. Peak Hour	1,469	+28%
A.M. Peak Period	2,788	+21%
P.M. Peak Hour	1,180	+38%
P.M. Peak Period	2,517	+32%
Estimated Transitway Capacity (vph)	1,500	---
Transitway Vehicle Occupancy (a.m. peak hour)	3.12	- 3.4%
Transitway Violation Rate	less than 1%	0%
Transitway Breakdown Rate (10/84-12/87) (vehicle miles of travel per breakdown)	29,500	NA
Transitway Accident Rate, Accidents/MVM (1986-87)	1.07	NA
Transitway Lane, Measure of Peak-Hour Effectiveness (passenger-miles/hr.) ¹	229	+13%
Estimated Travel Time Elasticity, Houston Transitway	-0.45	NA

¹The multiple of peak-hour passengers times speed.

Note: Site specific data collected at Bunker Hill.



IV. DATA RELATING TO FREEWAY MAINLANE OPERATION

The previous section of this report reviewed data pertaining to the transitway. As indicated in that section, in the a.m. peak-hour the transitway is moving over 4500 persons in nearly 1500 vehicles. Given this volume on the transitway and the fact that freeway lane and shoulder widths were reduced to provide space for a transitway, this section of the report investigates what has happened to the operations on the freeway mainlanes. In the subsequent section of this report, the transitway and freeway data are combined and analyzed.

The freeway data are collected during the a.m. peak period (6:00 to 9:30 a.m.) and the p.m. peak period (3:30 to 7:00 p.m.). The principal location where freeway data are collected is on the Bunker Hill overpass (3 directional freeway lanes); volumes are counted manually at this location. This location is between an exit and an entrance ramp. As a result, it understates absolute freeway volume but should accurately reflect trend data. The site was selected for purposes of safety and visibility during data collection.

Characteristics of Freeway Mainlane Motorists

Surveys of motorists using the freeway mainlanes have been undertaken on several occasions, both "before" and "after" the transitway was implemented. License plates have been read during the a.m. peak period, address files accessed, and surveys mailed to the motorists.

A summary of selected characteristics is shown in Table 13. Some of the reasons for using the auto as well as characteristics of that auto use are summarized in Table 14. More detailed presentation of these data is included in Texas Transportation Institute Research Reports 484-4 and 484-8.

Table 13. Characteristics of Motorists in the Katy Freeway Mainlanes,
A.M. Peak Period

Characteristic	Survey Date ¹			
	1984	1985	1986	1987
Age in Years (50th Percentile)	41	40	40	38
Sex				
Male	56%	64%	66%	62%
Female	44%	36%	34%	38%
Occupation				
Professional or Managerial	68%	70%	68%	64%
Clerical	11%	9%	9%	13%
Student	1%	2%	2%	2%
Sales	14%	12%	14%	12%
Other	6%	7%	7%	9%
Education in Years (avg.)	15.0	15.7	15.9	15.5
Trip Destination				
Downtown	---	38%	33%	23%
Texas Medical Center	---	9%	3%	3%
City Post Oak	---	24%	10%	13%
Greenway Plaza	---	8%	4%	5%
Other	---	21%	50%	56%
Trip Purpose				
Work	---	94%	91%	92%
School	---	3%	2%	3%
Other	---	3%	7%	5%

¹1984 data is prior to the opening of the transitway.

Table 14. Characteristics of Auto Use on the Katy Freeway Mainlanes,
A.M. Peak Period

Characteristics	Survey Date ¹			
	1984	1985	1986	1987
Why choose auto?				
Need car for job	---	22%	25%	21%
Convenience and Flexibility	---	17%	26%	21%
No Bus, Carpool or Van Available	---	22%	21%	18%
Work Odd Hours	---	10%	10%	25%
Vehicle Occupancy (persons/vehicle)				
1	---	83%	89%	83%
2	---	12%	7%	13%
3+	---	5%	4%	4%
Does Job Require a Car?				
Yes, always	56%	37%	36%	---
Yes, sometimes	1%	37%	29%	---
No	43%	26%	25%	---
Employer Pay Parking?				
Yes, pays all	48%	46%	39%	---
Yes, pays part	9%	8%	8%	---
No	43%	46%	53%	---
Employer Pay Transit Fare				
Yes, pays all	11%	2%	5%	---
Yes, pays part	9%	3%	2%	---
No or don't know	80%	95%	90%	---

¹1984 data is prior to the opening of the transitway.

Motorist Attitudes Regarding Transitway

A major reason for changing the definition of who was able to use the transitway was to increase the acceptance of the transitway by non-transitway users. And, as transitway volumes have increased, the perception of the freeway motorists regarding the utilization of the transitway has changed perceptibly. The majority of motorists feel the transitway is a good transportation improvement (Table 15).

Table 15. Perception of the Utilization of the Katy Transitway
By Motorists in the General Freeway Lanes

Measure of Effectiveness	Non Transitway Users			
	3/85 ¹	4/86 ²	4/87 ³	10/87 ³
Transitway A.M. Peak Period Vehicle Volume	138	256	2410	2922
Is the transitway sufficiently utilized?				
Yes	3%	3%	36%	44%
No	90%	92%	55%	42%
Not Sure	7%	5%	9%	14%
Is the transitway a good transportation improvement?				
Yes	41%	36%	56%	63%
No	35%	43%	29%	20%
Not Sure	24%	21%	15%	17%

¹Authorized buses and vanpools (before carpools).

²Authorized buses, vanpools and 3+ carpools.

³2+ vehicles, no authorization.

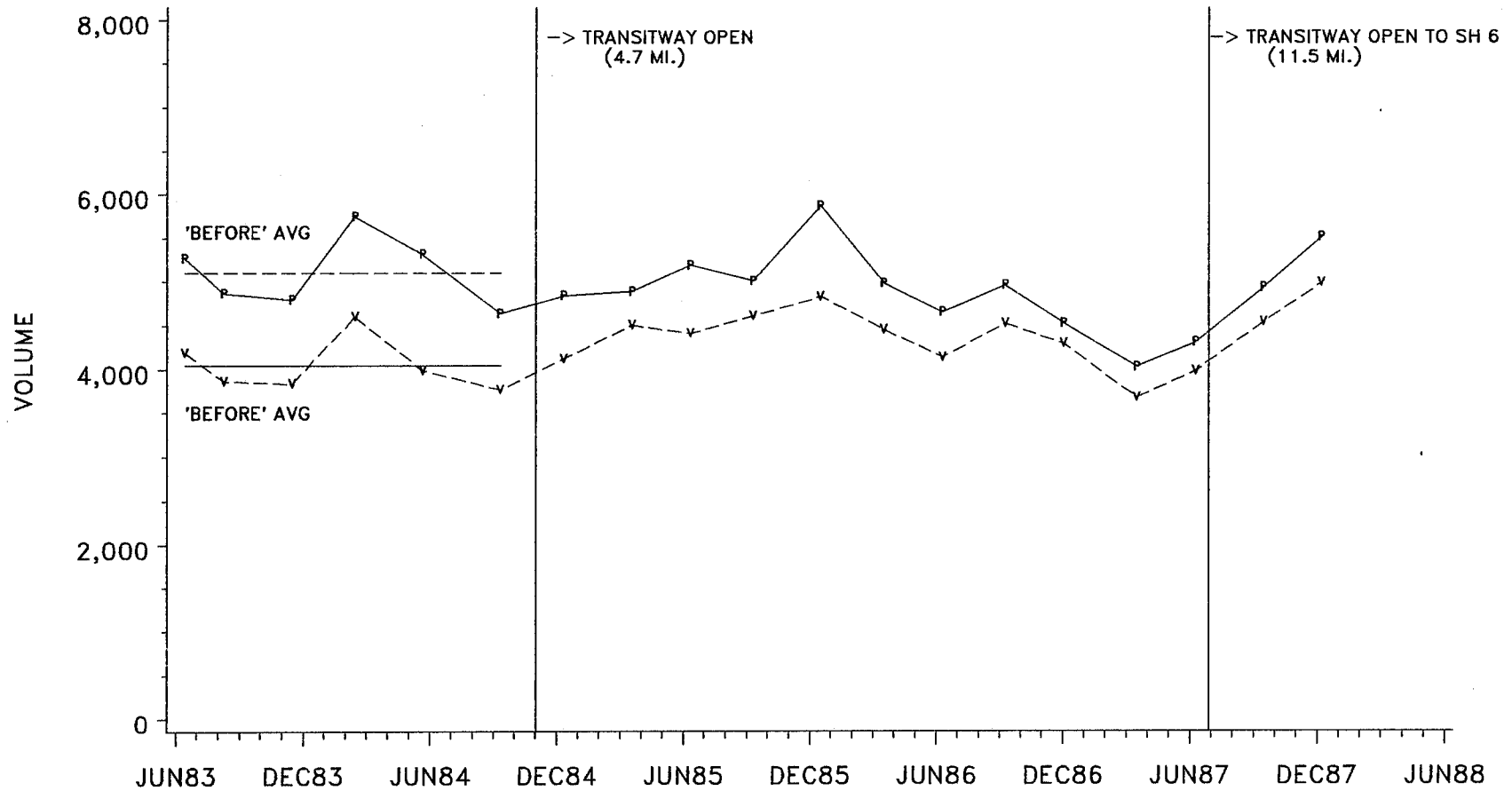
Freeway Mainlane Person Volumes

In spite of the diversion of carpools from the mainlanes to the transitway, person throughput on the freeway mainlanes has not declined since the transitway opened. As shown in this report, increases in vehicle volume have offset the decrease in average occupancy. Again, freeway volumes are collected on the Bunker Hill overpass; this count location is between an exit ramp and an entrance ramp.

A.M. Peak Hour and Peak Period

Trends in both a.m. person and vehicle movement, as measured at Bunker Hill, are depicted in Figures 29 and 30. In December 1987, 5284 persons were moved on the freeway in the peak hour, with 17,399 moved in the 3.5 hour peak period. This represents a 3.6% increase over the pre-transitway value for the peak hour, and an 11.1% increase for the peak period. However, as shown in Figures 29 and 30, considerable variation exists in the trend line for

KATY FREEWAY (IH 10W)
A.M. PEAK HOUR FREEWAY TRIPS



57

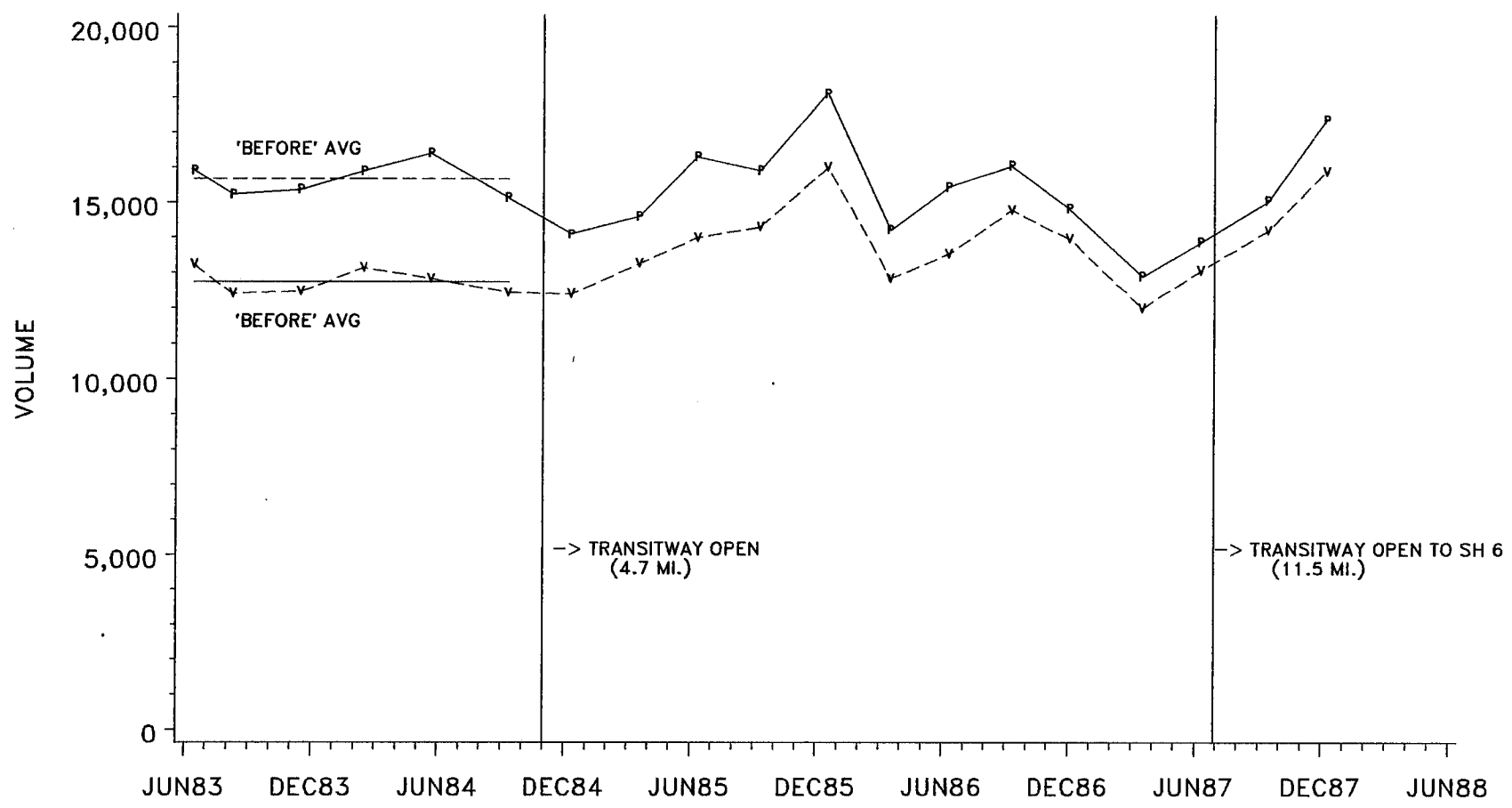
DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION

LEGEND : P = MAINLANE PERSONS
V = MAINLANE VEHICLES

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 29

KATY FREEWAY (IH 10W)
A.M. PEAK PERIOD FREEWAY TRIPS



A.M. PEAK PERIOD DEFINED AS FROM 5:45 TO 9:30 A.M.
DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION

LEGEND : P = MAINLANE PERSONS
V = MAINLANE VEHICLES

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 30

freeway person volume since the transitway became operational; during some months this volume has decreased relative to pre-transitway levels.

P.M. Peak Hour and Peak Period

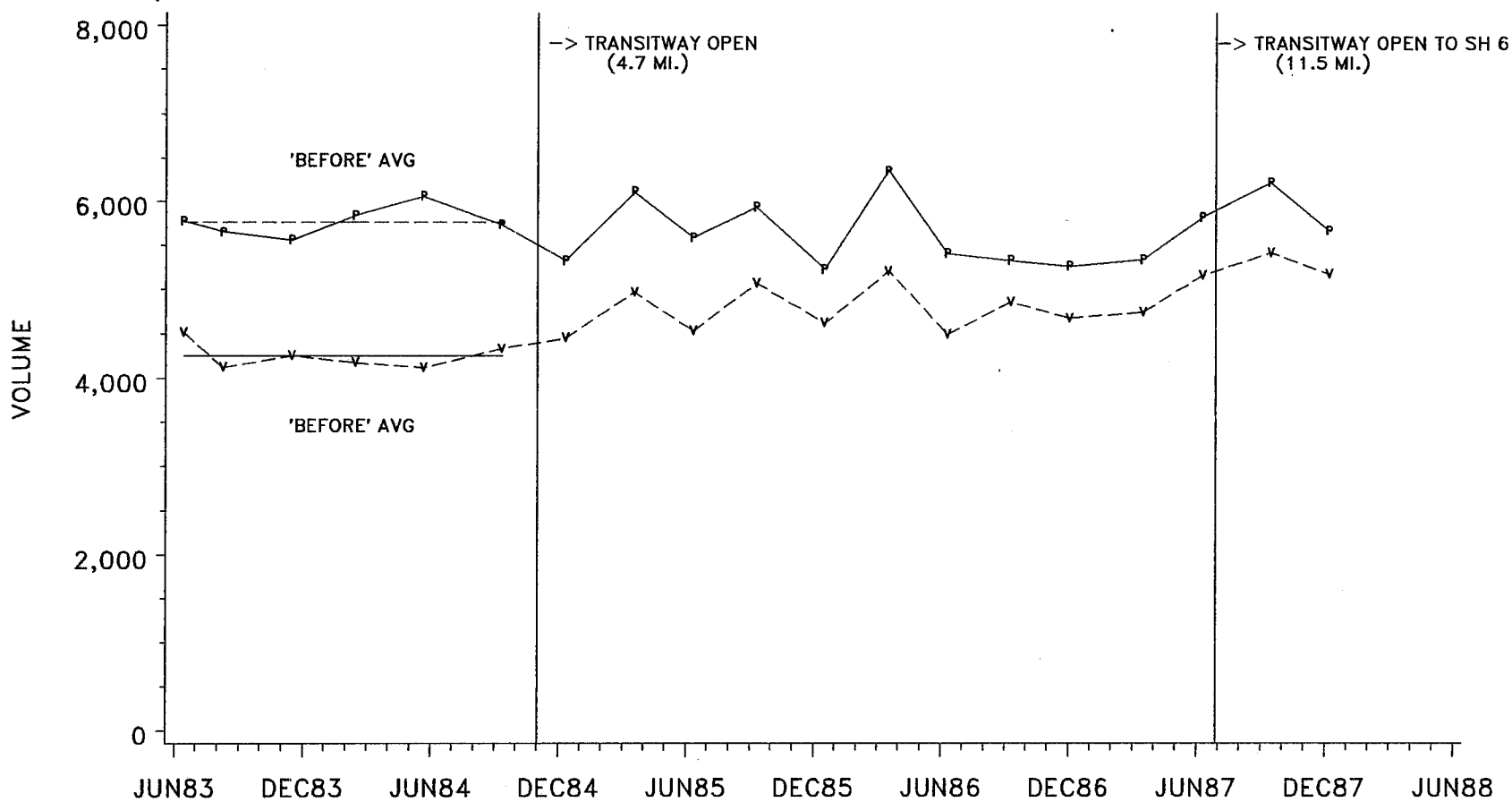
Trends in both p.m. person and vehicle movement, as measured at Bunker Hill, are depicted in Figures 31 and 32. In December 1987, 5667 persons were moved on the freeway in the peak hour, with 18,953 persons moved in the 3.5-hour peak period. Peak-hour volumes are essentially equal to pre-transitway levels, while the peak-period volume represents a 12.3% increase over the pre-transitway volume. As was the case in the a.m., the volumes shown in Figures 31 and 32 have exhibited considerable variation since the transitway became operational.

Freeway Vehicular Volumes

In spite of the volume being moved on the transitway, the volumes on the Katy Freeway remain high. Traffic counts are recorded at 3 locations. Locations of these count stations are shown in Figure 11.

1. At Bunker Hill, on the overpass between an off-ramp and an on-ramp. Volume counts are low due to the location between ramps. Volumes and occupancies have been counted manually at this location since June 1983. Thus, this is the best data for "before" and "after" comparisons.
- 2 and 3. Loop detectors are present at the Silber and Gessner overpasses, also located between an off-ramp and an on ramp. These loops became operational after construction was completed and provide data since 1985. The Silber count provides a reflection of the overall change in travel demands in the area, while the count at Gessner is more directly impacted by the operations at the Gessner

KATY FREEWAY (IH 10W)
P.M. PEAK HOUR FREEWAY TRIPS



09

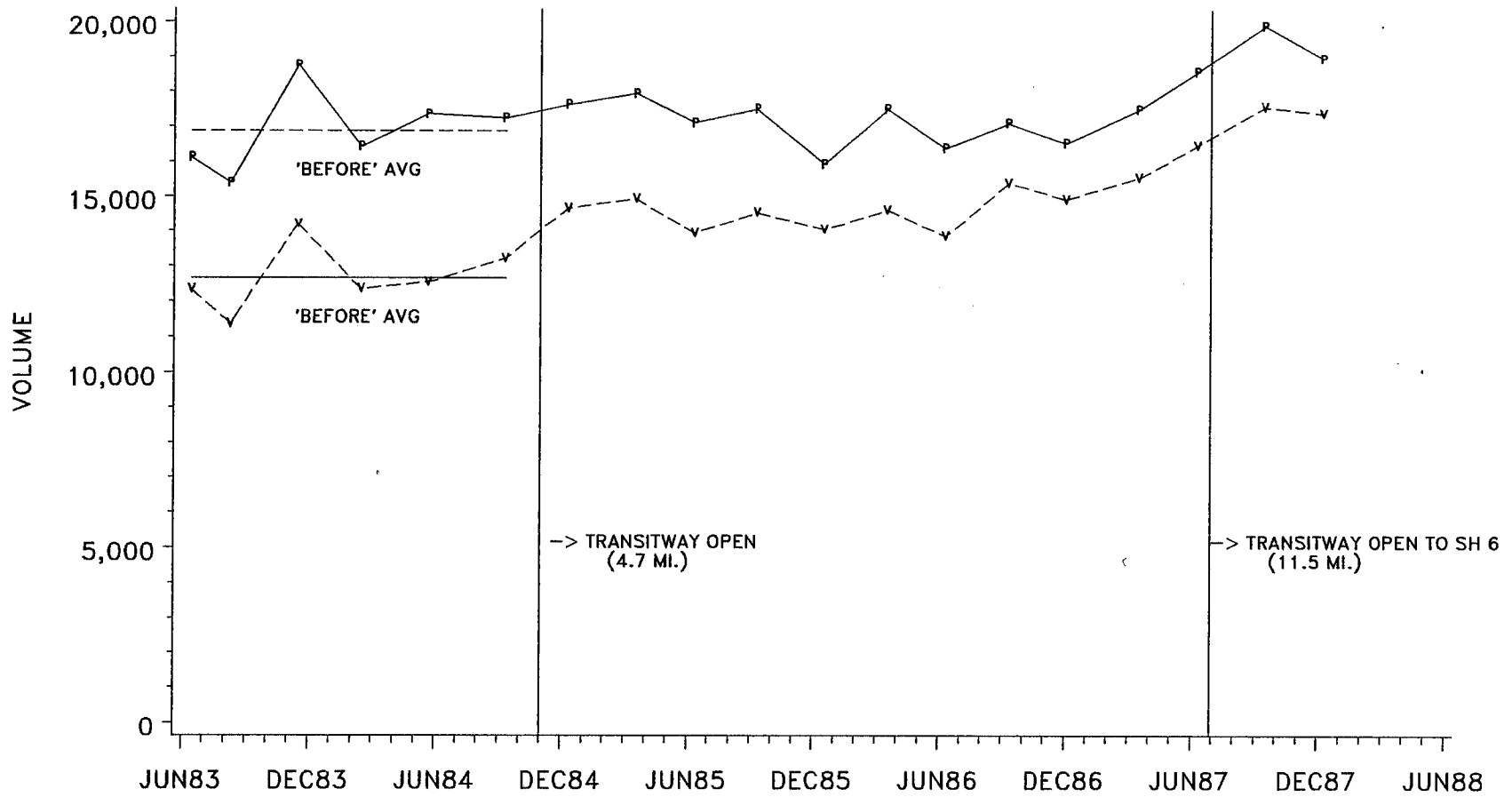
DATA COLLECTED WESTBOUND OVER BUNKER HILL, 3 LANE SECTION

LEGEND : P = MAINLANE PERSONS
V = MAINLANE VEHICLES

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 31

KATY FREEWAY (IH 10W)
P.M. PEAK PERIOD FREEWAY TRIPS



P.M. PEAK PERIOD DEFINED AS FROM 3:30 TO 7:00 P.M.
DATA COLLECTED WESTBOUND OVER BUNKER HILL, 3 LANE SECTION

LEGEND : P = MAINLANE PERSONS
V = MAINLANE VEHICLES

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 32

access ramp to the transitway as well as impacts resulting from the construction of the interchange between the Katy Freeway and Beltway 8.

