

1. Report No. SWUTC/96/465090-1	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Houston Employee Commute Options Program: An Analysis of Options and Their Potential Energy and Emissions Benefits		5. Report Date July 1996	
		6. Performing Organization Code	
7. Author(s) J.A. Crawford, K.M. Hall, and K.S. Rao		8. Performing Organization Report No.  Research Report 46590-1	
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. 0079	
12. Sponsoring Agency Name and Address Southwest Region University Transportation Center Texas Transportation Institute The Texas A&M University System College Station, TX 77843-3135		13. Type of Report and Period Covered  Sept 1994 - Aug 1996	
		14. Sponsoring Agency Code	
15. Supplementary Notes Supported by a grant from the Office of the Governor of the State of Texas, Energy Office Research Study Title: Monitoring Energy and Emissions Benefits of Transportation Control Measures			
16. Abstract  <p>A specific program of the 1990 Clean Air Act Amendments is the Employer Trip Reduction Program (ETR), which is sometimes recognized as the Employee Commute Options (ECO) program. This program required all employers of 100 or more employees in severe and extreme nonattainment areas to develop and implement plans that increase the automobile passenger occupancy (APO) levels of vehicles arriving to the worksite between the hours of 6:00 a.m. and 10:00 a.m. by 25 percent.</p> <p>In cooperation with the Texas Natural Resource Conservation Commission (TNRCC), a database of submitted and approved ETR plans and worksite registration forms was developed. The database represents approximately 1,200 worksites that accounts for 396,488 employees in the eight-county nonattainment area that arrive to the worksite between 6:00 a.m. and 10:00 a.m.. This database represents the most comprehensive collection of employee and employer preferences toward TCM/TDM strategies on a regional scale in Texas.</p> <p>The purpose of this study was to evaluate the potential impact of the ETR program on Houston's mobile source emissions and fuel consumption. A secondary objective was to evaluate the characteristics of the ETR program through plans submitted by affected worksites.</p> <p>The ETR database was used to evaluate the potential effectiveness of the ETR program throughout the eight-county nonattainment area had it achieved 100 percent compliance and met the target average passenger occupancies set in the plan. To supplement this analysis, a survey was conducted to determine the indirect trip rates caused as result of participation in the ETR program. The database was also used for an initial examination into the preferences of employees and employers in choosing specific transportation control measures. Recommendations for future research, based on the finding from this study, are also presented in the report.</p>			
17. Key Words Employer Trip Reduction Program, Clean Air Act Amendments, Mobile Source Emissions, Automobile Energy Benefits, Employee Commute Options Program, Transportation Control Measures		18. Distribution Statement No Restrictions. This document is available to the public through NTIS: 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 192	22. Price

**HOUSTON EMPLOYEE COMMUTE OPTIONS PROGRAM:  
AN ANALYSIS OF OPTIONS AND THEIR POTENTIAL  
ENERGY AND EMISSIONS BENEFITS**

by

Jason A. Crawford  
Assistant Research Scientist

Kevin M. Hall  
Assistant Research Scientist

and

Keithreddipalli S. Rao  
Assistant Research Scientist

Research Report 465090-1

Sponsored by

The Office of the Governor of the State of Texas, Energy Office  
Southwest Region University Transportation Center  
Texas Transportation Institute  
The Texas A&M University System  
College Station, Texas 77843-3135

July 1996

## ABSTRACT

A specific program of the 1990 Clean Air Act Amendments is the Employer Trip Reduction Program (ETR), which is sometimes recognized as the Employee Commute Options (ECO) program. This program required all employers of 100 or more employees in severe and extreme nonattainment areas to develop and implement plans that increase the automobile passenger occupancy (APO) levels of vehicles arriving to the worksite between the hours of 6:00 a.m. and 10:00 a.m. by 25 percent.

In cooperation with the Texas Natural Resource Conservation Commission (TNRCC), a database of submitted and approved ETR plans and worksite registration forms was developed. The database represents approximately 1,200 worksites that accounts for 396,488 employees in the eight-county nonattainment area that arrive to the worksite between 6:00 a.m. and 10:00 a.m.. This database represents the most comprehensive collection of employee and employer preferences toward TCM/TDM strategies on a regional scale in Texas.

The purpose of this study was to evaluate the potential impact of the ETR program on Houston's mobile source emissions and fuel consumption. A secondary objective was to evaluate the characteristics of the ETR program through plans submitted by affected worksites.

The ETR database was used to evaluate the potential effectiveness of the ETR program throughout the eight-county nonattainment area had it achieved 100 percent compliance and met the target average passenger occupancies set in the plan. To supplement this analysis, a survey was conducted to determine the indirect trip rates caused as result of participation in the ETR program. The database was also used for an initial examination into the preferences of employees and employers in choosing specific transportation control measures. Recommendations for future research, based on the finding from this study, are also presented in the report.

## ACKNOWLEDGMENTS

This publication was developed as part of the University Transportation Centers Program which is funded 50% in oil overcharge funds from the Stripper Well settlement as provided by the State of Texas Governor's Energy Office and approved by the U.S. Department of Energy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Many people helped with the data collection and analysis conducted for the study. Mr. Tony Williams and Mr. Al Giles of the Texas Natural Resource Conservation Commission (TNRCC) helped coordinate the data collection activities of the Employer Trip Reduction files at the Houston TNRCC office. They also responded to information requests regarding the ETR program in Houston. Mr. David Schrank from the Texas Transportation Institute conducted the statistical analysis of the employer and employee data. He also assisted with the coordination efforts during the data reduction phase of the study. Mr. Stephen Farnsworth, a graduate student at Texas A&M University, provided assistance with the data reduction and analysis. Ms. Nada Trout of TTI assisted in the design and preparation of the surveys used for this study. Mr. Pat Beck, of TTI, is responsible for the graphics contained in this report. Ms. Janet Ricci, and Mr. Darryl Pucket, also from TTI, provided their time and assistance with copying the ETR files from the Houston TNRCC office. Bret Baker, an undergraduate student, provided assistance with copying ETR files. Mr. Keith Knapp of TTI assisted in compiling the initial literature search for the study. Ms. Brenda Manak from the Houston TTI office coordinated personnel and obtained the copying machine. The efforts of these individuals are both acknowledged and appreciated.

Special thanks also go to our mentors for this project. Their guidance was invaluable. Our mentors were:

Dr. Raymond A. Krammes, P.E.  
Dr. George B. Dresser



## **EXECUTIVE SUMMARY**

### **INTRODUCTION**

The Clean Air Act Amendments of 1990 (CAAA) and the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) include many transportation-related requirements aimed at countering reduced mobility and increased traffic congestion in major cities to reduce auto-related air pollution. A specific program of the CAAA is the Employer Trip Reduction Program (ETR), which is sometimes recognized as the Employee Commute Options (ECO) program. The Employer Trip Reduction program required all employers of 100 or more employees in severe and extreme nonattainment areas to develop and implement plans that increase the automobile passenger occupancy (APO) levels of vehicles arriving to the worksite between the hours of 6:00 a.m. and 10:00 a.m. by 25 percent. The mandate was intended to influence work-related trips only.

Employers and employees challenged the validity of the ETR program on several points. Employers found the ETR mandates to be very costly and time consuming. The trip reduction mandates challenged employers to review traditional management practices in order to reduce vehicle trips to the worksite. Company employee transportation coordinators (ETCs) also discovered that Houston's land development patterns often conflicted with trip reduction strategies. Employees argued that the program was an infringement upon their privacy rights because they felt that the government was dictating how they travel.

On April 18, 1995, this publicly unpopular regulation was suspended indefinitely in the Houston region. In December 1995, the mandatory ETR requirements in the CAAA were repealed through H.R. 325. Currently in Texas, the ETR program has been replaced by a voluntary program called Regional Commute Alternatives Program (RCAP).

The ETR program changed dramatically when it was transformed from a mandatory program to a voluntary program. Any potential benefits that the program may have achieved, changed with the new ruling of "encouraging" ridesharing programs rather than "requiring" employees to rideshare. The new ruling, however, does satisfy employers who felt that requiring companies to develop ridesharing programs was onerous, and would have achieved minimal improvements in Houston's air quality.

To gauge the success of the ETR program required measurement concerning its mobile source emission and fuel consumption impacts. Due to the legislative changes during the course of this study, the original study objectives were redefined to produce a useful product despite the barriers faced by the research team.

## STUDY OBJECTIVES

The purpose of this study was to evaluate the potential impact of the ETR program on Houston's mobile source emissions and fuel consumption. A secondary objective was to evaluate the characteristics of the ETR program through plans submitted by affected worksites.

In cooperation with the Texas Natural Resource Conservation Commission (TNRCC), a database of submitted and approved ETR plans and worksite registration forms was developed. The database accounts for approximately 1,200 companies from a potential total of 1,791 worksites required to register. Another 200 to 300 worksite plans and surveys had yet to be filed by TNRCC when the database was created. In addition, 200 Independent School District (ISD) worksites were not included in the ETR database because of the uncertain nature of ISDs being required to comply with the regulation.

The database contains a total of 396,488 employees in the eight-county nonattainment area that arrive to the worksite between 6:00 a.m. and 10:00 a.m.. This database represents the most comprehensive collection of employee and employer preferences toward TCM/TDM strategies on a regional scale in Texas. Nine employment centers were defined as part of this study: Energy Corridor, Westchase, Galleria, Greenspoint, CBD/Downtown, Greenway Plaza, Medical Center, Petrochemical, and Clearwater/Clear Lake/NASA. Approximately, 182,000 employees work in these employment centers with the remaining total working throughout the eight-county region. While only 30 percent of the registered worksites are in the employment centers, the total employee population for all of the employment centers represents 46 percent of the total amount of employees in the database.

Information from the ETR database was used to evaluate the potential mobile source emission and fuel consumption benefits of the program. The study area encompassed the entire eight-county nonattainment region of Houston, Texas. As part of this analysis effort, a survey was conducted among a sample of employees to determine how their vehicle would be used if left at home. The results of this small survey would be used to identify a reduction in the program's benefits through indirect trips.

The TDM/TCM preferences of the employers and employees surveyed for the ETR database were used to compare voiced employee and employer preferences to the actual employer trip reduction measures selected at worksites. An analysis of worksite location, worksite size, and type of business was also conducted to determine the potential impacts these factors may have had on employee and employer preferences to the various TDM/TCM strategies.

## **RESULTS**

### **Indirect Trips**

Indirect trip changes represent: (a) the increase in trips by other household members because of the availability of an extra vehicle; and (b) for participants in telecommuting and compressed work week programs, the additional trips made by the employee on the day off. Initial indications from this study show that 81.3 percent of ETR-affected employees state that their vehicle would remain unused at home if they participated in a trip reduction strategy. Of the 18.7 percent of employees who stated the vehicle left at home would be used, 10.3 percent reported that the vehicle would be used for non-work trips by another household member, and 8.4 percent stated the other household members would use it for work-related trips. Based on this survey, one in five trips eliminated would be countered by additional vehicle trips made with a vehicle left at home.

### **Mobile Source Emissions and Fuel Consumption**

Based on this study, the ETR program would have reduced VOC and NO<sub>x</sub> emission by 3 tons per day, each; CO emissions would have been reduced by 25 tons per day. These reduction estimates would only be achieved if the program experienced a 100 percent compliance, and the target APO levels were met. Fuel consumption would have been reduced by 53,000 gallons daily if this program were implemented with the assumed characteristics. The effect of indirect travel would have discounted the total benefits of the ETR program by 12 percent. This represents a large share of predicted benefits being lost to induced trip making through indirect trips.

### **Regional Characteristics**

An examination of employee characteristics showed that more employees work at manufacturing and service worksites than in any other S.I.C. category in Houston. Manufacturing accounts for 20 percent of the total employee population, while the service-related industries account for 22 percent of the total employee population. Unlike manufacturing, one-half of those considered service-type employees work within the employment centers.

A correlation between higher APO levels and proximity to HOV lanes and access to transit services was found. The average APO gets progressively lower the farther away the employment center or region is from downtown and/or from the HOV lanes. The CBD/Downtown had the largest average baseline APO of 1.45. This APO level was just below the target APO of 1.47 determined by the Houston-Galveston Area Council (H-GAC), the regional agency responsible for the ETR program. Employment centers outside Houston's inner loop did not benefit from HOV lanes. Houston's HOV lanes currently are

unidirectional and do not serve demand for trips on Houston's fringe. Transit access for these employment centers also decreased as the distance from the inner loop increase. Transit has typically served the CBD area and functions on a more radial system. The impacted employment centers (away from the CBD/Downtown) averaged APO levels slightly more than the minimum 1.0.

### **TDM/TCM Preferences**

Of the TDM/TCM measures presented to employees and employers, employees rated the 4/40 compressed work week, variable/flexible work hours, and guaranteed ride home programs highest among those available. The employers did show some support for these measures, however, their responses showed that information dissemination and assistance had a higher priority. The employers' preferred measures were: free carpool/vanpool matching list of others to rideshare with, more information regarding bus routes, guaranteed ride home for emergencies and unscheduled overtime, preferential parking for carpools/vanpools, variable/flexible work hours, and compressed work weeks.

The impact of worksite location was more evident in the employer preferences rather than the employee preferences. Employer interest increased with the proximity to the CBD/Downtown for the following ridesharing strategies: more information regarding bus routes, bus fare subsidies, carpool subsidies, vanpool subsidies, and parking strategies.

Employer interest in implementing some TDM/TCM incentives and measures was typically greater for larger companies than in small to medium-sized worksites. Compressed work weeks, variable/flexible work hours, and telecommuting each received greater interest among larger worksites. Interest in bus fare, carpool, and vanpool subsidies was greater by small to medium worksites than at larger worksites. Employees, though, had a greater interest in subsidies for carpools and vanpools than employers regardless of worksite size.

Quantifying the effect of business type on TDM/TCM selection/preference was less tangible than worksite location or size. Government, services, finances, and wholesale trade industries consistently supported ridesharing incentives and measures at worksites. Alternative work schedules and arrangements, such as compressed work weeks, variable/flexible work hours, and telecommuting were also supported. Interest in telecommuting was confined to three types of businesses: government, services, and finance-related industries.

### **RECOMMENDATIONS FOR FUTURE RESEARCH**

1. Evaluate the Regional Commute Alternatives Program (RCAP) in Houston, Texas,

RCAP is a voluntary program and efforts should be undertaken to monitor the participation

of Houston employers in this program. Further efforts should be made to ascertain the travel, mobile source emission, and fuel consumption benefits of this voluntary program.

2. Further develop regional monitoring plans.

Regional monitoring plans are important to metropolitan areas, especially those deemed nonattainment, in both assessing the effectiveness of newly implemented and existing TDM/TCM programs, and identifying geographic areas or population segments which might be better served by refined or additional TDM/TCM programs.

3. Continue work on defining and quantifying the effects caused by indirect trips.

Policy makers should be fully informed about a potential effectiveness of a trip reduction program. Also, the profession's understanding of these trip types will help to evaluate potential TCM projects better.

4. Continue analysis of TDM/TCM strategies preferred by employees and employers in Houston, Texas.

By studying attitudinal preferences in Houston, a better understanding of what policies and programs that may be applicable to other suburban cities may be developed. Also, a better understanding of these preferences may be gained through further analysis of this information.

5. Develop a Statewide Voluntary Trip Reduction Program.

The mandatory trip reduction requirements have been removed from Houston, Texas; however, Houston will continue to experience a growth in vehicle miles driven and concurrently experience a growth in mobile source emissions. Other cities in Texas are or will experience similar scenarios. A better understanding of the programs and policies needed to support voluntary trip reduction efforts throughout the state is required. The creation of new legislation or policies directed at curbing the growth of VMT and auto-related pollution would require decision makers to have a basic understanding of the support programs and outreach efforts vital to implement such a program.

# TABLE OF CONTENTS

	Page
ABSTRACT .....	v
ACKNOWLEDGMENTS .....	vi
EXECUTIVE SUMMARY .....	vii
LIST OF FIGURES .....	xvi
LIST OF TABLES .....	xix
CHAPTER I. INTRODUCTION .....	1
STUDY APPROACH .....	2
ORGANIZATION OF REPORT .....	4
CHAPTER II. OVERVIEW OF CLEAN AIR ACT AMENDMENTS AND EMPLOYER TRIP REDUCTION PROGRAM .....	5
REQUIREMENTS OF THE 1990 CLEAN AIR ACT AMENDMENTS .....	5
EMPLOYER TRIP REDUCTION REQUIREMENTS .....	6
HISTORY OF EMPLOYER TRIP REDUCTION PROGRAMS IN HOUSTON .....	10
COMMON ARGUMENTS AGAINST IMPLEMENTING ETR IN HOUSTON .....	12
CHAPTER III. STUDY DESIGN DEVELOPMENT .....	15
PRE-ETR SUSPENSION (ORIGINAL) .....	15
Objectives .....	15
Study area .....	15
Factors influencing design .....	16
Sampling procedures .....	17
<i>Hypothesis</i> .....	17
<i>Stratification</i> .....	17
<i>Surveys</i> .....	17
Worksite survey .....	18
Employee household survey .....	18
<i>Expansion Factors</i> .....	19
Analysis methodology .....	21
<i>Travel</i> .....	21
<i>Mobile Source Emissions</i> .....	21
<i>Fuel Consumption/Energy</i> .....	23
Results of Pre-ETR Suspension Plan .....	24

	Page
POST-ETR SUSPENSION (REVISED) .....	24
Energy and Mobile Source Emission Benefits .....	25
Direct Travel Impacts .....	25
<i>Direct Vehicle Trip Changes</i> .....	25
Direct VMT Changes .....	26
Indirect Travel Impacts .....	27
<i>Indirect Vehicle Trip Changes</i> .....	27
<i>Indirect VMT Changes</i> .....	29
Mobile Source Emissions Impacts .....	29
Energy Impacts .....	30
Results .....	30
CHAPTER IV. HOUSTON ETR PROGRAM ANALYSIS .....	35
DATABASE OF ETR PLANS .....	35
METHODOLOGY FOR ANALYZING ETR DATABASE .....	38
Location of Worksite .....	39
Worksite Size .....	41
Standard Industrial Classification Code .....	42
WORKSITE CHARACTERISTICS .....	43
Location and Size .....	43
Location and Type of Business .....	44
EMPLOYEE CHARACTERISTICS .....	47
Location and Size .....	49
Location and Type of Business .....	50
FINDINGS FROM THE ETR DATABASE .....	51
Impact of HOV Lanes and Transit on APO .....	51
Employee and Employer Preferences Toward Alternative Modes .....	52
<i>Employee Preferences</i> .....	52
<i>Worksite Preferences</i> .....	56
<i>Impact of Worksite Location on Employee and Employer Preferences</i> ..	59
<i>Impact of Worksite Size on Employee and Employer Preferences</i> .....	60
<i>Impact of Business Type on Employee and Employer Preferences</i> .....	61
PROBLEMS ENCOUNTERED WITHIN THE ETR DATABASE .....	61
ETR Worksite Registration Form .....	62
Average Passenger Calculation Form .....	62
Employee Survey Results - Alternative Mode Preferences .....	62
Summary of Trip Reduction Measures - Worksite ETR Plan .....	62

	Page
CHAPTER V. CONCLUSIONS .....	65
ATTITUDES TOWARD THE ETR PROGRAM .....	65
INDIRECT TRAVEL .....	65
MOBILE SOURCE EMISSIONS AND FUEL CONSUMPTION .....	65
ETR PROGRAM CHARACTERISTICS .....	66
CHAPTER VI. RECOMMENDATIONS FOR FUTURE RESEARCH .....	69
REFERENCES .....	71
APPENDIX A. ACRONYMS AND DEFINITIONS .....	A-1
APPENDIX B. MOBILE SOURCE EMISSIONS PRIMER .....	B-1
APPENDIX C. HOUSTON TRAVEL SURVEY EXAMPLE .....	C-1
APPENDIX D. EMPLOYEE HOUSEHOLD VEHICLE USE SURVEY .....	D-1
APPENDIX E. FUEL CONSUMPTION TABLES .....	E-1
APPENDIX F. SAMPLE EMPLOYEE SURVEY RESULTS - ALTERNATIVE MODE PREFERENCE FORM .....	F-1
APPENDIX G. SAMPLE SUMMARY OF TRIP REDUCTION MEASURES FORM ....	G-1
APPENDIX H. S.I.C. CODE TRANSLATION .....	H-1
APPENDIX I. EMPLOYEE AND EMPLOYER INFORMATION BY WORKSITE SIZE .....	I-1
APPENDIX J. EMPLOYEE AND EMPLOYER INFORMATION BY S.I.C. CODES .....	J-1
APPENDIX K. EMPLOYEE AND EMPLOYER INFORMATION BY ACTIVITY CENTER .....	K-1
APPENDIX L. EMPLOYEE AND EMPLOYER INFORMATION BY REGION .....	L-1



## LIST OF FIGURES

	Page
Figure 2-1. Target APO level for the eight county nonattainment area. ....	7
Figure 2-2. APO calculation form used in Houston, Texas. ....	9
Figure 3-1. Results of indirect trip survey in Houston, Texas ....	28
Figure 4-1. Major employment centers and transportation facilities in Houston, Texas ....	40
Figure 4-2. Concentric regions of Houston, Texas ....	41
Figure 4-3. Concentration of employee and worksite populations in Houston, Texas ....	49
Figure I-1. Employee and employer interest in bus route information ....	I-2
Figure I-2. Employee interest in local bus service ....	I-2
Figure I-3. Employee interest in late evening bus service ....	I-3
Figure I-4. Employee and employer interest in subsidizing bus fares ....	I-3
Figure I-5. Employee and employer interest in park-and-ride service ....	I-4
Figure I-6. Employee and employer interest in preferential carpool/vanpool parking ....	I-4
Figure I-7. Employee and employer interest in carpool subsidies ....	I-5
Figure I-8. Employee and employer interest in vanpool subsidies ....	I-5
Figure I-9. Employee and employer interest in preferential carpool/vanpool matching ...	I-6
Figure I-10. Employee and employer interest in guaranteed ride home programs ....	I-6
Figure I-11. Employee and employer interest in mid-day shuttle buses ....	I-7
Figure I-12. Employee and employer interest in company vehicles for mid-day trips ....	I-7
Figure I-13. Employee interest in high occupancy vehicle (HOV) lanes ....	I-8
Figure I-14. Employee and employer interest in bike products ....	I-8
Figure I-15. Employee and employer interest in bike purchase subsidies ....	I-9
Figure I-16. Employee and employer interest in secured bike rack ....	I-9
Figure I-17. Employee interest in walking incentives ....	I-10
Figure I-18. Employee and employer interest in locker facilities ....	I-10
Figure I-19. Employee and employer interest in shower facilities ....	I-11
Figure I-20. Employee and employer interest in 3/36 compressed work week ....	I-11
Figure I-21. Employee and employer interest in 4/40 compressed work week ....	I-12
Figure I-22. Employee and employer interest in 9/80 compressed work week ....	I-12
Figure I-23. Employee and employer interest in on-site banking facilities ....	I-13
Figure I-24. Employee and employer interest in on-site day care facilities ....	I-13
Figure I-25. Employee and employer interest in cafeteria on-site ....	I-14
Figure I-26. Employee and employer interest in variable work hours ....	I-14
Figure I-27. Employee and employer interest in telecommuting ....	I-15
Figure I-28. Employee and employer interest in increased parking fees ....	I-15
Figure J-1. Employee and employer interest in bus route information ....	J-2
Figure J-2. Employee interest in local bus service ....	J-2
Figure J-3. Employee interest in late evening bus service ....	J-3
Figure J-4. Employee and employer interest in subsidizing bus fares ....	J-3