Daily Traffic Volumes

Average daily traffic volumes are available from the loop detectors at Silber and Gessner. In terms of daily travel, ADT on the Katy Freeway at these two locations has decreased slightly since 1985 (Table 16); however, given the accuracy of the traffic counts, the conclusion would need to be that essentially there has been no change in this volume.

Table 16. Average Daily Traffic, 1985-1987, Katy Freeway Mainlanes

Location	Direction and Date					
	Eastbound			Westbound		
	3/85	8/86	10/87	3/85	8/86	10/87
Silber Overpass, 4 Lanes	90,325	89,507	87,730	86,978	87,622	85,690
% Change, 1985-1986	---	-0.9%	---	---	+0.7%	---
% Change, 1985-1987	---	---	-2.9%	---	---	-1.5%
Gessner Overpass, 3 Lanes	70,069	69,250	64,064	70,919	69,965	69,147
% Change, 1985-1986	---	-1.2%	---	---	-1.3%	---
% Change, 1985-1987	---	---	-8.6%	---	---	-2.5%

A.M. Traffic Volumes

The data relating to a.m. traffic volumes are not conclusive. It is apparent, however, that, in spite of the volume of traffic being moved on the transitway, that freeway volumes have not decreased significantly (Table 17). Vehicular volumes at Bunker Hill "before" and "after" the transitway was implemented are also depicted in Figures 29 through 32. At Bunker Hill, traffic volumes have increased by over 20% in comparison to pre-transitway volumes. Data from Gessner and Silber are not available prior to opening the transitway; however, the trend data at these locations since 1985 has not

paralleled that at Bunker Hill. The manual counts at Bunker Hill are considered more accurate than the loop counts at Gessner and Silber.

Table 17. A.M. Peak-Direction (Eastbound) Traffic Volumes, Katy Freeway Mainlanes

Location and Time Period	Representative Pre-Transitway Value	Date		
		3/85	8/86	1987 ¹
Bunker Hill, 3 Lanes ²				
Peak Hour	4,043	4,507	4,528	4,993
Peak Period (6-9:30 a.m.)	12,750	13,261	14,802	15,925
Gessner, 3 Lanes ³				
Peak Hour	---	5,526	5,523	5,127
Peak Period (6:30-9:30 a.m.)	---	15,263	15,528	13,448
Silber, 4 Lanes ³				
Peak Hour	---	7,295	7,113	7,200
Peak Period (6:30-9:30)	---	20,589	19,445	20,783

¹Silber and Gessner data are for 10/87. Bunker Hill data are for 12/87.

²Manual counts.

³Loop detector counts.

P.M. Traffic Volumes

P.M. data are similar to a.m. data (Table 18). The trend data collected at Bunker Hill are summarized in Figures 29 through 32. As was the case in the a.m., current volumes at Bunker Hill, in comparison to pre-transitway volumes, have increased by over 20%. Also, as was the case in the a.m., the loop count data does not closely parallel the manual count data.

Table 18. P.M. Peak Direction (Westbound) Volumes, Katy Freeway Mainlanes

Location and Time Period	Representative Pre-Transitway Value	Date		
		3/85	8/86	1987 ¹
Bunker Hill, 3 Lanes ²				
Peak Hour	4,266	4,974	4,864	5,178
Peak Period (3:30-7 p.m.)	12,706	14,937	15,497	17,410
Gessner, 3 Lanes ³				
Peak Hour	---	4,985	4,933	5,886
Peak Period (3:30-6:30 p.m.)	---	14,270	12,835	16,911
Silber, 4 Lanes ³				
Peak Hour	---	6,368	6,278	6,426
Peak Period (6:30-9:30)	---	17,539	17,692	18,535

¹Silber and Gessner data are for 10/87. Bunker Hill data are for 12/87.

²Manual counts.

³Loop detector counts.

Vehicle Occupancy

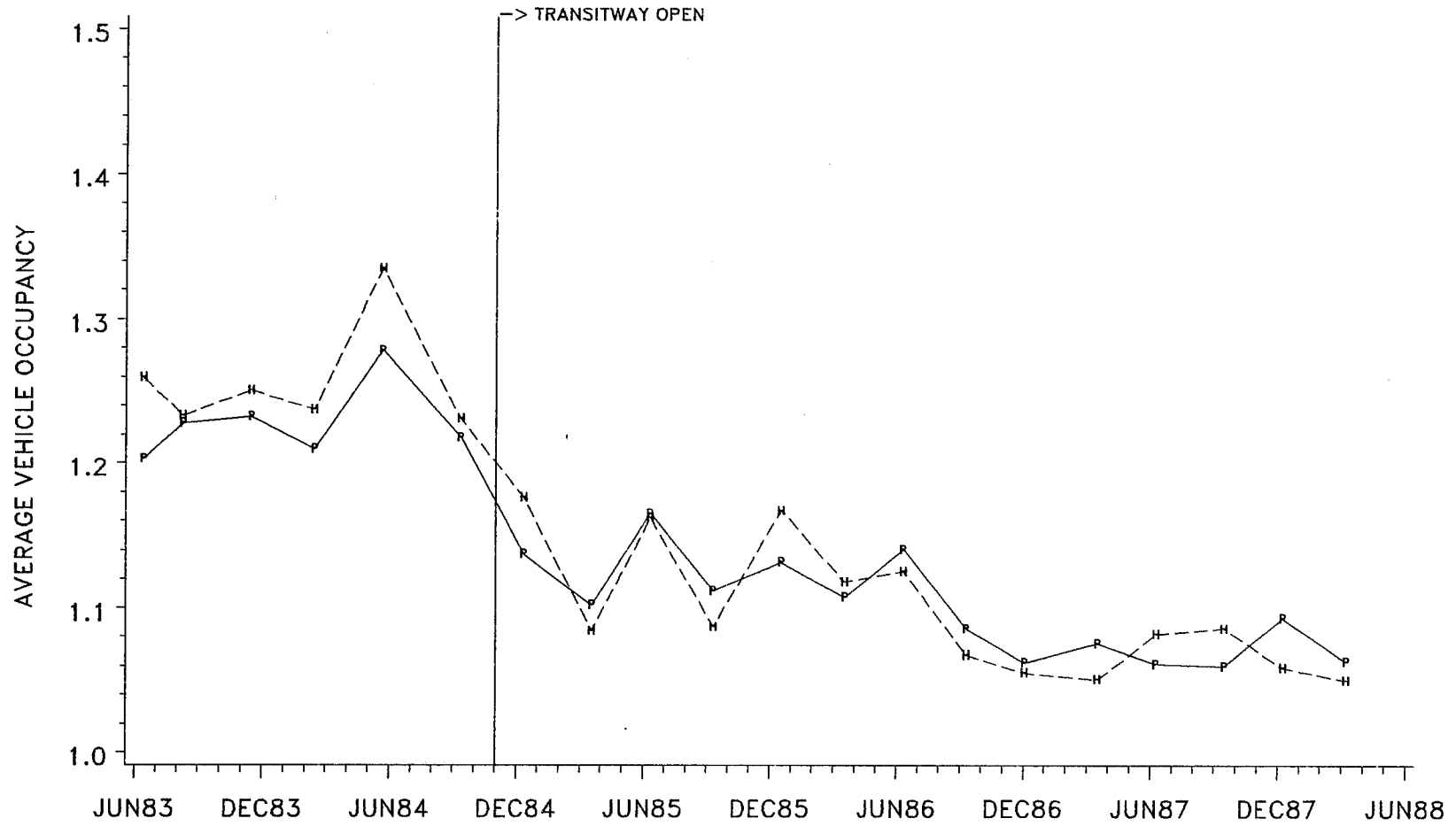
Opening the transitway has significantly reduced mainlane vehicle occupancy. This has particularly been the case since the transitway was opened to 2+ carpools.

During the a.m. peak hour, mainlane occupancy has declined from a pre-transitway level of 1.26 to 1.06 persons per vehicle, a decline of 16.1% (Figure 33). In the peak period, occupancy has dropped from 1.23 to 1.09, a reduction of 11%.

During the p.m. peak hour, persons per vehicle have declined from a pre-transitway level of 1.33 to 1.09, a reduction of 17.5% (Figure 34). This same trend has occurred during the p.m. peak period.

KATY FREEWAY (IH 10W) MAINLANES
 A.M. PEAK HOUR & PEAK PERIOD AVERAGE OCCUPANCY

65



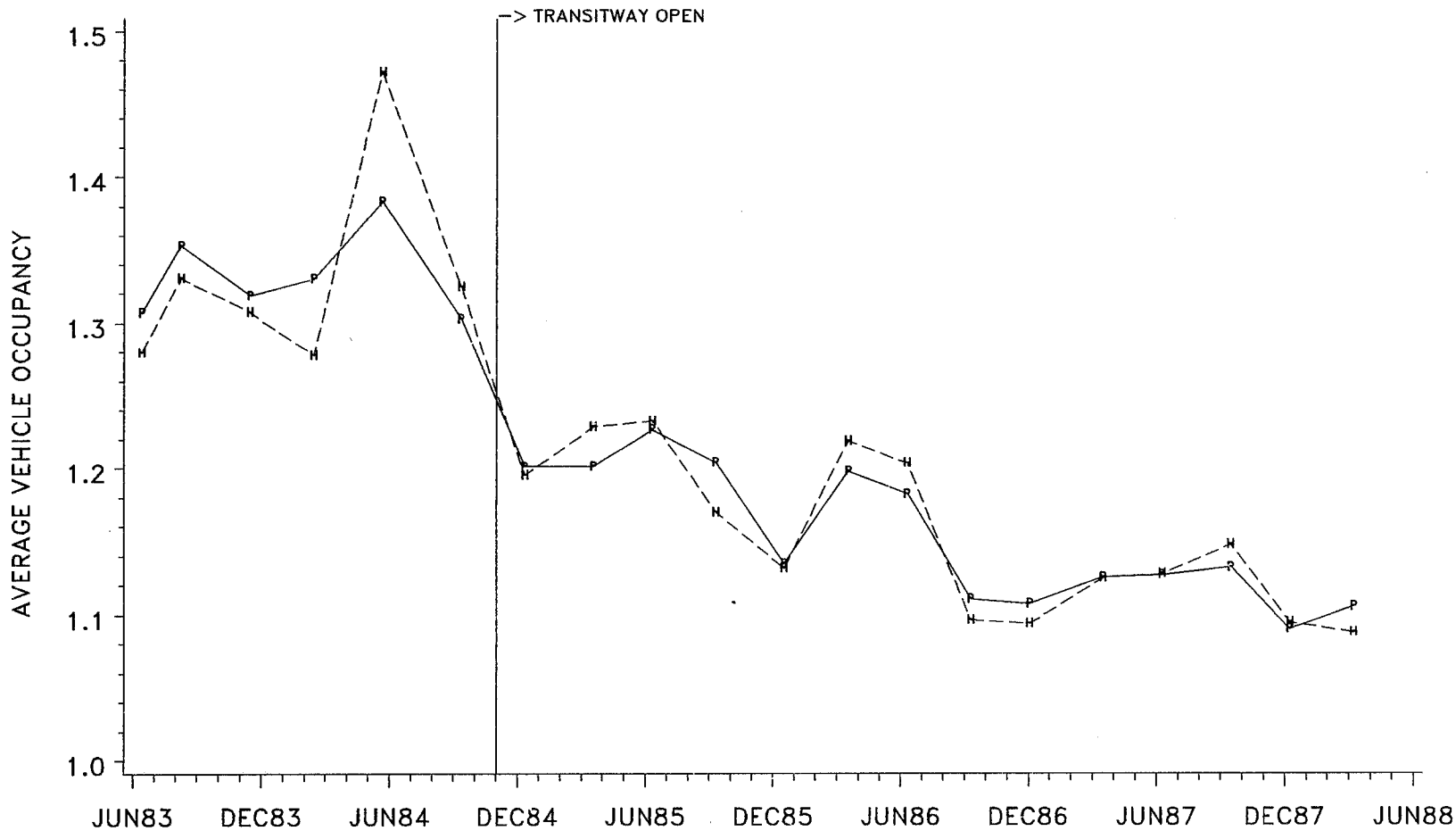
DATA COLLECTED EASTBOUND AT BUNKER HILL

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : H = PEAK HOUR OCCUPANCY
 P = PEAK PERIOD OCCUPANCY

FIGURE 33

KATY FREEWAY (IH 10W) MAINLANES P.M. PEAK HOUR & PEAK PERIOD AVERAGE OCCUPANCY



DATA COLLECTED WESTBOUND AT BUNKER HILL
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : H = PEAK HOUR OCCUPANCY
P = PEAK PERIOD OCCUPANCY

FIGURE 34

Travel Time and Speed

Travel time and speed data are collected on a quarterly basis. Figures 35 and 36 summarize these data for the a.m. and p.m. peak periods. In those figures, all the data collected prior to opening the transitway are combined and averaged to represent pre-transitway conditions. The data collected since June 1987, the date at which the transitway was extended to SH 6, are averaged to represent current conditions.

Speeds on the freeway mainlanes have increased. The increase became most evident after 2+ carpools were allowed to use the transitway. These data are summarized in Table 19.

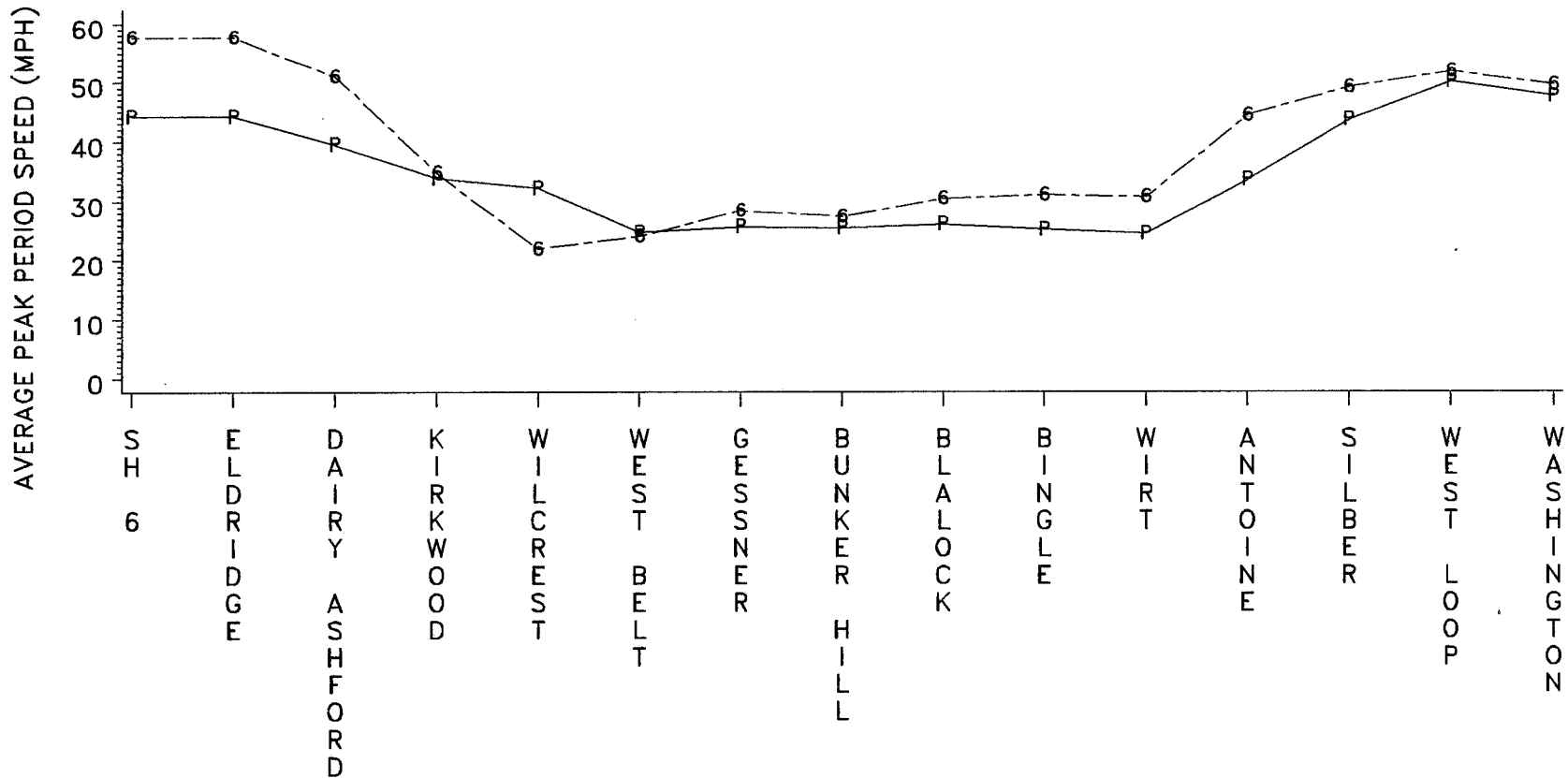
Table 19. Travel Speeds in the Katy Freeway Mainlanes, Pre-Transitway and Current, SH 6 to West Loop (11.56 miles)

Time Period	Pre-Transitway Speed (mph)	Current 12/87 Speed (mph)	% Change
A.M. Peak Hour	21.45	22.53	+ 5.0%
A.M. Peak Period (3.5 hr)	32.19	34.01	+ 5.6%
P.M. Peak Hour	25.91	32.79	+26.6%
P.M. Peak Period (3.5 hr)	34.27	43.34	+26.5%

These general trends have been confirmed by other travel time and speed data collected on the Katy Freeway since 1985. Those data were collected between SH 6 and the Southern Pacific Railroad overpass, a distance of 13.2 miles (those limits were selected since CBD-bound transitway traffic re-enters the Katy Freeway at Washington Avenue; thus, these limits provide a basis for comparing total transitway travel time with non-transitway travel time). As discussed in the subsequent section of this report, the improving freeway mainlane speeds do reduce the travel time savings offered by the transitway, particularly during the p.m. peak period.

Data for 1985 through 1987 are summarized in Table 20. These data provide further corroboration of the data reported in Table 19. Additional

KATY FREEWAY (IH 10W) TRAVEL TIME AND SPEED SURVEY
 EASTBOUND, SH 6 TO WASHINGTON
 A.M. PEAK PERIOD



89

TRANSITWAY OPENED OCTOBER 29, 1984
 DATA COLLECTED 6:00 TO 9:30 AM JUNE, 1983 TO MARCH, 1988
 TRANSITWAY OPERATES FROM SH 6 TO WEST LOOP (11.5 MI.)

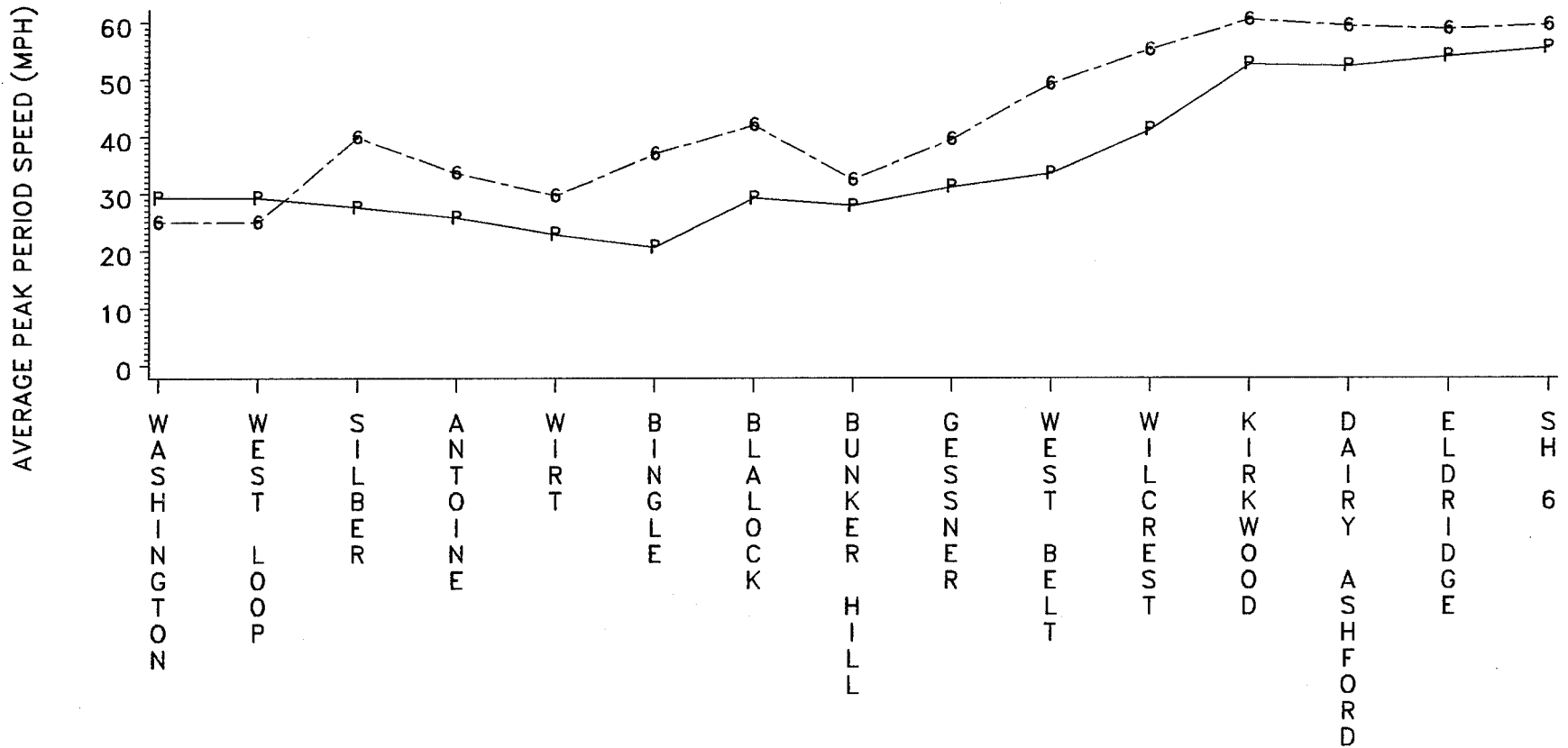
LEGEND : P = FREEWAY SPEEDS PRIOR TO OPENING TRANSITWAY
 6 = FREEWAY SPEEDS SINCE TRANSITWAY OPEN TO SH 6 (6/87)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 35

KATY FREEWAY (IH 10W) TRAVEL TIME AND SPEED SURVEY
 WESTBOUND, WASHINGTON TO SH 6
 P.M. PEAK PERIOD

69



TRANSITWAY OPENED OCTOBER 29, 1984
 DATA COLLECTED 4:00 TO 7:00 PM JUNE, 1983 TO MARCH, 1988
 TRANSITWAY OPERATES FROM SH 6 TO WEST LOOP (11.5 MI.)

LEGEND : P = FREEWAY SPEEDS PRIOR TO OPENING TRANSITWAY
 6 = FREEWAY SPEEDS SINCE TRANSITWAY OPEN TO SH 6 (6/87)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 36

elaboration and discussion of the data shown in Table 20 are included in Texas Transportation Institute Research Report 484-7.

Table 20. Katy Freeway Mainlanes, Average Speed, SH 6 to the Southern Pacific Railroad (13.2 miles)

Time Period	Average Speed (mph)		
	3/85	7/86 ¹	11/87
A.M. Operations			
Peak 2 Hours (6:30-8:30 a.m.)	26	38	30
Peak 3 Hours (6-9 a.m.)	30	42	36
P.M. Operations			
Peak 2 Hours (5-7 p.m.)	32	38	41
Peak 3 Hours (4-7 p.m.)	37	41	44

¹Speeds during the summer months are generally higher than during the remainder of the year.

Freeway Accident Rates

Implementation of the transitway involved removal of the inside freeway shoulder and a narrowing of the main traffic lanes. This change in the cross section raised concerns regarding safety.

Accident data have been analyzed for a period from 1982 through 1987. At least, to date, the freeway accident rate has not been adversely impacted due to the implementation of the transitway (Table 21). Certain operational improvements were made to the freeway at the same time the transitway was constructed; as a result, the decline in rates shown in Table 21 would appear to be attributable to several factors. Also, a general decline has occurred in the overall accident rate for Harris County freeways.

Table 21. Katy Freeway Accident Rate¹, "Before" and "After" Transitway

Time Period	No. of Accidents	Accident Per MVM ²	% Change From "Before" Transitway
"Before" Transitway 1/82-5/83	797	1.69	---
During Transitway Construction 6/83-10/84	865	1.78	+ 5.3%
"After" Transitway 11/84-12/87	1375	1.25	-26.0%

¹Accidents are analyzed between Gessner and Post Oak. This corresponds to Phase 1 of the transitway which has been in operation since October 29, 1984.

²Million vehicle miles.

Freeway Lane Measure of Effectiveness

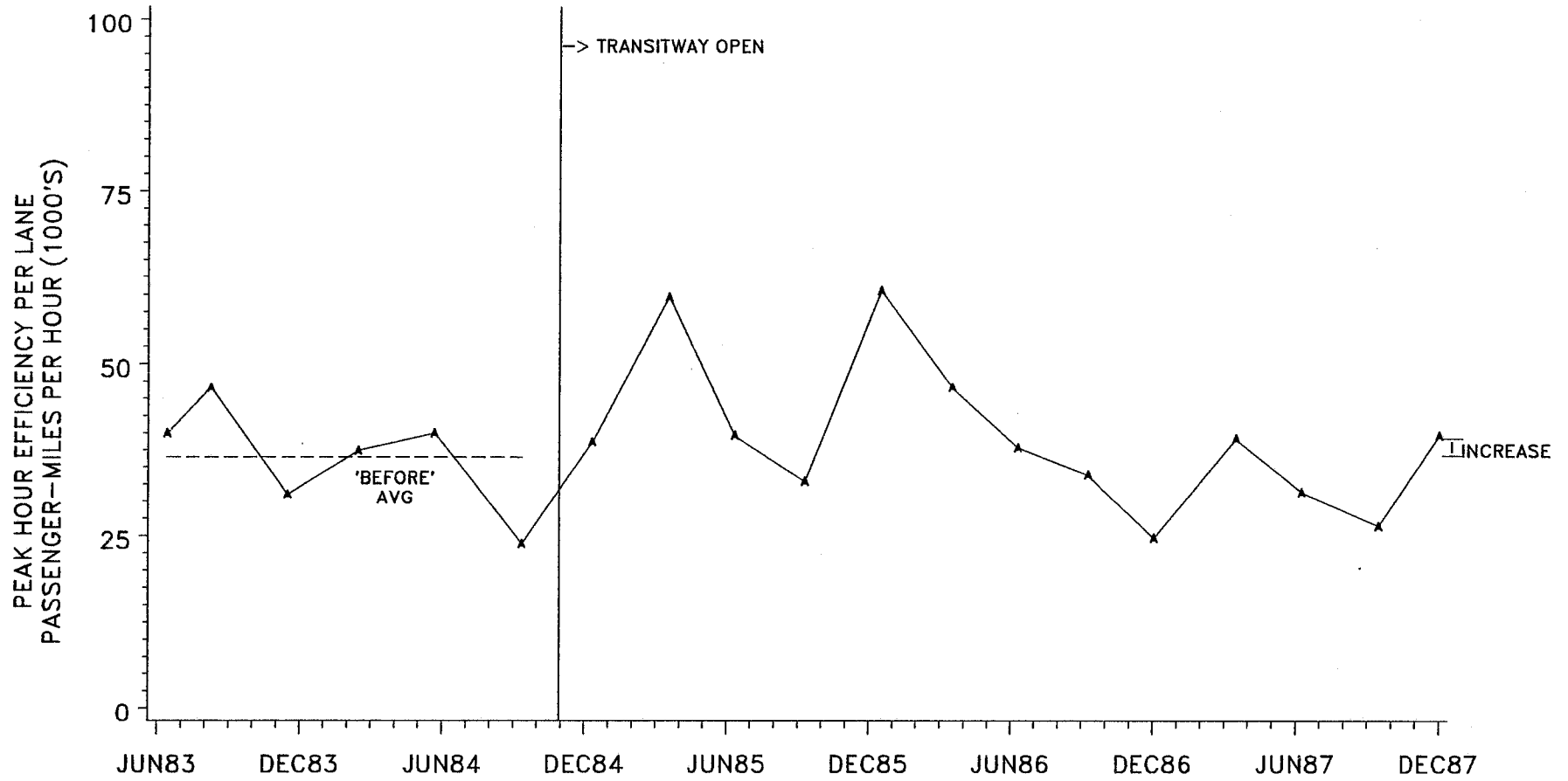
In assessing the efficiency of a freeway lane, a measure that has been used is the multiple of peak-hour passengers times average operating speed. For the peak hour, this is generally expressed as passenger-miles per hour (passengers times mph).

For the Katy Freeway mainlanes during the a.m. peak hour in December 1987, this value (expressed in 1000's) was estimated to be 39.7. The efficiency of the freeway lanes has increased since the transitway opened (Figure 37). The freeway is moving a somewhat higher volume of persons and is doing it at a higher average operating speed.

Summary of Selected Freeway Mainlane Data

A summary of selected data describing the operation of the freeway mainlanes is provided in Table 22.

KATY FREEWAY TRANSITWAY EVALUATION A.M. PEAK HOUR FREEWAY EFFICIENCY



PEAK HOUR EFFICIENCY PER LANE EXPRESSED AS THE MULTIPLE OF
PEAK HOUR PASSENGERS TIMES AVERAGE OPERATING SPEED.
DATA COLLECTED AT BUNKER HILL
SOURCE : TEXAS TRANSPORTATION INSTITUTE

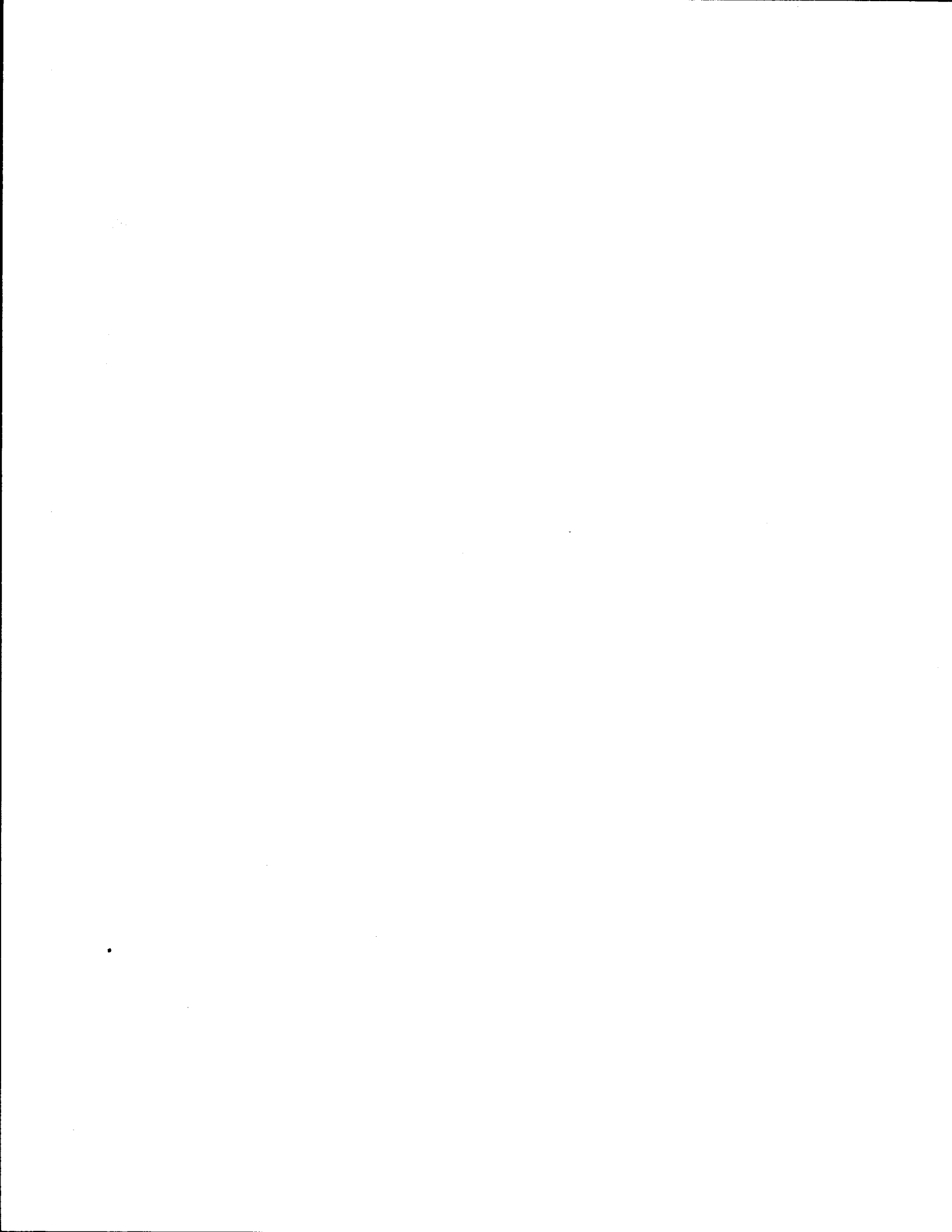
LEGEND : A = A.M. PEAK HOUR EFFICIENCY

FIGURE 37

Table 22. Summary of Selected Katy Freeway Mainlane Data

Data	"Representative" Pre-Transitway Value	Current 12/87 Value	% Change 12/86 to 12/87
<u>Motorist Characteristics</u>			
Occupation			
Professional or Managerial	68%	64%	---
Clerical or Sales	25%	27%	---
Destination			
Downtown	---	23%	-30%
City Post Oak	---	13%	+30%
Other	---	64%	+12%
Trip Purpose, % Work	---	92%	+ 1%
Is Transitway a Good Improvement			
Yes	---	63%	+12%
No	---	20%	-31%
Not Sure	---	17%	+13%
<u>Person Volume</u>			
A.M. Peak Hour	5,100	5,284	+17%
P.M. Peak Hour	5,657	5,667	+11%
<u>Vehicle Volume</u>			
A.M. Peak Hour	4,043	4,993	+16%
P.M. Peak Hour	4,266	5,178	+11%
<u>Vehicle Occupancy (persons/vehicle)</u>			
A.M. Peak Hour	1.26	1.06	0%
P.M. Peak Hour	1.33	1.09	0%
<u>Travel Speed (mph)</u>			
A.M. Peak Hour	21.45	22.53	---
P.M. Peak Hour	25.91	32.79	---
<u>Accident Rate (accidents/MVM)</u>			
	1.69	1.25	---
<u>A.M. Peak-Hour Lane Efficiency (1000's)¹</u>			
	36.5	39.7	---

¹The multiple of peak-hour passengers times average travel speed.



V. COMBINED FREEWAY MAINLANE AND TRANSITWAY DATA

The previous two sections of this report have reviewed data relating to the operation of the transitway and the operation of the freeway mainlanes. This section combines that information and compares current travel conditions in the corridor with the conditions that existed prior to creation of the transitway.

Provision of the transitway increased the directional number of travel lanes by 33%. The data presented in this section were collected at Bunker Hill.

Person Volumes

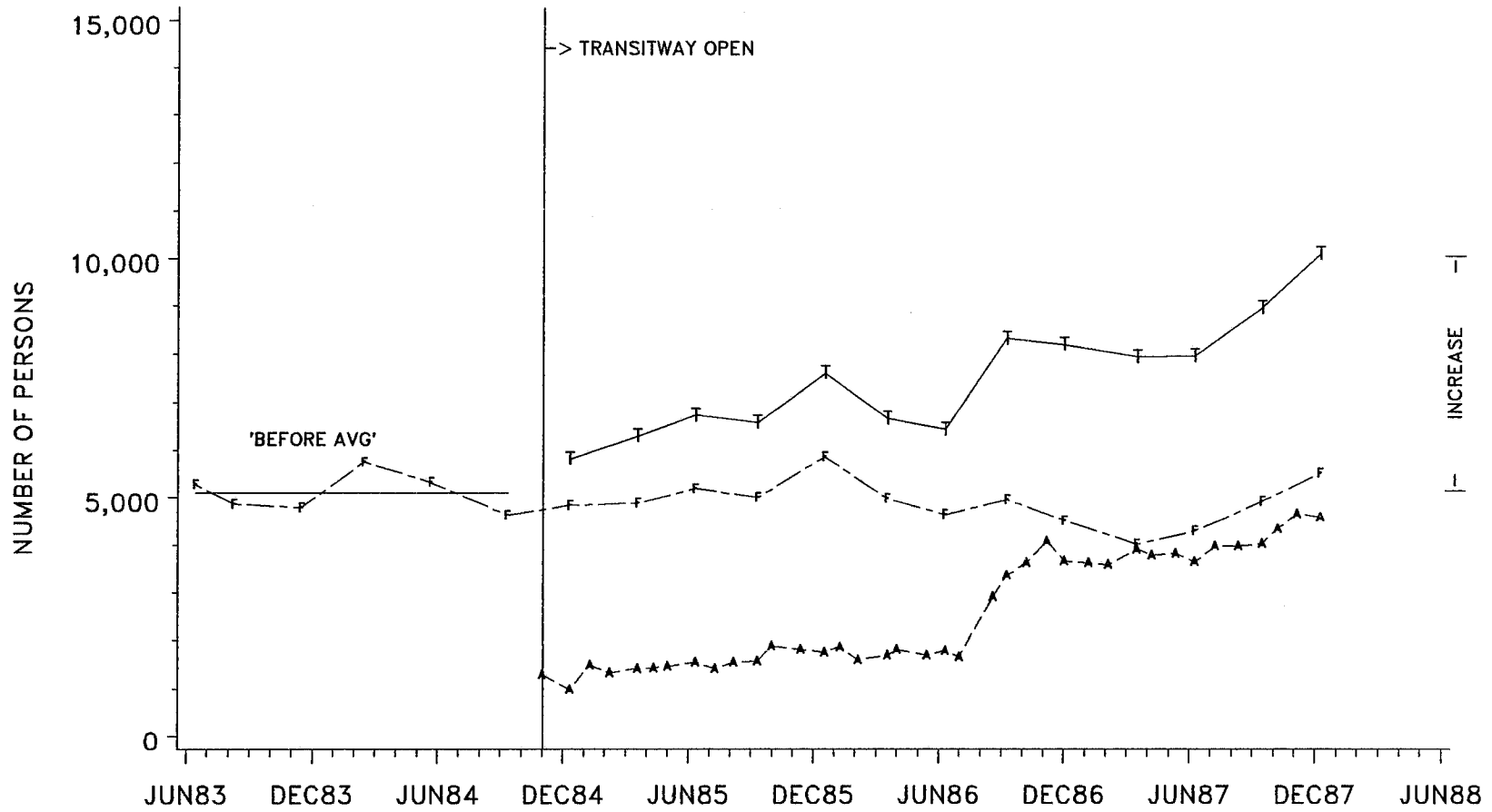
A.M. Operations

Data are collected for the a.m. peak hour (typically 7:00 to 8:00 a.m.) and for the a.m. peak period (6:00 to 9:30 a.m.).

A.M. Peak Hour. Prior to opening the transitway, the peak-hour person volume on the freeway mainlanes was approximately 5,100. In December 1987, the total peak-hour, peak-direction volume at the Bunker Hill count location was 9,864; of that volume, 4,580, or 46%, was on the transitway (Figure 38). In comparison to the pre-transitway volume, a.m. peak-hour person volume has increased by 93%.

A.M. Peak Period. Prior to opening the transitway, a peak-period person volume on the freeway mainlanes of 15,655 was recorded. In December 1987, the total peak-period, peak-direction person volume at the Bunker Hill count location was 26,102; of that volume, 8,703, or 33%, was on the transitway (Figure 39). In comparison to the pre-transitway volume, a.m. peak-period person volume has increased by 67%.

KATY FREEWAY (IH 10W) AND TRANSITWAY A.M. PEAK HOUR PERSON TRIPS



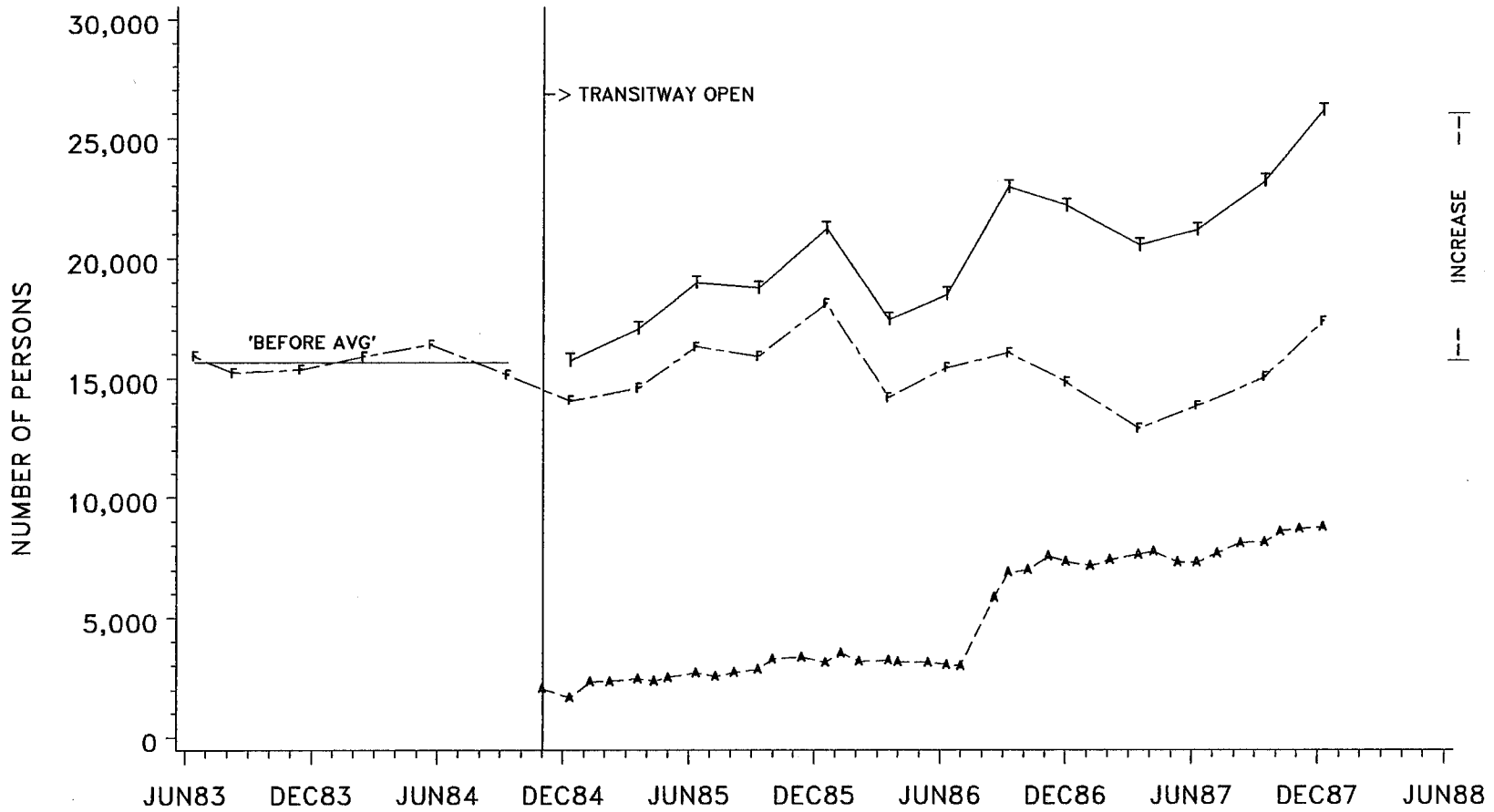
DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL PERSONS
F = MAINLANE PERSONS
A = TRANSITWAY PERSONS

FIGURE 38

KATY FREEWAY (IH 10W) AND TRANSITWAY
A.M. PEAK PERIOD PERSON TRIPS

77



A.M. PEAK PERIOD DEFINED AS FROM 5:45 TO 9:30 A.M.
DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL PERSONS
F = MAINLANE PERSONS
A = TRANSITWAY PERSONS

FIGURE 39

P.M. Operations

Data are collected for the p.m. peak hour (typically 5:00 to 6:00 p.m.) and for the p.m. peak period (3:30 p.m. to 7:00 p.m.).

P.M. Peak Hour. Prior to opening the transitway, the peak-hour person volume on the freeway mainlanes was approximately 5,657. In December 1987, the total peak-hour, peak-direction volume at the Bunker Hill count location was 9,479; of that volume, 3812, or 40%, was on the transitway (Figure 40). In comparison to the pre-transitway volume, p.m. peak-hour person volume has increased by 68%.