Figure J-5	Employee and employer interest in park-and-ride service . . . . .	J-4
Figure J-6	Employee and employer interest in preferential carpool/vanpool parking . . . .	J-4
Figure J-7	Employee and employer interest in carpool subsidies . . . . .	J-5
Figure J-8	Employee and employer interest in vanpool subsidies . . . . .	J-5
Figure J-9	Employee and employer interest in preferential carpool/vanpool matching . . .	J-6
Figure J-10	Employee and employer interest in guaranteed ride home programs . . . . .	J-6
Figure J-11	Employee and employer interest in mid-day shuttle buses . . . . .	J-7
Figure J-12	Employee and employer interest in company vehicles for mid-day trips . . . .	J-7
Figure J-13	Employee interest in high occupancy vehicle (HOV) lanes . . . . .	J-8
Figure J-14	Employee and employer interest in bike products . . . . .	J-8
Figure J-15	Employee and employer interest in bike purchase subsidies . . . . .	J-9
Figure J-16	Employee and employer interest in secured bike rack . . . . .	J-9
Figure J-17	Employee interest in walking incentives . . . . .	J-10
Figure J-18	Employee and employer interest in locker facilities . . . . .	J-10
Figure J-19	Employee and employer interest in shower facilities . . . . .	J-11
Figure J-20	Employee and employer interest in 3/36 compressed work week . . . . .	J-11
Figure J-21	Employee and employer interest in 4/40 compressed work week . . . . .	J-12
Figure J-22	Employee and employer interest in 9/80 compressed work week . . . . .	J-12
Figure J-23	Employee and employer interest in on-site banking facilities . . . . .	J-13
Figure J-24	Employee and employer interest in on-site day care facilities . . . . .	J-13
Figure J-25	Employee and employer interest in cafeteria on-site . . . . .	J-14
Figure J-26	Employee and employer interest in variable work hours . . . . .	J-14
Figure J-27	Employee and employer interest in telecommuting . . . . .	J-15
Figure J-28	Employee and employer interest in increased parking fees . . . . .	J-15
Figure K-1	Employee and employer interest in bus route information . . . . .	K-2
Figure K-2	Employee interest in local bus service . . . . .	K-2
Figure K-3	Employee interest in late evening bus service . . . . .	K-3
Figure K-4	Employee and employer interest in subsidizing bus fares . . . . .	K-3
Figure K-5	Employee and employer interest in park-and-ride service . . . . .	K-4
Figure K-6	Employee and employer interest in preferential carpool/vanpool parking . . .	K-4
Figure K-7	Employee and employer interest in carpool subsidies . . . . .	K-5
Figure K-8	Employee and employer interest in vanpool subsidies . . . . .	K-5
Figure K-9	Employee and employer interest in preferential carpool/vanpool matching . .	K-6
Figure K-10	Employee and employer interest in guaranteed ride home programs . . . . .	K-6
Figure K-11	Employee and employer interest in mid-day shuttle buses . . . . .	K-7
Figure K-12	Employee and employer interest in company vehicles for mid-day trips . . . .	K-7
Figure K-13	Employee interest in high occupancy vehicle (HOV) lanes . . . . .	K-8
Figure K-14	Employee and employer interest in bike products . . . . .	K-8
Figure K-15	Employee and employer interest in bike purchase subsidies . . . . .	K-9
Figure K-16	Employee and employer interest in secured bike rack . . . . .	K-9
Figure K-17	Employee interest in walking incentives . . . . .	K-10

	<b>Page</b>
Figure K-18 Employee and employer interest in locker facilities .....	K-10
Figure K-19 Employee and employer interest in shower facilities .....	K-11
Figure K-20 Employee and employer interest in 3/36 compressed work week .....	K-11
Figure K-21 Employee and employer interest in 4/40 compressed work week .....	K-12
Figure K-22 Employee and employer interest in 9/80 compressed work week .....	K-12
Figure K-23 Employee and employer interest in on-site banking facilities .....	K-13
Figure K-24 Employee and employer interest in on-site day care facilities .....	K-13
Figure K-25 Employee and employer interest in cafeteria on-site .....	K-14
Figure K-26 Employee and employer interest in variable work hours .....	K-14
Figure K-27 Employee and employer interest in telecommuting .....	K-15
Figure K-28 Employee and employer interest in increased parking fees .....	K-15
Figure L-1 Employee and employer interest in bus route information .....	L-2
Figure L-2 Employee interest in local bus service .....	L-2
Figure L-3 Employee interest in late evening bus service .....	L-3
Figure L-4 Employee and employer interest in subsidizing bus fares .....	L-3
Figure L-5 Employee and employer interest in park-and-ride service .....	L-4
Figure L-6 Employee and employer interest in preferential carpool/vanpool parking ....	L-4
Figure L-7 Employee and employer interest in carpool subsidies .....	L-5
Figure L-8 Employee and employer interest in vanpool subsidies .....	L-5
Figure L-9 Employee and employer interest in preferential carpool/vanpool matching ...	L-6
Figure L-10 Employee and employer interest in guaranteed ride home programs .....	L-6
Figure L-11 Employee and employer interest in mid-day shuttle buses .....	L-7
Figure L-12 Employee and employer interest in company vehicles for mid-day trips ....	L-7
Figure L-13 Employee interest in high occupancy vehicle (HOV) lanes .....	L-8
Figure L-14 Employee and employer interest in bike products .....	L-8
Figure L-15 Employee and employer interest in bike purchasesubsidiess .....	L-9
Figure L-16 Employee and employer interest in secured bike rack .....	L-9
Figure L-17 Employee interest in walking incentives .....	L-10
Figure L-18 Employee and employer interest in locker facilities .....	L-10
Figure L-19 Employee and employer interest in shower facilities .....	L-11
Figure L-20 Employee and employer interest in 3/36 compressed work week .....	L-11
Figure L-21 Employee and employer interest in 4/40 compressed work week .....	L-12
Figure L-22 Employee and employer interest in 9/80 compressed work week .....	L-12
Figure L-23 Employee and employer interest in on-site banking facilities .....	L-13
Figure L-24 Employee and employer interest in on-site day care facilities .....	L-13
Figure L-25 Employee and employer interest in cafeteria on-site .....	L-14
Figure L-26 Employee and employer interest in variable work hours .....	L-14
Figure L-27 Employee and employer interest in telecommuting .....	L-15
Figure L-28 Employee and employer interest in increased parking fees .....	L-15

## LIST OF TABLES

	Page
Table 2-1. Number of Air Quality Non-Attainment Areas Nationally .....	5
Table 2-2. Chronology and Important Dates of the Houston ETR Program .....	11
Table 3-1. Distribution of Affected Worksites and Employees Over The Houston-Galveston Nonattainment Area .....	16
Table 3-2. Distribution of Worksites and Employees by Worksite Size .....	18
Table 3-3. Estimated Energy and Mobile Source Emission Impacts of the Houston ETR Program .....	31
Table 3-4. Daily Rates for Emissions and Fuel Consumption in Houston/Galveston Area .....	32
Table 3-5. Estimated Relative Reduction in Emissions and Fuel Consumption from the Proposed ETR Program in Houston, Texas .....	32
Table 4-1. Summary of Information Found in TTI ETR Database .....	37
Table 4-2. Major Employment Centers in Houston by Zip Code Zone .....	37
Table 4-3. Total Number of Worksites by Location and Worksite Size .....	44
Table 4-4. Total Number of Worksite Types by Location .....	46
Table 4-5. Total Number of Employees by Location and Worksite Size .....	47
Table 4-6. Total Number of Employees by Location and Worksite Type .....	48
Table 4-7. Average Baseline APO at Employment Centers and Regions .....	53
Table 4-8. Employee and Employer Preferences Toward Alternative Modes .....	54
Table 4-9. Implementation Status of Incentive or Measure (1993) .....	58
Table 5-1. Summary of Incentives Rated Highest Among Employees/Employers .....	67

## **CHAPTER I INTRODUCTION**

Single occupant driving in the United States continues to escalate, despite the increased attention given to transit, travel demand strategies (TDM) and transportation control measures (TCMs) by urban planners and transportation professionals. The growth in vehicle-miles of travel (VMT) over the past ten years has generally offset any reductions in automobile emissions gained through technological advances in the operating efficiency and cleanliness of automobile engines. As a result, automobile-generated air pollution continues to represent a significant share of the air pollution problem being experienced in many urban centers throughout the United States.

The Clean Air Act Amendment (CAAA) of 1990 and subsequent regulations issued by the U.S. Environmental Protection Agency (EPA) establish air quality standards that cities, counties, and urban areas must comply with, in order to maintain or improve current air quality levels. Those cities, counties, and urban areas not meeting the federal air quality standards are considered nonattainment areas. The 8-county Houston metropolitan area is classified as a severe ozone air quality nonattainment area.

The CAAA and the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) include many transportation-related requirements aimed at addressing reduced mobility and increased traffic congestion to reduce auto-related air pollution. Several requirements focus on programs designed to reduce the amount of VMT and increase the auto occupancy rates of vehicles. A specific program that has a direct impact on approximately 1.8 million employees of the 8-county Houston metropolitan area is the Employer Trip Reduction Program (ETR), which is sometimes recognized as the Employee Commute Options (ECO) program.

The Employer Trip Reduction program requires that all employers of 100 or more employees in a severe and extreme nonattainment area develop and apply plans that increase the automobile passenger occupancy (APO) levels of vehicles arriving to the worksite between the hours of 6:00 a.m. and 10:00 a.m. by 25 percent. The mandate is intended for work related trips only, which accounts for approximately 21.5 percent of all trips on the national average (1). Data from Houston indicates that this percentage is 18.7 (2). To comply with the trip reduction mandates, area employers must consider several travel demand management (TDM) strategies or transportation control measures (TCMs), such as carpooling and telecommuting, to increase the APO level at the worksite.

The Texas Natural Resource Conservation Commission (TNRCC), formerly known as the Texas Air Control Board (TACB), and the Houston-Galveston Area Council of Governments (H-GAC) are the agencies responsible for administering the program under the guidance of the EPA and the U.S. Department of Transportation. On April 18, 1995, this publicly unpopular regulation was suspended indefinitely in the Houston region. The U.S. Congress and President Clinton repealed the mandatory ETR requirements from the CAAA through H.R. 325 in December 1995.

Although there are many documents detailing implementation strategies for TDMs/TCMs, few documents quantify the energy and emissions benefits of such strategies or worksite-related programs. This is partly due to the fact that TDM programs, for the most part, were implemented on a voluntary basis before the inception of the ETR mandates. Regulation XV in Southern California, based on which the national ETR program is modeled, was examined for its trip reduction qualities (3) and effects on employer ridesharing policies (4,5). However, extensive energy and emissions benefits of this regulation have not been published within professional or academic literature.

The purpose of this study was to evaluate the potential effectiveness of the ETR program and subsequent TDM/TCM measures implemented on the mobile source emission production in the Houston nonattainment area. This report documents the legislative history of the ETR program in Houston, and examines the potential impact the program may have had on Houston's air quality by reviewing the alternative strategies that companies were considering for compliance with the ETR program. This study was not intended to examine the effectiveness of a specific ETR program at any one worksite, but is designed to establish a basic understanding of the energy and emissions impacts the mandated ETR program may have had on the Houston region.

## **STUDY APPROACH**

The original intent of this study was to accurately depict the energy and emissions benefits of the ETR program in the Houston metropolitan area, based upon changes in travel behavior from companies implementing trip reduction strategies to comply with the ETR requirements. The study was designed to examine the number of trips reduced, changes in VMT, and the resulting changes in vehicle emissions by administering pre-ETR and post-ETR travel diaries to several cooperative Houston employees at multiple worksite locations.

Because of strong disfavor among Houston businesses and employees, legislators suspended the ETR program in early 1995 and began to reexamine the basic principles of the program. On April 18, 1995, the TNRCC, under guidance from the EPA, changed the compliance requirements from mandatory, to a voluntary, incentive-based program. The new ETR program encourages companies to continue with their efforts to increase the worksite APO in "good faith." The ETR program no longer carries the threat of fines or sanctions if companies fail to attain the target APO within the defined time frames.

An informal survey of Houston employers conducted by the Texas Transportation Institute (TTI) at the time of the TNRCC announcement revealed that the ETR program no longer received the same attention from companies that it did prior to the changing of the mandatory compliance requirement. Therefore, several smaller to medium sized companies reduced or eliminated their ETR programs altogether. Only large employers reported continuing with their ETR efforts, especially those that had access to high-occupancy vehicle facilities, such as companies with worksites located downtown. Because an analysis of pre- and post-ETR travel behavior based upon

implemented programs at worksites was no longer valid, a new study design was developed to quantify the potential benefits of implementing a region-wide ETR program during the project.

The new study design was developed to understand the energy and emissions benefits of the ETR program based upon an analysis of the difference between the original worksite APO and the target APO. The change in the number of trips would be measured based upon companies hypothetically reaching their target APOs rather than actually measuring the changes in the number of trips. Energy and emissions information can then be calculated by factoring in worksite location, average work trip length, and average travel time to the worksite. Worksite location, average work trip lengths, and travel times are available from the worksite registration and APO forms formally submitted to TNRCC by Houston employers. In cooperation with the TNRCC, a database of submitted and approved ETR plans and worksite registration forms was developed. The database accounts for approximately 1,200 companies from a potential total of 1,791 required registered worksites. Approximately 200 Independent School District (ISD) worksites were not included in the ETR database because of the unresolved debate about the validity of requiring ISD worksites to comply with the trip reduction program (work schedules for most ISD employees include a 3-month vacation during the summer months, when ozone problems traditionally occur). Another 200 to 300 worksite plans and surveys had yet to be filed by TNRCC when the database was created.

The database represents a comprehensive review of employee and employer interests in TDM and TCM strategies in the 8-county Houston metropolitan region. The database contains the TDM/TCM preferences of approximately 400,000 surveyed employees in the Houston metropolitan region. The database also contains 88 potential trip reduction measures that the worksite transportation coordinator could choose from to reduce the number of work-generated trips at a site. Within the plans, companies submitted the following information:

- Designation of an employee transportation coordinator (ETC) and proof of adequate training.
- Enforceable certification signed by the highest designated ranking official (HRO).
- Initial and target APO levels.
- Alternate mode preferences of employees.
- Trip reduction measures and incentives to be implemented to attain the target APO level.
- Description of tracking and evaluation methods of the worksite plan.

The above information was used to compare employee preferences with employer trip reduction measures selected. An analysis of worksite location, worksite size, and type of business was also conducted to determine the potential impacts these factors may have had on employee and employer preferences to the various TDM/TCM strategies. Furthermore, a more comprehensive exploration of worksite location and its impact on original APO was conducted to determine specific area trip reduction efforts that would be needed to meet the target APO. A general comparison of employee alternate mode preferences to actual trip reduction strategies chosen by companies is also discussed.

## **ORGANIZATION OF REPORT**

Following this introduction, the report is divided into four chapters. Chapter II provides a brief overview of the transportation requirements of the CAAA and the ETR program. The history of the ETR program detailing how public opinion and disfavor with the program reshaped basic requirements in the Houston region is also discussed in this chapter. This is followed by the original energy and emissions study design, which was intended to determine the energy and emission benefits by surveying pre- and post-ETR travel behavior. The post-suspension energy and emission study design is also discussed in this chapter. Chapter IV presents an analysis of the Houston ETR program based upon submitted and approved plans to TNRCC in Houston. The chapter details how worksite location, company size, and proximity to transit may have influenced an employer's selection of trip reduction strategies. Conclusions from this project are presented in Chapter V and are followed by recommendations for future research.

The report has many appendices referred throughout the document; however, Appendix A was provided for the reader to reference the many acronyms and technical terms used in this report easily.



## CHAPTER II

### OVERVIEW OF CLEAN AIR ACT AMENDMENTS AND EMPLOYER TRIP REDUCTION PROGRAM

#### REQUIREMENTS OF THE 1990 CLEAN AIR ACT AMENDMENTS

The 1990 CAAAs were created to promote a greater integration of transportation and air quality. Title I of the CAAA establishes the criteria for achieving and maintaining the National Ambient Air Quality Standards (NAAQS) for several pollutants including the following: ozone (O<sub>3</sub>), carbon monoxide (CO), and small particulate matter less than 10 microns (PM<sub>10</sub>). As defined by the EPA, metropolitan areas that exceed the minimum allowable levels are considered in nonattainment of federal air quality standards. These areas are then classified as either extreme, severe, serious, moderate, or marginal depending on the level of nonattainment.

Nationally, 96 ozone nonattainment areas and 51 carbon monoxide nonattainment areas have been designated. Table 2-1 shows the number of urban areas for each nonattainment area classification for ozone and carbon monoxide. Within Texas, the Houston-Galveston-Brazoria area is the only severe ozone nonattainment area classified in Texas. Beaumont and El Paso are classified as serious ozone nonattainment areas, and Dallas is classified as a moderate nonattainment area. El Paso is the only metropolitan area in Texas that exceeds carbon monoxide standards and is classified as a moderate nonattainment area for this pollutant.

**Table 2-1**  
**Number of Air Quality Nonattainment Areas Nationally**

Nonattainment Classification	Pollutant	
	Ozone	Carbon Monoxide <sup>1</sup>
Extreme	1	NA
Severe	8	NA
Serious	16	3
Moderate	32	48
Marginal	39	NA
Total	96	51

<sup>1</sup> Carbon monoxide is only categorized as either serious or moderate

Depending upon the severity of the air quality problem, the metropolitan area must take actions to reduce the amount of source pollution emissions within defined time frames. The more severe the air quality problem, the greater the amount of actions that must be taken to comply with the air quality standards. For severe nonattainment areas, such as the Houston-Galveston-Brazoria area, the federal air quality standards must be achieved by November 15, 2007. The Houston-Galveston-Brazoria area must meet all moderate and serious area requirements and other transportation provisions specifically created for severe nonattainment areas.

Within two years of enactment, revisions were made to the State Implementation Plans (SIPs) that detail how emissions will be offset through a reduction in VMT. The CAAA required the Employer Trip Reduction revision to the SIP be submitted by November 15, 1992. An emissions inventory had to be submitted by November 15, 1993 and be updated every three years thereafter. By 1996, the Houston area must demonstrate a 15 percent reduction in ozone emissions and must show a 3 percent reduction annually until 2007. Ozone and sulfur dioxide emissions must be reduced by 65 percent in the Houston area by 2007 (6).

The 8-county region (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties) is formally known as the Houston-Galveston-Brazoria ozone nonattainment area and is second only to Southern California in ozone severity. According to TNRCC, 47 percent of harmful ozone and sulphur dioxide emissions come from large industrial plants and 17 percent come from small businesses (6). The Houston/Galveston area is recognized as having the largest concentration of oil refineries and petrochemical plants in the nation; however, if industrial emissions were completely cut to zero, Houston would still not meet air quality standards set forth by the EPA (7). The remaining emissions result from motor vehicle use, which accounts for 36 percent of ozone and sulphur dioxide emissions (6).

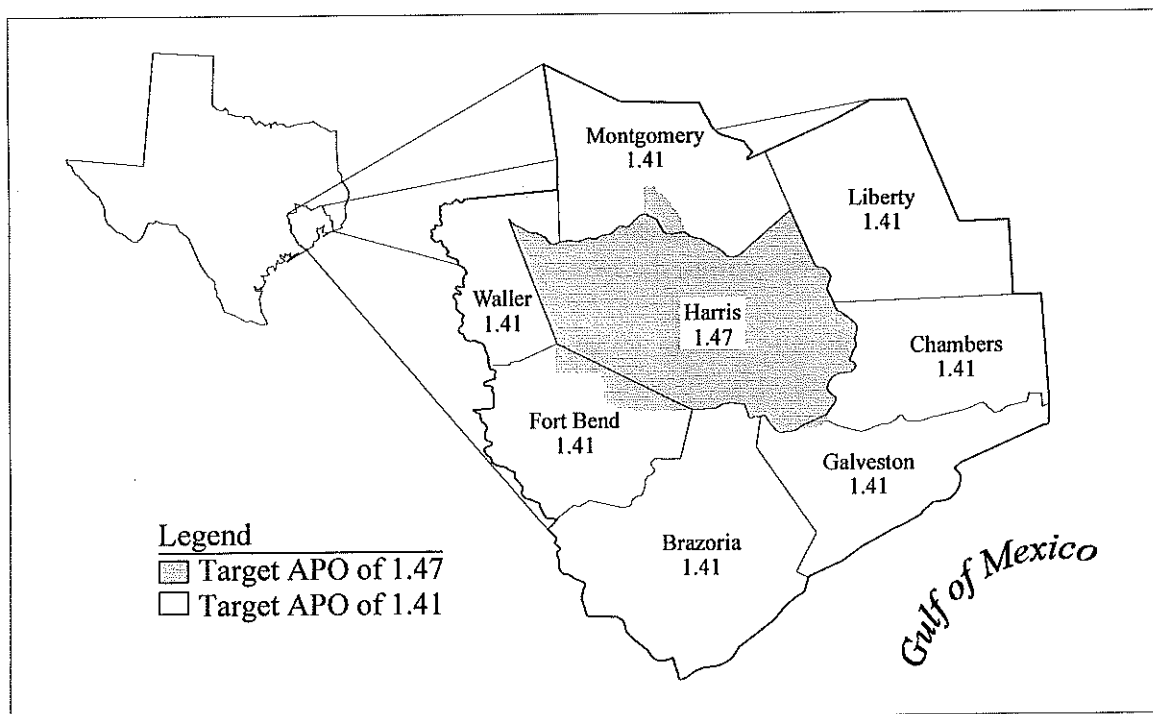
Areas failing to comply with the air quality standards by the specified deadlines are subject to mandatory fines on stationary source emissions. The noncompliance can also result in a downgrading of the nonattainment area air quality classification. States, as well as urban areas, can lose Federal-Aid highway funds for not demonstrating proper compliance. In Texas, \$900 million per year of Federal-Aid highway funds could have been in jeopardy for failing to comply (8).

## **EMPLOYER TRIP REDUCTION REQUIREMENTS**

The CAAA required severe and extreme nonattainment areas, such as the Houston-Brazoria-Galveston area, to increase the APO rates for trips to large employer sites by no less than 25 percent over the regional average by 1996. As part of the revisions to the SIP, employers with 100 or more employees in extreme and severe nonattainment areas were to develop Employer Trip Reduction (ETR) plans to increase the average passenger occupancy (APO) of vehicles arriving to the worksite between the hours of 6:00 a.m. and 10:00 a.m. The participating employers were charged to determine an appropriate set of strategies for the worksite to reduce the amount of vehicle trips generated by the worksite.

TNRCC is the state agency responsible for ensuring compliance with the trip reduction requirements in the state of Texas. This agency is also responsible for developing strategies for reducing auto-related emissions that have resulted from a growth in VMT. TNRCC and H-GAC together are responsible for administering the ETR program in Houston.

Working with TNRCC, H-GAC determined a regional baseline APO of 1.17. To increase the baseline APO of 1.17 by 25 percent, the target APO for the region would be 1.47. However, differences in population, emissions, and access to HOV facilities between Harris County and the remaining seven counties in the nonattainment area caused H-GAC to reevaluate a comprehensive APO target for the entire 8-county region. A lower APO of 1.41 was established for the other seven counties while the Harris County target APO remained at 1.47. Figure 2-1 illustrates the different target APO levels within the 8-county nonattainment area.



**Figure 2-1** Target APO level for the eight county nonattainment area

As part of the administration of the ETR program, TNRCC established several objectives and deadlines for companies. The first requirement within the submission schedule was registering company worksites by September 1, 1993. The official registration form included information on the initial APO level of the worksite, the number of employees arriving to the worksite between the hours of 6:00 a.m. and 10:00 a.m., and information on employee preferences for 25 alternative transportation strategies. TNRCC required a 75 percent response rate to the survey from employees arriving between the hours of 6:00 a.m. and 10:00 a.m. Otherwise, the company would have to re-survey employees until the minimum 75 percent response rate was achieved. A 90 percent response

rate was required to avoid having non-responses counted as single occupant vehicles in the initial worksite APO calculation. Fines as high as \$10,000 to \$25,000 per day could also be levied against a worksite that failed to follow the submittal process schedule or meet the defined target APO.

Worksite APO levels were determined by applying vehicle equivalents (VE) to employee trips arriving between the hours of 6:00 a.m. and 10:00 a.m. Vehicle equivalents are determined based on the number of employees sharing a vehicle. For example, a 1.0 VE is given to those employees arriving to the worksite in a single occupant vehicle and 0.5 VE to those employees arriving in a 2-person carpool. Lower VEs are given to employees who share rides to work, such as carpooling and vanpooling. The VE credits for ridesharing are determined by the actual number of passengers in a vehicle. Higher passenger rates receive lower VEs and increase the worksite APO. The lowest VE of 0.0 is given to those employees who use transit, walk, or ride a bike to work. Figure 2-2 shows the worksheet used to calculate the initial APO of a worksite.