P.M. Peak Period. Prior to opening the transitway, a peak-period person volume on the freeway mainlanes of approximately 16,873 was recorded. In December 1987, the total peak-period, peak-direction volume at the Bunker Hill count location was 27,082; of that volume, 8,129, or 30%, was on the transitway (Figure 41). In comparison to the pre-transitway volume, p.m. peak-period person volume has increased by 61%.

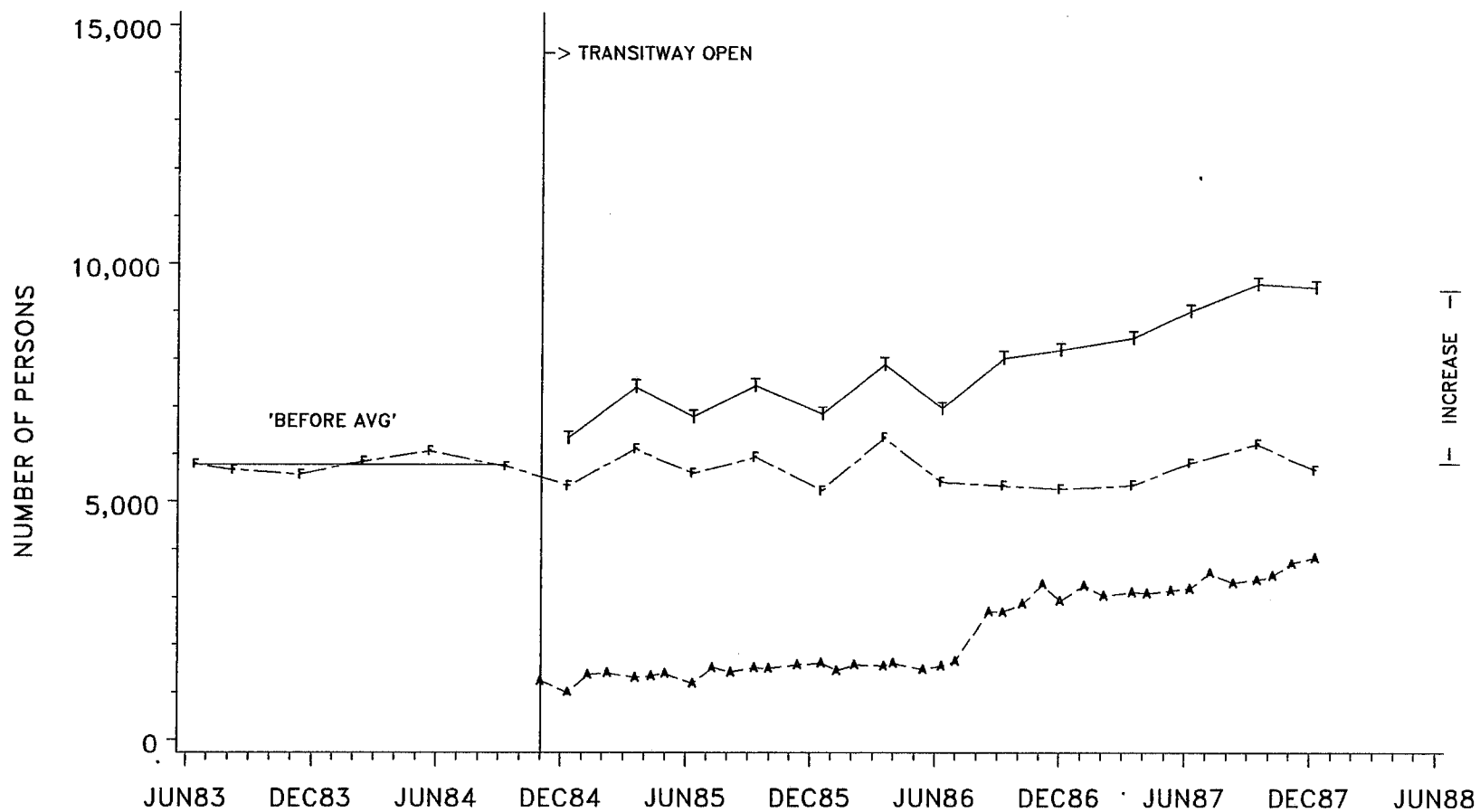
Vehicular Volumes

A.M. Operations

A.M. peak-hour vehicle volumes have increased by 60%, from a pre-transitway volume of 4,403 to a December 1987 volume of 6,462; of those 6,462 vehicles, 1,469, or 23%, were operating in the transitway. In the a.m. peak period, pre-transitway volumes were 12,750. By December 1987, this volume had increased to 18,713; of those 18,713 vehicles, 2,788, or 15%, were operating in the transitway.

KATY FREEWAY (IH 10W) AND TRANSITWAY
P.M. PEAK HOUR PERSON TRIPS

79

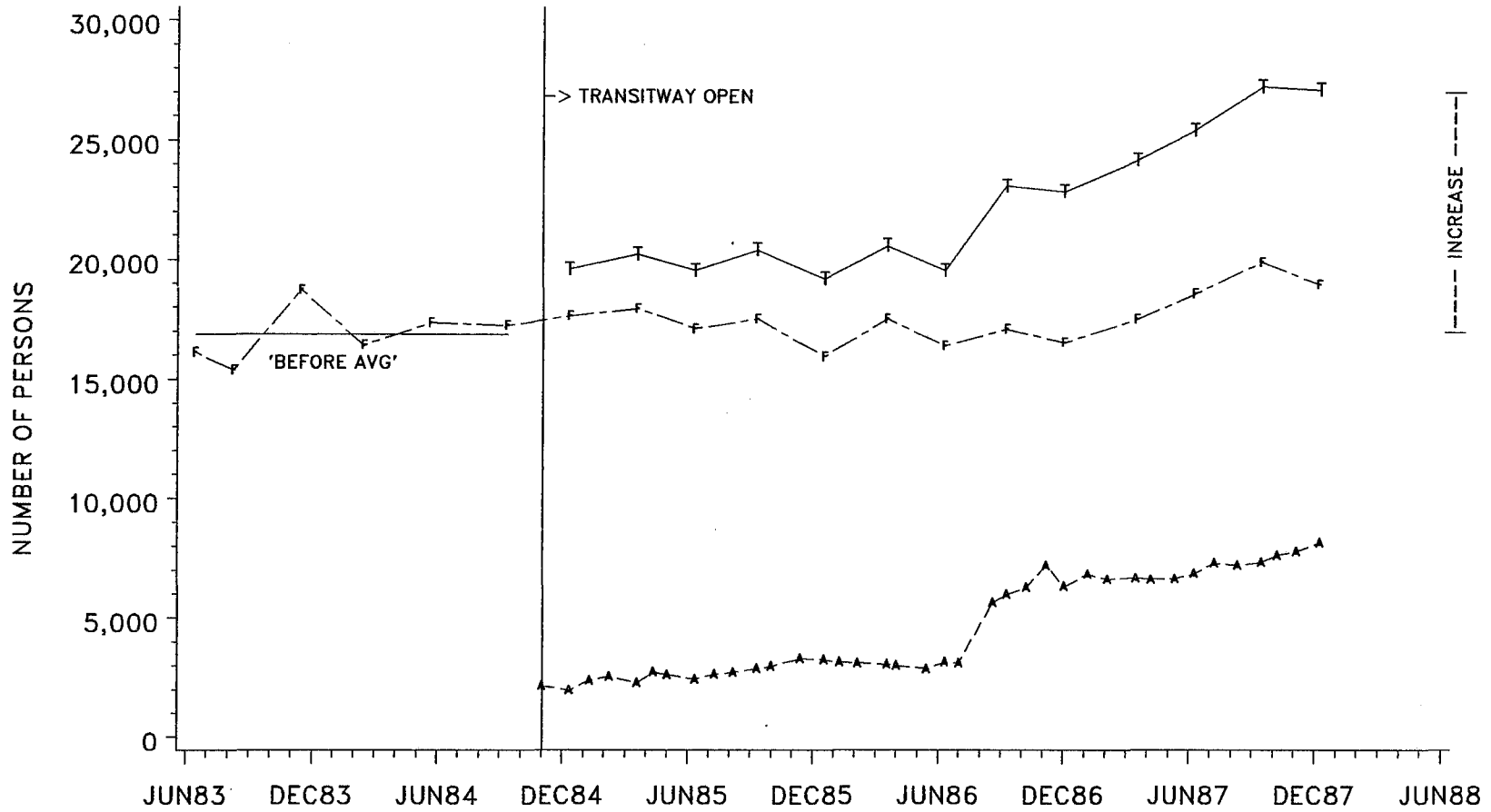


DATA COLLECTED WESTBOUND OVER BUNKER HILL, 3 LANE SECTION
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL PERSONS
F = MAINLANE PERSONS
A = TRANSITWAY PERSONS

FIGURE 40

KATY FREEWAY (IH 10W) AND TRANSITWAY P.M. PEAK PERIOD PERSON TRIPS



P.M. PEAK PERIOD DEFINED AS FROM 3:30 TO 7:00 P.M
 DATA COLLECTED WESTBOUND OVER BUNKER HILL, 3 LANE SECTION
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL PERSONS
 F = MAINLANE PERSONS
 A = TRANSITWAY PERSONS

FIGURE 41

P.M. Operations

P.M. peak-hour volumes have increased by 49%, from a pre-transitway volume of 4,266 to a December 1987 volume of 6,358; of those 6,358 vehicles, 1,180, or 18%, were operating on the transitway. In the p.m. peak period, pre-transitway volumes were 12,706. By December 1987, this volume had increased to 19,927; of those 19,927 vehicles, 2,517, or 13%, were operating on the transitway.

Average Vehicle Occupancy

A major objective of the transitway projects is to increase the average vehicle occupancy (persons/vehicle) on the roadway. Average occupancy has increased during both the a.m. and p.m. peak periods.

A.M. Operations

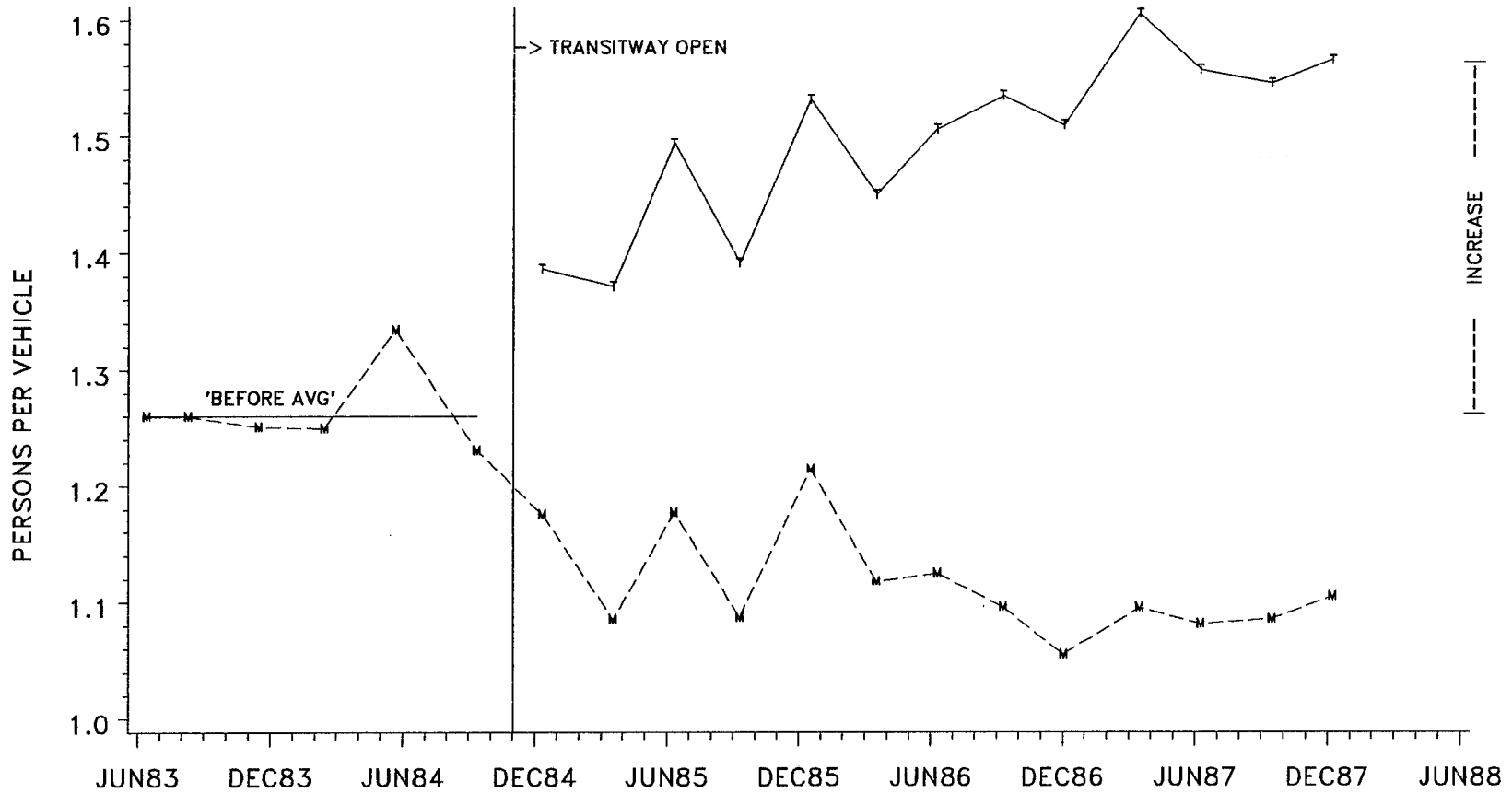
Prior to opening the transitway, the a.m. peak-hour occupancy for the freeway mainlanes was 1.26. In December 1987, the combined transitway and freeway occupancy was 1.53, an increase of 21% (Figure 42). In the a.m. peak period, occupancy has increased from 1.23 to 1.39, an increase of 14% (Figure 43).

P.M. Operations

The p.m. occupancy was higher than the a.m. occupancy prior to opening the transitway. The increases in the average p.m. occupancy have been smaller than the increases in a.m. occupancy.

Prior to opening the transitway, the p.m. peak-hour occupancy for the freeway mainlanes was 1.33. In December 1987, the combined transitway and freeway occupancy was 1.49, an increase of 12% (Figure 44). In the p.m. peak

KATY FREEWAY (IH 10W) AND TRANSITWAY A.M. PEAK HOUR AVERAGE OCCUPANCY



DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION

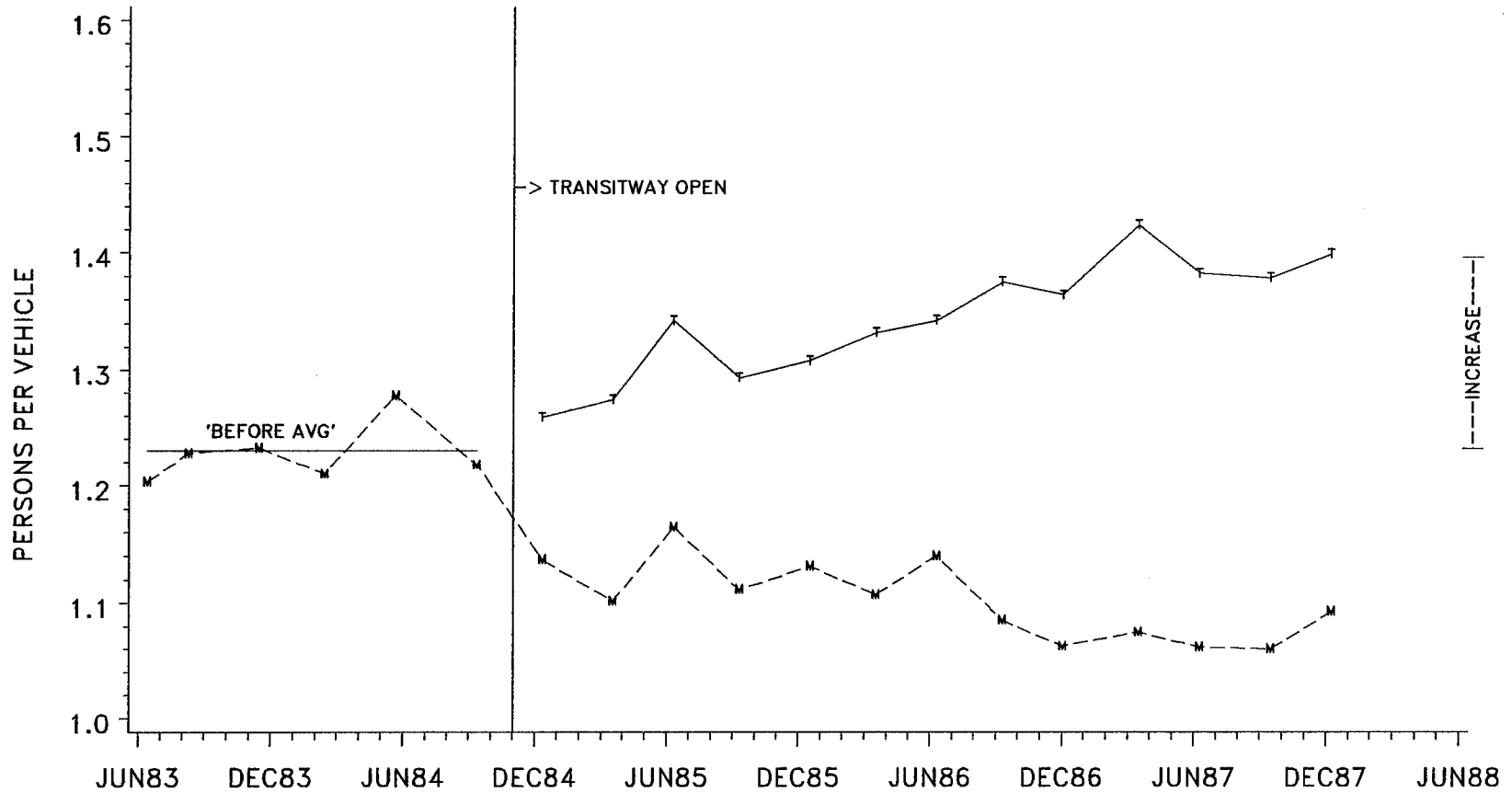
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : M = MAINLANE OCCUPANCY
T = TOTAL OCCUPANCY
(FREEWAY PLUS TRANSITWAY)

FIGURE 42

KATY FREEWAY (IH 10W) AND TRANSITWAY
A.M. PEAK PERIOD AVERAGE OCCUPANCY

83



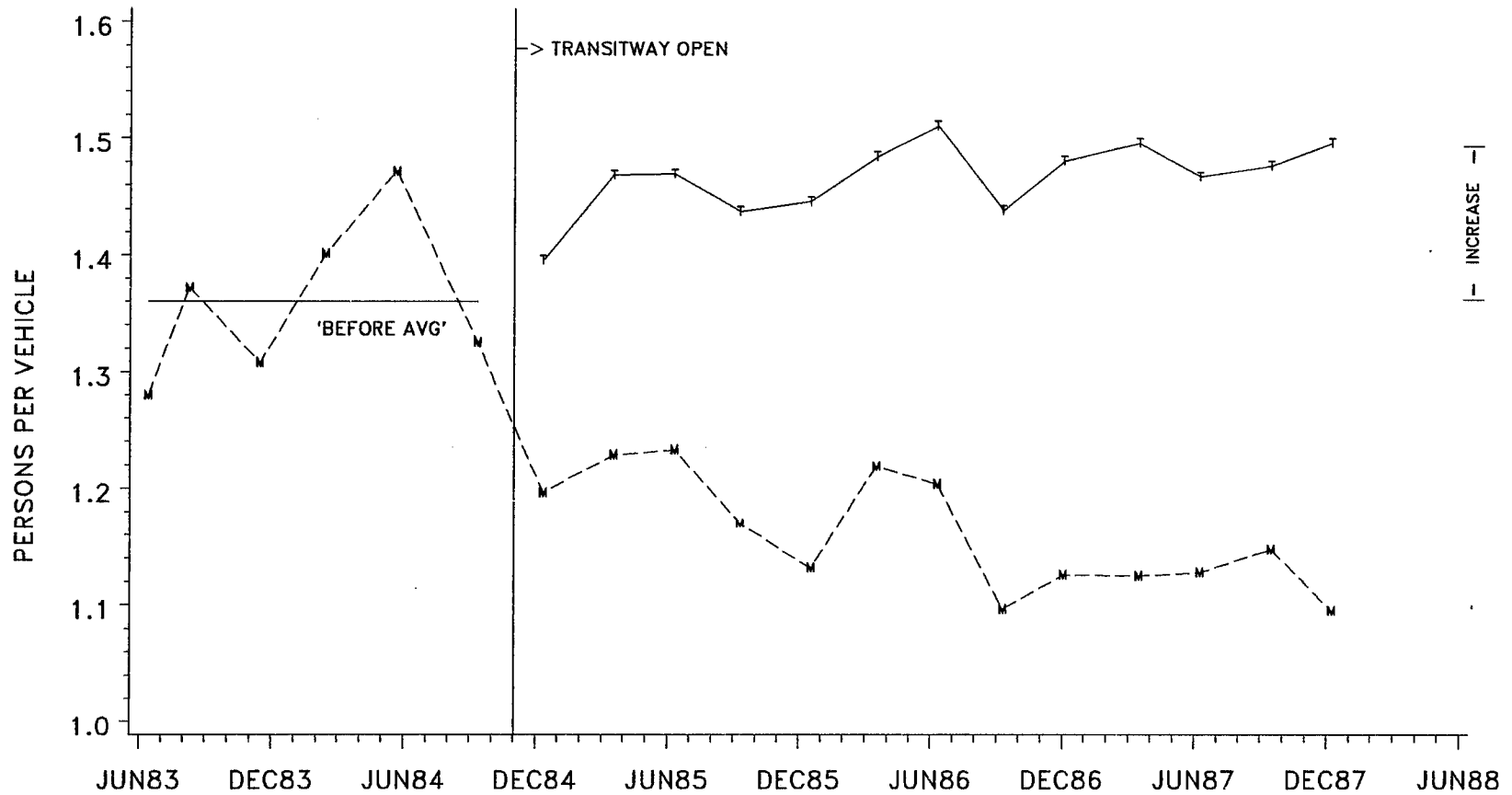
A.M. PEAK PERIOD DEFINED AS FROM 5:45 TO 9:30 A.M.
DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : M = MAINLANE OCCUPANCY
T = TOTAL OCCUPANCY
(FREEWAY PLUS TRANSITWAY)

FIGURE 43

KATY FREEWAY (IH 10W) AND TRANSITWAY
P.M. PEAK HOUR AVERAGE OCCUPANCY



DATA COLLECTED WESTBOUND OVER BUNKER HILL, 3 LANE SECTION

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : M = MAINLANE OCCUPANCY
T = TOTAL OCCUPANCY
(FREEWAY PLUS TRANSITWAY)

FIGURE 44

period, occupancy increased from 1.33 to 1.36, an increase of only 2% (Figure 45).

Freeways With and Without Transitways

Freeways with transitways have nearly a 40% higher average occupancy than do freeways without transitways (Table 23). Also, while the trend has been for an increasing average occupancy on the Katy Freeway (with transitway), the trend has been toward a lower occupancy on the Gulf Freeway (without transitway). These data are shown in Figure 46.

Table 23. Average A.M. Peak-Hour Occupancies, Houston Freeways With and Without Transitways, December 1987

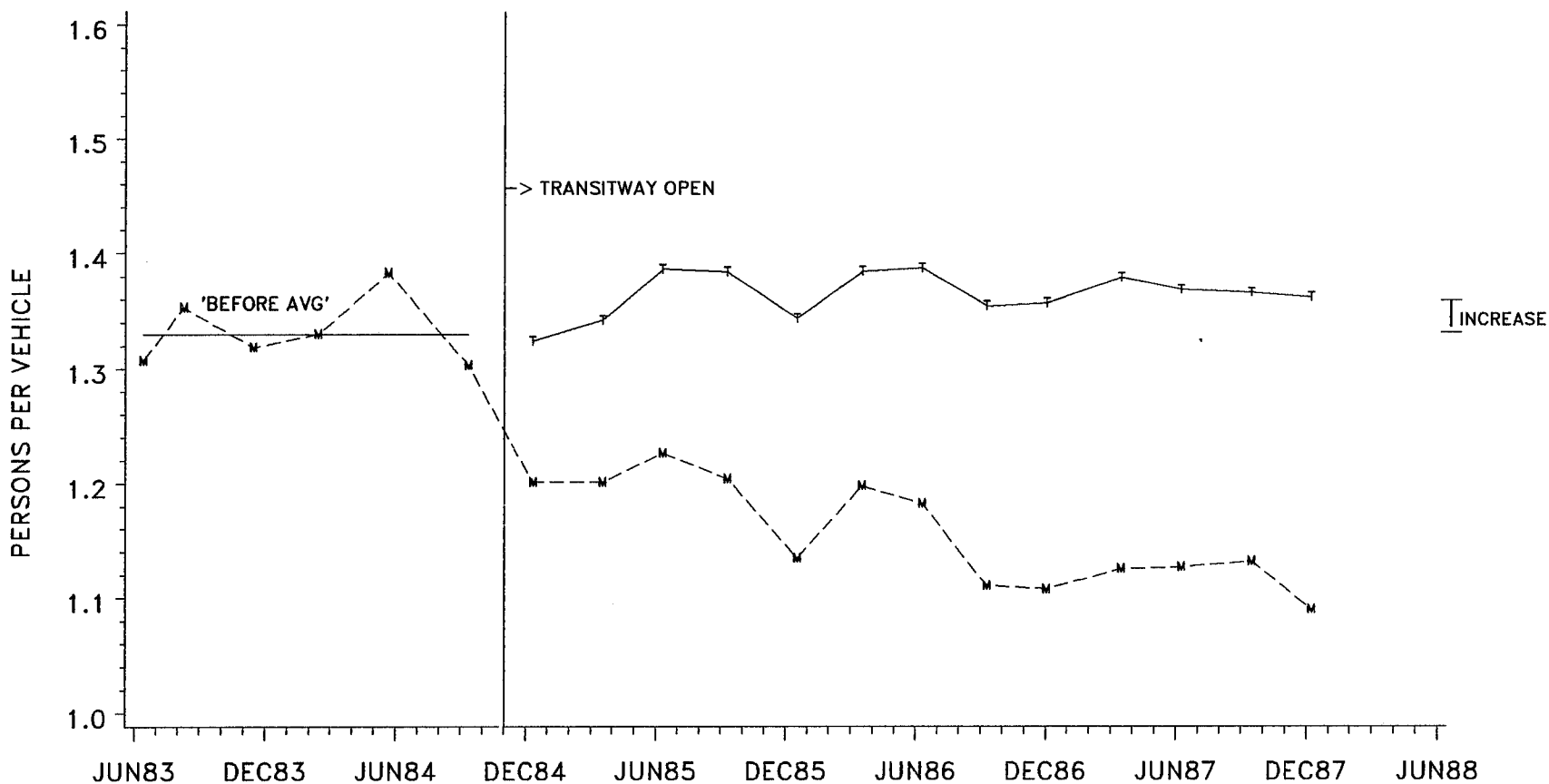
Freeway ¹	A.M. Peak-Hour, Peak-Direction Average Vehicle Occupancy (persons/vehicle)	
With Transitway, Average	1.65	
North (I-45N)		1.77
Katy (I-10)		1.53
Without Transitway, Average	1.20	
Gulf (I-45S)		1.25
Southwest (US 59)		1.20
Northwest (US 290)		1.14

¹North Freeway data collected at Little York, Katy data collected at Bunker Hill, Gulf data collected at Monroe, Southwest data collected at Westpark, and Northwest data collected at Pinemont.

Combined Volume and Occupancy Data

Due to the higher average occupancy on the transitway relative to the freeway, the transitway is moving a higher volume of persons per lane (Figure 47). Table 24 summarizes these data.

KATY FREEWAY (IH 10W) AND TRANSITWAY
P.M. PEAK PERIOD AVERAGE OCCUPANCY



98

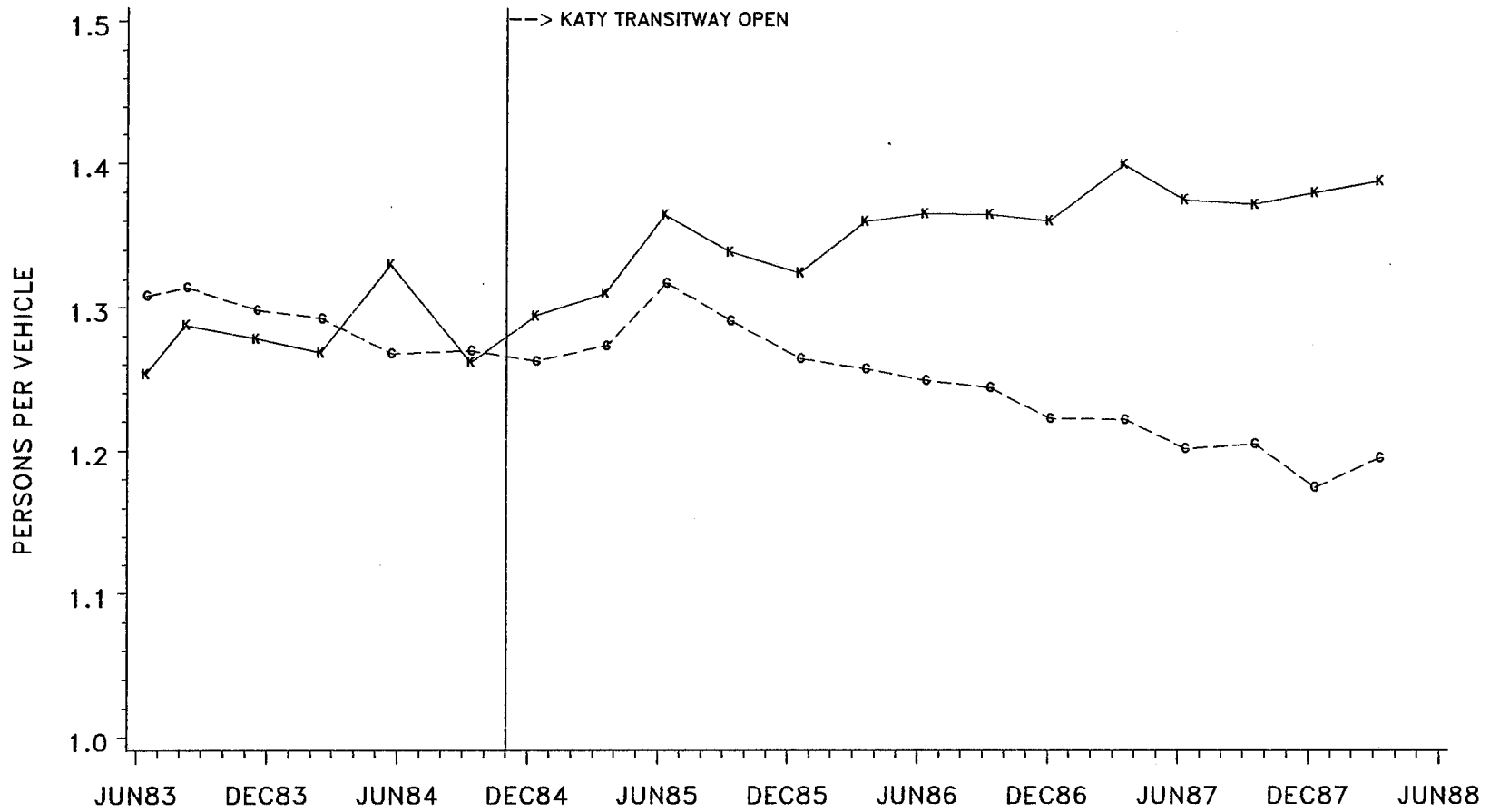
P.M. PEAK PERIOD DEFINED AS FROM 3:30 TO 7:00 P.M.
DATA COLLECTED WESTBOUND OVER BUNKER HILL, 3 LANE SECTION

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : M = MAINLANE OCCUPANCY
T = TOTAL OCCUPANCY
(FREEWAY PLUS TRANSITWAY)

FIGURE 45

A.M. & P.M. PEAK PERIOD AVERAGE OCCUPANCY
 FREEWAY WITH AND WITHOUT TRANSITWAY

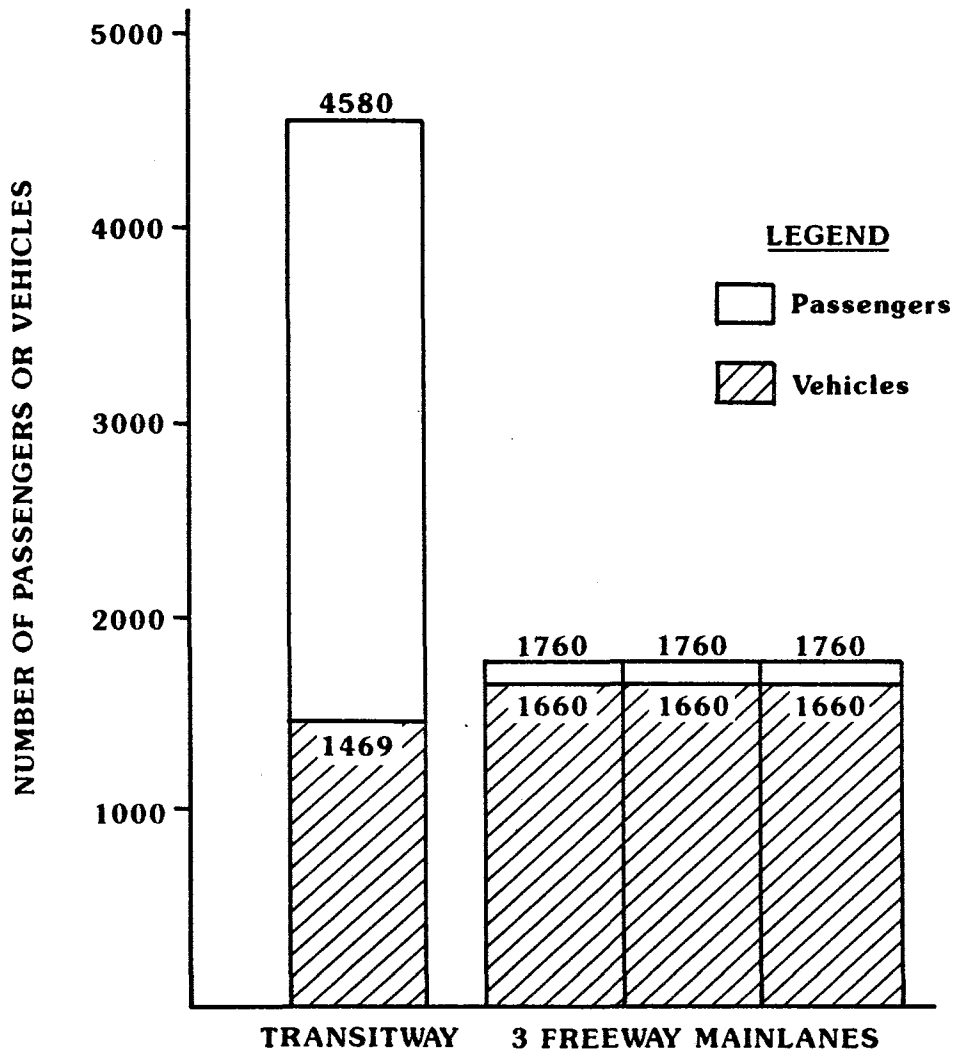


KATY FREEWAY (IH 10W) DATA COLLECTED AT BUNKER HILL
 GULF FREEWAY (IH 45S) DATA COLLECTED AT MONROE

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : K = KATY FREEWAY OCCUPANCY
 (FREEWAY PLUS TRANSITWAY)
 G = GULF FREEWAY OCCUPANCY
 (NO TRANSITWAY)

FIGURE 46



Note: Freeway volumes are counted at the Bunker Hill overpass between an off-ramp and an on-ramp. Thus, freeway volumes are low due to the count location between ramps.

Figure 47. Katy Freeway and Transitway, Relative Volumes A.M. Peak Hour Lane Efficiency, December 1987

Table 24. Volume and Occupancy Data, Katy Freeway Mainlanes and Transitway, December 1987

Operating Period	% of Total Vehicles	% of Total Persons
A.M. Peak Hour		
Freeway Mainlanes (3 lanes)	77%	54%
Katy Transitway (1 lane)	23%	46%
A.M. Peak Period (6-9:30 a.m.)		
Freeway Mainlanes (3 lanes)	85%	67%
Katy Transitway (1 lane)	15%	33%
P.M. Peak Hour		
Freeway Mainlanes (3 lanes)	81%	60%
Katy Transitway (1 lane)	19%	40%
P.M. Peak Period		
Freeway Mainlanes (3 lanes)	87%	70%
Katy Transitway (1 lane)	13%	30%

Note: Data collected at Bunker Hill.

Carpooling Characteristics

An intent of the transitway projects is to increase the use of ridesharing. Usage of the bus mode is addressed more fully in the subsequent section of this report.

Surveys of carpoolers using the Katy Transitway have been undertaken on several occasions. License plates have been read during the a.m. peak period, address files accessed, and surveys mailed to the carpoolers.

A summary of selected characteristics is shown in Table 25. Data relating to use of the carpool mode is presented in Table 26. More detailed presentation of these data is included in Texas Transportation Institute Research Reports 484-4 and 484-8.

Table 25. Characteristics of Carpoolers in the Katy Transitway,
A.M. Peak Period

Characteristic	Survey Date		
	1985	1986	1987
Age in years (50th percentile)	41	40	36
Sex			
Male	71%	62%	58%
Female	29%	38%	42%
Occupation			
Professional or Managerial	78%	68%	63%
Clerical	11%	15%	16%
Student	1%	8%	5%
Sales	2%	6%	8%
Other	8%	3%	8%
Education in years (avg.)	16.1	15.3	15.6
Trip Destination			
Downtown	29%	49%	39%
Texas Medical Center	3%	3%	6%
City Post Oak	13%	15%	22%
Greenway Plaza	13%	0%	6%
Other	42%	33%	27%

Table 26. Characteristics of Carpool Use on the Katy Transitway,
A.M. Peak Period

Characteristic	Survey Date		
	1985	1986	1987
Previous Mode of Travel			
Drove Alone	50%	46%	52%
Other Carpool	24%	18%	31%
Didn't Make Trip	20%	18%	6%
Vanpool	4%	4%	2%
Bus	2%	8%	9%
Other	---	6%	---
Before Carpooling, Use Transitway?			
Yes, Bus	3%	7%	8%
Yes, Vanpool	2%	7%	1%
Why Carpool on Transitway?			
Saves Time	27%	26%	---
Freeway Too Congested	26%	25%	---
Costs Less	16%	10%	---
Reliable Schedule	13%	10%	---
Would You Carpool If No Transitway?			
Yes	70%	59%	49%
No	16%	25%	37%
Not Sure	14%	16%	13%

Increase in Carpooling Due to Transitway Implementation

Typically, allowing carpools to use an HOV lane increases the total volume of carpools using the freeway³. With the introduction of 2+ carpools, this has also occurred on the Katy Freeway.

Data relating to carpool volumes on the Katy Freeway have been collected at Bunker Hill since 1983. These data, for the a.m. peak hour and peak period, are summarized in Figures 48 and 49. For the p.m. peak hour and peak period, the data are presented in Figures 50 and 51. A summary of pre-transitway and current carpool volumes is provided in Table 27.

Table 27. Estimated Increase in 2+ Carpooling on the Katy Freeway and Transitway

Time Period	"Representative" Pre-Transitway Volume	Current 12/87 Volume	% Change
A.M. Peak Hour	505	1630	+223%
A.M. Peak Period	1570	3566	+127%
P.M. Peak Hour	768	1518	+ 98%
P.M. Peak Period	2334	3732	+ 60%

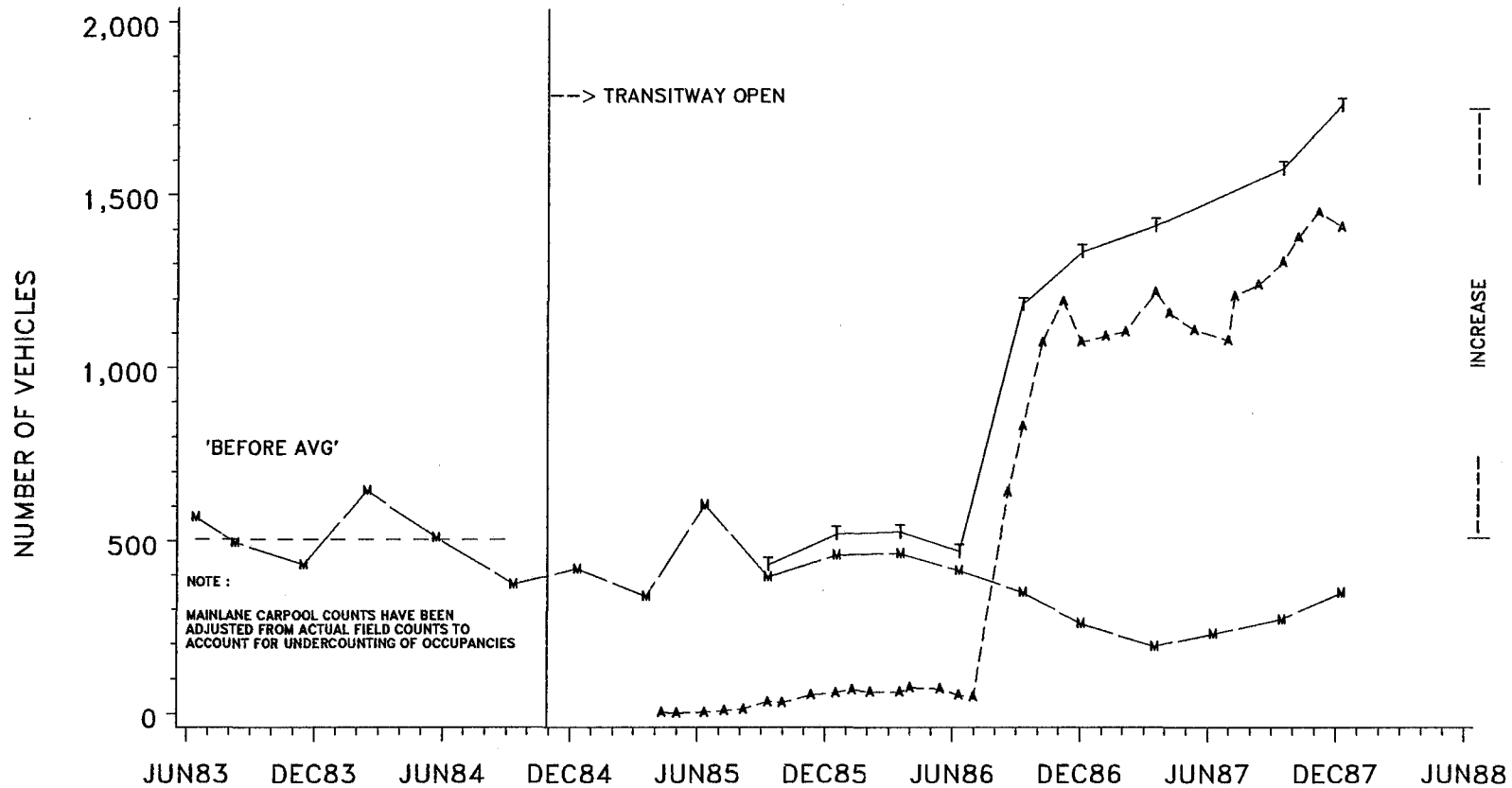
Note: Data collected at Bunker Hill.

The data in Table 27 suggest that carpooling on the Katy Freeway has increased substantially since the inception of the transitway. However, if this increase in carpooling is simply the result of diverting carpools from parallel routes to the transitway, overall corridor occupancy would not have increased.

To address this question, surveys of carpoolers using the transitway were conducted in March 1987 and October 1987. It is apparent that

³"The Impacts of Carpool Utilization on the Katy Freeway Transitway, 30-Month 'After' Evaluation". Texas Transportation Institute Research Report 484-7, April 1988.