Upon registering the worksite with TNRCC, companies then had to develop ETR plans to reduce work-generated trips. The ETR plans contain 88 trip reduction measures that the employee transportation coordinator (ETC) could choose from to reduce work generated trips at a site. The ETC checked either “Yes” or “No” on the ETR plan worksheet to show whether the company was going to offer/implement the strategy. Other information contained on the ETR plan worksheet included the status of the trip reduction measure chosen (New, Revised, Existing) and the quarter the strategy would be carried out within the two-year time frame for compliance.

The submission schedule for the actual ETR plans was dependant upon the size of the company worksite. Companies with 200 or more employees submitted ETR plans on September 15, 1994, and companies with between 100-199 employees submitted plans on November 15, 1994. Other information submitted with the ETR plan includes:

- Initial and target APO
- Mechanisms to ensure proper tracking and evaluation of selected measures
- Enforceable certification signed by the highest ranking official (HRO)
- Designation of an employee transportation coordinator (ETC) and identification of adequate training, support, review, and other elements

The target APO for the company had to be reached within two years of submitting the ETR plan. Companies that could demonstrate compliance within the two years would be required to: (1) annually survey their employees to document continued compliance, and (2) resubmit reviewed and updated, if necessary, ETR plans every two years to demonstrate continued efforts to maintain compliance. Conversely, companies that did not meet the target APO would be required to: (1) resubmit a revised plan to TNRCC within 60 days after the target deadline, and (2) submit trip reduction plans annually until the target APO is achieved.

## Average Passenger Occupancy (APO) Calculation Form

Response Rate (75% Required) \_\_\_\_\_

Survey Week \_\_\_\_\_

Worksite I.D. \_\_\_\_\_

Mode of Transportation Used by Employees	Vehicle Equivalent	X	Number of Employee Trips by Mode	=	Calculated Vehicle Equivalent
A Drove or Rode Alone	1.00	X		=	
B Carpool, Taxi, or Limousine		X		=	
Two Employees	0.50	X		=	
Three Employees	0.33	X		=	
Four Employees	0.25	X		=	
Five Employees	0.20	X		=	
Six Employees	0.16	X		=	
C Vanpool (seven or more employees)	0.00	X		=	
D Bus	0.00	X		=	
E Walk	0.00	X		=	
F Bicycle	0.00	X		=	
G Did not report to this worksite because of:					
	0.00	X		=	
2) day off due to compressed work week	0.00	X		=	
H If response rate is less than 90%, enter number of non-residents times five in "Number of Employee Trips by Mode" column (if 90% or greater, enter zero)	1.00	X		=	
I Add the "Number of Employee Trips by Mode" column down and enter total in space to the right					
J Add the "Calculated Vehicle Equivalent" column down and enter total in the space to the right					
3) Vacation, sickness, jury duty, company travel, reporting to another worksite, etc.					
K If response rate is greater than 90%, enter number of non-respondents times five; if less than 90%, enter zero					
L Add lines I, J, and K for total employee trips between 6 and 10 a.m. Monday- Friday (This should equal the number of 6-10 a.m./Monday-Friday employees times five)					
M Divide the amount on line I by the amount on line J and enter in block to right. This is your worksite's APO					
N Enter target APO here (1.47 or 1.41; see instructions)					
O Divide the amount on line I by the amount on line N. This is the maximum weekly number of vehicle trips allowable for you to reach target APO					
P Subtract amount on line O from amount on line J. This is the number of vehicle trips that need to be reduced weekly for you to reach target APO					
Q Divide amount on line P by five. This is the number of vehicle trips you need to reduce each day to reach target APO					

**Figure 2-2** APO calculation form used in Houston, Texas

After months of strong public and political opposition and debate, compliance with the ETR mandates changed on September 6, 1994. TNRCC announced a new position of flexibility and voluntary compliance with the Houston ETR program rather than mandatory compliance and expeditious fines for failing to comply.

## **HISTORY OF EMPLOYER TRIP REDUCTION PROGRAMS IN HOUSTON**

News of the Employer Trip Reduction Program first began to surface among Houston employers when ETR regulations were formally adopted by the former Texas Air Control Board (TACB) in October 1992 (9). Adoption of the program officially put a series of requirements that employers would be required to comply with to improve air quality in the region into motion. Despite opposition to the program, most companies in the 8-county nonattainment area complied with the worksite registration deadline on September 1, 1993. Approximately 1,700 worksites were required to register with the TNRCC. Within a year, companies were required to submit ETR plans outlining alternative transportation strategies for reducing trips to the worksite. However during this time, employers and employees began to recognize fully the implications of a program that would require basic changes in lifestyle and challenge traditional employee management policies at worksites.

On September 6, 1994, the TNRCC, under guidance from the U.S. EPA, relaxed their stance from a mandatory compliance program to a voluntary program, which encourages companies to offer incentives to employees to carpool rather than requiring trip reduction efforts. Companies no longer faced the threat of sanctions as long as employers displayed "good faith efforts" in complying with the new rulings. Companies were still required to meet the ETR plan submittal deadlines on September 15, 1994 and November 15, 1994.

On April 18, 1995, Governor George W. Bush signed Senate Bill 290, which authorized into law a 180-day delay in the ETR program. The Bill also permitted the Governor to seek successive 45-day compliance and enforcement waivers from the EPA once the original 180-day delay expired (10). Employers who had submitted ETR plans as scheduled were not required to take any more action on implementing trip reduction plans. Companies, though, that had not submitted ETR plans were still required to do so (10).

Later that year on October 4, 1995, Governor Bush extended the first authorized 45-day delay of the ETR program signed into law by Senate Bill 290. The Governor also outlined Texas' new position toward ETR and repeated that the state would take a more "flexible" approach that would better represent the needs of Texas (11). At this time, TNRCC was in the process of replacing the ETR program in the State Implementation Plan (SIP) with a Regional Commute Alternatives Program (RCAP). The revised SIP was then to be submitted to the EPA for approval. The RCAP would officially remove the mandatory compliance requirements of the ETR program and replace it with a voluntary commute program that would encourage all drivers to participate in trip reduction alternatives to reduce VMT (11).

The final action to repeal the ETR provision in the CAAA came on December 23, 1995, when President Clinton signed H.R. 325. This action was the result of months of work to reduce the regulatory burden the Federal government had imposed on states and municipalities.

Interest in implementing ridesharing or other trip reduction strategies at companies fell because of the new “flexible” and voluntary ruling. Although some companies may have continued with their ETR programs, the full benefits of a mandatory program in Houston will never be realized because most of the Houston employers reduced ETR programs to the minimum compliance levels. Table 2-2 shows the chronological history of the ETR program in Houston and other important dates that have affected the program.

**Table 2-2**  
**Chronology and Important Dates of the Houston ETR Program**

Date	Event
October 16, 1992	ETR regulations are adopted by TACB Board of Directors (9)
September 1, 1993	Worksite registration deadline
Mid-1994	Carol Browner, administrator of U.S. EPA, indicates in a letter to U.S. Senator Frank Lautenberg, D-N.J., that the EPA is willing to adopt a more flexible view toward compliance by removing the threat of penalties for failing to attain target APOs (12).
September 6, 1994	TNRCC announces new flexible guidelines and removes the potential for fines as long as companies continue with a “good faith effort”
September 15, 1994	ETR plan submittal deadline for companies with 200 or more employees
November 15, 1994	ETR plan submittal deadline for companies with 100-199 employees
April 18, 1995	Texas Governor George W. Bush signs Texas Senate Bill 290 into law, which authorizes a 180-day delay in the ETR program and allows the Governor to suspend the program on a series of 45-day increments once the original 180 days has passed (10)
October 4, 1995	ETR program suspended an additional 45 days
December 23, 1995	President Clinton signs HR 325, eliminating the ETR program from the CAAAs.
May 1995	H-GAC, in cooperation with TNRCC, the Metropolitan Transit Authority (Houston METRO), TxDOT, the City of Houston, and Harris County, formed a task force that will develop a voluntary trip reduction plan for the region called the Regional Commute Alternatives Program (RCAP).

In May 1995, H-GAC, in cooperation with the TNRCC, the Metropolitan Transit Authority (Houston METRO), TxDOT, the City of Houston, and Harris County, formed a task force that

developed a voluntary trip reduction plan for the region called the Regional Commute Alternatives Program (RCAP). The RCAP is similar in policy to the mandatory ETR regulations in attempting to reduce congestion and improve mobility in the region. However, unlike the mandatory trip reduction requirements that focused on work-related travel between 6:00 a.m. and 10:00 a.m., the new program is reviewing TDM/TCM strategies that would reduce VMT, trips, and emissions for all trips, regardless of type, throughout the day. The new program focuses on promoting transit use, carpooling, vanpooling, and other trip reduction measures in the major employment centers of Houston.

The task force identified four primary components to be pursued with RCAP. The four components are (1) a Regional Vanpool Program; (2) a Regional Rideshare Program (e.g., rideshare matching); (3) a Public Awareness and Education Campaign; and (4) the development of Transportation Management Organizations (TMOs) in the region. These program elements are currently in varying stages of implementation and development (13).

The Regional Vanpool Program will focus on employees that commute into, or within, major employment centers. As of June 1996, five van providers were selected for this program. The vanpool program will have the following services: (1) home to worksite commuter service; (2) a lunchtime shuttle; (3) a worksite-to-worksite shuttle; and (4) a fixed route circulator. The Public Awareness and Education Campaign is currently being delayed until the Vanpool Program and Regional Rideshare Program are completely implemented. Currently, four TMOs have been formally recognized by H-GAC and will be receiving Congestion Mitigation/Air Quality (CMAQ) start-up funds within the next two years. The four TMOs in Houston receiving the CMAQ funding are the Clear Lake Transportation Partnership, North Houston/Intercontinental TMO, the Transportation Efficiency Council (TREC) in the Galleria/Greenway Plaza area, and the Westchase Business Council (13).

TNRCC, along with H-GAC, is encouraging those employers that submitted trip reduction plans to continue with their ridesharing efforts. At this time, no further ETR actions are required of those companies that submitted the trip reduction plans by the submittal deadline. Those worksites that failed to submit by the deadline are still required to do so. RCAP is designed to encourage worksites in Houston to take advantage of the programs being offered through RCAP voluntarily. RCAP is also designed to encourage voluntary trip reduction efforts throughout the state of Texas.

## **COMMON ARGUMENTS AGAINST IMPLEMENTING ETR IN HOUSTON**

The Employer Trip Reduction Program was a controversial regulation from conception. Employers and employees, alike, challenged the validity of the program on several points. Employers found the ETR mandate to be very costly and time consuming. In 1992, estimates developed by H-GAC indicated that employers could anticipate spending \$50.00 to \$200.00 per year per employee on trip reduction efforts (14). The trip reduction mandates also challenged employers to review traditional management practices to reduce trips to the site. For example, flextime,



compressed work weeks, and telecommuting are just a few of the 88 options available to worksite ETC's, but these and other measures would require a review and change in traditional management and employee oversight policies.

While developing commute alternatives, company ETCs discovered that Houston's land development patterns often conflicted with trip reduction strategies. Houston is primarily a suburban city with decentralized job and employment centers, which makes it difficult for Houston METRO to service with transit. Several companies were challenged to improve average passenger occupancy levels without transit service and direct access to HOV lanes. The HOV lanes in Houston primarily serve the downtown area and major employment centers inside IH-610. There are approximately 870 affected companies not located inside IH-610. Carpooling and vanpooling programs are also difficult to develop when population densities are low and trip origin and destination patterns are dispersed.

Employees argued that the program was an infringement upon privacy rights. The personal automobile is viewed by many employees as a sovereign right and should remain autonomous from regulations. Employees, who choose to rideshare, were concerned about emergencies arising away from the worksite and being unable to address the problem in a timely manner. Considering that nearly 80 percent of Houstonians drive to work alone, ridesharing or trip reduction alternatives would have required significant changes in daily routines and personal behavior (14).

Furthermore, employers and employees often cited the government's own air quality improvement estimates for the program. The ETR program in Houston was anticipated to reduce volatile organic compound emissions by 3,620 pounds per day, which would account for less than a 0.2 percent gain in air quality (12). According to TNRCC, Houston may have as much as 2.3 million pounds of volatile organic pollutants in the air on any given day (12). The program, according to challengers, would have had a minimal impact on a city that leads the nation in industrial pollution (7). This report estimates the potential impacts the ETR program would have made on mobile source emissions and fuel consumption in the Houston region if the ETR program was implemented as originally planned by federal, state, and local agencies.

## **CHAPTER III**

### **STUDY DESIGN DEVELOPMENT**

The regulatory environment within which this study was initiated had changed drastically during the study. Before these changes were enacted a detailed data collection and analysis approach was developed based on the assumption that there would be wide spread participation in the ETR program due to its mandatory nature. Several large employer sites were also contacted to solicit participation in this data collection effort. The original plan for data collection, however, had to be shelved and a new analysis methodology had to be developed because the changes in the regulatory environment rendered the original data collection plan infeasible. In this chapter both the data collection and analysis approaches are discussed. The original plan is also discussed to document the methodology and in the hope that it could be useful for a future study if ETR/ECO or something on similar lines is revived. Appendix B is provided as a primer on mobile source emissions for readers who are not familiar with this subject area.

The original study design discussion reviews the factors influencing its design, sampling procedures, and analysis methodologies. Later discussion moves into the specifics of the modified study design used after ETR suspension in January 1995.

#### **PRE-ETR SUSPENSION (ORIGINAL)**

##### **Objectives**

The original study design had two objectives. The first objective was to determine travel impacts of changes in trip making behavior of employees resulting from the implementation and enforcement of the ECO program. The second objective was to estimate the regional energy and emission benefits based on the travel changes observed.

##### **Study Area**

The study area chosen was Harris County, which is one of eight counties in the Houston-Galveston, Texas, nonattainment area. Harris County was chosen as the study area for the energy and mobile source emission analysis because it contains 84 percent of the affected employment in the nonattainment area and has a broad spectrum of worksite sizes within its borders. The distribution of worksites and employees by the eight-county nonattainment area are shown below in Table 3-1. The data shown in this table is different from the data used in the revised analysis and the ETR program analysis.

**Table 3-1**  
**Distribution of Affected Worksites and Employees Over**  
**The Houston-Galveston Nonattainment Area**

County	Worksites	Employees	Avg. Employees/Worksite
Brazoria	64	25,785	402
Chambers	8	3,315	414
Fort Bend	71	22,371	315
Galveston	65	30,540	470
Harris	1,455	526,758	362
Liberty	12	2,502	208
Montgomery	53	13,183	249
Waller	7	2,528	361

Source: (15)

### **Factors Influencing Design**

The research team first identified several factors that might influence the ability to obtain data or influence the outcome of this study. The factors identified were:

- Types of ECO Programs Implemented by Employers
- Employer Size
- Worksite Location
  - Access to transit at work place
  - Access to rideshare and HOV facilities/services
- Indirect Trips
- Willingness to Participate in this Study
  - ECO monitoring programs implemented by employers
  - Employee surveys
  - Level of employer commitment
  - Pre-ECO APO level compliance
- Study Participants that Move Residences or Worksite Locations
- Employee Work Class

A brief discussion of each factor is included in Appendix B. As can be seen for the above list, several factors had the possibility of significantly affecting the outcome of this study. Due to the

limited resources of this project, the research team was required to identify only one factor to design the study methodology around. Selecting more than one controlling factor would have required too large a sample size for statistical validity and was infeasible.

Five factors were determined to be important to this study. These factors were (1) types of programs, (2) employer size, (3) worksite location, (4) pre-ECO APO level, and (5) employee work class. Of these five variables, employer size was selected as the controlling variable for the study. If possible, the remaining four variables effect on the ETR program would be observed, but conclusions would not be statistically valid.

## **Sampling Procedures**

### *Hypothesis*

The hypothesis posed by the study team was that implementation of ECO programs was driven by worksite size. Worksite size assumes that the employer has a greater amount of resources that could be allocated to ECO program development at individual sites. In effect, larger employers can support staff members who are charged with the administration of the ECO program at a worksite(s). Smaller employers, it is assumed, do not have the resources available to dedicate staff to the development of ECO plans. This may be reflected in the types of programs selected for implementation at worksites. As a result, the amount of trip reduction that occurs at worksites may be affected.

### *Stratification*

The scope of the original study design was to sample at least 20 employers from each of three worksite size categories (a total of 60 surveys): 100-199, 200-999, and 1000 and over. As previously discussed, the ECO legislation defined different requirements for the 100-199 and 200+ categories. The division in the 200 and greater category was chosen arbitrarily. Table 3-2 shows the distribution of the number of worksites and employees over these categories in the eight-county nonattainment area and Harris County, individually. As shown Table 3-2, the distribution of worksite sizes for Harris County resembles that of the region. This was a deciding factor in the selection of Harris County as the study area.

### *Surveys*

Two survey types were to be used with this design: a worksite and employee household. The worksite survey was further focused through two surveys to find strategies carried out and to measure the change in the APO level after strategy application.

**Table 3-2**  
**Distribution of Worksites and Employees by Worksite Size**

Characteristic		Worksite Size (employees)		
		100-199	200-999	≥ 1000
Worksites	Region	890	748	97
	Study Area	748	625	82
Employees	Region	126,180	281,171	219,631
	Study Area	105,762	235,807	185,189

Source: (15)

**Worksite survey** Two surveys were planned to be administered at each of the 60 worksites: one survey to determine the scope of ECO strategies carried out, and the other to measure the changes in the APO level after implementation.

The first survey was designed to gather information on the ECO strategies carried out at the worksite. This data would include start date, type of strategies, cost to the employer, number of new ECO participants, and number of employees participating in similar programs before ECO implementation. The last two data groups listed (number of new ECO participants and number of ECO participants before ECO implementation) would be the most difficult for the ETC to estimate; however, this data is also the most critical in the analysis methodology for establishing relationships to estimate regional changes caused by the ECO program.

The second survey would be used to determine the APO level of the worksite during the follow-up survey of the employee. This survey would be administered to an additional 20 worksites in each category. Based on contacts with some ETCs in the nonattainment area, some worksites were planning on monthly or quarterly APO checks for all employees at their worksite. In cases where APO checks were not scheduled for a regular interval, the ETC would be requested to solicit at least 50 employees to participate in the follow-up APO survey. APO levels at these worksites would then be estimated based on the results of the 50-person sample.

The initial APO (from forms submitted to TNRCC as part of registration) and the follow-up APO levels would be used to determine the number of people who shifted from SOV to other modes. The after APO survey was planned for April-May 1995. The initial APO survey was conducted by the affected employers and submitted to TNRCC before November 1994 as partial fulfillment of the state ECO requirements.

**Employee household survey** The proposed sampling consisted of a travel diary for one employee at each sampled worksite to be completed before and after the planned ECO strategies at a worksite

were implemented. Data were planned to be collected from 40 or more employees in each employer size category (120 total) on employee travel patterns before and after use of ECO programs. A larger sample of employees would not be possible because of several reasons:

- 1) the data reduction effort would be enormous and very resource intensive and this study did not permit a large employee sample
- 2) identifying a large number of potential participants before they actually change mode, as acknowledged previously in this chapter, is difficult
- 3) getting employees to volunteer for this study is difficult.

The ETC was requested to identify employees that are likely to shift to non-SOV modes because of participation in the ETR programs.

To collect travel changes resulting from trip behavior changes, travel diaries (Appendix C) were to be administered for each employee in the sample and all vehicles used by that employee's household. The employees would be requested to complete the trip diaries for one working day before they started participating in the ECO program. They were also requested to complete a diary for one working day after they began participating in the ECO program in which they actually used an alternate mode to work. Collecting data for only one day of the week assumes that there is no change in trip making behavior on days when the employee actually commutes as a SOV, which may be false. For example, an employee that participates in a vanpool program three times per week may make more trips on the remaining two days to run errands.

Information obtained on the employee's household vehicles would be used to quantify the effects of indirect trips due to the ECO program. A high incident of indirect trips may detract from the desired benefits of the ECO program. Indirect trip effects were previously identified by Systems Applications International (16) but no efforts have been made to quantify this trip making behavior.

### *Expansion Factors*

Expansion factors are required to compute regional travel and energy changes from the changes observed in the samples. The expansion factors used in this analysis are based on estimates of the regional participation in the ECO program. First, the average participation rate of employees participating in an ECO-type program for the first time is calculated.

$$P_{cat} = \frac{1}{n} * \sum_1^n \left( \frac{new}{WS} \right)_{size} * 100 \quad (3-1)$$

where,  $P_{cat}$  = Average participation rate for new employees in percentage for the worksite category (%)  
 $n$  = Number of employer sites sampled  
 $new$  = Employee participating in ECO program for first time (from ETC survey)  
 $WS$  = Employee size of the worksite

After the participation rate for each category is calculated, the total number of new participants is calculated for each worksite size category.

$$New_{cat} = \frac{P_{cat}}{100} * size_{cat} \quad (3-2)$$

where,  $New_{cat}$  = Total number of new participants in the worksite size category  
 $size_{cat}$  = Total number of employees in the worksite size category  
 $P_{cat}$  = Average participation rate of new employees in percentage for the worksite category (%)

The number of regional participants can now be estimated with equation 3-3.

$$N_{REG} = \sum_{i=1}^{Cat} New_{Cat} \quad (3-3)$$

where,  $New_{cat}$  = Total number of new participants in the worksite size category  
 $N_{REG}$  = Total number of new participants in the region  
 $Cat$  = Worksite size category

After estimating the regional participation in the ECO program, regional changes can now be computed through proportions from observed changes in the sample from the following equation:

$$\frac{X}{N} = \frac{X_{REG}}{N_{REG}} \quad (3-4)$$

where,     X       =   Variable of interest ( $\Delta$  starts,  $\Delta$  trips,  $\Delta$  VMT)  
              N       =   Number of employees in the sample  
              X<sub>REG</sub>   =   Regional Values  
              N<sub>REG</sub>   =   Total number of new participants in the region

Equation 3-4 assumes that all changes in the sample are directly proportional to the changes experienced regionally.

### **Analysis Methodology**

#### *Travel*

This data was to be extracted from travel diaries completed by study participants. Travel data to be extracted from the travel surveys included the change in commute and non-commute trips, and changes in VMT. The information was to be coded in ASCII format and processed using FORTRAN-coded programs.

#### *Mobile Source Emissions*

Three mobile source emission sources were of primary concern for this study. These were start, hot soak, and running emissions. Diurnal emissions were not of interest because it would not significantly affect emission changes due to the ETR program.

Trip-related emissions were calculated by first determining the emission reductions associated with cold and hot start emission reductions. Cold and hot start emission factors were developed according to procedures outlined by Systems Applications International (16). The procedures are shown in the following two equations:



$$EF_{cst} = (EXH_{100\% \text{ cst}, 26MPH} - EXH_{100\% \text{ stb}, 26MPH}) * 3.59 \quad (3-5)$$

$$EF_{hst} = (EXH_{100\% \text{ hst}, 26MPH} - EXH_{100\% \text{ stb}, 26MPH}) * 3.59 \quad (3-6)$$

where,  $Ef_{cst}$  = Cold-start emission factor (g/trip)  
 $Ef_{hst}$  = Hot-start emission factor (g/trip)  
3.59 = Length of FTP driving cycle trip-start portion (miles/trip)  
EXH = Exhaust emission factor (g/mile)  
26 mph = Speed of the trip-start portion of the FTP  
100% stb = 100 percent hot-stabilized operating mode  
100% cst = 100 percent cold-start operating mode  
100% hst = 100 percent hot-start operating mode

The equations for determining changes in vehicle start emissions for the three pollutants are shown below.

$$\Delta VOC_{start} = \Delta TRIPS_{cst} * EF_{VOC_{cst}} + \Delta TRIPS_{hst} * EF_{VOC_{hst}} \quad (3-7)$$

$$\Delta CO_{start} = \Delta TRIPS_{cst} * EF_{CO_{cst}} + \Delta TRIPS_{hst} * EF_{CO_{hst}} \quad (3-8)$$

$$\Delta NOx_{start} = \Delta TRIPS_{cst} * EF_{NOx_{cst}} + \Delta TRIPS_{hst} * EF_{NOx_{hst}} \quad (3-9)$$

where,  $\Delta TRIPS_{cst}$  = Change in cold-start trips  
 $\Delta TRIPS_{hst}$  = Change in hot-start trips

Vehicle emissions from hot soak were to be estimated from the equation below.

$$\Delta VOC_{hot \text{ soak}} = \Delta TRIPS * EF_{VOC_{hot \text{ soak}}} \quad (3-10)$$

The mobile source emission changes directly due to trip reduction is calculated from the following equations:

$$\Delta VOC_{trip} = \Delta VOC_{start} + \Delta VOC_{hot\ soak} \quad (3-11)$$

$$\Delta CO_{trip} = \Delta CO_{start} \quad (3-12)$$

$$\Delta NOx_{trip} = \Delta NOx_{start} \quad (3-13)$$

Running emission changes in this analysis did not include evaporative loss from running loss, crankcase, or refueling. The running emission equations are shown below:

$$\Delta VOC_{running} = \Delta VMT * EF_{VOC_{slb,spd}} \quad (3-14)$$

$$\Delta CO_{running} = \Delta VMT * EF_{CO_{slb,spd}} \quad (3-15)$$

$$\Delta NOx_{running} = \Delta VMT * EF_{NOx_{slb,spd}} \quad (3-16)$$

Emission factors identified in the above equations above were to be generated for CO, VOC, and NOx using EPA's MOBILE5a emission factor model. VOC and NOx are of particular interest because these pollutants are known precursors to the formation of ozone in summer months. An assumption to be used in generating the emission factors was that the regional vehicle composition would be applicable to the vehicles affected by ECO. In addition the emission factor development focused on light duty gasoline and diesel, vehicles and trucks (LDGV, LDGT1, LDDV, and LDDT). A weighted average was developed based on these vehicle types. Speeds used in the equations would be obtained from H-GAC planning models and would reflect regional speeds.

#### *Fuel Consumption/Energy*

Fuel consumption factors would be generated from data generated by Oak Ridge National Laboratories (ORNL). A fuel consumption factor would be developed for a national representative composite vehicle. Regional speeds obtained from H-GAC would be used.

The equation for starting fuel consumption is shown below.

$$\Delta FC_{start} = \Delta TRIPS_{cst} * FCF_{cst} + \Delta TRIPS_{hst} * FCF_{hst} \quad (3-17)$$

The equation for calculating running fuel consumption is shown in the equation below.

$$\Delta FC_{running} = \Delta VMT * FCF_{spd} \quad (3-18)$$

### **Results of Pre-ETR Suspension Plan**

Two events hampered the application of this study design. First a significant change in the regulatory environment occurred. This change, previously documented in Chapter II, resulted in a loss of commitment to carry out ECO strategies. Second, a distinct lack of initiative by the employers and employees to participate in the ECO program because of the changing regulatory environment was witnessed. The lack of participation early in the ECO process resulted in a potentially biased sample of worksites that agreed to carry out the data collection efforts.

The changes described above led to the reformulation of a study design by the research team. This revised study design is described in the following section.

### **POST-ETR SUSPENSION (REVISED)**

As discussed previously, this study was designed to measure the impact of the ETR/ECO program on the trip making behavior of employees at participating employer sites. Trip dairies were to be administered at participating worksites to document changes in travel. Several employer sites were contacted and the participation of several employers was also obtained. Due to legislative actions, however, the program was suspended for some time and finally repealed. Most of the worksites that agreed to participate in the study decided to suspend their program because of the new legislative stance.

In view of the above-mentioned difficulties a new format was needed to obtain energy and emissions information from the ETR/ECO program. The energy and emissions impacts of the program were evaluated based on the information submitted in the ETR worksite trip reduction plans before the suspension of the program. The foundation of the analysis is based on all worksites achieving their target worksite AVO within the original time frame, in essence assuming a 100 percent compliance rate. The study area remained the eight county nonattainment area for Houston-Galveston. The methodology and the underlying assumptions are discussed in the following sections.

## **Energy and Mobile Source Emission Benefits**

Energy and emission reductions are achieved from: (1) reduction in the number of vehicle trips (through reductions in cold and hot starts), (2) reduction in the amount of vehicular travel or vehicle miles traveled (by avoiding the running emissions), and (3) changes in speed (higher hydrocarbon and CO emissions at lower speeds). To estimate the energy and emissions benefits of ETR program, estimating the changes in vehicle trips, VMT and speed is necessary. It should be noted that the estimated regional change in commute vehicle trips makes up only 2.5 percent of the total peak-hour vehicle trips and therefore would not likely have a major impact on the regional speed. In this study, only vehicle trip and VMT effects of the ETR program were considered. The following sections discuss the methodology for estimating vehicle trip and VMT reductions in detail.

The impacts of the ETR program, both for vehicle trips and VMT, can be separated into direct and indirect changes. Direct travel impacts are the result of vehicle trips and VMT reduced directly from employees leaving their vehicle at home and using alternative modes of travel. Indirect travel impacts are the additional trips made by other household members due to the availability of an additional vehicle, which was discussed earlier in this chapter. The following paragraphs discuss these travel impacts and the methodology used to estimate their impacts as a result of the ETR program.

### **Direct Travel Impacts**

#### *Direct Vehicle Trip Changes*

Direct trip changes represent the number of employee SOV trips reduced at the worksite by using an alternative mode. Not all TDM/TCM strategies, however, remove vehicle trips from the transportation network. A flextime program, for example, does not result in any trip or VMT reductions if it is used merely to reduce the number of employees arriving during the peak period between 6:00 a.m. and 10:00 a.m., since the ETR program is targeted at trips during the peak hour. On the other hand, a flextime program may be implemented to give greater flexibility to employees in choosing other non-SOV modes like carpooling and vanpooling. It is assumed here that flextime, if implemented, is used to facilitate alternative mode use and not to reduce the number of employees arriving within the 6:00 a.m. to 10:00 a.m. window.

The direct trip changes were estimated for each worksite based on its base and target APO and the employee trips arriving between 6:00 a.m. and 10:00 a.m. The base and target APO were reported in the worksite ETR plans. If the base APO was not reported, as in some cases, the regional AVO was used as a surrogate.

The trip reduction estimated based on the current and target APOs was adjusted for partial vehicle trips. It should be noted that all ETR participants do not leave their vehicles at home. Some transit users may drive their vehicle to a transit station, and likewise, some carpool and vanpool

participants may drive alone to a park-and-ride site, and then rideshare with other commuters. In such cases, no reduction in vehicle trips occurs. According to the RIDES database (17) 95 percent of all carpool/vanpool participants leave their vehicle at home. From this reference, the assumption that only 95 percent of the participants will leave their vehicle at home, resulting in a reduction in vehicle trips, was made. The vehicle trips reduced was computed using the following relations:

$$DT = EMP_{6-10} * \left[ \frac{1}{APO_c} - \frac{1}{APO_t} \right] * 0.95 \quad (3-19)$$

where, DT = Total number of direct vehicle trips reduced  
 EMP<sub>6-10</sub> = Number of employee trips between 6:00 a.m. and 10:00 a.m.  
 APO<sub>c</sub> = Base Average Passenger Occupancy for the site  
 APO<sub>t</sub> = Target Average Passenger Occupancy for the site  
 0.95 = Decimal percentage of participants assumed to leave their vehicle at home, resulting in a reduction in vehicle trips

$$PDT = EMP_{6-10} * \left[ \frac{1}{APO_c} - \frac{1}{APO_t} \right] * 0.05 \quad (3-20)$$

where, PT = Partial vehicle trips made by some carpool/vanpool participants  
 EMP<sub>6-10</sub> = Number of employee trips between 6:00 a.m. and 10:00 a.m.  
 APO<sub>c</sub> = Base Average Passenger Occupancy for the site  
 APO<sub>t</sub> = Target Average Passenger Occupancy for the site  
 0.05 = Decimal percentage of participants assumed use their vehicle for carpools/vanpools

### *Direct VMT Changes*

The direct VMT change was obtained from direct trip change information computed above in combination with the average trip length (miles) information provided on the submitted ETR plans. Sometimes the average work trip length was missing. A 13.9 mile, regional-average work trip length was assumed for all worksites that did not report a trip length. This regional average work trip length is based on projections by Houston-Galveston Area Council (18,19).

As mentioned previously, some employees make partial trips to a park-and-ride lot or other meeting place before continuing their trip to work in a shared mode. The guidelines developed by

TNRCC for the Houston area ETR participants specified that partial trips that are less than half the complete trip to work will be considered as a trip reduction. Therefore, in this analysis it was assumed that the 5 percent employees who do not leave their vehicle at home, travel half way to their worksite. The following relation was used:

$$VMT_d = L_w (DT + 0.5 * PT) \quad (3-21)$$

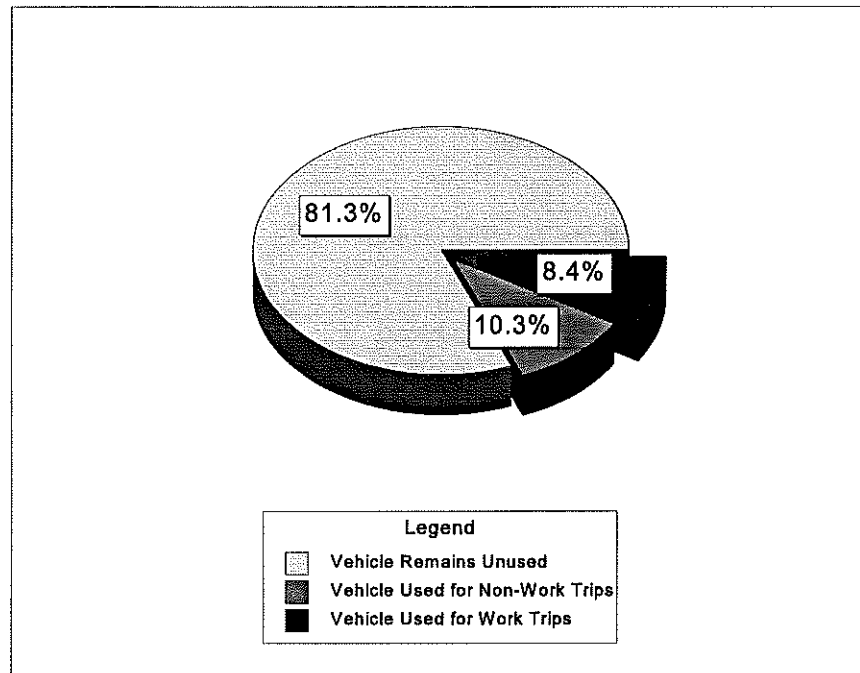
where,  $VMT_d$  = Total direct VMT reduced  
 $DT$  = Total number of vehicle trips reduced  
 $PT$  = Partial vehicle trips made by some carpool/vanpool participants  
 $L_w$  = Average worksite trip length, miles  
 $0.5$  = Assumes partial vehicle trips make half of  $L_w$ , miles

## Indirect Travel Impacts

### *Indirect Vehicle Trip Changes*

When a vehicle is left at home by a participating employee, it may be used by other household members for making work and non-work trips. These trips will offset the emission and energy savings obtained from the program. Indirect trip changes represent two cases: (a) the increase in trips by other household members because of the availability of an extra vehicle; and (b) for participants in telecommuting and compressed work week programs, the additional trips made by the employee on the day off. The effect from additional trips made by telecommuters and compressed work week participants was not considered for this analysis.

To determine the vehicle usage by other household members, a survey was conducted among employees at major employer sites in the Houston area. A sample questionnaire used in the survey is included in Appendix D. The questionnaire was distributed to a total of 1,500 employees at 60 randomly selected ETR sites. A total of 715 surveys (48 percent response) was returned. Among these respondents, 74 respondents did not say how their vehicle would be used if left at home. Among the valid responses, 81.3 percent said that their vehicle would remain unused. Of those who said that the vehicle would be used, if left at home, 10.3 percent said that the vehicle would be used for non-work purposes and 8.4 percent said that it would be used for making work trips. These responses are shown in the Figure 3-1 below. These percentages were used in this analysis to determine the work and non-work usage of the unused vehicles.



**Figure 3-1** Results of indirect trip survey in Houston, Texas

To estimate the work and non-work trips made by other household members, it was assumed that for each vehicle used by other household members, either one work or one non-work trip will be made per day. It should be noted that more than one non-work trip may be made per day, further decreasing the benefits of the ECO program. On the other hand, an employee with access to a vehicle may use it for other trips during the work day (e.g., trips during the lunch hour). These other work-based trips were not accounted for in the estimation of the direct trip effects discussed above. It is assumed that the underestimation of indirect trips offsets the underestimation of direct trips. The total indirect trips were estimated as shown below:

$$\begin{aligned}
 IT &= IT_w + IT_{nw} \\
 IT_w &= DT * 0.084 \\
 IT_{nw} &= DT * 0.103
 \end{aligned}
 \tag{3-22}$$

where,

IT	=	Total indirect vehicle trip increases
IT <sub>w</sub>	=	Increase in indirect vehicle work trips
IT <sub>nw</sub>	=	Increase in indirect vehicle non-work trips
DT	=	Total number of vehicle trips reduced
0.084	=	Indirect vehicle trip rate for work trips
0.103	=	Indirect vehicle trip rate for non-work trips

### *Indirect VMT Changes*

The VMT impacts of indirect trip changes were estimated based on the trip increases computed above. A regional average work trip length of 13.9 miles and a non-work trip length of 7.5 miles was used for this purpose. These trip lengths are based on information provided by H-GAC. The VMT for indirect trips,  $VMT_{it}$ , was estimated using the relation below.

$$VMT_{it} = (IT_w * 13.9) + (IT_{nw} * 7.5) \quad (3-23)$$

where,  $VMT_{it}$  = VMT from indirect trips  
 $IT_w$  = Work-related indirect trips  
 $IT_{nw}$  = Non-work-related indirect trips  
13.9 = Regional work trip length, miles (18)  
7.5 = Regional non-work trip length, miles (18)

### **Mobile Source Emissions Impacts**

The mobile source emissions impacts of the ETR program were estimated based on the vehicle trip and VMT effects generated from the previous equations. The emission factor rates for both starting and running emissions were obtained using the MOBILE5a (20) emission factor model. Emission rates for Light Duty Gasoline Vehicles (LDGV) were used in this study; most vehicles likely to be used by affected employees belong to this MOBILE vehicle class.

All work trips were assumed to be cold starts. On the other hand, only 43 percent of non-work trips were assumed to be cold starts. This is based on information contained in MOBILE5a model. The total change in cold starts for the region from the program was computed as shown below.

$$CS = -DT + (IT_w + 0.43 * IT_{nw}) \quad (3-24)$$

where, CS = Total change in cold starts  
DT = Total number of vehicle trips reduced  
 $IT_w$  = Increase in indirect work vehicle trips  
 $IT_{nw}$  = Increase in indirect non-work vehicle trips  
0.43 = Percent of non-work trips assumed to be in cold start mode



Similarly, the total change in the number of hot starts is computed as below:

$$HS = 0.57 * IT_{nw} \quad (3-25)$$

where,     HS     =   Total change in hot starts  
          IT<sub>nw</sub>   =   Increase in indirect non-work vehicle trips  
          0.57   =   Percent of non-work trips assumed to be in hot start mode

The cold and hot start emission rates for VOC, CO and NOx were used with the cold and hot start changes computed above to estimate the total emission changes for each pollutant.

The VMT changes computed for each participating worksite were adjusted for indirect effects because the indirect effects offset some trip reduction through additional travel by other household members using the vehicle left at home by participating employees. For the direct trips, where information was available, the average work trip length in miles and minutes was used to estimate the speed for the trips to each worksite. The estimated speed was used to calculate the running emission rates for VOC, CO, and NOx. For the indirect trips, emission rates were computed based on the regional 24-hour speed of 37.8 mph as estimated by H-GAC.

## Energy Impacts

The composite fuel consumption data developed by FHWA (21) at the ORNL was used, with the VMT changes computed above to estimate the fuel consumption benefits from the ETR/ECO program to the region. The fuel consumption data developed by ORNL is used in various traffic simulation models including NETSIM (a microscopic arterial network traffic simulation model developed by FHWA and widely used). The fuel consumption rate is expressed in ml/sec for different speeds and accelerations (Appendix E). It represents the 1980-1992 vehicle population. This is the most recent data available.

## Results

Table 3-3 shows the energy and mobile source emission impact of the ETR program to the Houston area.

**Table 3-3**  
**Estimated Energy and Mobile Source Emission Impacts of the Houston ETR Program**

<b>Source</b>	<b>VOC (tons/day)</b>	<b>CO (tons/day)</b>	<b>NOx (tons/day)</b>	<b>Fuel (gal/day)</b>
Direct Travel	- 3.19	- 28.16	- 3.21	- 60,103
Indirect Travel	+ 0.37	+ 3.20	+ 0.38	+ 6,760
<b>NET</b>	<b>- 2.82</b>	<b>- 24.96</b>	<b>- 2.83</b>	<b>- 53,343</b>

The estimated impacts are based on the estimated trip reduction from the 1,224 worksites included in the TTI ETR database. As mentioned previously, the database does not include about 200 Independent School District (ISD) worksites and another 300 worksites that failed to submit their ETR plans in time to TNRCC. The actual emissions and energy impacts may improve up to 25 percent if the impacts of the ETR program at the remaining 300 sites not included in the database is assumed to be similar to those included. The participation of the ISD has been a contentious issue since the inception of the program because schools remain closed during summer when the ozone problem occurs.

The results of this analysis, shown in Table 3-3, show that with 100 percent compliance and attaining the target APO level, the ETR program would reduce nearly 3 tons per day of both VOC and NOx, and almost 25 tons per day of CO from mobile sources. Also, a little more than 53,000 gallons of fuel would be saved with this program. The counter benefits of indirect travel, also shown in Table 3-3, can be seen to be approximately 12 percent the benefits gained through direct travel reduction.

To put the estimated benefits of the ETR program in perspective, daily rates for emissions, excluding biogenic sources, and estimated fuel consumption for the Houston-Galveston area is shown in Table 3-4. These rates show that on-road mobile sources are a little more than one-third the daily point source emissions. Also, almost five million gallons, or 91,000 barrels of fuel are consumed by Houston residents on a daily basis.

Table 3-5 shows how the estimated benefits of the ETR program would have affected the daily rates shown in Table 3-4. On-road mobile sources would be reduced by 16 percent daily and would reduce daily emission production by 3 percent. The high percent reductions for the mobile source categories are due to the aggregation of each of the three pollutants. Much of the daily emission reduction shown in Table 3-5 is attributed to the reduction of CO emissions.

**TABLE 3-4**  
**Daily Rates for Emissions and Fuel Consumption**  
**in Houston/Galveston Area**

Category	Daily Rate
<b>Emissions <sup>1</sup></b>	
<i>Area Source</i>	190 tons
<i>Point Source</i>	505 tons
<i>On-Road Mobile Source</i>	193 tons
<i>Off-Road Mobile Source</i>	138 tons
<i>TOTAL</i>	1,029 tons
<b>Fuel Consumption <sup>2,3</sup></b>	4,710,711 gal

Notes: <sup>1</sup> Biogenic emissions not included. (22)

<sup>2</sup> Based on a daily VMT of 101,186,068. (23)

<sup>3</sup> Based on 21.48 miles traveled per gallon for passenger cars. (24)

**TABLE 3-5**  
**Estimated Relative Reduction in Emissions and Fuel Consumption**  
**from the Proposed ETR Program in Houston, Texas**

Category	Reduction from Daily Rates			
	VOC	CO	NOx	Total
<b>Emissions</b>				
<i>On-Road Mobile Source</i>	1.5 %	12.7 %	1.5 %	16 %
<i>On- and Off-Road Mobile Source</i>	0.8 %	7.5 %	0.8 %	9.1 %
<i>TOTAL</i>	0.3 %	2.4 %	0.3 %	3.0 %
<b>Fuel Consumption</b>				1.1 %

It is interesting that the reduction in emissions is greater than the reduction in fuel consumption for the region. Fuel consumption estimates were solely based on VMT. This is important to note because mobile source emission changes were based on VMT and vehicle trip changes. The per trip component of mobile source emissions contributes heavily to the overall reduction in emissions and hence the different percent reductions in fuel consumption and emissions.

The results presented here are very similar to the results predicted by TNRCC. Those results previously discussed in Chapter II, showed that the ETR program was expected to reduce VOC emissions by 3,620 pounds per day, or 1.81 tons per day. This would represent a 0.2 percent daily reduction in total emissions. The results shown here yield a 0.3 percent reduction in daily emissions of VOC. These show better benefits because of the 100 percent compliance assumption made in the analysis. Also of note, H-GAC estimated that with 80 percent compliance in 2010, the program would reduce NOx emissions by 3.26 tons per day; results from this study show that with today's transportation network and employment characteristics, 3.21 tons per day of NOx are reduced per day from direct travel impacts.

## **CHAPTER IV**

### **HOUSTON ETR PROGRAM ANALYSIS**

The employer trip reduction plan, despite its critics, created a greater awareness of the dependency on the automobile for mobility in Houston. The ETR program also increased the basic knowledge of alternatives to the automobile by requiring employees and employers to implement strategies that would reduce or remove work generated trips. Employees and employers became increasingly familiar with the different travel demand management (TDM) strategies or transportation control measures (TCMs) available to them to comply with the ETR regulation. TDM and TCM are general terms used to describe measures or incentives designed to increase the average passenger occupancy of vehicles, or to shift or remove trips altogether from congested periods of the day.

This chapter presents the findings from the ETR database developed by TTI. The ETR database represents the most comprehensive review of attitudes toward various TDM and TCM strategies in Houston. By developing a database of this size, comparisons were made of employee preferences with worksite implementation plans and to gain a better understanding of how worksite location, worksite size, and type of business might influence which alternative transportation strategies are selected. The information, as analyzed, can provide insight about what may influence an employee's or employer's willingness to continue or adopt certain TDM or TCM strategies.

#### **DATABASE OF ETR PLANS**

With the cooperation of the Houston TNRCC office, a database was developed containing submitted worksite registration forms and ETR plans. Photocopies were made of 1,224 registered worksite files. A total of 1,791 worksites was required to register with the TNRCC, but approximately 200 to 300 worksite plans and surveys were yet to be filed by TNRCC when the database was created. Another 200 Independent School District (ISD) worksites were not included in the ETR database because of the uncertain nature of ISDs being required to comply with the regulation. The following forms were copied from the TNRCC worksite ETR files:

- Worksite Registration form
- Average Passenger Occupancy (APO) Calculation form
- Employee Alternative Mode Preference Survey
- Worksite Summary of Trip Reduction Measures
- Tracking and Evaluation Plan

The Worksite Registration forms were required to be submitted by September 1, 1993. The form details many descriptive characteristics about the worksite. Information such as the employee population at the worksite, number of employees arriving to worksite between 6:00 a.m. and 10:00

a.m. (Monday through Friday), type of business, and worksite location are on the Worksite Registration Form.

The Average Passenger Occupancy (APO) Calculation Form, which was submitted with the Worksite Registration Form, provides a detailed account of the various transportation modes currently used by employees. The number of vehicle trips made to the worksite and the target APO are also available on the APO Calculation Form.

A total of 25 transportation alternatives is included on the Employee Alternative Mode Preference Survey given to employees. Trip reduction alternatives ranged from the simple, such as providing more information about bus routes at worksites, to the complex, such as telecommuting. Appendix F is a reproduction of the official Employee Alternative Mode Preference Survey distributed to employees. Companies were required to compile this information and list the percentage of employees at the worksite responding positively to each trip reduction measure. Approximately 400,000 employees in the eight-county area that arrive to the worksite between 6:00 a.m. and 10:00 a.m. are represented in the ETR database.

The Worksite Summary of Trip Reduction Measures form contains information regarding employer's interest in trip reduction strategies. This form was developed by TNRCC and a reproduction is included in Appendix G. Unlike the employee preference survey, employers were given a more comprehensive list of trip reduction measures from which to choose. A total of 88 trip reduction measures is listed within the Summary of Trip Reduction Measures. For each trip reduction measure, the employer indicated whether or not the worksite planned to offer that particular incentive to employees (Yes or No), the status of the incentive (New, Revised, or Existing), and the quarter the incentive or measure was to be carried out in the two-year compliance time frame.