KATY FREEWAY (IH 10W) AND TRANSITWAY 2+ CARPOOL UTILIZATION
 A.M. PEAK HOUR
 DATA COLLECTED AT BUNKER HILL



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

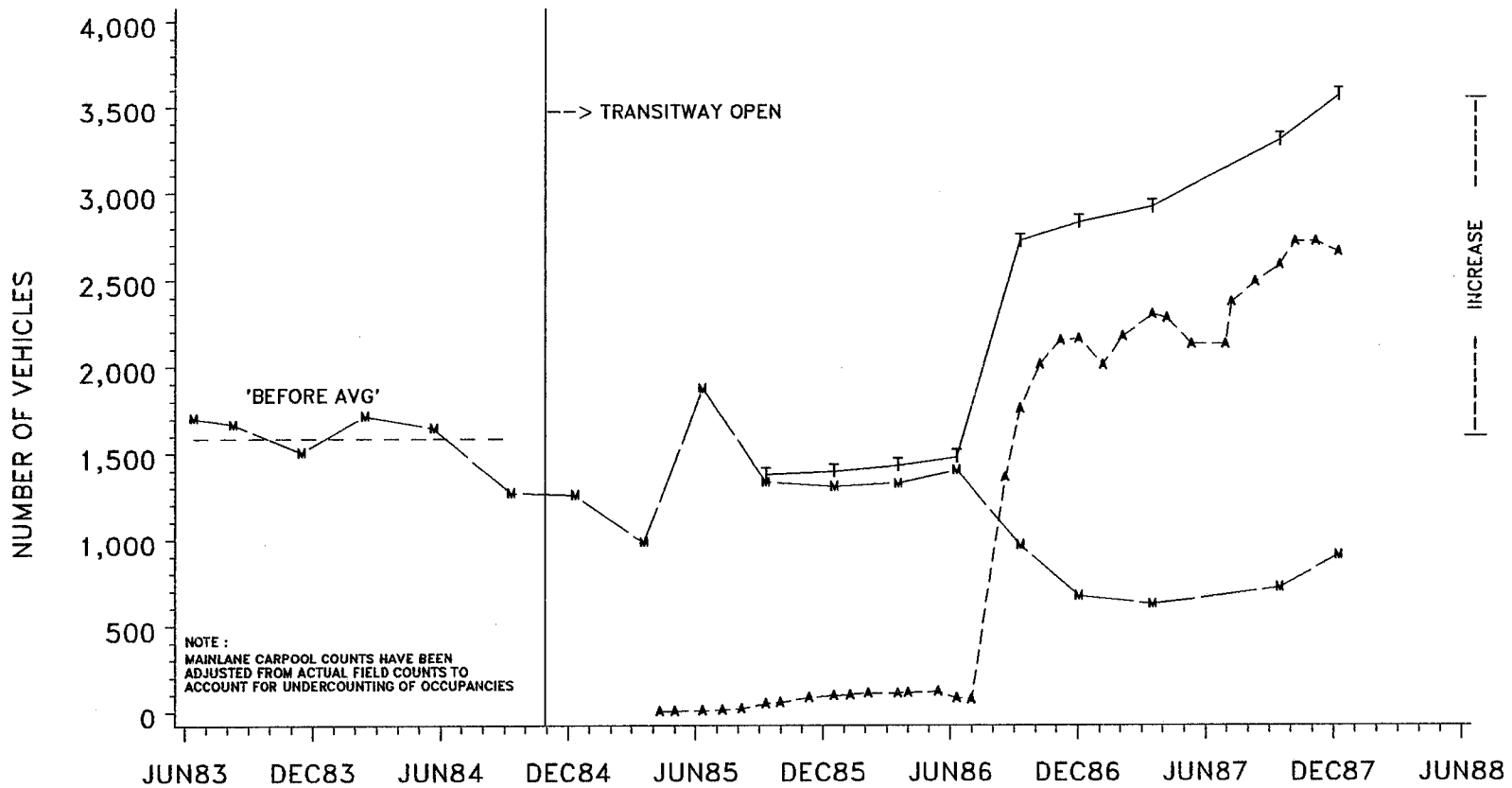
LEGEND : T = TOTAL 2+ CARPOOLS
 A = TOTAL TRANSITWAY 2+ CARPOOLS
 M = TOTAL MAINLANE 2+ CARPOOLS

FIGURE 48

SOURCE : TEXAS TRANSPORTATION INSTITUTE

KATY FREEWAY (IH 10W) AND TRANSITWAY 2+ CARPOOL UTILIZATION
 A.M. PEAK PERIOD
 DATA COLLECTED AT BUNKER HILL

96



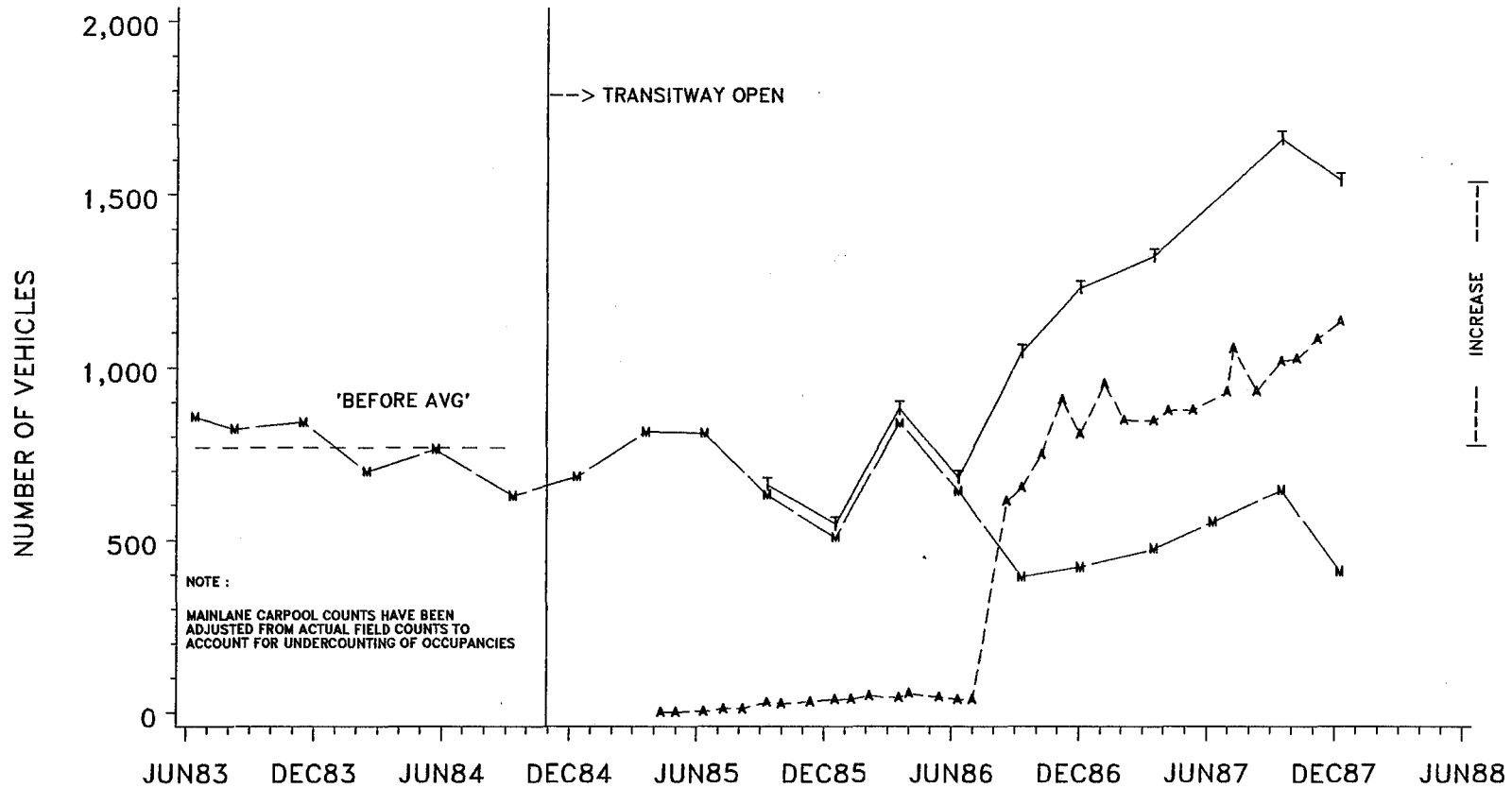
KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987
 PEAK PERIOD IS 5:45 - 9:30 AM

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

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 49

KATY FREEWAY (IH 10W) AND TRANSITWAY 2+ CARPOOL UTILIZATION
P.M. PEAK HOUR
DATA COLLECTED AT BUNKER HILL



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

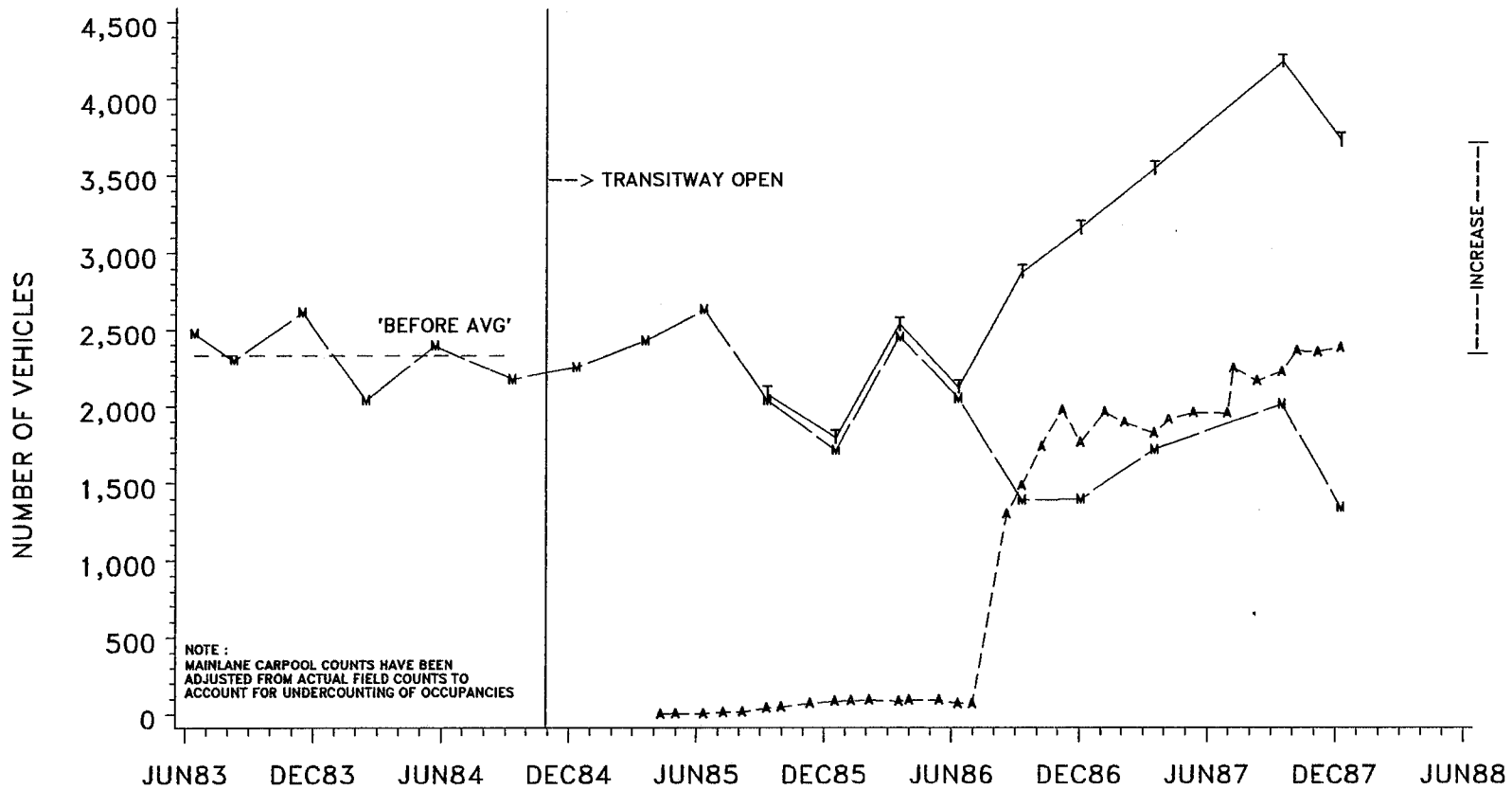
LEGEND : T = TOTAL 2+ CARPOOLS
A = TOTAL TRANSITWAY 2+ CARPOOLS
M = TOTAL MAINLANE 2+ CARPOOLS

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 50

KATY FREEWAY (IH 10W) AND TRANSITWAY 2+ CARPOOL UTILIZATION
P.M. PEAK PERIOD
DATA COLLECTED AT BUNKER HILL

96



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
PEAK PERIOD IS 3:30 - 7:00 PM

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

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 51

approximately 55% to 60% of the carpools using the transitway are "new" carpools (sum of previous mode being either "drove alone" or "did not make trip"). It is also evident that the volume of new carpools continued to increase between the March and October surveys. These data are shown in Figure 52.

The data collected on the Katy Transitway and shown in Figure 52 are in general agreement with similar data collected in Los Angeles and Minneapolis (Table 28). It is apparent that successful HOV lanes will generate a significant volume of new carpools.

Table 28. Previous Travel Mode For Carpoolers on High-Occupancy Vehicle Lanes

Previous Mode	Houston Katy Transitway	Minneapolis I-394 Interim HOV Lane ¹	Los Angeles Rte. 55 HOV Lane ²
Drove Alone	52%	46%	56%
Carpooled or Vanpooled	33%	47%	33%
Rode a Bus	9%	7%	0%
New Trip	6%	---	11%

¹"The Minneapolis Experience, The State Highway 12/Interstate 394 HOV Lane". Proceeding of the Second National Conference on High-Occupancy Vehicle Lanes and Transitways, October 1987.

²Orange County Transit District.

Carpool Increase to Suburban Activity Centers

A major issue today is congestion in suburban areas and at suburban activity centers. This type of travel is difficult to serve cost effectively with traditional transit.

The data presented previously in this section show that total carpools have increased dramatically on the Katy Freeway. A significant increase has also occurred in carpools with destinations at major non-downtown employment centers.

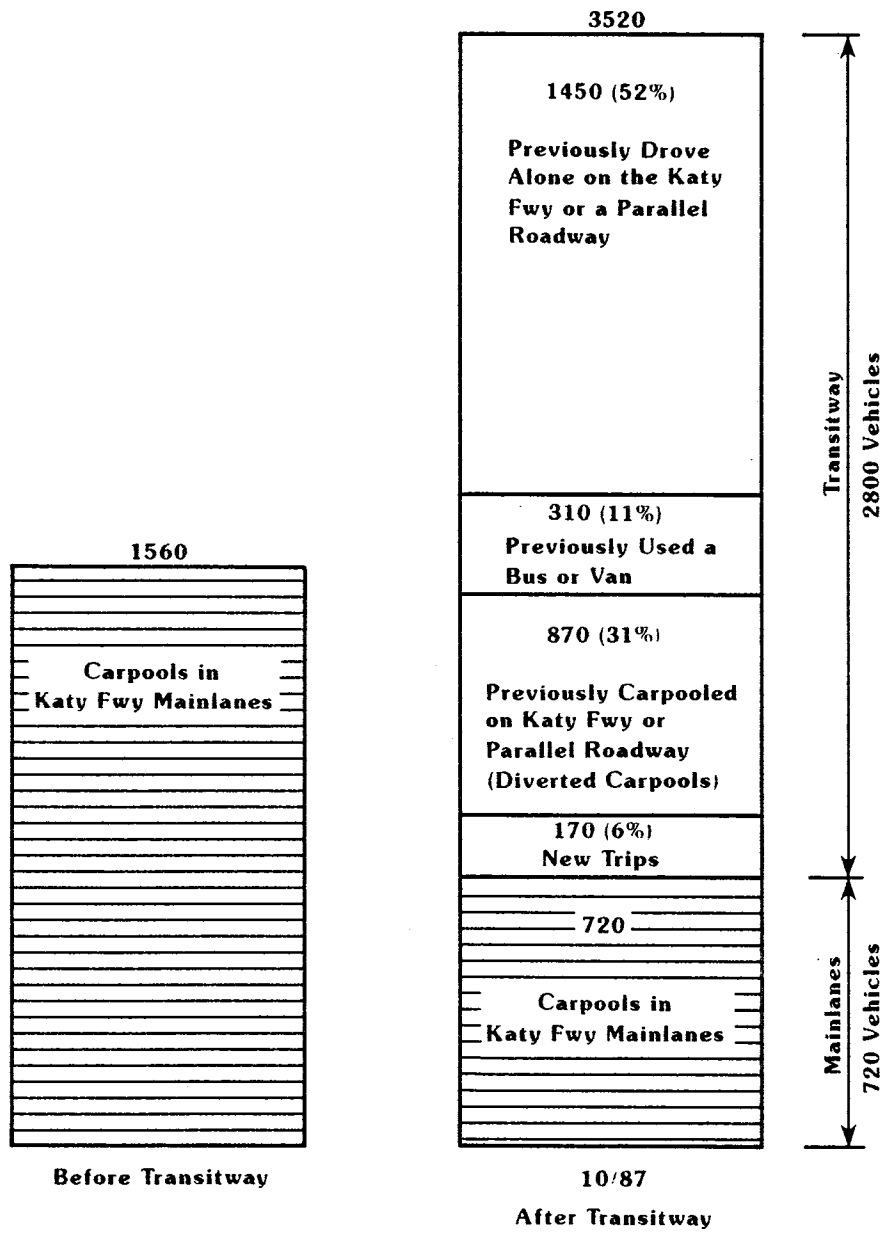


Figure 52. A.M. Peak Period 2+ Carpool Volumes (Freeway + Transitway) "Before" and "After" Transitway

Data collected by TTI indicate that, in March 1985 (prior to carpools being allowed onto the transitway), 630 carpools were on the Katy Freeway mainlanes during the a.m. peak period destined to City Post Oak, Greenway Plaza, or the Texas Medical Center. In October 1987, this volume had increased by 72% to 1084; of that 1084 volume, 924, or 85%, were on the transitway. Thus the transitway has been effective at increasing the occupancy of vehicles destined to the major suburban activity centers.

Travel Time Savings

As shown in Table 26, travel time savings and travel time reliability improvements are essential for a transitway to be successful. Previous TTI research⁴ has determined that these lanes must offer a 5 to 10 minute minimum travel time savings in order to encourage switches to ridesharing modes.

Travel time saved by the transitway users is calculated by comparing the freeway mainlanes to the transitway for the same time period, and then determining the number of vehicles and persons using the transitway during that time period. The data are collected between SH 6 and the Southern Pacific Railroad (SPRR) overpass, a total distance of 13.2 miles.

Data have been collected for both the a.m. and the p.m. operating periods. It should be realized that these data understate actual travel time savings. Data are collected during non incident conditions on a Tuesday. Monday and Friday volumes are heavier, and, thus, travel time savings are greater on those days. Also, non incident conditions only exist during about 60% of the peak periods. When incidents occur, travel savings on the transitway can be considerably greater.

⁴"Guidelines for Estimating the Cost Effectiveness of High-Occupancy Vehicle Lanes", Texas Transportation Institute Research Report 339-5, 1986.

A.M. Operating Period

Eastbound a.m. (6-9 a.m.) travel times are shown in Tables 29 and 30. Table 29 analyzes the eastbound direction from SH 6 to the Gessner entrance to the transitway. For that section of the transitway, users of the transitway save time during all time periods. Table 30 presents data for the section between the Gessner ramp and the SPRR. The data indicate that early morning users of the transitway actually lose time over this distance. That is because freeway speeds remain reasonably high during non incident operation, and transitway users incur delays at the Post Oak transitway terminus and the route followed to re-enter the Katy Freeway mainlanes.

Table 29. Eastbound AM Travel Time Savings for Katy Transitway Traffic, November 1987, SH 6 to Gessner (6.3 miles)

Time of Day	Average Travel Time		Time Saved By Transitway (minutes)	Transitway Volumes				Travel Time Saved (Person Minutes)
	Non-Transitway (minutes)	Transitway (minutes)		Vans	Buses	Carpools	Persons	
6:00 am	6.8	6.0	0.8	2	5	70	275	220
6:30	11.6	6.4	5.2	12	10	262	990	5,148
7:00	15.5	7.3	8.2	10	10	413	1,305	10,701
7:30	17.4	6.8	10.6	4	7	373	1,035	10,971
8:00	10.3	6.8	3.5	2	6	192	575	2,013
8:30	7.9	6.0	1.9	1	2	77	200	380
3 Hour Total			6.7	31	40	1,387	4,380	29,433
2 Hour Total			7.4	28	33	1,240	3,905	28,833

Table 30. Eastbound AM Travel Time Savings for Katy Transitway Traffic, November 1987, Gessner to S.P.R.R. (6.9 miles)

Time of Day	Average Travel Time		Time Saved By Transitway (minutes)	Transitway Volumes				Travel Time Saved (Person Minutes)
	Non-Transitway (minutes)	Transitway (minutes)		Vans	Buses	Carpools	Persons	
6:00 am	7.4	8.9	-1.5	3	7	91	387	-581
6:30	10.1	10.3	-0.2	18	15	417	1,540	-308
7:00	11.6	11.1	0.5	15	18	706	2,346	1,173
7:30	12.7	11.4	1.3	6	19	747	2,320	3,016
8:00	11.3	9.4	1.9	4	11	430	1,198	2,276
8:30	10.6	8.9	1.7	1	9	219	600	1,020
3 Hour Total			0.8	47	79	2,610	8,391	6,596
2 Hour Total			1.2	26	57	1,102	6,464	7,485
Total Time Saved = 29,433 + 6,596 = 36,029 Person Minutes (6:00-9:00 am)								
Total Time Saved = 28,833 + 7,485 = 36,318 Person Minutes (6:30-8:30 am)								

The "time saved by transitway" in Tables 29 and 30 need to be added to obtain total travel time savings. Maximum time savings occur between 7:30 and 8:00 a.m.; nearly 12 minutes are saved by using the transitway during that time period. Figure 53 depicts freeway and transitway a.m. travel times for 1987.

The number of vehicles, by type and occupancy rate, was determined from independent surveys taken during the same month. Because of the loss of time in the first hour of operation, the two-hour total travel time saved is greater than the three-hour total. The total travel time saved is approximately 600 person hours per morning peak for transitway users. Due to the increased length of the transitway and the increased volume of transitway users, this time savings is 90% greater than that realized in 1986 and 128% greater than that which occurred in 1985.

P.M. Operating Period

Similar calculations for the afternoon period are shown in Tables 31 and 32. These travel time savings are less impressive because of the improvements to the mainlane speeds. The significant increase in p.m. operating speeds was documented in the previous section of this report. However, as noted previously, it should not be overlooked that the transitway is providing improved travel time reliability. The transitway does offer some travel time savings for about a 2-hour period. Figure 54 depicts p.m. freeway and transitway travel times for 1987.