The Tracking and Evaluation Plan form was submitted with the Worksite Summary of Trip Reduction Measures. The purpose of this form is to show how the worksite will evaluate the effectiveness of its ETR plan. Worksites typically listed a variety of mechanisms in bullet format to show compliance with the rule. The information from the Tracking and Evaluation Plan forms was not entered into the ETR database.

The ETR database was created using the dBASE software package. A separate dBASE file was created for each form photocopied from the worksite file. Specific information from the forms was coded into the program and input into the Statistical Analysis Software (SAS) program for analysis. Table 4-1 summarizes which information from the worksite files is available in the ETR database. Information was selected from the worksite files to analyze employee/employer ETR preferences, and to conduct the energy and air quality calculations for this project.

**Table 4-1**  
**Summary of Information Found in ETR Database**

<b>ETR Worksite Registration Form</b>
<ul style="list-style-type: none"> <li>• Name of employer</li> <li>• Mailing address including street, city, zip code, and county</li> <li>• Name, address, and phone number of Top Ranking Official</li> <li>• Name, address, and phone number of Employee Transportation Coordinator (ETC)</li> <li>• Worksite Name</li> <li>• Worksite location including street, city, zip code, and county</li> <li>• Five primary four-digit Standard Industrial Classification Codes (SIC Codes)</li> <li>• Total number of registered employer's employees and contract employees at site</li> <li>• Number of employees in F.1 reporting to worksite between 6-10 a.m., Monday-Friday</li> </ul>
<b>Average Passenger Occupancy (APO) Calculation Form</b>
<ul style="list-style-type: none"> <li>• Number of surveys returned from 6-10 a.m., Monday-Friday employees</li> <li>• Adjusted total number of employee trips</li> <li>• Worksite APO</li> <li>• Target APO</li> <li>• Average miles to work, one way - reported by employees</li> <li>• Average minutes to work, one way - reported by employees</li> </ul>
<b>Employee Survey Results - Alternative Mode Preferences</b>
<ul style="list-style-type: none"> <li>• Incentive or measure</li> <li>• Asked, not asked</li> <li>• Percent Responding Positively</li> </ul>
<b>Worksite Summary of Trip Reduction Measures</b>
<ul style="list-style-type: none"> <li>• Trip Reduction Measure</li> <li>• Offered - Yes or No</li> <li>• Status - New, Revised, Existing</li> </ul>
<b>Tracking and Evaluation Plan</b>
<ul style="list-style-type: none"> <li>• No information entered from this form</li> </ul>

The comparison of employee preferences to employer implementation plans was done by matching the 25 incentives or measures listed on the Employee Alternative Mode Preference Survey with similar incentives or measures listed on the Worksite Summary of Trip Reduction Measures

form. Eighty-eight trip reduction measures or incentives were listed on the Worksite Summary of Trip Reduction Measures form, while only 25 incentives or measures listed on the Employee Alternative Mode Preference Survey. Twenty-one of the 25 incentives or measures listed on the employee survey directly or indirectly matched with those listed on the worksite list. Four of the incentives or measures listed on the employee survey (local bus service to your worksite, late evening bus service, High Occupancy Vehicle (HOV) lanes, and walking incentives) are not listed on the Worksite Trip Reduction Summary list. Consequently, only employee responses to these four measures are available.

A similar situation exists for the responses to compressed work weeks. Employees were surveyed to determine preferences for three types of compressed work weeks - 3/36, 4/40 and the 9/80 compressed work week. Worksites, though, only reported if a compressed work week was implemented, but were not required to specify which type of compressed work week would be implemented at the worksite. Therefore, the employee responses differ for each compressed work week strategy, while the worksite or employer responses remain the same for each compressed work week strategy.

Contrarily, more information exists about worksite activities for three other measures or incentives (employer paying for all or some carpool/vanpool costs, bike commuting incentives, and showers/lockers provided for those who walk or bike to worksite). For example, the Worksite Trip Reduction Summary listed carpool and vanpool subsidies separately, while the two measures are listed as a single measure on the Employee Alternative Mode Preference Survey. The same situation exists for biking incentives and shower/lockers at the worksite. The Worksite Summary of Trip Reduction plans list multiple biking incentives and the showers/lockers as separate.

Zip code, worksite street address, employee reported average miles to work, and employee reported average minutes to work were used to calculate energy and emission benefits. The average miles to work and minutes to work are found on the APO calculation sheets and the worksite geographic information is on the Worksite Registration Form.

## **METHODOLOGY FOR ANALYZING ETR DATABASE**

An analysis of worksite location, worksite size, and type of business was conducted to determine their potential impacts on employee and employer preferences to the various TDM/TCM strategies. The location of worksites was examined by using (1) major employment centers and (2) by defining concentric regions around the Houston CBD. The type of business was identified using the Standardized Industrial Classification (SIC) Codes located on the Worksite Registration Forms. The worksite employment size was identified on the Worksite Registration Form, as well. Each of these factors along with access to transit and/or HOV lanes, and area type (suburban or urban) was initially thought to be influencing factors in the selection or preference toward one measure or strategy over another.



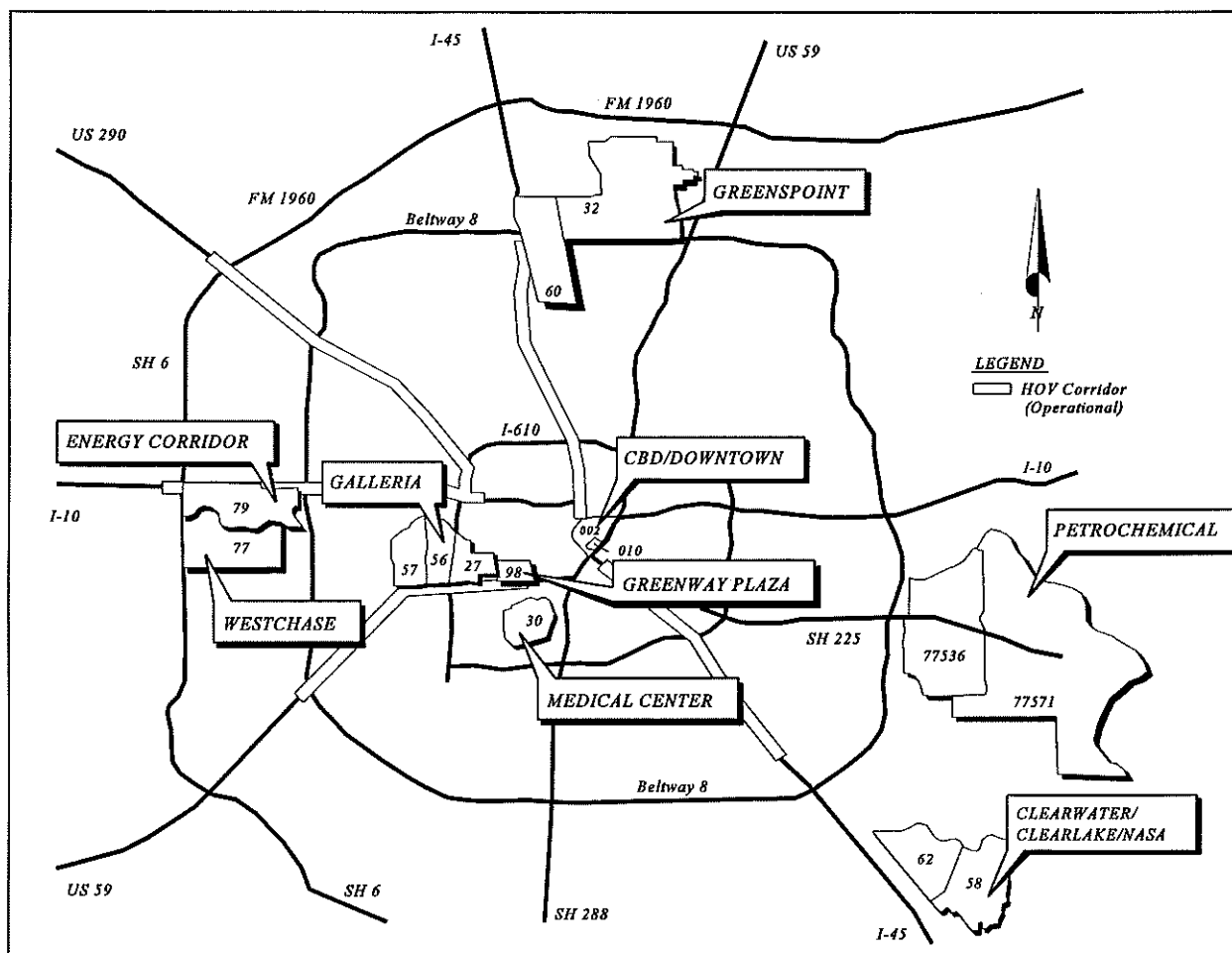
## Location of Worksite

Access to transit and/or HOV lanes, and proximity to downtown were thought to play key roles in determining which TDM strategies were preferred among employees and employers by location. Consequently, two separate geographic studies were conducted. Employee and employer preferences were studied at nine major employment centers and by defining concentric regions around the Houston CBD. The nine major employment centers were identified with the assistance of Houston METRO and other professionals familiar with the Houston metropolitan region. For simplicity, the zip code zone of the employment center was used to define the boundary of the employment center. Table 4-2 identifies the nine major employment centers and the accompanying zip code zones that define the boundary of each center.

**Table 4-2**  
**Major Employment Centers in Houston by Zip Code Zone**

<b>Employment Center</b>	<b>Zip Code Zones</b>
Greenspoint (Intercontinental Airport)	77032, 77060
Downtown/CBD	77002, 77010
Medical Center	77030
Greenway Plaza	77098
Galleria	77056, 77057, 77027
Energy Corridor/I-10 W	77079
Westchase	77077
Clearwater/Clearlake/NASA	77058, 77062
Petrochemical/SH 225	77536, 77571
Non-Major Employment Centers	All Other Zip Code Zones

Figure 4-1 illustrates the location of the nine major employment centers used in the analysis. The major transportation corridors in Houston and existing HOV lanes are also identified on Figure 4-1.

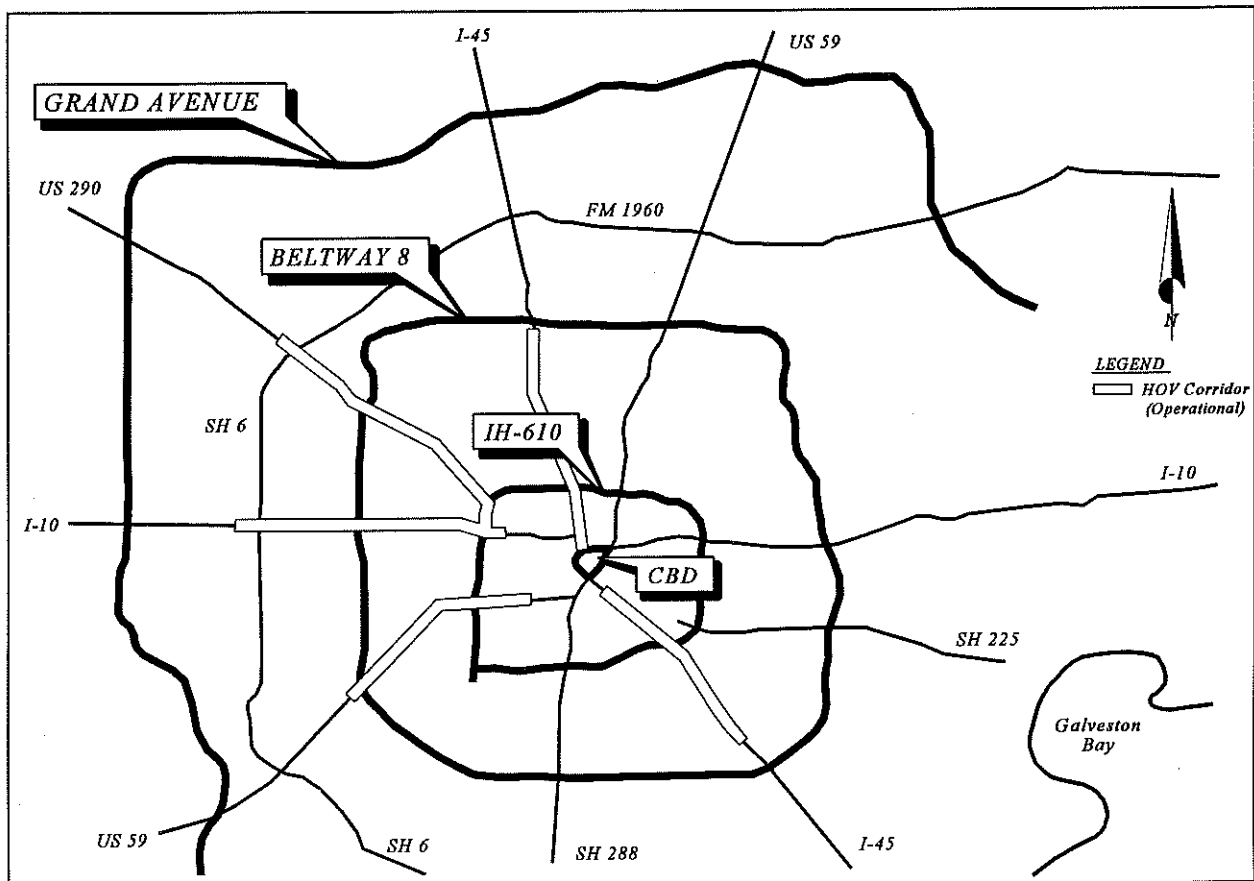


**Figure 4-1** Major employment centers and transportation facilities in Houston, Texas

The concentric regions were developed by using the established or planned circumferential highway network surrounding downtown Houston. For most worksites, the location could be defined by using the zip code zones that are within each region; however, some zip code zones were in two regions when the circumferential road splits the zip code zone. When the zip code zone was split into two regions, the worksite street address was used to determine which circumferential region the worksite belonged. Each region was separated and did not contain the previous region. The following beltways or circumferential roads were used to define the general regions.

- Central Business District (CBD)/Downtown
- Inside IH-610
- Inside Beltway 8
- Inside Grand Parkway (Proposed Road)
- Outside Grand Parkway/All Others

The regions become characteristically more suburban in development style as the distance increased from downtown. By developing concentric regions around Houston, employee and employer preferences in suburban locations without transit and HOV access could be compared with urban locations, such as worksites inside IH-610, that have transit and HOV services. Figure 4-2 illustrates the concentric regions defined by existing or planned beltways surrounding Houston.



**Figure 4-2** Concentric regions and transportation facilities of Houston, Texas

### Worksite Size

The worksite employee population was initially thought to be a major influencing factor for employers rather than employees choosing TCM strategies. Larger employee populations at a worksite may suggest a larger on-site human resource department and possibly a greater willingness to carry out more expensive measures, such as subsidizing ridesharing or initiating telecommuting. Worksite employee populations were divided into three major groups:

- 100-199 employees (small)
- 200-999 employees (medium)
- 1,000+ employees (large)

Among the participating worksites, those with 100-199 employees are considered small by size. There were 586 worksites categorized as small within the ETR database. This group is one of the two original worksite size categories established by TNRCC to distinguish between large and small worksites. The TNRCC considered worksites with 200 or more employees to be large and, consequently, had a different submission schedule than smaller companies.

The 200-999 worksite employee population group was developed to represent medium-sized worksites within the region. There are 556 worksites with 200-999 employees in the ETR database. This group represented the second largest amount of worksites, but contained the largest amount of employees (171,995).

Worksites with 1,000 or more employees were classified as large worksites in the ETR database. A total of 82 worksites had an employee population of 1,000 or more. However, these few companies represented the second largest amount of employees in the region.

### **Standardized Industrial Classification Code**

The SIC codes are an official statistical classification established by the federal government to describe business types. Eleven official divisions within the codes and 99 major groups are used to describe the types of industries. These divisions were used to compress the list to ten divisions for this analysis. The ten major divisions developed for the purposes of this study were as follows:

- agriculture, forestry, fishing, hunting, and trapping;
- mining;
- construction;
- manufacturing;
- transportation and public utilities;
- wholesale trade;
- eating and drinking establishments and miscellaneous retail;
- finance, insurance, and real estate;
- services; and,
- government.

Nearly 200 worksites and 45,899 employees were absent from the worksite classification information. The worksites missing from this data, failed to indicate a SIC code on their Worksite Registration Form. Consequently, some differences in worksite and employee populations between the SIC code figures with those that are in the location and worksite size information existed. Appendices H shows the range of SIC codes and the major divisions used for this study.

## **WORKSITE CHARACTERISTICS**

To analyze the characteristics of the worksites, the location of the worksite was combined with the size of the worksite and type of business at the worksite, respectively. Table 4-3 combines location with worksite size, and Table 4-4 combines location with type of business. The following section is a brief discussion of the highlights from the worksite characteristics.

### **Location and Size**

A total of 1,224 worksites was included in the ETR database. The employment centers accounted for a total of 359 worksites, or 30 percent of the worksites in the ETR database. Table 4-3 shows the total number of companies within the employment centers and concentric regions by worksite size. As evident in Table 4-3, a majority of worksites were not in the employment centers, which is a testament to the suburban nature of the Houston metropolitan region. The region beyond IH-610 contained more than 850 worksites, which represented 70 percent of the worksites.

Furthermore, it appears that the size of the worksites decreases with distance from the CBD/Downtown area. Fifty percent of the worksites outside the IH-610 Loop employ less than 200 employees. The CBD/Downtown employment center had the greatest concentration of large (1,000 or more employees) and medium-sized (200-999 employees) worksites. This is more apparent when the CBD/Downtown region is combined with the region between IH-610 and the CBD. This area is informally recognized as the core area of Houston. More than 75 percent of the worksites in the core area of Houston employ more than 200 people. One-half of all large worksites (1,000 or more employees) are in these two regions. The remaining large worksites are dispersed throughout the 8-county region. Including the CBD/Downtown region, a total of 357 worksites is registered inside the Inner Loop or core area. The 357 worksites in these two areas account for 30 percent of the worksites in the ETR database.

The CBD/Downtown employment center is the largest concentration of worksites among the nine major employment centers. The area has 104 registered worksites. The worksites are primarily those with less than 1,000 employees. The Medical Center has the second highest concentration of companies (nine total) exceeding 1,000 or more employees. The Medical Center is located outside downtown but inside IH-610.

The Galleria area has the second greatest concentration of worksites among employment centers with 81 total. This figure increases to 107 when the Galleria employment center is combined with the Greenway Plaza employment center. The two centers are near each other and primarily consist of worksites with less than 200 employees. Almost 50 percent of the worksites in these two employment centers employ less than 200 people. Among the employment centers, the Galleria area is second to the CBD/Downtown area with the number of worksites that employ less than 200 people.

**Table 4-3**  
**Total Number of Worksites by Location and Worksite Size**

Location	Worksite Size			
	<199	200-999	>1000	Total
<b>Employment Centers</b>				
Greenspoint	14	17	2	33
CBD/Downtown	43	44	17	104
Medical Center	10	13	9	32
Greenway	10	14	2	26
Galleria	42	34	5	81
Energy Corridor	7	12	2	21
Westchase	3	4	0	7
NASA	9	13	5	27
Petro/225	19	6	3	28
Other	429	399	37	865
<b>Total</b>	<b>586</b>	<b>556</b>	<b>82</b>	<b>1,224</b>
<b>Concentric Regions</b>				
CBD/Downtown	43	45	17	105
Between IH-610 and CBD	123	105	24	252
Between Beltway 8 and IH-610	183	191	14	388
Between Grand Parkway and Beltway 8	162	145	21	328
Outside Beltway 8	75	70	6	151
<b>Total</b>	<b>586</b>	<b>556</b>	<b>82</b>	<b>1,224</b>

When the area between the proposed Grand Parkway and IH-610 are combined, this area contains the largest concentration of medium-sized companies with 336 worksites. This accounts for nearly 30 percent of all worksites in the ETR database. The employment centers in this region tend to have more small to medium-sized worksites.

### **Location and Type of Business**

Table 4-4 shows the total number of worksites within each type of business by location. As mentioned previously, nearly 200 companies failed to indicate the type of business on the Worksite Registration Form. Because of this, some dissimilarities between the total number of worksites in Table 4-3 and Table 4-4 exist.

The two largest types of businesses in the 8-county region are manufacturing (238 worksites) and services (213 worksites). Most of these worksites are located outside the Inner Loop (IH-610). Approximately 80 percent of the manufacturing worksites and 66 percent of the service related worksites are located outside IH-610.

Manufacturing and service-related industries, however, represent a significant portion of worksite types inside IH-610, including the CBD/Downtown region. A quarter of all worksites in these two regions is service related. More specifically, 34 percent of all worksites in the CBD/Downtown region are service related. This is the largest business type in the CBD/Downtown region. Manufacturing and government worksites each account for 16 percent of the worksites inside the combined areas of IH-610 and downtown.

The Clearwater/Clearlake/NASA and Medical Center employment centers are two other areas that are closely associated with service-related industries. More than half of the worksites in these two centers are registered as service related.

The Galleria and Greenway Plaza employment centers represent the largest number of worksites registered as financial industries. One-fourth of all worksites in the Galleria area are registered as financial. The Galleria area also has the largest concentration of transportation and public utility worksites among the employment centers. Eight of the 64 sites in the Galleria are listed in this category.

**Table 4-4**  
**Total Number of Worksite Types by Location**

Location	S.I.C. Code										
	Agri.	Mining	Const.	Manu.	Trans. & Public Util.	Wholesale	Food	Finance	Services	Govt.	Total
<b>Employment Centers</b>											
Greenspoint	1	6	0	2	5	2	0	5	3	2	26
CBD/Downtown	5	8	0	5	5	2	0	6	25	13	69
Medical Center	2	1	0	0	0	1	0	0	11	5	20
Greenway	1	1	0	2	0	1	0	3	3	1	12
Galleria	3	8	1	7	8	6	0	18	10	3	64
Energy Corridor	1	6	0	2	2	5	0	1	4	0	21
Westchase	0	1	0	0	1	1	0	0	4	0	7
NASA	0	0	1	0	5	1	0	0	14	2	23
Petro/225	0	0	4	10	2	0	0	0	2	0	18
Other	14	30	22	210	96	142	5	35	137	83	774
<b>Total</b>	<b>27</b>	<b>61</b>	<b>28</b>	<b>238</b>	<b>124</b>	<b>161</b>	<b>5</b>	<b>68</b>	<b>213</b>	<b>109</b>	<b>1,034</b>
<b>Concentric Regions</b>											
CBD/Downtown	6	13	1	6	10	3	0	7	32	15	93
Inside 610	6	11	0	42	29	31	1	14	40	36	210
Inside Beltway 8	8	16	3	72	40	64	1	27	59	32	322
Inside Gr. Pkwy	6	19	12	81	36	49	2	10	59	12	286
Other	1	2	12	37	9	14	1	10	23	14	123
<b>Total</b>	<b>27</b>	<b>61</b>	<b>28</b>	<b>238</b>	<b>124</b>	<b>161</b>	<b>5</b>	<b>68</b>	<b>213</b>	<b>109</b>	<b>1,034</b>



## EMPLOYEE CHARACTERISTICS

Similar to the summary of worksite characteristics, employee characteristics are summarized by worksite size and worksite type with respect to location. Table 4-5 combines worksite location with size and Table 4-6 combines location with type of business. The employee totals differ slightly between the two tables because some worksites neglected to indicate the type of business conducted at the worksite. Nearly 46,000 employees are not accounted for in Table 4-6 because of this registration error. The following is a brief discussion of the highlights from the employee characteristics.

**Table 4-5**  
**Total Number of Employees by Location and Worksite Size**

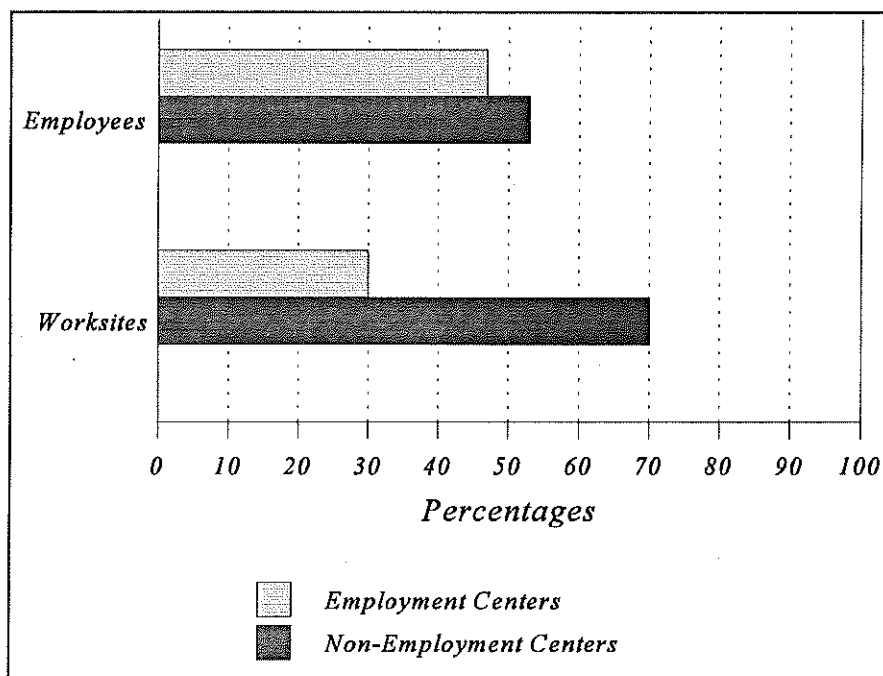
Location	Worksite Size			
	<199	200-999	>1000	Total
<b>Employment Centers</b>				
Greenspoint	1,697	5,671	3,482	10,850
CBD/Downtown	4,586	16,386	43,042	64,014
Medical Center	1,123	3,460	26,056	30,639
Greenway	1,456	4,324	9,318	15,098
Galleria	7,664	12,409	6,197	26,270
Energy Corridor	918	6,918	1,953	9,789
Westchase	325	1,639	0	1,964
NASA	2,318	6,505	6,217	15,040
Petro/225	3,046	2,365	3,456	8,867
Other	63,107	112,318	38,532	213,957
<b>Total</b>	<b>86,240</b>	<b>171,995</b>	<b>138,253</b>	<b>396,488</b>
<b>Concentric Regions</b>				
CBD/Downtown	4,586	16,576	43,042	64,204
Between IH-610 and CBD	16,280	32,357	48,815	97,452
Between Beltway 8 and IH-610	26,520	55,661	10,750	92,931
Between Grand Parkway and Beltway 8	20,786	42,910	30,430	94,126
Outside Beltway 8	18,068	24,491	5,216	47,725
<b>Total</b>	<b>86,240</b>	<b>171,995</b>	<b>138,253</b>	<b>396,488</b>

**Table 4-6**  
**Total Number of Employees by Location and Worksite Type**

Location	S.I.C. Code										
	Agri.	Mining	Const.	Manu.	Trans. & Public Util.	Wholesale	Food	Finance	Services	Govt.	Total
<b>Employment Centers</b>											
Greenspoint	107	3,241	0	688	3,705	106	0	683	678	871	10,079
CBD/Downtown	2,229	12,260	179	2,394	5,518	365	0	2,028	14,429	22,982	62,384
Medical Center	3,420	2,060	0	0	0	134	0	0	11,097	4,445	21,156
Greenway	104	10,249	0	458	570	180	0	2,147	676	255	14,639
Galleria	751	2,995	1,947	1,339	6,469	1,165	0	5,049	2,288	733	22,736
Energy Corridor	2,655	1,481	0	2,306	650	1,226	0	84	1,387	0	9,789
Westchase	0	332	0	0	89	560	0	0	983	0	1,964
NASA	0	0	1,255	0	2,178	101	0	0	8,022	3,087	14,643
Petro/225	0	0	542	5,265	279	0	0	0	243	116	6,445
Other	3,838	6,996	12,745	57,865	17,788	17,729	714	12,848	38,576	17,655	186,754
<b>Total</b>	<b>13,104</b>	<b>39,614</b>	<b>16,668</b>	<b>70,315</b>	<b>37,246</b>	<b>21,566</b>	<b>714</b>	<b>22,839</b>	<b>78,379</b>	<b>50,144</b>	<b>350,589</b>
<b>Loops</b>											
CBD/Downtown	2,229	12,450	179	2,394	5,518	365	0	2,028	14,429	22,982	62,574
Inside 610	4,438	13,665	0	7,514	8,507	5,280	0	6,690	18,664	12,781	77,539
Inside Beltway 8	1,967	8,195	2,503	20,893	12,047	8,451	197	9,245	14,048	5,987	83,533
Inside Grand	Pkwy3	5,009	3,148	29,161	9,899	6,131	473	2,271	19,560	5,571	85,456
Other	237	295	10,838	10,353	1,275	1,339	44	2,605	11,678	2,823	41,487
<b>Total</b>	<b>13,104</b>	<b>39,614</b>	<b>16,668</b>	<b>70,315</b>	<b>37,246</b>	<b>21,566</b>	<b>714</b>	<b>22,839</b>	<b>78,379</b>	<b>50,144</b>	<b>350,589</b>

## Location and Size

A total of 396,488 employees is registered in the ETR database. While only 30 percent of the worksites are in the employment centers, the total employee population for all of the employment centers represents 46 percent of the total amount of employees in the database. Approximately, 182,000 employees work in the employment centers with the remaining total working throughout the 8-county region. These relationships are shown in Figure 4-3.



**Figure 4-3** Concentrations of employee and worksite populations in Houston, Texas

Medium-sized worksites employ the most people in the 8-county region. Almost 172,000 employees work at medium-sized worksites. Worksites with 1,000 or more employees have the second highest total of employees at 138,253. A majority of the worksites with 1,000 or more employees are located inside the Inner Loop. Less than 27 percent of the employees at small worksites and 35 percent of the employees at medium-sized worksites work in the employment centers; however, more employees at large worksites (1,000 or more employees) work at employment centers than elsewhere. Nearly 72 percent of all employees at large worksites work at a defined employment center. Almost a third of those employees work downtown.

The CBD/Downtown region and the region between IH-610 and the CBD represent a significant share of the total amount of employees in Houston. These two regions, when combined, account for 41 percent of the total employee population. The three employment centers within these

two regions, CBD/Downtown, Medical Center, and Greenway Plaza, employs 109,751 people, or 67 percent of the employees in the two regions.

The CBD/Downtown and Medical Center are the two largest concentrations of employees among the nine employment centers. More than 64,000 people work in the downtown area at ETR registered worksites. The Medical Center has the second largest employee population with 30,639. A significant portion of the employees in the Downtown and Medical Center are employed at large worksites.

The Galleria area is another significant area of employment. More than 26,000 people are employed at this employment center. Unlike the CBD/Downtown and Medical Center employment centers, though, most of the employees work at small to medium-sized worksites. The Galleria has the second highest total of employees working at medium-sized worksites among employment centers. When the Galleria is combined with the Greenspoint Plaza employment center, the two centers represent 10 percent of the total amount of employees in the 8-county region.

Suburban centers, such as Greenspoint, Energy Corridor, Westchase, and Clearwater/Clearlake/NASA, have more employees in small to medium-sized worksites than those worksites inside the Inner Loop. Only the Petrochemical/SH 225 employment center has more employees represented in large worksites. Westchase does not have a worksite with more than 1,000 employees.

### **Location and Type of Business**

Table 4-6 shows the total number of employees within each type of business by location. More employees work at manufacturing and service worksites than in any other category. Manufacturing accounts for 20 percent of the total employee population while the service-related industries account for 22 percent of the total employee population. Unlike manufacturing, one-half of those considered service-type employees work within the employment centers. More than 80 percent of the manufacturing employees, though, work outside an employment center. Similar to this finding, more than 80 percent of wholesale employees do not work at a defined employment center.

Contrarily, employees within government, mining, and agriculturally-related industries tend to have worksites at one of the nine major employment centers. More than 65 percent of all government employees work at an employment center, with most of those working in the CBD/Downtown center.

The Greenway Plaza and Galleria employment centers have a large concentration of employees working for industries related to finance, mining (oil and gas extraction, and traditional mining), and transportation and public utilities. More than one-third of all employees in mining and extraction-related industries work in these two employment centers. Almost one-fourth of all financial employees work in the Galleria area. Furthermore, more than 6,000 employees work for

transportation and public utility worksites in the Galleria center, which accounts for more than 17 percent of all employees in this industry.

## **FINDINGS FROM THE ETR DATABASE**

The following is a brief review of the findings from the employee and employer TDM selections based on worksite size, type of business, and location. A complete listing of employee and employer choices are available in Appendices I, J, K, and L. The employee and employer responses are given in percentages rather than absolute numbers for comparison purposes in these Appendices.

### **Impact of HOV Lanes and Transit on APO**

Access to transit and HOV lanes, with respect to worksite location is considered a significant influence in selecting TDM/TCM strategies. The CBD/Downtown area is served by several HOV lanes and has comprehensive local and commuter bus service. The Galleria and Greenway Plaza employment centers have access to the HOV lanes on US 59 (Southwest Freeway), IH-10 (Katy Freeway), and US 290 (Northwest Freeway); however, transit coverage in this area is less in comparison to the service provided in the CBD/Downtown area.

Conversely, Greenspoint, the Energy Corridor, Westchase, Clearwater/Clearlake/NASA, and the Petrochemical/SH 225 Corridor are all suburban employment centers. The HOV operations next to the Energy Corridor, Greenspoint, and Clearwater/Clearlake/NASA areas do not benefit the commuters in these areas because the HOV facilities operate opposite to the travel patterns to these employment centers. The Clearwater/Clearlake/NASA area has a similar situation with very limited transit service in the area. The Petrochemical employment center does not have any access to transit or HOV facilities.

The influence of transit and HOV lane access is evident in the average baseline APO's in Houston. The CBD/Downtown area, which has the greatest access to HOV facilities and the most comprehensive transit service in the region, has the largest average baseline APO of 1.45. This figure is just below the target APO of 1.47 determined by H-GAC.

The average APO gets progressively lower the farther away the employment center or region is from downtown and/or from the HOV lanes. For example, the Energy Corridor, Westchase, Clearwater/Clearlake/NASA, and Petrochemical employment centers each have baseline APO's that average slightly more than the minimum 1.0. Accordingly, more single occupant driving by work force population occurs in these centers, which may be a direct reflection of the limited transit service in these areas and the limited impact of the HOV lanes.

Interestingly, though, the average baseline APO for the 865 worksites not included within any particular employment center is 1.16. The baseline APO for the region established by H-GAC

was 1.17. Table 4-7 shows the average baseline APO for the major employment centers and for the concentric regions of Houston.

### **Employee and Employer Preferences Toward Alternative Modes**

A general comparison of employee alternate mode preferences to measures or incentives chosen by the worksite is shown in Table 4-8. The total number of employees responding favorably to individual strategies and the size of the survey population in each category is shown. The table also shows the total number of companies that showed on the Worksite Summary of Trip Reduction Measures which measure or incentive would be implemented within the worksite ETR plan.

#### *Employee Preferences*

Employees at registered worksites were given the opportunity to express interest in 25 alternative transportation alternatives. Employee populations were determined by multiplying the percentage of employees interested in a particular incentive or measure at a worksite to the total amount of employees surveyed at the worksite. The responses for each incentive or measure were then summed at each worksite to yield the total number of employees interested in a TDM/TCM strategy. Worksites were permitted to set which alternatives would be included in the worksite survey. Therefore, surveyed employee populations vary among the 25 alternatives listed in Table 4-8.

Employee preferences for particular incentives or measures were determined by reviewing the percentage of employees interested. Employee interest in most of the transportation alternatives is generally low. Only few incentives or measures received positive interest from more than one-quarter of the surveyed employees. Three incentives or measures listed on the Employee Alternative Mode Preference Survey did receive higher interest than others. Two of the measures are associated with changes in work schedules rather than changes in passenger occupancy levels. The three incentives or measures receiving the highest interest are listed in order of decreasing interest:

- 4/40 compressed work week
- guaranteed ride home programs
- variable/flexible work hours

The 4/40 compressed work week received a positive response from 52 percent of those employees surveyed. Two other compressed work week schedules were presented to employees - 3/36 compressed work week and the 9/80 compressed work weeks schedule. Neither of these two compressed work week schedules received favorable interest when compared to the 4/40 compressed work week response. Only 18 percent of the employees responded favorably to a 3/36 compressed work week. The 9/80 compressed work weeks received a greater interest with 62,041 employees showing interest or 23 percent. In contrast, more than 153,000 employees showed an interest in participating in a 4/40 compressed work week. It is unclear whether employees could show interest in more than one compressed work week.

Guaranteed Ride Home Program or rides for emergencies and unscheduled overtime received the second highest favorable response from employees. Approximately 44 percent of 356,708 surveyed employees were interested this program. The 356,708 surveyed employees represents the highest survey population size of the 25 alternatives on the Alternative Mode Preference Survey. Consequently, employers must have also viewed Guaranteed Ride Home Programs as an integral part of their trip reduction plans.

**Table 4-7**  
**Average Baseline APO at Employment Centers and Regions**

<b>Location</b>	<b>Baseline APO</b>
<b>Major Employment Centers</b>	
Greenspoint	1.089
Downtown/Central Business District	1.457
Medical Center	1.249
Greenway Plaza	1.186
Galleria	1.118
Energy Corridor/I-10 West	1.048
Westchase	1.033
Clearwater/Clearlake/NASA	1.057
Petrochemical	1.097
Other	1.162
<b>Concentric Regions</b>	
Downtown/Central Business District	1.476
Between IH-610 and Central Business District	1.162
Between Beltway 8 and IH-610	1.168
Between Grand Parkway and Beltway 8	1.097
Outside Beltway 8	1.162

**Table 4-8  
Employee and Employer Preferences Toward Alternative Modes**

Incentive or Measure	Employees		Employers
	Responding Favorably	Potential <sup>1</sup>	Worksites Implementing <sup>2</sup>
<b>Bus Services</b>			
1. More information regarding bus routes	41,265	302,962	686
2. Local bus service to your worksite	66,363	306,962	N/A
3. Late evening bus service	41,047	285,511	N/A
4. Employer paying for all or a portion of bus passes	79,391	288,978	370
5. Park & Ride service to your worksite	81,155	329,331	69
<b>Carpool/Vanpool</b>			
6. Preferential parking for carpools/vanpools	62,005	345,590	608
7. Employer paying for all or some of carpool/vanpool costs	92,287	298,130	261/310 <sup>3</sup>
8. Free carpool/vanpool matching or list of others to rideshare with	85,237	346,291	818
9. Guaranteed Ride Home for emergencies and unscheduled overtime	155,342	356,708	672
10. Mid-day shuttle bus to shopping/dining areas near your worksite	46,929	259,616	112
11. Employer provided vehicles for mid-day business trips	52,336	271,458	424
12. High Occupancy Vehicle (HOV) lanes	45,575	282,441	N/A
<b>Biking/Walking</b>			
13. Biking commuting incentives	24,423	287,127	73/46 <sup>4</sup>
14. Secured bike racks	19,500	286,628	481
15. Walking incentives	13,933	270,948	N/A
16. Showers/lockers provided if you walk or bike to worksite	29,969	268,151	419/507 <sup>5</sup>
<b>Compressed Work Week</b>			
17. 3/36 Work Week	47,544	250,620	537
18. 4/40 Work Week	153,293	296,468	537
19. 9/80 Work Week	62,041	267,342	537
<b>On-site Facilities</b>			
20. Banking facilities on-site	43,529	241,721	463
21. Day care on-site	30,653	203,162	44
22. Cafeteria on-site	48,508	226,601	518
<b>General</b>			
23. Variable/flexible work hours	115,238	299,230	583
24. Telecommuting	74,007	275,720	283
25. Increased costs for parking	40,080	287,382	257
26. Other (list)	26,472	182,500	N/A

<sup>1</sup> calculated by summing 6-10a.m. , M-F employee population for worksites that surveyed employees about the measure or incentive indicated

<sup>2</sup> 1,224 total worksites in the database

<sup>3</sup> worksites implementing carpool/worksites implementing vanpools

<sup>4</sup> worksites implementing bike purchase subsidies/companies implementing bike product giveaways

<sup>5</sup> worksites implementing locker facilities/companies implementing shower facilities



Another measure that received high interest from employees was variable/flexible work hours. Approximately 40 percent of the nearly 300,000 surveyed employees responded favorably to this measure. This strategy encourages employees to travel during less congested periods of the day or to stagger their arrival times with more flexibility.

Incentives or measures that received moderate interest from employees included: park-and-ride service to the worksite, free carpool/vanpool matching, employer paying for a portion of bus passes, the employer paying for all or some costs of carpooling/vanpooling, and telecommuting. Unlike the incentives or measures receiving the highest interest, these strategies are associated with alternative travel or increasing vehicle occupancy rates rather than changes to the work schedule. Two of these measures deal directly with the employer or worksite subsidizing all or part of the alternative transportation mode. By doing so, the employee's cost of participating in alternative travel is decreased, which may affect interest in ridesharing.

Walking and biking programs received the lowest interest from employees among the 25 alternative measures and incentives on the survey. The low interest in these programs and support strategies to these programs is probably due to Houston's hot and humid climate and its dispersed land use patterns, which make walking and biking to work less convenient than the automobile.

On-site facilities, such as cafeterias, day-care, and banking facilities, also received lower positive responses from employees. The justification for providing on-site facilities for ridesharing employees is simple. Employees have the opportunity to conduct errands on-site rather than conduct personal business away from the worksite during lunch or during travel to/from the worksites. The need for a personal automobile is thereby reduced by the convenience of on-site facilities. Among the three on-site facilities, cafeterias received the highest positive response with 21 percent.

Other employer-sponsored programs such as, preferential parking, midday shuttle buses to shopping/dining areas near the worksite, employer provided vehicles for midday business, and increased costs for parking, received fairly low interest from employees. Each of these incentives or measures was positively viewed by less than 20 percent of the employee population. Furthermore, employees would rather have a Guaranteed Ride Home Program at the worksite than have late evening bus service in the region to provide travel service for unscheduled overtime. Only 14 percent of 285,511 surveyed employees showed an interest in late evening bus service.

High Occupancy Vehicle (HOV) lanes, a trademark of ridesharing and transit policy in Houston, were not viewed very positively by employees. Of the 282,441 employees surveyed, only 16 percent responded positively to the measure. Several explanations may account for the low rating. Employees, especially those not served by HOV lanes, may have had a dramatic impact on the ratings. Approximately one-half of the total surveyed employee population does not work inside the Inner Loop where HOV lanes primarily serve. Therefore, the benefits of the HOV lanes are minimal to these employees. Furthermore, HOV lanes are dissimilar to other measures and incentives listed on the survey. Employees may believe that reduced costs of alternative modes (i.e.,

subsidizing carpooling or transit) and work schedule changes are more tangible than large regional programs.

### *Worksite Preferences*

Worksite preferences toward the 25 incentives or measures listed on the Employee Alternative Mode Survey were determined by reviewing the Worksite Summary of Trip Reduction Measures. For each trip reduction measure, worksites indicated whether or not it planned to offer that particular incentive to employees (Yes or No), and the status of the incentive (New, Revised, or Existing). The implementation status for each incentive or measure as indicated by worksites in 1993 is summarized in Table 4-9. The table only accounts for those worksites that indicated the status of the individual trip reduction strategy. Table 4-9 does not include worksites that checked “Yes” on the Worksite Trip Reduction Summary but did not indicate a status.

Worksites or employers appear to have been interested in those incentives or measures that are relatively inexpensive to implement. Worksites may have been unwilling to commit to more expensive incentives or measures, such as subsidies, because of the uncertain status of the ETR program when the worksite trip reduction plans were being created. The most popular incentives or measures to employers are as follows:

- free carpool/vanpool matching list of others to rideshare with
- more information regarding bus routes
- guaranteed ride home for emergencies and unscheduled overtime
- preferential parking for carpools/vanpools
- variable/flexible work hours
- compressed work weeks

The most popular incentive among worksites was free carpool/vanpool matching list. Almost 70 percent of the companies believed that this strategy should be an integral part of trip reduction plans. To compliment ridesharing efforts, 50 percent of the worksites would have provided preferential parking for carpools/vanpools and another 55 percent would have started a Guaranteed Ride Home Program. A Guaranteed Ride Home Program is the third most popular incentive or measure chosen by worksites. More information regarding bus routes received slightly more interest.

Compressed work weeks is another TDM/TCM strategy that received positive interest among employers in Houston. Worksites were not able to show which type of compressed work week would be implemented at the worksite. Despite this, 44 percent of the worksites or employers said that a compressed work week schedule would be available to employees. Another alternative work schedule, variable/flexible work hours, received slightly more worksite interest than compressed work weeks. A total of 583 worksites or 47 percent of the worksite population would have implemented some sort of variable/flexible work hour schedule for employees. Neither compressed

work weeks nor variable/flexible work hours require a great deal of capital expenditure for the employer. The strategies, though, do challenge traditional management practices.

Subsidies for transit or ridesharing received moderate to low interest from employers. A total of 310 worksites, or 30 percent of the worksite population, would have subsidized all or a portion of bus passes. Carpooling and vanpooling subsidies received less interest, but it appears that employers were more interested in subsidizing the costs of vanpooling than carpooling. One-quarter of the employers were willing to subsidize all or some costs of vanpooling, while 21 percent of the employers would have done the same for carpooling. Employers, though, were interested in permitting employees to use company vehicles to conduct midday business trips. More than a third of the employers would have allowed employee use of company vehicles for midday business trips.

Similar to employees, walking and biking incentives/measures did not receive much attention from employers. The installation of bike racks at worksites received moderate interest, but this may be a result of companies identifying bike racks as a low cost strategy within trip reduction plans. Support measures for biking and walking, such as showers and lockers, received moderate attention. Slightly more than 40 percent of the worksites said lockers would be made available to employees that walked or biked to work. Another 34 percent of the worksites said showers would be available to employees who walked or biked. However, 90 percent of the companies that said shower and locker facilities on the worksite trip reduction plan already have those facilities on site.

Other on-site facilities, such as banking and cafeterias, received moderate interest from worksites. Approximately 40 percent of the worksites said that both measures would be offered to employees. Similar to shower and locker facility interest, more than 90 percent of the on-site cafeterias exist and 77 percent of the on-site banking facilities already exist. Contrarily, only 4 percent of the worksites responded that on-site day care facilities would be a part of the trip reduction plans as an incentive to employees to rideshare. Based on these figures, it was assumed that most worksites do not currently have on-site day care facilities.

Telecommuting and increased costs for parking received little interest from worksites. Telecommuting may be too radical a change in management practices for employers to embrace as a trip reduction strategy. Only 23 percent of the worksites showed an interest in this strategy. Similar to telecommuting, increasing the cost of parking to employees at a worksite may have been too controversial a management practice to carry out.

**Table 4-9**  
**Implementation Status of Incentive or Measure (1993)**

Incentive or Measure	Status		
	New	Revised	Existing
<b>Bus Services</b>			
1. More information regarding bus routes	458	7	163
2. Local bus service to your worksite	N/A	N/A	N/A
3. Late evening bus service	N/A	N/A	N/A
4. Employer paying for all or a portion of bus passes	231	14	97
5. Park & Ride service to your worksite	40	2	11
<b>Carpool/Vanpool</b>			
6. Preferential parking for carpools/vanpools	466	26	58
7a. Employer paying for all or some of carpool costs	214	4	13
7b. Employer paying for all or some of vanpool costs	263	3	17
8. Free carpool/vanpool matching or list of others to rideshare	659	7	101
9. Guaranteed Ride Home for emergencies and unscheduled	511	20	89
10. Mid-day shuttle bus to shopping/dining areas near your	35	0	66
11. Employer provided vehicles for mid-day business trips	42	14	337
12. High Occupancy Vehicle (HOV) lanes	N/A	N/A	N/A
<b>Biking/Walking</b>			
13a. Bike purchase subsidies	61	0	3
13b. Bike products	32	0	4
14. Secured bike racks	182	28	246
15. Walking incentives	N/A	N/A	N/A
16a. Lockers provided if you walk or bike to worksite	27	19	437
16b. Showers provided if you walk or bike to worksite	22	18	360
<b>Compressed Work Week</b>			
17. 3/36 Work Week	253	44	186
18. 4/40 Work Week	253	44	186
19. 9/80 Work Week	253	44	186
<b>On-site Facilities</b>			
20. Banking facilities on-site	36	3	355
21. Day care on-site	10	0	29
22. Cafeteria on-site	25	2	472
<b>General</b>			
23. Variable/flexible work hours	178	50	303
24. Telecommuting	155	15	94
25. Increased costs for parking	109	11	67

### *Impact of Worksite Location on Employee and Employer Preferences*

The impact of worksite location is more evident in employer preferences than in employee preferences. The distance or proximity from downtown has the greatest impact on employer preferences toward ridesharing incentives and measures. Employer interest increases with proximity to downtown with the following ridesharing strategies:

- more information regarding bus routes
- bus fare subsidies
- carpool subsidies
- vanpool subsidies
- parking strategies

The preference or willingness to support these types of ridesharing programs is more apparent when the information is examined by employment center. Employment centers, such as the CBD/Downtown, Medical Center, Greenway Plaza, and the Galleria have higher employer support for ridesharing programs than those worksites in other employment centers. The proximity of these employment centers to the HOV lanes probably influences the decisions among employers to support ridesharing. The only employment center where employee interest in bus, carpool, and vanpool subsidies is greater than employer interest is the Greenspoint employment center. Employee interest in carpooling and vanpooling subsidies is also greater at the Petrochemical and NASA employment centers.