Table 31. Westbound PM Travel Time Savings for Katy Transitway Traffic, November 1987, S.P.R.R. to Gessner (6.9 miles)

Time of Day	Average Travel Time		Time Saved By Transitway (minutes)	Transitway Volume				Travel Time Saved (Person Minutes)
	Non-Transitway (minutes)	Transitway (minutes)		Vans	Buses	Carpools	Persons	
3:30 pm	8.2	9.1	-0.9	7	3	135	407	-366
4:00	8.9	9.6	-0.7	17	9	299	1,024	-717
4:30	8.8	10.4	-1.6	19	14	365	1,435	-2,296
5:00	10.8	11.4	-0.6	7	12	534	1,632	-979
5:30	15.5	12.6	2.9	10	19	550	1,909	5,536
6:00	14.3	9.4	4.9	0	8	314	898	4,400
6:30	11.6	9.0	2.6	2	5	164	482	1,253
3 Hour Total			1.0	55	67	2,226	7,380	7,197
2 Hour Total			2.1	19	44	1,562	4,921	10,210

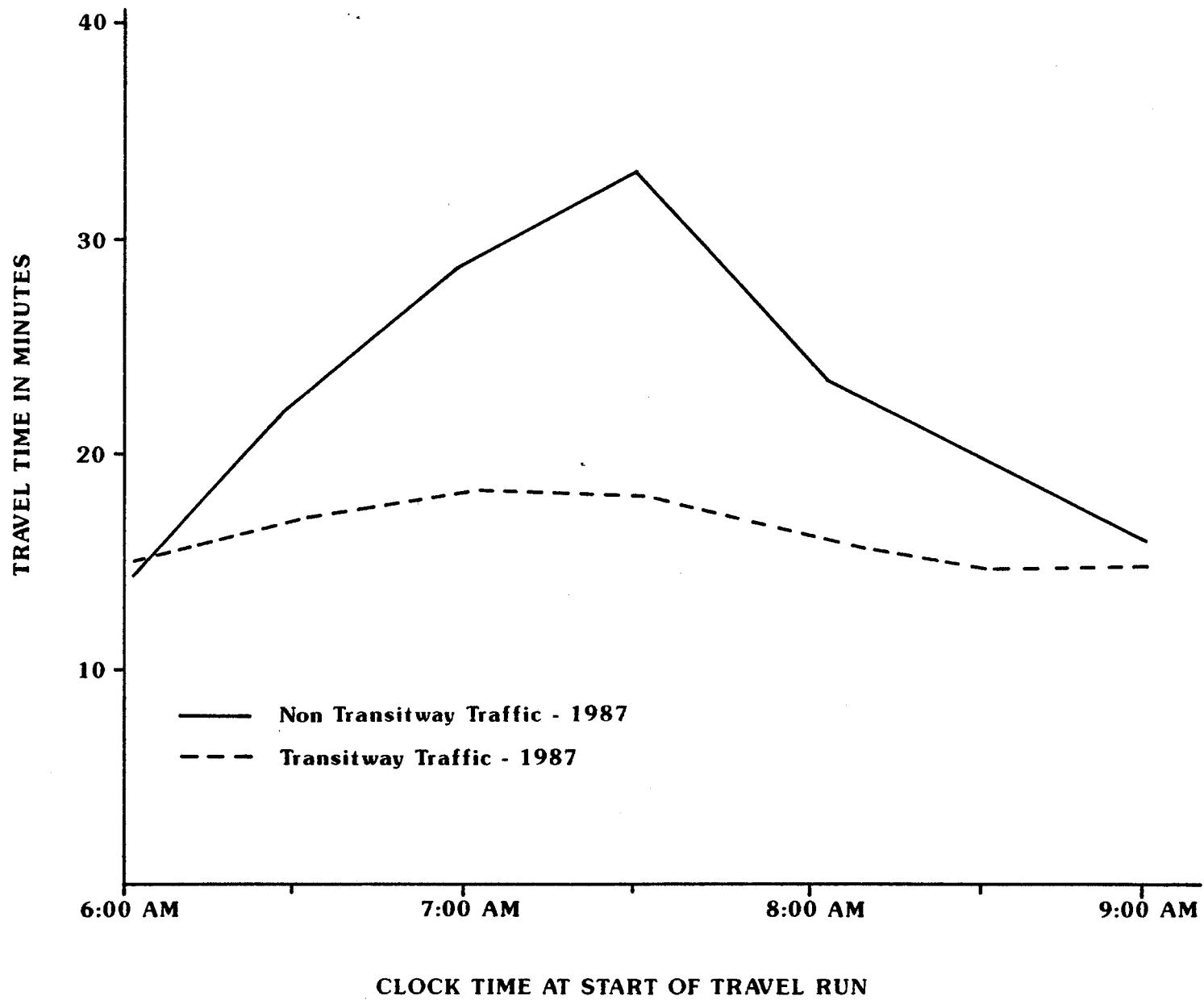


Figure 53. Katy Freeway Mainlane and Transitway Travel Times, A.M. Eastbound, S.P.R.R. to SH 6 (13.2 miles), 1987

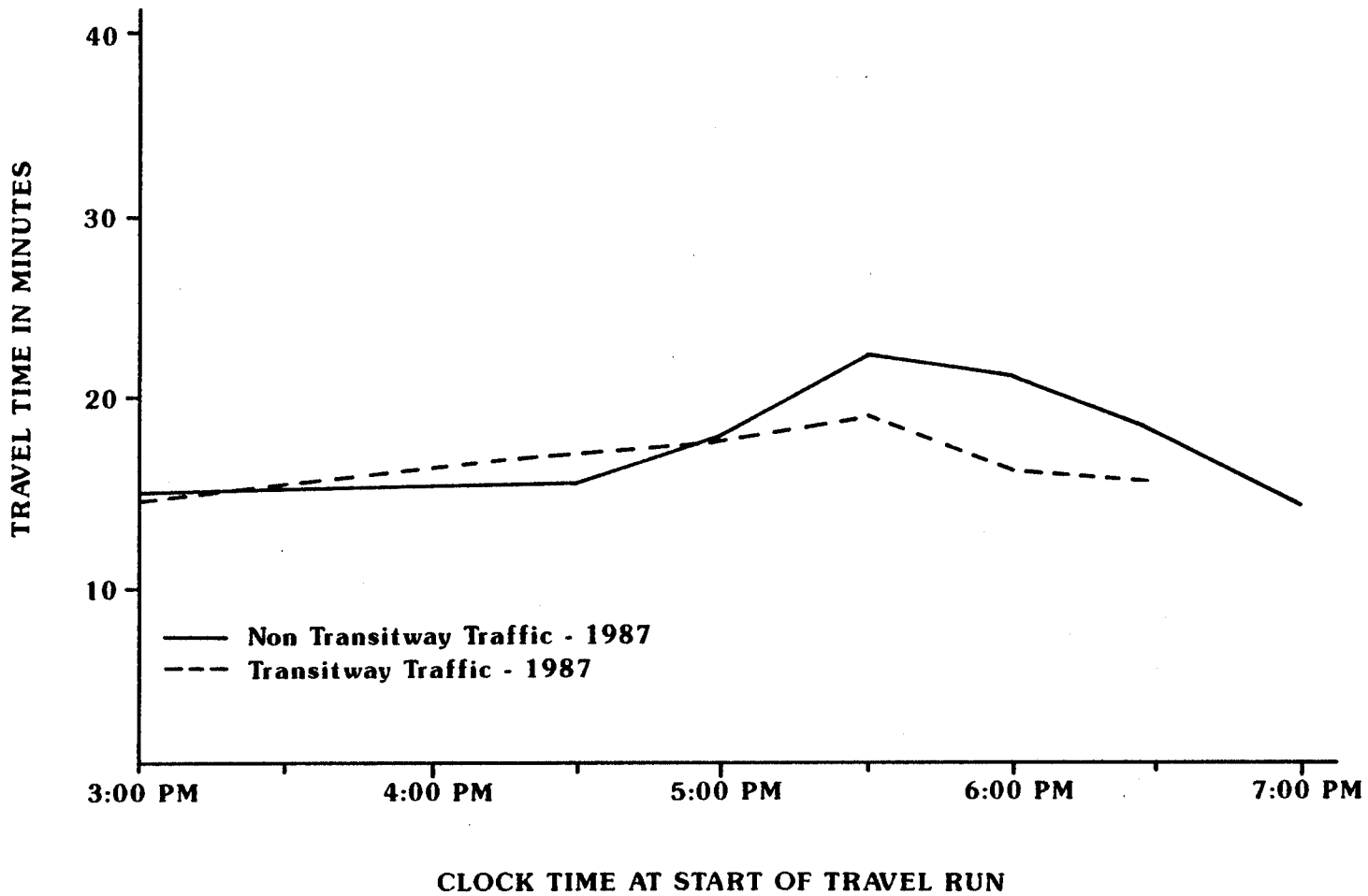


Figure 54. Katy Freeway Mainlane and Transitway Travel Times, P.M. Westbound, S.P.R.R. to SH 6 (13.2 miles), 1987

Table 32. Westbound PM Travel Time Savings for Katy Transitway Traffic,
November 1987, Gessner to SH 6 (6.3 miles)

Time of Day	Average Travel Time		Time Saved By Transitway (minutes)	Transitway Volumes				Travel Time Saved (Person Minutes)
	Non-Transitway (minutes)	Transitway (minutes)		Vans	Buses	Carpools	Persons	
3:30 pm	6.4	6.4	0	2	1	55	150	0
4:00	6.4	6.9	-0.5	8	5	117	440	-220
4:30	6.5	7.0	-0.5	8	7	158	700	-350
5:00	7.0	6.8	0.2	2	6	213	740	148
5:30	7.2	6.8	0.4	4	10	215	860	344
6:00	6.9	7.0	-0.1	0	4	128	370	-37
6:30	6.8	7.0	-0.2	1	2	65	190	-38
3 Hour Total			---	23	34	896	3,300	-153
2 Hour Total			-0.2	7	22	621	2,160	417

Transitway Mode Split

Data collected during the a.m. peak period in the vicinity of Bunker Hill allow determination of the percentage of trips to various activity centers that are being served by the transitway. Of the total a.m. peak period traffic on the Katy Freeway and transitway at Bunker Hill, the transitway is serving over half the trips to the CBD. It is generally serving in the range of 30% to 40% of the trips to the other 3 major activity centers.

Table 33. Estimated Transitway Mode Split, A.M. Peak Period at Bunker Hill, December 1987

Destination	Freeway	A.M. Peak Period Person Trips				Total
		Total	Bus	Van	2+ Carpool	
Downtown	4002 (46%)	4757 (54%)	2336	150	2271	8759
City Post Oak	2262 (63%)	1340 (37%)	0	59	1281	3602
Greenway Plaza	870 (71%)	349 (29%)	0	0	349	1219
Texas Medical Center	522 (57%)	399 (43%)	50	0	349	921
Other	9743 (84%)	1858 (16%)	99	186	1573	11,601
TOTAL	17399 (67%)	8703 (33%)	2485	395	5823	26,102

Measure of Efficiency for the Freeway and Transitway

In assessing the efficiency of a lane on the Katy Freeway, a measure that has been used is the multiple of peak-hour passengers times average operating speed. For the peak hour, this is generally expressed as passenger-miles per hour (passengers times mph). The measure is expressed in 1000's.

For the overall facility, this efficiency has to combine the single lane transitway with 3 lanes of freeway traffic. It is computed as shown below.

$$\frac{(\text{Transitway Passengers}) (\text{Transitway Speed}) + (\text{Freeway Passengers}) (\text{Freeway Speed})}{4 \text{ lanes}}$$

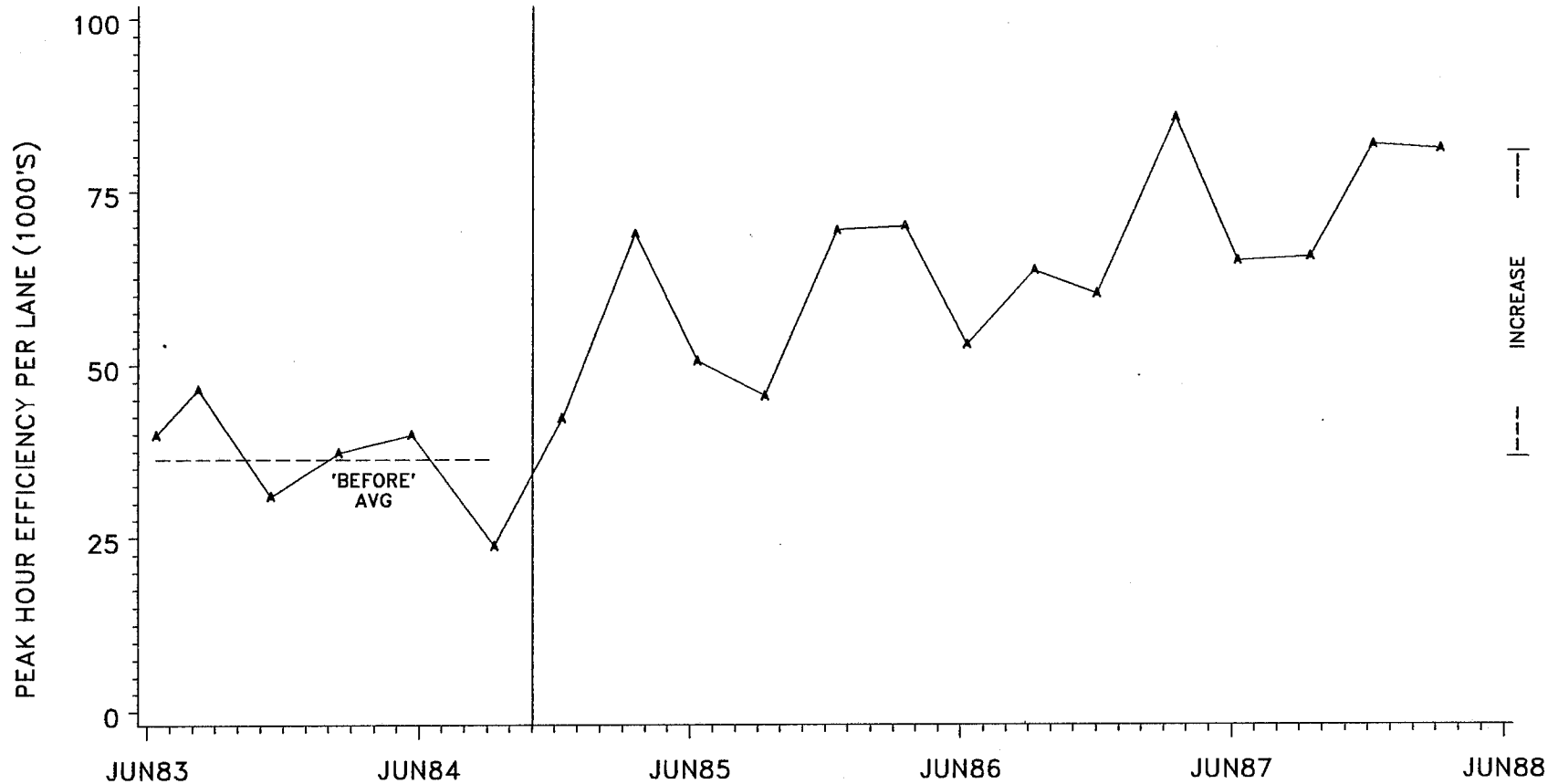
For the combined freeway and transitway in the a.m. in December 1987, this value (expressed in 1000's) was estimated to be approximately 86. Implementation of the transitway greatly increased the per lane efficiency (Figure 55). Prior to implementation of the transitway, the per lane efficiency was approximately 36.

Summary, Selected Combined Freeway Mainlane and Transitway Data

A summary of selected data describing the combined operation of the freeway mainlanes and the transitway is shown in Table 34. Additional summary data relating to carpooling on the transitway is presented in Table 35.

KATY FREEWAY TRANSITWAY EVALUATION
 A.M. PEAK HOUR FREEWAY AND TRANSITWAY EFFICIENCY

105



PEAK HOUR EFFICIENCY PER LANE EXPRESSED AS THE MULTIPLE OF PEAK HOUR PASSENGERS TIMES AVERAGE OPERATING SPEED. FOR THE PERIOD AFTER THE OPENING OF THE TRANSITWAY, IT REPRESENTS TOTAL PERSONS (FREEWAY + TRANSITWAY) MULTIPLIED BY THE WEIGHTED AVERAGE SPEED AND DIVIDED BY 4 LANES
 DATA COLLECTED AT BUNKER HILL
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : A = A.M. PEAK HOUR EFFICIENCY

FIGURE 55

Table 34. Summary of Combined Katy Freeway Mainlane and Katy Transitway Data

Characteristic Combined Freeway and Transitway	"Representative" Pre-Transitway Value	Current 12/87 Value	% Change 12/86-12/87
Person Volume			
A.M. Peak Hour	5100	9864	+ 20%
% in transitway	---	46%	+ 5%
P.M. Peak Hour	5657	9479	+ 18%
% in transitway	---	40%	+ 11%
Vehicle Volume			
A.M. Peak Hour	4043	6462	+ 19%
% in transitway	---	23%	+ 10%
P.M. Peak Hour	4266	6358	+ 15%
% in transitway	---	19%	+ 16%
Average Vehicle Occupancy (persons/vehicle)			
A.M. Peak Hour	1.26	1.53	+ 1%
P.M. Peak Hour	1.33	1.49	+ 2%
Freeways w/transitways ¹	---	1.65	---
Freeways w/o transitways ²	---	1.20	---
Transitway Travel Time Savings (min.)			
A.M. Peak Hour	---	12	+ 47%
P.M. Peak Hour	---	5	- 55%
Transitway Mode Split ³			
% Trips to CBD	---	54%	+ 15%
% Trips to City Post Oak	---	37%	+ 32%
% Trips to Greenway Plaza	---	29%	- 6%
% Trips to Texas Medical Center	---	43%	+ 95%
A.M. Peak-Hour Lane Efficiency (1000's) ⁴	36	86	---

¹The average of occupancies for the North (I-45) and Katy (I-10) Freeways.

²The average of occupancies for the Gulf (I-45), Northwest (US 290) and Southwest (US 59) Freeways.

³Measured at Bunker Hill, approximately 10 miles west of downtown. This is the percentage of the total trips (freeway plus transitway) that are on the transitway.

⁴This is the multiple of total peak-hour passengers (freeway plus transitway) multiplied by the weighted average speed and divided by 4 lanes.

Table 35. Summary of Selected Data Relating to Carpooling, Combined
Katy Freeway Mainlane and Transitway Data

Carpooling Characteristic Combined Freeway and Transitway	"Representative" Pre-Transitway Value	Current 12/87 Value	% Change 12/86-12/87
<u>Transitway Carpool Characteristics</u>			
Occupation			
Professional or Managerial	---	63%	- 7%
Clerical	---	16%	+ 7%
Sales	---	8%	+ 33%
Age in Years (50th percentile)	---	36	- 10%
Sex, % Male	---	58%	- 6%
Trip Destination			
Downtown	---	39%	- 20%
Texas Medical Center	---	6%	+100%
City Post Oak	---	22%	+ 40%
Greenway Plaza	---	6%	NA
<u>2+ Carpool Volumes</u>			
A.M. Peak Hour	505	1630	---
P.M. Peak Hour	768	1518	---
<u>Carpools Destined to 3 Suburban Activity Centers (a.m. peak period)</u>	630	1084	---
<u>Previous Mode for Transitway Carpoolers</u>			
Drove Alone	---	52%	+ 13%
Other Carpool	---	31%	+ 72%
Didn't Make Trip	---	6%	- 67%
Bus or Vanpool	---	11%	- 8%
<u>Before Carpooling, Did You Use Transitway</u>			
Yes, Bus	---	8%	+ 14%
Yes, Van	---	1%	- 86%



VI. BUS TRANSIT DATA

Implementation of the transitway has resulted in substantial increases in bus transit utilization in the Katy Freeway corridor. In this section, data are presented pertaining to the following: 1) bus passengers and bus trips; 2) bus occupancy; 3) bus operating speed; and 4) number of vehicles parked in corridor park-and-ride facilities.

Ridership Characteristics

On-board transit surveys have been conducted in the Katy corridor in 1985, 1986, and 1987.

Characteristics of the Transit Patrons

Characteristics of transit riders are summarized in Table 36. Riders tend to be young, educated, and the majority are white-collar workers. Virtually all trips are for work, are destined to downtown Houston, and are made 4 or more times per week. For over 90% of the riders, an auto was available for the trip.

Just over a third of the transit patrons previously drove alone, while another third were already riding a bus prior to the opening of the transitway. Just over 20% of the patrons are making new trips -- a trip they did not make prior to using a bus on the transitway.

Perceived Impacts of the Transitway on Mode Choice

In the surveys, a series of questions were asked concerning why the individuals were riding a bus (Table 37). The principal reasons given were:

Table 36. Characteristics of Bus Transit Patrons Using the Katy Transitway

Characteristic	Year of Survey		
	1985	1986	1987
Age in Years (50th percentile)	33	32	34
Sex			
Male	49%	44%	42%
Female	51%	56%	58%
Occupation			
Professional or Managerial	69%	66%	58%
Clerical	21%	26%	27%
Student	3%	3%	3%
Sales	4%	4%	6%
Other	3%	1%	6%
Education in Years (avg.)	15.6	15.4	15.6
Trip Purpose			
Work	99%	97%	98%
School	1%	2%	1%
Other	0%	1%	1%
Trip Frequency (days/week)			
5 or more	---	95%	80%
4	---	3%	9%
less than 4	---	2%	11%
Trip Destination			
Downtown	96%	95%	94%
University of Houston	3%	1%	1%
Texas Medical Center	1%	1%	2%
Other	0%	3%	3%
Auto Available for Trip			
No	---	7%	10%
Yes, but inconvenient	---	7%	8%
Yes, but prefer bus	---	86%	82%
Employer Payment of Bus Fare			
Pays all	19%	15%	13%
Pays part	38%	41%	43%
Pays none	43%	44%	44%
Previous Travel Mode			
Drove Alone	24%	35%	34%
Carpool or Vanpool	9%	11%	12%
Park-and-ride bus	23%	18%	16%
Regular Route or Express Bus	31%	16%	17%
Did not make trip	12%	18%	21%
Other	1%	2%	0%

Source: Texas Transportation Institute surveys.

1) freeway too congested; 2) save time; 3) time to relax; 4) reliable trip time; and 5) costs less.

Table 37. Perceived Impacts of the Transitway on Bus Mode Choice

Attitude or Reason	Year of Survey		
	1985	1986	1987
Why use bus on transitway			
Freeway too congested	18%	20%	---
Saves Time	14%	16%	---
Time to relax	17%	18%	---
Reliable travel schedule	14%	14%	---
Costs less	15%	14%	---
Dislike driving	13%	11%	---
Other	9%	7%	---
Ride bus if no transitway			
Yes	69%	43%	52%
No	15%	26%	20%
Not sure	16%	31%	28%
How important was transitway in decision to ride bus			
Very important	39%	57%	54%
Somewhat important	26%	27%	24%
Not important	35%	16%	22%

Source: Texas Transportation Institute surveys.

When asked whether they would ride the bus if there were no transitway, in the 1987 survey, 52% said yes. However, in all the surveys a substantial majority have indicated that the transitway was at least somewhat important in their decision to ride a bus.

Bus Passengers and Bus Trips

Since the opening of the transitway, both peak-period bus passengers and bus trips at Bunker Hill have increased by over 150% (Table 38 and Figure

56). Metro has been able to provide this increase in bus service without reducing occupancy per bus.

Table 38. Increase in Bus Passengers and Bus Trips, "Before" and "After" Katy Transitway

Time Period ¹	"Before" Value		December 1987 Value		Percent Change	
	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
Peak Hour						
Passengers	336	297	1327	1270	+295%	+328%
Bus Trips	11	10	38	32	+246%	+210%
Peak Period (3.5 hr)						
Passengers	900	1144	2485	2475	+176%	+116%
Bus Trips	32	38	82	72	+156%	+ 89%

¹Data Measured at Bunker Hill.

The increases in bus service and bus ridership in the Katy corridor have been substantially greater than those realized in one of the corridors without a transitway (Table 39). It appears that the transitway has been a significant factor in increasing transit usage.

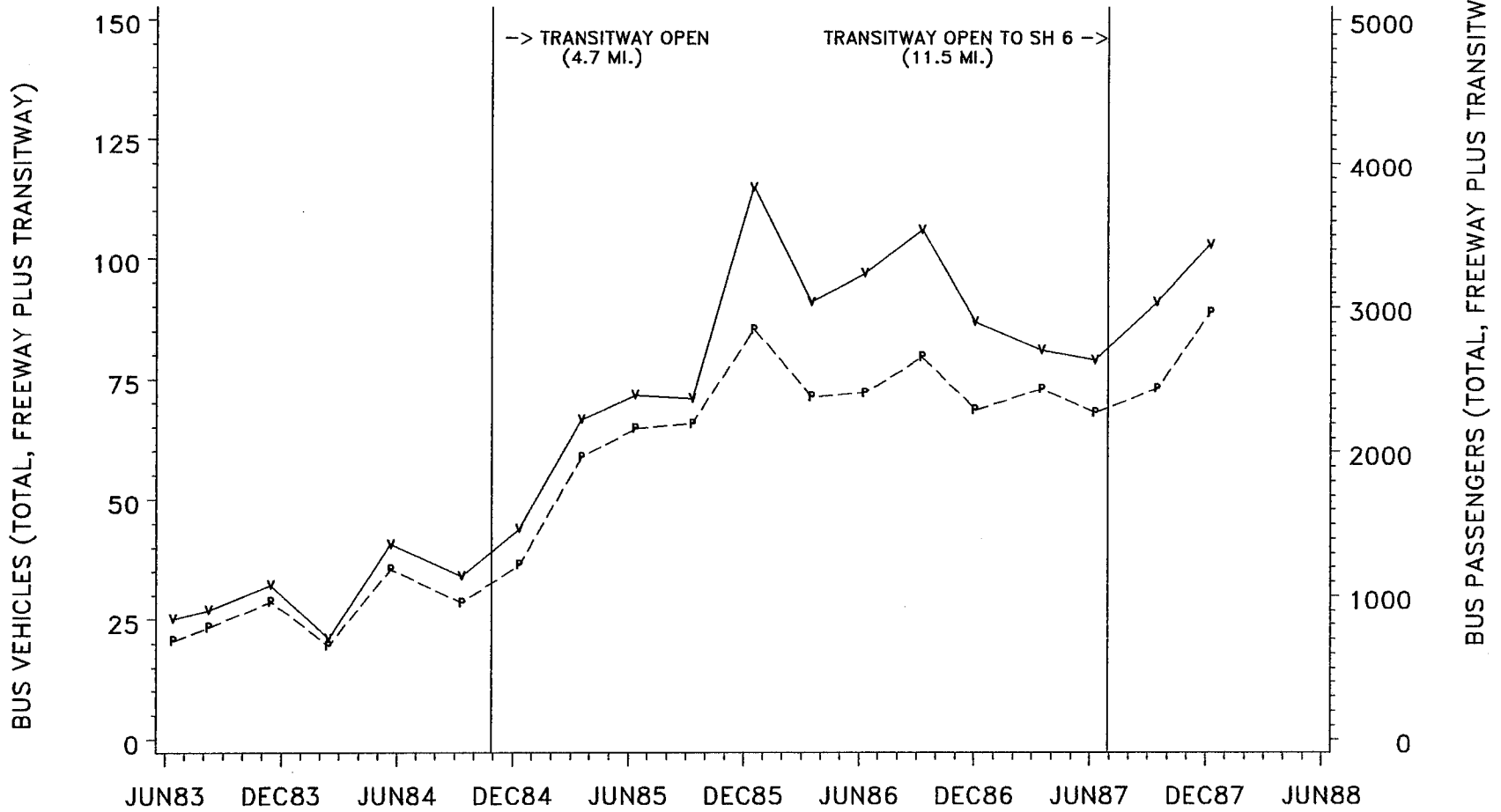
Table 39. Increase in Peak Period Bus Passengers, Freeway Corridors With and Without Transitways

Corridor	"Before" Value (9/84)	"Current" Value (12/87)	Percent Change
With transitway, Katy Freeway ¹	900	2485	+176%
Without Transitway, Gulf Freeway ²	1188	1111	- 6%

¹Data measured at Bunker Hill

²Data measured at Monroe

KATY FREEWAY (IH 10W) AND TRANSITWAY
 A.M. PEAK PERIOD BUS VEHICLE AND PASSENGER TRIPS



A.M. PEAK PERIOD DEFINED AS FROM 5:45 TO 9:30 A.M.
 DATA COLLECTED EASTBOUND OVER BUNKER HILL, 3 LANE SECTION
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND :
 - - - - BUS PASSENGER VOLUME
 _____ BUS VEHICLE VOLUME

FIGURE 56

Bus Occupancy

As shown in the previous tables, although substantial increases have been made in the volume of bus trips, the increase in bus passengers has been even greater. The result has been that average occupancy has actually increased (Table 40).

Table 40. Change in Average Bus Occupancy (Persons/bus),
"Before" and "After" Transitway

Time Period	"Before" Value (9/84)	"Current" Value (12/87)	Percent Change
Peak Hour			
a.m.	30.5	34.9	+14.4%
p.m.	28.7	39.7	+38.3%
Peak Period (3.5 hr.)			
a.m.	28.1	30.3	+ 7.8%
p.m.	30.1	34.4	+14.3%

Note: Data collected at Bunker Hill.

Bus Operating Speed

A major intent of the transitway is to increase travel speed and provide a more reliable trip time; both of these were cited as major reasons for using the transitway (Table 37).

Bus operating speeds have increased dramatically. These data are summarized in Table 41.

Table 41. Average Bus Operating Speed Between SH6 and Post Oak,
"Before" and "After" Transitway

Time Period	"Before" Value ¹ (9/84)	"Current" Value ² (12/87)	Percent Change
Peak Hour			
a.m.	21.4	50.0	+134%
p.m.	25.9	55.0	+112%
Peak Period (3.5 hr.)			
a.m.	32.2	54.0	+ 68%
p.m.	34.3	56.0	+ 63%

Notes: Travel speeds measured from transitway interchange at SH 6 to end of flyover structure.
Delay at the Post Oak intersection is not included.

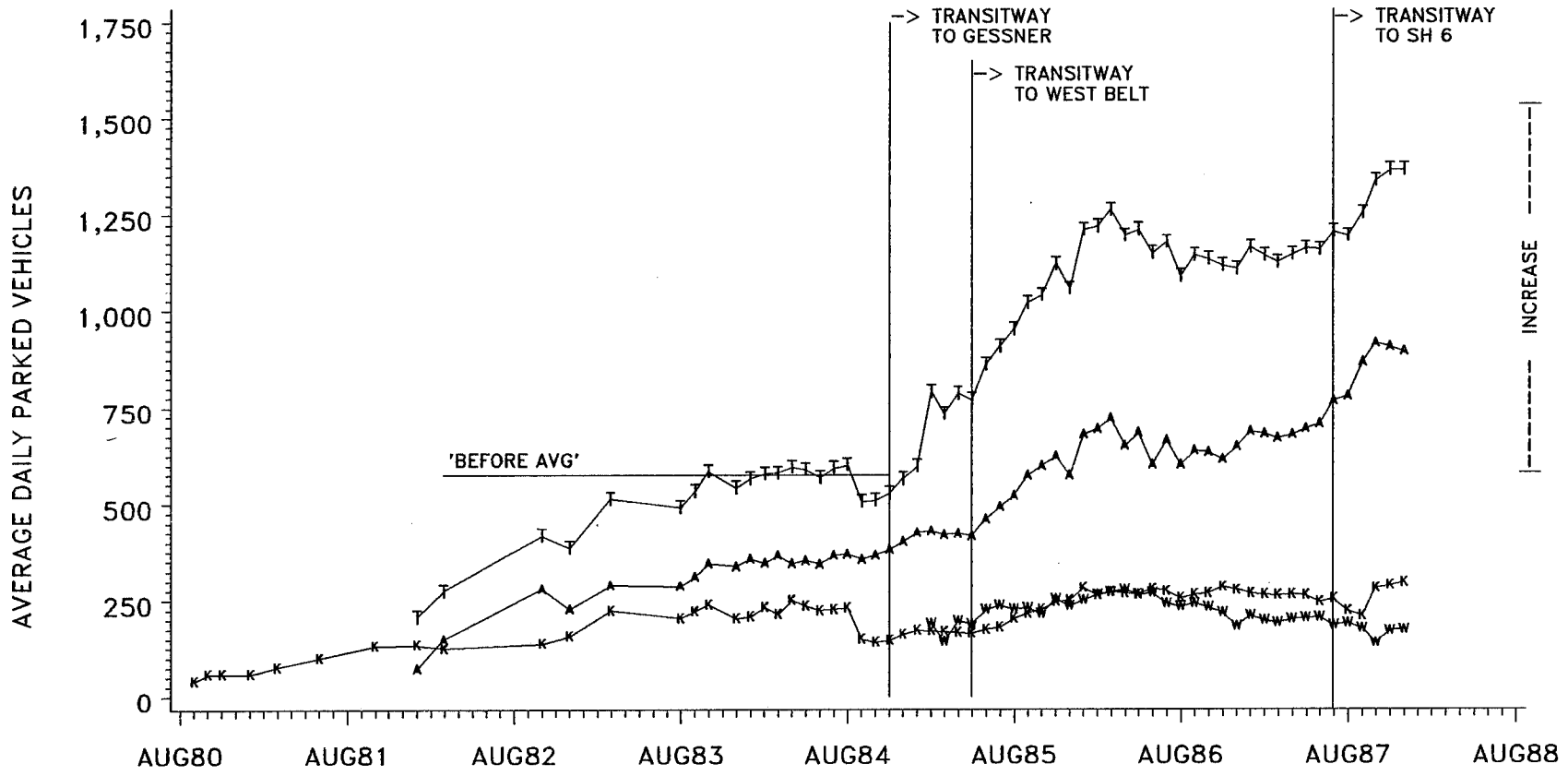
¹Speed in freeway mainlanes.

²Speed in transitway.

Vehicles Parked in Corridor Park-and-Ride Facilities

As noted previously in this report, Metro operates 3 major park-and-ride facilities in the Katy corridor. Bus service is provided at the lots. Significant increases have occurred in the number of cars parking at these lots (Figure 57). Whereas approximately 575 cars (a representative average for the year preceding the opening of the transitway) parked in these lots prior to the transitway opening, in December 1987, 1368 cars were parked at the lots, an increase of 138%. During the time in which this 138% increase was occurring, an increase in the range of 10% was occurring in corridors that did not have transitways (Figure 58 and Table 42). It is apparent that the transitway is responsible for most of the increase in transit usage in the corridor.

KATY FREEWAY (IH 10W) TRANSITWAY CORRIDOR PARK-AND-RIDE DEMAND



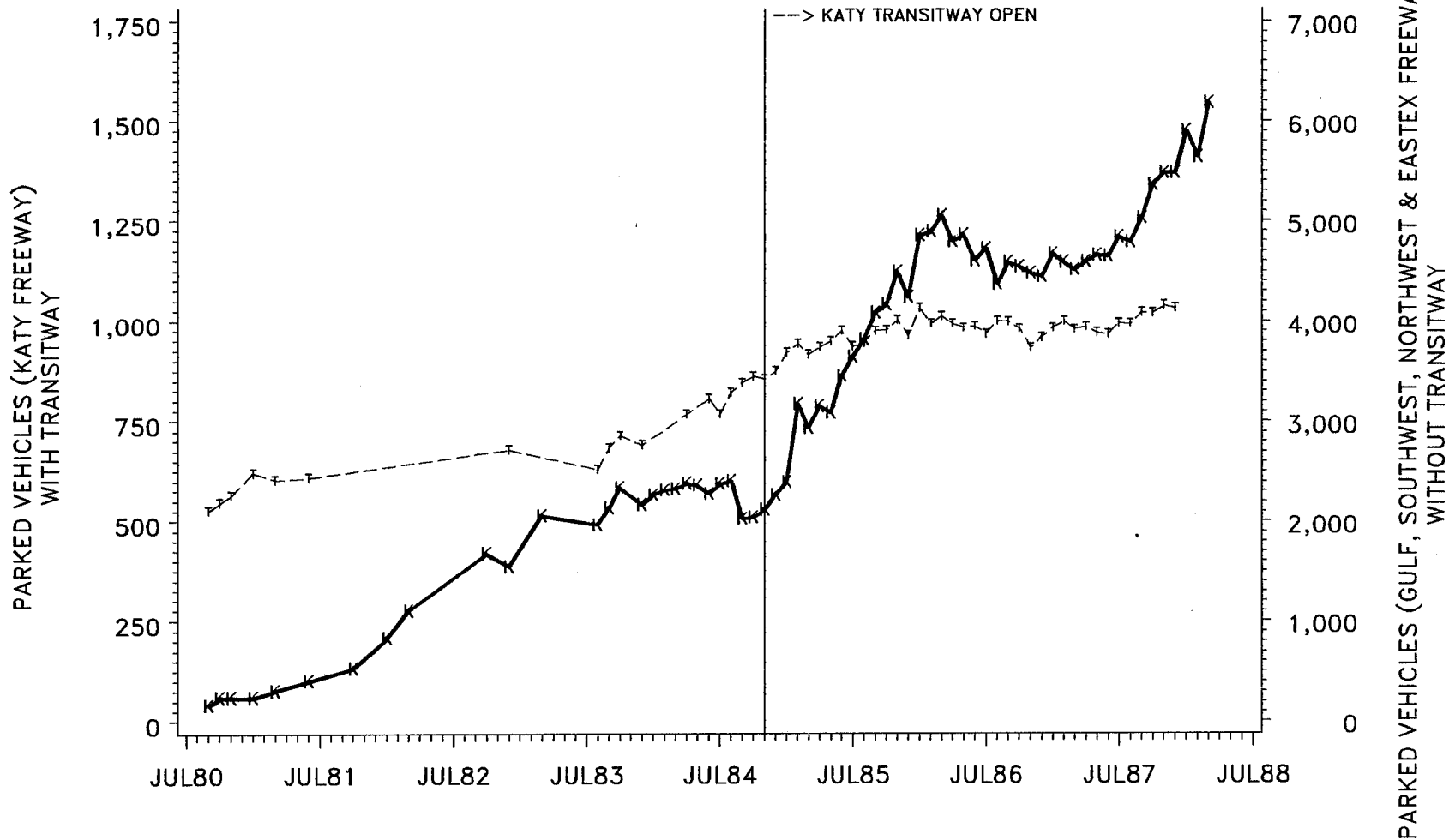
KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987

LEGEND : T = TOTAL PARKED VEHICLES
 K = KINGSLAND LOT (1326 SPACES)
 W = WEST BELT LOT (1111 SPACES)
 A = ADDICKS LOT (1155 SPACES)

SOURCE : TEXAS TRANSPORTATION INSTITUTE

FIGURE 57

AVERAGE DAILY VEHICLES PARKED AT PARK-AND-RIDE LOTS FREEWAYS WITH AND WITHOUT TRANSITWAYS



SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : K - KATY FREEWAY
T - TOTAL, NON TRANSITWAY FREEWAYS

FIGURE 58

Table 42. Increase in Vehicles Parked at Park-and-Ride Facilities,
Freeway Corridors With and Without Transitways

Corridor	"Before" Value	"Current" Value (12/87)	Percent Change
With transitway Katy Freeway	575 ²	1368	+138%
Without Transitway, Gulf Freeway ¹	2722 ³	3033	+ 11%

¹Sum of data from the Northwest (US 290), Southwest (US 59) and Gulf (I-45) freeways.

²Representative of utilization for the year preceding the opening of the transitway.

³Data for 9/84.

Park-and-Pool Facilities

In addition to the park-and-ride facilities that are served by bus transit, 3 park-and-pool lots are operated in the corridor. These are lots where carpool formation occurs. All 3 of these lots are located west of the western terminus of the transitway. Utilization of those lots is shown in Table 43. Utilization increased during 1987.

A survey of users of these lots was conducted in 1987. It is documented in more detail in Research Report 484-8. The median distance travelled to the lot in the morning was 4.0 miles; the median distance from the lot to the destination was 24.5 miles. Major destinations were: downtown, 44%; City Post Oak, 19%; Greenway Plaza, 7%; and Texas Medical Center, 4%. Carpools were formed at the lots by 71% of the users, the remaining 29% forming vanpools. Ninety-four percent of the park-and-pool lot users travelled on the Katy Transitway for at least a portion of their trip.

Table 43. Utilization of Park-and-Pool Lots in the Katy Freeway Corridor

Lot	No. of Parking Spaces	Daily Parked Vehicles		Percent Increase 1986-1987
		12/86	12/87	
Fry Road	374	70 ¹	89	+ 27%
Mason Road	386	18	55	+206%
Barker-Cypress	409	53	42	- 21%
TOTAL	1169	141	186	+ 32%

¹Data for February 1987; lot was not open in December 1986.

Summary of Transit Data

Implementation of the transitway has resulted in significant increases in transit utilization. Selected transit impacts are summarized in Table 44.

Table 44. Summary of A.M. Bus Transit Impacts of Implementing the Katy Transitway

Type of Data	"Representative" Pre-Transitway Value	"Representative" 12/87 Value	% Change
<u>Ridership Characteristics</u>			
Occupation			
Professional or Managerial	---	58%	---
Clerical	---	27%	---
Age in years (50th percentile)	---	34	---
Education in years (avg.)	---	15.4	---
Trip Purpose (% work)	---	98%	---
Trip Destination (% downtown)	---	94%	---
Auto Available for Trip (% yes)	---	90%	---
Previous Mode (before using transitway)			
Drove Alone	34%	---	---
Carpool or Vanpool	12%	---	---
Rode Bus	33%	---	---
Did Not Make Trip	21%	---	---
Transitway important or somewhat important in decision to ride bus (% Yes)	---	78%	---
<u>Bus Passengers</u>			
A.M. Peak Hour	336	1327	+295%
A.M. Peak Period	900	2485	+176%
<u>Bus Vehicle Trips</u>			
A.M. Peak Hour	11	38	+246%
A.M. Peak Period	32	82	+156%
<u>Bus Occupancy (Persons/bus)</u>			
A.M. Peak Hour	30.5	34.9	+ 14.4%
A.M. Peak Period	28.1	30.3	+ 7.8%
<u>Average Bus Operating Speed (mph)¹</u>			
A.M. Peak Hour	21.4	50.0	+134%
A.M. Peak Period	32.2	54.0	+ 68%
<u>Vehicle Parked at Park-and-Ride Lots</u>	575	1368	+138%

¹Average speed from SH 6 to the end of the flyover structure. Does not include intersection delay at Post Oak. Pre-transitway speeds are in the freeway lanes, 12/87 speeds are in the transitway.

VII. CONCLUSIONS

Transitway Impacts

The transitway was developed on the Katy Freeway as a means of increasing the person movement capacity of the facility and to offer a means of accommodating future growth in corridor travel demand. To those ends, the following have been achieved.

1. *The single transitway lane serves over 40% of the total volume of persons moved on the roadway during the peak hour (Table 45).*

Table 45. Percent of Total Person Movement on the Transitway

Time Period	Percent of Person Movement	
	Freeway Mainlanes ¹	Transitway
A.M. Peak Hour	54%	46%
A.M. Peak Period	67%	33%
P.M. Peak Hour	60%	40%
P.M. Peak Period	70%	30%

¹The freeway volume is understated in that it is counted between an off-ramp and an on-ramp. Data collected at Bunker Hill in a 3-lane section.

2. *The transitway project has created increases in the use of transit and ridesharing, thereby increasing average vehicle occupancy and total person throughput.*

- In comparison to pre-transitway conditions, peak-hour bus ridership has increased by 300%. The peak-hour volume of 2+ carpools has increased by 100% in the p.m. and 220% in the a.m. These increases have not been experienced on freeways without transitways.

- In comparison to pre-transitway conditions, a.m. peak-hour average vehicle occupancy has increased by 21%, while p.m. peak-hour vehicle occupancy has increased by 12%.
- The transitway increased directional lanes by 25%. In comparison to pre-transitway conditions, a.m. peak-hour person volume has increased by 93%, while p.m. peak-hour person volume has increased 68%.
- In the a.m. peak-hour, the transitway is serving 4600 persons. Demand estimation performed in 1982 predicted that, in 1987, the peak-hour volume would be approximately 4,700 persons; however, the 1982 projection anticipated no carpool usage of the transitway.

3. *The transitway is serving a respectable modal share.*

- Of the trips on the freeway and transitway during the a.m. peak period at Bunker Hill: 54% of downtown trips are on the transitway; 43% of Texas Medical Center trips are on the transitway; 37% of City Post Oak trips are on the transitway; and 29% of Greenway Plaza trips are on the transitway.
- In comparison to pre-transitway conditions, a.m. peak period carpool volumes to the 3 suburban activity centers have increased by over 70%.

4. *The per lane efficiency (the multiple of person volume times average speed) for the transitway is relatively high.*

- Using this measure of effectiveness for the a.m. peak hour, the efficiency of the transitway lane is more than 5 times greater than the efficiency of a general purpose freeway mainlane.

- In comparison to pre-transitway conditions for the a.m. peak hour, the overall per lane efficiency of the roadway (combined freeway and transitway) has increased by 139%.

Freeway Impacts

Implementation of the transitway has not resulted in a degradation of service or safety on the freeway mainlanes. The accident rate has declined, while freeway mainlane speeds and volumes have increased slightly.

Motorists in the freeway mainlanes have come to accept the transitway. In an October 1987 survey, when asked whether the transitway was a good transportation improvement, 63% of the motorists said "yes", 20% said "no", and 17% said "not sure".

Future Issues

By most measures, the Katy Transitway has been a successful improvement. It should be recognized that both travel patterns and congestion in the corridor make this an ideal freeway corridor for an HOV facility. A number of issues will need to be addressed in the future.

1. *Vehicular capacity of the transitway is becoming a concern.*

- The capacity is estimated to be 1500 vph. In the a.m. peak hour, actual volumes often exceed 1400 vph. Already, approaches are being considered for forcing a reduction in peak-hour transitway demand⁵.

⁵"Options for Managing Traffic Volumes and Speeds on the Katy Transitway". Texas Transportation Institute Research Report 484-6, 1987.

2. *It will become necessary to significantly increase the average vehicle occupancy.*

- The transitway is already operating near its vehicular capacity. In order to obtain design year person volumes, over time average vehicle occupancy will need to increase by 60% to 100%.

3. *Operational concerns will continue to exist.*

- The facility must provide relatively high speeds and reliable travel times.
- In order for the facility to appear utilized, it will probably be necessary to maintain peak-hour volumes of 1000 vph or more.
- The capability of effectively enforcing the operating rules must be maintained.

4. *Transitways are not the solution to all urban congestion problems.*

- Transitways can be effective tools to help maintain mobility in certain corridors. Providing transitways does not eliminate the need to pursue a range of other transportation improvements, including: 1) new street and highway construction; 2) improved operation of the street and highway system; 3) demand management strategies; and 4) other mass transportation improvements.