Proximity to downtown also influences the propensity of employers to implement parking incentives or measures. Interest in increasing parking fees is dramatically higher for worksites inside IH 610 and within the downtown region where parking is already at a premium. Suburban sites may be more unwilling to charge for parking when parking is abundant and usually free. Interest in preferential parking strategies also increases among worksites inside Loop 610; however, interest in preferential parking is fairly high among other regions as well. Preferential parking may be easier to carry out at suburban locations because it may be less controversial than increasing employee parking fees.

Other strategies that may be affected by worksite location might be alternative work arrangements, such as variable/flexible work hours and telecommuting. Employer and employee interest in variable/flexible work hours is relatively high among all regions and employment centers. Yet it does appear that interest is slightly higher for worksites inside IH 610, including the employment centers in this region. Variable/flexible work hours could be used to enhance employee convenience in ridesharing in these regions and shift a large percentage of trips outside the peak periods.

Employer interest in telecommuting is relatively low among most regions in Houston; however, employee interest in telecommuting is much higher than employer interest at several employment centers. The Galleria, Greenway Plaza, Energy Corridor, Westchase,

Clearwater/Clearlake/NASA, and Petrochemical employment centers have significant employee interest in telecommuting. The six employment centers account for more than 77,000 employees. Employee interest in telecommuting at non-employment center worksites is only slightly higher than employer interest, but these worksites account for more than 210,000 employees. This is one of the few TDM/TCM incentives or measures where employee interest is greater than employer interest.

Employee and employer interest by employment center and region in each of the 25 TDM/TCM incentives and measures can be found in Appendices K and L.

### *Impact of Worksite Size on Employee and Employer Preferences*

Employer interest in implementing the 25 TDM/TCM incentives and measures is typically greater for larger companies than in small to medium-sized worksites. Strategies, such as on-site facilities (i.e., banking, cafeterias, showers, and lockers) and alternative work schedules or arrangements, are especially popular among larger worksites. A majority of on-site facilities, though, already exist at most large worksites which can be misleading

Compressed work weeks, variable/flexible work hours, and telecommuting each received greater interest among larger worksites. Most large worksites were initially at or near the target APO at the time of registration, especially those in the CBD area. Removing a work-related trip through a compressed work week or through telecommuting would have required little effort by the employer to comply with the ETR regulation. Furthermore, the larger worksites probably have greater staff devoted to personnel management, which may make it easier to implement non-traditional management practices. The 4/40 compressed work week is the most popular work schedule change among employees despite worksite size. Employees at small to medium-sized worksites are more interested in participating in a 4/40 compressed work week than those at larger worksites.

Three TDM/TCM strategies where interest by either small or medium-sized worksites exceeded larger worksites are bus fare subsidies, carpool and vanpool subsidies. Employer interest in carpool and vanpool subsidies is fairly similar among the three different worksite sizes. Employer interest at small to medium-sized worksites is slightly higher than large worksites in carpool subsidies. Employer interest in subsidizing bus fares is greater among worksites with 100-199 employees. More than 50 percent of worksites with small employee populations indicated bus fare subsidies would be a part of the trip reduction plans. In comparison, approximately 35 percent of medium to large worksites would have implemented bus fare subsidies. It is unclear whether there are more smaller worksites located along local or commuter bus routes than worksites of other sizes.

Employee interest in the 25 TDM/TCM strategies is variable among the three different worksite sizes. Employees, though, have a greater interest in subsidies for carpools and vanpools than employers regardless of worksite size. Appendix I shows employee and employer interest in the 25 TDM/TCM strategies among the three different worksite sizes.

### *Impact of Business Type on Employee and Employer Preferences*

Quantifying how business type impacts employer or employee preference toward the 25 TDM/TCM strategies is less tangible than worksite location and size. Only a few trends are evident in the data available in Appendix J. Four types of businesses generally support ridesharing incentives or measures (more bus route information, subsidizing bus fares, and subsidizing carpools/vanpools) more than other types of businesses. Government, services, finances, and wholesale trade consistently supported ridesharing incentives and measures at the worksites. These four industries account for 551 worksites and 173,000 employees. Government-related worksites showed the highest level of participation among worksite types. Manufacturing-related industries, which represent 238 worksites and 70,000 employees, have very little interest in implementing ridesharing incentives or measures. Another ridesharing support measure, guaranteed ride home programs, received high interest from most business types and among employees in these businesses.

Alternative work schedules and arrangements, such as compressed work weeks, variable/flexible work hours, and telecommuting have similar results. Variable/flexible work hours have extremely high interest among government, services, finance, and wholesale trade industries. Compressed work weeks received moderate to high interest from most business types. More than 80 percent of government-related worksites showed an interest in implementing a compressed work week. Wholesale trade, which represent 161 worksites and 21,556 employees showed the lowest interest in compressed work weeks among the major business types. Similar to previous findings, employees are most interested in the 4/40 compressed work week.

Interest in telecommuting is confined to three types of businesses: government, services, and finance-related industries. Less than 10 percent of the wholesale worksites showed an interest in telecommuting, but this may be because of the very nature of the type of work. Two other industries that represent a significant percentage of the total amount of worksites, transportation & public utilities and manufacturing, have little interest in telecommuting.

### **PROBLEMS ENCOUNTERED WITHIN THE ETR DATABASE**

While developing the database, a number of problems or instances where the information provided in the worksite company file was incomplete, incorrect, or contradictory to other materials found in the file were encountered. The following are some common problems or errors found when the database was created:

## **ETR Worksite Registration Form**

- No company registration form present in worksite file
- Multiple registration forms reflecting different information for the same worksite included in the file
- Company name entered as worksite name
- Company address including zip code information entered as worksite address
- SIC Code information missing
- SIC Code information is incorrect
- Multiple SIC Code information entered for worksite without delineating hierarchy
- Total number of registered employees and contract employees at worksite missing
- Number of employees arriving to worksite between 6:00 a.m. and 10:00 a.m. missing
- Companies combined contract employees with regular worksite employee counts

## **Average Passenger Calculation Form**

- Number of employees scheduled to arrive between 6:00 a.m. and 10:00 a.m. does not match the number listed on the ETR Worksite Registration Form
- Average miles to work, one way missing
- Average minutes to work, one way missing
- Failed to submit one APO calculation form for each worksite within the company
- Worksite created APO form that was slightly different from the official TNRCC APO calculation form
- APO calculations wrong - internal mathematical errors on the form

## **Employee Survey Results - Alternative Mode Preferences**

- Percent responding positively missing when survey indicates employees were asked about a particular incentive or measure
- Employees were only asked to respond to selected incentives or measures rather than to all of the incentives and measures found on the employee survey sheet

## **Summary of Trip Reduction Measures - Worksite ETR Plan**

- Non response in the offered columns but would show the status of the incentive or measure as new, revised, or existing
- Worksite indicated that measure or incentive would not be offered but would check the status of the measure as new or revised

Depending on the type of information involved, omissions or errors by the worksite could create difficulties when comparing data with other worksites. For example, incomplete data for employee preferences at multiple worksites created varying employee survey populations within the



database. Several tests were created in the SAS program to account for any discrepancies in the information.

## **CHAPTER V CONCLUSIONS**

### **ATTITUDES TOWARD THE ETR PROGRAM**

Employers and employees challenged the validity of the ETR program on several points. Employers found the ETR mandates to be very costly and time consuming. The trip reduction mandates challenged employers to review traditional management practices to reduce vehicle trips to the worksite. Company ETCs also discovered that Houston's land development patterns often conflicted with trip reduction strategies. Employees argued that the program was an infringement upon their privacy rights because they felt that the government was dictating how they travel.

The ETR program changed dramatically when it was transformed from a mandatory program to a voluntary program. Any potential benefits that the program may have achieved, changed with the new ruling of "encouraging" ridesharing programs rather than "requiring" employees to rideshare. The new ruling, however, does satisfy employers who felt that requiring companies to develop ridesharing programs was onerous, and would have achieved minimal improvements in Houston's air quality.

### **INDIRECT TRAVEL**

Indirect trip changes represent: (a) the increase in trips by other household members because of the availability of an extra vehicle; and (b) for participants in telecommuting and compressed work week programs, the additional trips made by the employee on the day off. Initial indications from this study show that 81.3 percent of ETR-affected employees state that their vehicle would remain unused at home if they participated in a trip reduction strategy. Of the 18.7 percent of employees who stated the vehicle left at home would be used, 10.3 percent reported that the vehicle would be used for non-work trips by another household member, and 8.4 percent stated the other household members would use it for work-related trips.

### **MOBILE SOURCE EMISSIONS AND FUEL CONSUMPTION**

Based on this study, the ETR program would have reduced VOC and NO<sub>x</sub> emission by 3 tons per day, each; CO emissions would have been reduced by 25 tons per day. These reduction estimates would only be achieved if the program experienced a 100 percent compliance and the target APO levels were met. Fuel consumption would have been reduced by 53,000 gallons daily if this program were carried out with the assumed characteristics. The effect of indirect travel would have discounted the total benefits of the ETR program by 12 percent. This represents a large share of predicted benefits being lost to induced trip making through indirect trips.

## **ETR PROGRAM CHARACTERISTICS**

A database was created from 1,224 registered worksite files. A total of 1,791 worksites was required to register with the TNRCC, but approximately 200 to 300 worksite plans and surveys were yet to be filed by TNRCC when the database was created. Another 200 Independent School District (ISD) worksites were not included in the ETR database because of the uncertain nature of ISDs being required to comply with the regulation. This database represents the most comprehensive collection of employee and employer preferences toward TCM/TDM strategies on a regional scale in Texas.

The database contains a total of 396,488 employees in the eight-county nonattainment area that arrive to the worksite between 6:00 a.m. and 10:00 a.m.. Nine employment centers were defined as part of this study: Energy Corridor, Westchase, Galleria, Greenspoint, CBD/Downtown, Greenway Plaza, Medical Center, Petrochemical, and Clearwater/Clear Lake/NASA. Approximately, 182,000 employees work in these employment centers with the remaining total working throughout the eight-county region. While only 30 percent of the registered worksites are in the employment centers, the total employee population for all of the employment centers represents 46 percent of the total amount of employees in the database.

An examination of employee characteristics showed that more employees work at manufacturing and service worksites than in any other SIC category. Manufacturing accounts for 20 percent of the total employee population, while the service-related industries account for 22 percent of the total employee population. Unlike manufacturing, one-half of those considered service-type employees work within the employment centers.

A correlation between higher APO levels and proximity to HOV lanes and access to transit services was found. The average APO gets progressively lower the farther away the employment center or region is from downtown and/or from the HOV lanes. The CBD/Downtown has the largest average baseline APO of 1.45. This APO level is just below the target APO of 1.47 determined by H-GAC. Employment centers outside Houston's inner loop do not benefit from HOV lanes; Houston's HOV lanes currently are unidirectional and do not serve demand for trips on Houston's fringe. Transit access for these employment centers also decreases as the distance from the inner loop increase. Transit has typically served the CBD area and functions on a more radial system. The impacted employment centers (away from the CBD/Downtown) average APO levels slightly more than the minimum 1.0.

Interest in TDM/TCM strategies differed between employees and their employers. Table 5-1 shows some higher ranked incentives by employees and employers.

**TABLE 5-1**  
**Summary of Incentives Rated Highest Among Employees/Employers**

<b>Employees</b>	<b>Employers</b>
4/40 compressed work week	Free carpool/vanpool matching list of others to rideshare with
Guaranteed ride home programs	More information regarding bus routes
Variable/flexible work hours	Guaranteed ride home for emergencies and unscheduled overtime
	Preferential parking for carpools/vanpools
	Variable/flexible work hours
	Compressed work weeks

The impact of worksite location is more evident in the employer preferences rather than the employee preferences. Employer interest increases with the proximity to the CBD/Downtown for the following ridesharing strategies:

- more information regarding bus routes
- bus fare subsidies
- carpool subsidies
- vanpool subsidies
- parking strategies

Employer interest in implementing some TDM/TCM incentives and measures was typically greater for larger companies than in small to medium-sized worksites. Compressed work weeks, variable/flexible work hours, and telecommuting each received greater interest among larger worksites. Interest in bus fare, carpool, and vanpool subsidies was greater by small to medium worksites than at larger worksites. Employees, though, had a greater interest in subsidies for carpools and vanpools than employers regardless of worksite size.

Quantifying the effect of business type on TDM/TCM selection/preference was less tangible than worksite location or size. A few trends were evident though. Government, services, finances, and wholesale trade industries consistently supported ridesharing incentives and measures at worksites. Alternative work schedules and arrangements, such as compressed work weeks, variable/flexible work hours, and telecommuting were also supported. Interest in telecommuting was confined to three types of businesses: government, services, and finance-related industries.

While developing the ETR database, a number of problems or instances where the information provided in the worksite company file was incomplete, incorrect, or contradictory to

other materials found in the file were encountered. The problems were filtered through database management and statistical checks.

## **CHAPTER VI**

### **RECOMMENDATIONS FOR FUTURE RESEARCH**

1. Evaluate the Regional Commute Alternatives Program (RCAP) in Houston, Texas,

This study was initiated to evaluate the effectiveness of the ETR program in Houston, Texas. During the study, the ETR program was repealed, lifting all regulatory requirements previously placed on Houston employers. In a cooperative effort, the TNRCC started RCAP in place of the formal ETR program. RCAP is a voluntary program and efforts should be undertaken to monitor the participation of Houston employers in this program. Further efforts should be made to ascertain the travel, mobile source emission, and fuel consumption benefits of this voluntary program.

2. Further develop regional monitoring plans.

Two examples of regional monitoring plans are contained in this report. These examples provide future analysts a beginning point from which to improve the scope and accuracy of new monitoring plans. Regional monitoring plans are important to metropolitan areas, especially those deemed nonattainment, in both assessing the effectiveness of newly implemented and existing TDM/TCM programs, and identifying geographic areas or population segments that might be better served by refined or additional TDM/TCM programs.

3. Continue work on defining and quantifying the effects caused by indirect trips.

A limited effort in quantifying the effects of indirect trips from automobiles left at home was performed as part of this study; however, the results of this effort did lead to the discovery that up to 12 percent of a TDM strategy's benefits might be reduced from these indirect trips. Policy makers should be fully informed about a potential effectiveness of a trip reduction program. Also, the profession's understanding of these trip types will help to evaluate potential TCM projects better.

4. Continue analysis of TDM/TCM strategies preferred by employees and employers in Houston, Texas.

The ETR database is the most comprehensive database of employee and employer preferences toward various TDM/TCM strategies in Houston, Texas. This study initiated a detailed analysis of these preferences, and how employee and employer attitudes may be affected by worksite location, worksite size, worksite type, and proximity to HOV lanes and transit access.

Houston, Texas, similar to other southwestern cities, has experienced a tremendous amount of growth in recent years. This growth has been defined by automobile accessibility and suburban development patterns. By studying attitudinal preferences in Houston, a better understanding of what policies and programs that may be applicable to other suburban cities may be developed. A better understanding of these preferences may be gained through further analysis of this information.

5. Develop a Statewide Voluntary Trip Reduction Program.

The mandatory trip reduction requirements have been removed from Houston, Texas; however, Houston will continue to experience a growth in vehicle miles driven and concurrently experience a growth in mobile source emissions. Other cities in Texas are or will experience similar scenarios. The ETR program was an attempt to correct or manage VMT and mobile source emissions.

A voluntary trip reduction program, called the Regional Commute Alternatives Program (RCAP) is being initiated in Houston, to encourage all drivers to participate in trip reduction efforts voluntarily. The objectives of RCAP are similar to ETR, but the new program addresses all trips, whatever purpose, rather than placing responsibility on employers to reduce work related trips. A better understanding of the programs and policies needed to support voluntary trip reduction efforts throughout the state is required. The creation of new legislation or policies directed at curbing the growth of VMT and auto-related pollution would require decision makers to have a basic understanding of the support programs and outreach efforts vital to start such a program. The ETR database developed for the purposes of this project is one information source that could increase the basic understanding of what is needed to start a statewide program.

## REFERENCES

1. Patricia Hu and Jennifer Young. *1990 NPTS Databook, National Personal Transportation Survey*, Report No. FHWA-PL-94-010A. Federal Highway Administration, Washington, D.C. November 1993
2. Houston-Galveston Area Council. April 1996.
3. Waldo Lopez-Aqueres. "Conceptual Framework To Study the Effectiveness of Employer Trip-Reduction Programs," in *Transportation Research Record 1404*. Transportation Research Board, Washington D.C. 1993.
4. Eric T. Ferguson. "Evaluation of Employer-Sponsored Ridesharing Programs in Southern California," in *Transportation Research Record 1280*. Transportation Research Board, Washington D.C. 1990.
5. Kenneth C. Orski. "Evaluation of Employee Trip Reduction Programs Based on California's Experience with Regulation XV." Issue Papers for the 1993 ITE International Conference Held in Orlando, Florida 14-17 March, by the Institute of Transportation Engineers: Washington D.C.. 1993, pps. 155-165.
6. Katherine Kerr. "Breath of clean air to cost a bundle." Houston Post, Houston, TX. 1 March 1991, p. A-25.
7. Gaynell Terrell. "Industry has to clean up its act, and rules may pull plug on some." Houston Post, Houston, TX. 7 December 1992, 1A, pps. 1 & 13.
8. Gaynell Terrell. "Employers unhappy with new rules to reduce driving." Houston Post, Houston, TX. 1 July 1992, p. A-15.
9. Brian Wolfe. "Employer Trip Reduction (ETR) in Houston." TDM Review I, No. II (September 1993): pps. 12-19.
10. TNRCC Office of Air Quality - Mobile Source Division. "Employer Trip Reduction Program Update." [<http://www.tnrcc.state.tx.us/air/ms/etr495.htm>]. Last modified October 19, 1995.
11. TNRCC Office of Air Quality - Mobile Source Division. "Employer Trip Reduction Program Update." [<http://www.tnrcc.state.tx.us/air/ms/etruptd.htm>]. Last modified November 1, 1995.
12. David Ivanovich. "Clean Air Act will back off on car pools: Big firms get breathing room on regulations for rush hour." Houston Chronicle, Houston, TX. 6 September 1994, 1A, pps 1 & 8.



13. Texas Natural Resource Conservation Commission. "Employer Trip Reduction UPDATE." Texas Natural Resource Conservation Commission, Austin, TX. June 5, 1995.
14. Gaynell Terrell. "Sharing rides to work soon to be law of land." Houston Post, Houston, TX. 8 December 1992, pps A-13 & A-15.
15. Texas Natural Resource Conservation Commission ETR Registration Database. Texas Natural Resource Conservation Commission, Austin, TX. November 1994.
16. Systems Applications International. *Methodologies for Estimating Emission and Travel Activity Effects of TCMs*. Report No. EPA-420-R-94-002. U.S. Environmental Protection Agency, Office of Mobile Sources and Office of Air Quality Planning and Standards, Ann Arbor, MI. July 1994.
17. D. Burch. "RIDES' 1990 Database Survey" April 1990.
18. S.R. Consultants Inc, and Sierra Research, Inc. "Analysis of Potential Transportation Control Measures in the Houston-Galveston Area." Prepared for Houston-Galveston Area Council. February 1994.
19. Andy Mullins. Houston-Galveston Area Council. Fax message on November 3, 1994.
20. "User's Guide to MOBILE5." U.S. Environmental Protection Agency, Office of Mobile Sources, Ann Arbor, MI. 1994.
21. McGill, R. "Fuel Consumption and Emission Values for Traffic Models," *Report FHWA/RD-85/053*. Federal Highway Administration, Washington, D.C., 1985.
22. Texas Natural Resource Conservation Commission. *Revisions to the State Implementation Plan (SIP) for the Control of Ozone Air Pollution: Fix-ups to the 15% Rate-of-Progress SIP for Dallas/Fort Worth, El Paso, Beaumont/Port Arthur, and Houston/Galveston Ozone Nonattainment Areas, Employer Trip Reduction Program SIP, El Paso Section 818 Attainment Demonstration, Post-1996 Rate-of-Progress SIP for Beaumont/Port Arthur and Houston/Galveston Ozone Nonattainment Areas, and Summary of the Revised 1990 Base Year Ozone Nonattainment Area State Implementation Plan Emission Inventory for All Texas Nonattainment Areas*. Texas Natural Resource Conservation Commission, Austin, TX. July 24, 1996.
23. Houston-Galveston Area Council. Telephone conversation with Ranga Kandelam. June 12, 1996.

24. Marilyn Gross and Richard N. Feldman. Table 91, *National Transportation Statistics 1996. Report DOT-BTS-VNTSC-95-4*. U.S. DOT, Bureau of Transportaiton Statistics, Washington, DC. November 1995.

**APPENDIX A**  
**ACRONYMS AND DEFINITIONS**

## Appendix A: Acronyms and Definitions

---

<u>Acronym</u>	<u>Definition</u>
----------------	-------------------

APO	Average passenger occupancy. Applies to the average number of employees per vehicle equivalent arriving at a specific employer's worksite during the morning peak travel period and equals the number of employees reporting to a worksite between 6:00 a.m. and 10:00 a.m., Monday through Friday, divided by the number of vehicle equivalents in which employees report to work minus the APO credit ( <u>A1</u> ).
APO credit	The number of vehicle equivalents less than that needed to achieve the target APO for an employer for the previous year. The APO credit equals the number of vehicle equivalents used in calculating the target APO minus the actual number of vehicle equivalents measured in the survey ( <u>A1</u> ).
AVO	Average vehicle occupancy. The baseline number of employees per vehicle equivalents throughout the nonattainment area or a zone within the nonattainment area which has been measured for the year of the State Implementation Plan submission. The AVO applies to all commuting trips in the area between home and the worksite during the defined peak travel period of 6:00 a.m. and 10:00 a.m., Monday through Friday. Therefore, all commuters, including those who work for employers which less than 100 employees and who commute during the peak travel period, are included in this calculation ( <u>A1</u> ).
CAAA	Clean Air Act Amendments of 1990.
CO	Carbon monoxide. Odorless and colorless poisonous gas formed as a product of incomplete burning of fuel ( <u>A2</u> )
cst	Cold start. Trip start emission that produces the highest rate of emissions. Defined by EPA for a catalyst-equipped vehicle to occur after the engine has been turned off for 1 hour; noncatalyst vehicle require the engine to have been turned off for 4 hours.
ECO	Employee Commute Options program.
ETC	Employee transportation coordinator. Responsible for coordinating all trip reduction strategies at a worksite. Must receive training, be certified and registered with the state implementing agency.
ETR	Employer Trip Reduction program.

## Appendix A: Acronyms and Definitions

---

Employee	Any person, excluding volunteers, employed by a firm, person(s), business, educational institution, nonprofit agency or corporation, government department or agency, or other entity ( <u>A1</u> ).
Employer	Any person(s), firm, business, educational institution, government department or agency, nonprofit agency or corporation, or other entity which employs, by direct payroll or through contract, 100 or more persons at a single worksite. Entities under a common regulating body are considered a single employer and will require a single plan if they occupy a common worksite, unless each entity has 100 or more employees ( <u>A1</u> ).
HC	Hydrocarbons. Formed from incompletely burned or evaporated gasoline or solvents ( <u>A2</u> ). A known precursor to the formation of ground-level ozone.
HGAC	Houston-Galveston Area Council. The designated metropolitan planning organization for the eight county urban area of Houston, Texas.
HOV	High occupancy vehicle A passenger vehicle carrying more than one person.
hsk	Hot soak. When the vehicle's engine is turned off, the engine heat may cause exposed fuel to evaporate into the atmosphere.
hst	Hot start. Trip start emission associated with turning the vehicle's engine on after being turned off within 1 hour for catalyst-equipped vehicles and 4 hours for noncatalyst vehicles.
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991.
METRO	The Houston Metropolitan Transit Authority. The regional public transit authority.
MPO	Metropolitan planning organization.
NOX	Oxides of nitrogen. Formed as a product of high-compression internal combustion engines ( <u>A2</u> ). A known precursor the formation of ground-level ozone.
Peak travel period	The time between 6:00 a.m. and 10:00 a.m., Monday through Friday ( <u>A1</u> ).
PM10	Small particulate matter less than 10 micros in diameter. Generated from several sources including combustion by-product and tire wear.

## Appendix A: Acronyms and Definitions

---

SIC	Standard Industry Code. Used to identify the activity of a particular employment site.
TACB	Texas Air Control Board. Former state agency responsible for regulating and enforcing state and federal environmental legislation. Also see TNRCC.
TNRCC	Texas Natural Resource Conservation Commission. State agency responsible for regulating and enforcing state and federal environmental legislation.
VE	Vehicle equivalent. The calculated fraction of a motor vehicle used by each employee for commuting during the peak travel period ( <u>A1</u> ). Single occupant vehicle = 1.00 VE 4-Person carpool = 0.25 VE Employee using transit = 0.00 VE
Work-related trips	Trips between home and the worksite, including any stops en route to work during the peak travel period. ( <u>A1</u> )
Worksite	Unit of measure in the ECO program. A building or a group of buildings which are in actual physical contact or separated only by a private or public roadway or other private or public right-of-way and which are owned or operated by the same employer or by employers under common control as described under the employer definition ( <u>A1</u> ).

## References

- A1. Texas Air Control Board. "Employer Trip Reduction Program: Houston-Galveston Area." Texas Air Control Board, Austin, Texas. October 16, 1992.
- A2. W.S. Homburger and J.H. Kell. Fundamentals of Traffic Engineering, 12th Edition. Institute of Transportation Studies, University of California at Berkeley: Berkeley, California. January 1988.

**APPENDIX B**

**MOBILE SOURCE EMISSIONS PRIMER**

## **VEHICLE EMISSIONS DESCRIPTION**

A large number of pollutants are emitted into the atmosphere by motor vehicles. Three particular emission components are of highest concern: carbon monoxide (CO), volatile organic compounds (VOC) and oxides of nitrogen (NO<sub>x</sub>). VOC and NO<sub>x</sub> are known precursors to the formation of ozone. Ozone is formed when VOC and NO<sub>x</sub> react in the presence of sunlight.

Two processes produce emissions from motor vehicles: emissions from the vehicle's exhaust system, and evaporative emissions from the vehicle's fuel storage and delivery system. These two processes are further divided into different categories of emissions. The following is a brief discussion of the different categories of emissions from motor vehicles.

### **Exhaust Emissions**

#### *Cold Start*

Current catalytic emission control systems do not initiate full emission control until they reach their operating temperature. Also, under cold conditions a richer fuel-air mixture is provided to the cylinders to achieve satisfactory engine performance. A much higher VOC and CO emissions rate occurs during cold starts because of these factors.

#### *Hot Start*

The VOC and CO emission rates are much lower for engines that have warmed from previous use, than for cold starts. A warm engine does not require a rich fuel-air mixture like a cold engine and also the emission control system performs more efficiently.

#### *Hot Stabilized*

The vehicle is considered to be in hot stabilized mode after the engine has warmed and the emission control systems attains optimal operating temperatures. Under these conditions the emission rates are lower and are mainly dependent upon vehicle speed and engine load.

#### *Idle Emissions*

Idle emissions are the product of an idling engine.



## **Evaporative Emissions**

Evaporative emissions consist of Hydrocarbons entirely. These can be categorized into four groups.

### *Hot Soak*

When the engine is turned off, the engine heat may cause fuel exposed to it to evaporate into the atmosphere. These emissions are called hot soak emissions.

### *Diurnal*

These emissions are caused by diurnal temperature fluctuations over a 24-hour period. The fuel in the tank evaporates due to these fluctuations.

### *Running Losses*

Running loss emissions are those vapors generated during engine operation in gasoline tanks.

### *Resting Losses*

These are emissions resulting from vapors permeating parts of the evaporative emission control system (e.g., rubber vapor routing hoses), migrating out of the carbon canister, or evaporating liquid fuel leaks.

Detailed discussion of vehicle emissions are available in many sources including the MOBILE5a User's Manual.

## References

1. "User's Guide to MOBILE5," U.S. Environmental Protection Agency, Office of Mobile Source, Ann Arbor, MI. 1994.

**APPENDIX C**  
**HOUSTON TRAVEL SURVEY EXAMPLE**

Record Types 1, 2, and 3

HOUSEHOLD TRAVEL SURVEY  
PART 1: HOUSEHOLD INFORMATION

Sample # \_\_\_\_\_

Thank you for agreeing to participate in this important travel survey. If you have any questions, please call \_\_\_\_\_.

- 1 A. Is this your correct mailing address?
- ☐
- Yes
- ☐
- No If not, please enter the correct information on the lines below.

---



---

- B. Is your residence:
- ☐
- Single family detached
- 
- ☐
- Multi-unit (apartment/condo/townhouse)

C. How many people live at this address? \_\_\_\_\_

D. How many of the people who live at this address are five years old or older? \_\_\_\_\_

E. How many people visited your residence on this day who do not live there? \_\_\_\_\_

F. How many people in your household are employed? \_\_\_\_\_

G. How many vehicles (cars, vans, light trucks, and motorcycles) are available for use by members of your household? \_\_\_\_\_

- 2 Please assign a "Person Number" to each person residing in your household who is five years old or older, starting with "Person Number 1" as the designated head of the household. (Fill in appropriate question boxes for each person.)

Person Number	Sex M / F	Age	Licensed Driver? (circle one)	Relation to Person No. 1 (check box)				Employed? (circle one)	Did He/She Travel on the "Travel Day"? (circle one)
				2 Spouse	3 Child	4 Relative	5 Not Related		
Head of Household			1) Yes 2) No					1) Yes 2) No	1) Yes 2) No
2			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No	1) Yes 2) No
3			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No	1) Yes 2) No
4			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No	1) Yes 2) No
5			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No	1) Yes 2) No
6			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No	1) Yes 2) No
7			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No	1) Yes 2) No
8			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No	1) Yes 2) No
9			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No	1) Yes 2) No
10			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No	1) Yes 2) No

- 3 Please list all vehicles available to your household (including company cars, rental cars, motorcycles, etc.) and complete the following:

Vehicle Number	Year	Make	Model	Circle One	Odometer Readings On Travel Day	
					Beginning	Ending
1				Gas Diesel		
2				Gas Diesel		
3				Gas Diesel		
4				Gas Diesel		
5				Gas Diesel		

- 4 If you add up the
- annual
- income of
- all
- household members, into what range does it fall? (check one)

- 1) ☐ Less than \$5,000  
 2) ☐ \$5,000 to \$9,999  
 3) ☐ \$10,000 to \$14,999  
 4) ☐ \$15,000 to \$19,999  
 5) ☐ \$20,000 to \$24,999  
 6) ☐ \$25,000 to \$29,999  
 7) ☐ \$30,000 to \$34,999  
 8) ☐ \$35,000 to \$39,999  
 9) ☐ \$40,000 to \$49,999  
 10) ☐ \$50,000 or more

This completes the household information needed. Please proceed to Section 2 of this survey. Thank you for your cooperation!

## HOUSEHOLD TRAVEL SURVEY

## PART 2: TRIP INFORMATION

## FOR PERSON NUMBER 1 (Refer to Question 2 of the Household Information Questionnaire)

SAMPLE # : \_\_\_\_\_

Please fill out this form for ONE person only. Please enter your travel day: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

Month / Day

BEGIN: MY FIRST TRIP TODAY BEGAN AT: ☐ (1) Home ☐ (9) Other Location

PLEASE ENTER YOUR:

(Fill in address)

TRAVEL DAY: \_\_\_\_\_

Month / Day

DEPARTURE TIME: \_\_\_\_\_ a.m.  
\_\_\_\_\_ p.m.

(Place/address or nearest intersection) (city/state/zip code)

Trip Number	Location Address	When did you get here/leave here?	Type of Activity at this location (check one)	Purpose of Trip (check one)	Mode of Transportation (check one)	Total number of people in car/truck/van (including self)	If Driver, what vehicle was used? (make/model)	If Bus, what was the fare? How did you get to the bus stop?
1 FIRST I WENT TO:	Name of place Address or nearest intersection	Arrive A.M. _____ P.M. _____	<input type="checkbox"/> Residential <input type="checkbox"/> Basic <input type="checkbox"/> Manufacturing/Wholesale <input type="checkbox"/> Utility/Transportation/Communications <input type="checkbox"/> Construction <input type="checkbox"/> Retail <input type="checkbox"/> Commercial/Retail/Food <input type="checkbox"/> Services <input type="checkbox"/> Finance/Insurance/Real Estate <input type="checkbox"/> Governmental <input type="checkbox"/> Educational <input type="checkbox"/> Services <input type="checkbox"/> Park/OpenSpace <input type="checkbox"/> Other _____	<input type="checkbox"/> Return Home <input type="checkbox"/> Go to Work <input type="checkbox"/> Work Related <input type="checkbox"/> School <input type="checkbox"/> Social/Recreational / Eat <input type="checkbox"/> Shop/Buy Gas, Etc. <input type="checkbox"/> Pick up/Drop off <input type="checkbox"/> Passenger <input type="checkbox"/> Change Travel Mode <input type="checkbox"/> Other _____	<input type="checkbox"/> Driver (car/truck/van/motorcycle) <input type="checkbox"/> Passenger (car/truck/van/motorcycle) <input type="checkbox"/> Walk <input type="checkbox"/> Bicycle <input type="checkbox"/> Bus <input type="checkbox"/> School Bus <input type="checkbox"/> Taxi <input type="checkbox"/> Commercial Vehicle (over 1 ton) <input type="checkbox"/> Other _____	number of people	Year _____ Make _____ Model _____	Fare: \$ _____ 1) <input type="checkbox"/> Drove and Parked 2) <input type="checkbox"/> Dropped off 3) <input type="checkbox"/> Walked 4) <input type="checkbox"/> Carpooled 5) <input type="checkbox"/> Other _____
	City/State/Zip	Depart A.M. _____ P.M. _____				If you paid parking, what was parking cost? \$ _____		
2 THEN I WENT TO:	Name of place Address or nearest intersection	Arrive A.M. _____ P.M. _____	<input type="checkbox"/> Residential <input type="checkbox"/> Basic <input type="checkbox"/> Manufacturing/Wholesale <input type="checkbox"/> Utility/Transportation/Communications <input type="checkbox"/> Construction <input type="checkbox"/> Retail <input type="checkbox"/> Commercial/Retail/Food <input type="checkbox"/> Services <input type="checkbox"/> Finance/Insurance/Real Estate <input type="checkbox"/> Governmental <input type="checkbox"/> Educational <input type="checkbox"/> Services <input type="checkbox"/> Park/OpenSpace <input type="checkbox"/> Other _____	<input type="checkbox"/> Return Home <input type="checkbox"/> Go to Work <input type="checkbox"/> Work Related <input type="checkbox"/> School <input type="checkbox"/> Social/Recreational / Eat <input type="checkbox"/> Shop/Buy Gas, Etc. <input type="checkbox"/> Pick up/Drop off <input type="checkbox"/> Passenger <input type="checkbox"/> Change Travel Mode <input type="checkbox"/> Other _____	<input type="checkbox"/> Driver (car/truck/van/motorcycle) <input type="checkbox"/> Passenger (car/truck/van/motorcycle) <input type="checkbox"/> Walk <input type="checkbox"/> Bicycle <input type="checkbox"/> Bus <input type="checkbox"/> School Bus <input type="checkbox"/> Taxi <input type="checkbox"/> Commercial Vehicle (over 1 ton) <input type="checkbox"/> Other _____	number of people	Year _____ Make _____ Model _____	Fare: \$ _____ 1) <input type="checkbox"/> Drove and Parked 2) <input type="checkbox"/> Dropped off 3) <input type="checkbox"/> Walked 4) <input type="checkbox"/> Carpooled 5) <input type="checkbox"/> Other _____
	City/State/Zip	Depart A.M. _____ P.M. _____				If you paid parking, what was parking cost? \$ _____		
3 THEN I WENT TO:	Name of place Address or nearest intersection	Arrive A.M. _____ P.M. _____	<input type="checkbox"/> Residential <input type="checkbox"/> Basic <input type="checkbox"/> Manufacturing/Wholesale <input type="checkbox"/> Utility/Transportation/Communications <input type="checkbox"/> Construction <input type="checkbox"/> Retail <input type="checkbox"/> Commercial/Retail/Food <input type="checkbox"/> Services <input type="checkbox"/> Finance/Insurance/Real Estate <input type="checkbox"/> Governmental <input type="checkbox"/> Educational <input type="checkbox"/> Services <input type="checkbox"/> Park/OpenSpace <input type="checkbox"/> Other _____	<input type="checkbox"/> Return Home <input type="checkbox"/> Go to Work <input type="checkbox"/> Work Related <input type="checkbox"/> School <input type="checkbox"/> Social/Recreational / Eat <input type="checkbox"/> Shop/Buy Gas, Etc. <input type="checkbox"/> Pick up/Drop off <input type="checkbox"/> Passenger <input type="checkbox"/> Change Travel Mode <input type="checkbox"/> Other _____	<input type="checkbox"/> Driver (car/truck/van/motorcycle) <input type="checkbox"/> Passenger (car/truck/van/motorcycle) <input type="checkbox"/> Walk <input type="checkbox"/> Bicycle <input type="checkbox"/> Bus <input type="checkbox"/> School Bus <input type="checkbox"/> Taxi <input type="checkbox"/> Commercial Vehicle (over 1 ton) <input type="checkbox"/> Other _____	number of people	Year _____ Make _____ Model _____	Fare: \$ _____ 1) <input type="checkbox"/> Drove and Parked 2) <input type="checkbox"/> Dropped off 3) <input type="checkbox"/> Walked 4) <input type="checkbox"/> Carpooled 5) <input type="checkbox"/> Other _____
	City/State/Zip	Depart A.M. _____ P.M. _____				If you paid parking, what was parking cost? \$ _____		

Record Type 4

## HOUSEHOLD TRAVEL SURVEY

## PART 2: TRIP INFORMATION

SAMPLE # : \_\_\_\_\_

FOR PERSON NUMBER 1 (Refer to Question 2 of the Household Information Questionnaire)

Trip Number	Location Address	When did you get here/leave here?	Type of Activity at this location (check one)	Purpose of Trip (check one)	Mode of Transportation (check one)	Total number of people in car/truck/van (including self)	If Driver, what vehicle was used? (make/model)	If Bus, what was the fare? How did you get to the bus stop?
4 THEN I WENT TO:	<div> <div> <div>Arrive</div> <div> <div>A.M.</div> <div>P.M.</div> </div> </div> <div> <div>Depart</div> <div> <div>A.M.</div> <div>P.M.</div> </div> </div> </div> <div> <div>Name of place</div> <div>Address or nearest intersection</div> <div>City/State/Zip</div> </div>	<div> <div>0) <input type="checkbox"/> Residential</div> <div> <div>1) <input type="checkbox"/> Basic</div> <div> <div>Manufacturing/Wholesale</div> <div>Utility/Transportation/Communications</div> <div>Construction</div> </div> </div> <div> <div>2) <input type="checkbox"/> Retail</div> <div> <div>Commercial/Retail/Food</div> <div>Services</div> <div>Finance/Insurance/Real Estate</div> <div>Governmental</div> <div>Educational</div> <div>Services</div> <div>Park/OpenSpace</div> <div>Other _____</div> </div> </div> </div>	<div> <div>1) <input type="checkbox"/> Return Home</div> <div> <div>2) <input type="checkbox"/> Go to Work</div> <div> <div>3) <input type="checkbox"/> Work Related</div> <div>4) <input type="checkbox"/> School</div> </div> </div> <div> <div>5) <input type="checkbox"/> Social/Recreational / Eat</div> <div> <div>6) <input type="checkbox"/> Shop/Buy Gas, Etc.</div> <div>7) <input type="checkbox"/> Pick up/Drop off</div> </div> <div> <div>8) <input type="checkbox"/> Change Travel Mode</div> <div>9) <input type="checkbox"/> Other _____</div> </div> </div></div>	<div> <div>1) <input type="checkbox"/> Driver (car/truck/van/motorcycle)</div> <div> <div>2) <input type="checkbox"/> Passenger (car/truck/van/motorcycle)</div> <div> <div>3) <input type="checkbox"/> Walk</div> <div>4) <input type="checkbox"/> Bicycle</div> </div> </div> <div> <div>5) <input type="checkbox"/> Bus</div> <div> <div>6) <input type="checkbox"/> School Bus</div> <div>7) <input type="checkbox"/> Taxi</div> </div> <div> <div>8) <input type="checkbox"/> Commercial Vehicle (over 1 ton)</div> <div>9) <input type="checkbox"/> Other _____</div> </div> </div></div>	<div> <div>number of people</div> <div>_____</div> </div> <div> <div>If you paid parking, what was parking cost?</div> <div>\$ _____</div> </div>	<div> <div>Year _____</div> <div>Make _____</div> <div>Model _____</div> </div> <div> <div>Fare: \$ _____</div> </div>	<div> <div>1) <input type="checkbox"/> Drove and Parked</div> <div> <div>2) <input type="checkbox"/> Dropped off</div> <div>3) <input type="checkbox"/> Walked</div> </div> <div> <div>4) <input type="checkbox"/> Carpooled</div> <div>5) <input type="checkbox"/> Other _____</div> </div> </div>	
5 THEN I WENT TO:	<div> <div> <div>Arrive</div> <div> <div>A.M.</div> <div>P.M.</div> </div> </div> <div> <div>Depart</div> <div> <div>A.M.</div> <div>P.M.</div> </div> </div> </div> <div> <div>Name of place</div> <div>Address or nearest intersection</div> <div>City/State/Zip</div> </div>	<div> <div>0) <input type="checkbox"/> Residential</div> <div> <div>1) <input type="checkbox"/> Basic</div> <div> <div>Manufacturing/Wholesale</div> <div>Utility/Transportation/Communications</div> <div>Construction</div> </div> </div> <div> <div>2) <input type="checkbox"/> Retail</div> <div> <div>Commercial/Retail/Food</div> <div>Services</div> <div>Finance/Insurance/Real Estate</div> <div>Governmental</div> <div>Educational</div> <div>Services</div> <div>Park/OpenSpace</div> <div>Other _____</div> </div> </div> </div>	<div> <div>1) <input type="checkbox"/> Return Home</div> <div> <div>2) <input type="checkbox"/> Go to Work</div> <div> <div>3) <input type="checkbox"/> Work Related</div> <div>4) <input type="checkbox"/> School</div> </div> </div> <div> <div>5) <input type="checkbox"/> Social/Recreational / Eat</div> <div> <div>6) <input type="checkbox"/> Shop/Buy Gas, Etc.</div> <div>7) <input type="checkbox"/> Pick up/Drop off</div> </div> <div> <div>8) <input type="checkbox"/> Change Travel Mode</div> <div>9) <input type="checkbox"/> Other _____</div> </div> </div></div>	<div> <div>1) <input type="checkbox"/> Driver (car/truck/van/motorcycle)</div> <div> <div>2) <input type="checkbox"/> Passenger (car/truck/van/motorcycle)</div> <div> <div>3) <input type="checkbox"/> Walk</div> <div>4) <input type="checkbox"/> Bicycle</div> </div> </div> <div> <div>5) <input type="checkbox"/> Bus</div> <div> <div>6) <input type="checkbox"/> School Bus</div> <div>7) <input type="checkbox"/> Taxi</div> </div> <div> <div>8) <input type="checkbox"/> Commercial Vehicle (over 1 ton)</div> <div>9) <input type="checkbox"/> Other _____</div> </div> </div></div>	<div> <div>number of people</div> <div>_____</div> </div> <div> <div>If you paid parking, what was parking cost?</div> <div>\$ _____</div> </div>	<div> <div>Year _____</div> <div>Make _____</div> <div>Model _____</div> </div> <div> <div>Fare: \$ _____</div> </div>	<div> <div>1) <input type="checkbox"/> Drove and Parked</div> <div> <div>2) <input type="checkbox"/> Dropped off</div> <div>3) <input type="checkbox"/> Walked</div> </div> <div> <div>4) <input type="checkbox"/> Carpooled</div> <div>5) <input type="checkbox"/> Other _____</div> </div> </div>	
6 THEN I WENT TO:	<div> <div> <div>Arrive</div> <div> <div>A.M.</div> <div>P.M.</div> </div> </div> <div> <div>Depart</div> <div> <div>A.M.</div> <div>P.M.</div> </div> </div> </div> <div> <div>Name of place</div> <div>Address or nearest intersection</div> <div>City/State/Zip</div> </div>	<div> <div>0) <input type="checkbox"/> Residential</div> <div> <div>1) <input type="checkbox"/> Basic</div> <div> <div>Manufacturing/Wholesale</div> <div>Utility/Transportation/Communications</div> <div>Construction</div> </div> </div> <div> <div>2) <input type="checkbox"/> Retail</div> <div> <div>Commercial/Retail/Food</div> <div>Services</div> <div>Finance/Insurance/Real Estate</div> <div>Governmental</div> <div>Educational</div> <div>Services</div> <div>Park/OpenSpace</div> <div>Other _____</div> </div> </div> </div>	<div> <div>1) <input type="checkbox"/> Return Home</div> <div> <div>2) <input type="checkbox"/> Go to Work</div> <div> <div>3) <input type="checkbox"/> Work Related</div> <div>4) <input type="checkbox"/> School</div> </div> </div> <div> <div>5) <input type="checkbox"/> Social/Recreational / Eat</div> <div> <div>6) <input type="checkbox"/> Shop/Buy Gas, Etc.</div> <div>7) <input type="checkbox"/> Pick up/Drop off</div> </div> <div> <div>8) <input type="checkbox"/> Change Travel Mode</div> <div>9) <input type="checkbox"/> Other _____</div> </div> </div></div>	<div> <div>1) <input type="checkbox"/> Driver (car/truck/van/motorcycle)</div> <div> <div>2) <input type="checkbox"/> Passenger (car/truck/van/motorcycle)</div> <div> <div>3) <input type="checkbox"/> Walk</div> <div>4) <input type="checkbox"/> Bicycle</div> </div> </div> <div> <div>5) <input type="checkbox"/> Bus</div> <div> <div>6) <input type="checkbox"/> School Bus</div> <div>7) <input type="checkbox"/> Taxi</div> </div> <div> <div>8) <input type="checkbox"/> Commercial Vehicle (over 1 ton)</div> <div>9) <input type="checkbox"/> Other _____</div> </div> </div></div>	<div> <div>number of people</div> <div>_____</div> </div> <div> <div>If you paid parking, what was parking cost?</div> <div>\$ _____</div> </div>	<div> <div>Year _____</div> <div>Make _____</div> <div>Model _____</div> </div> <div> <div>Fare: \$ _____</div> </div>	<div> <div>1) <input type="checkbox"/> Drove and Parked</div> <div> <div>2) <input type="checkbox"/> Dropped off</div> <div>3) <input type="checkbox"/> Walked</div> </div> <div> <div>4) <input type="checkbox"/> Carpooled</div> <div>5) <input type="checkbox"/> Other _____</div> </div> </div>	

Appendix C: Houston Travel Survey Example

Record Types 5 and 6

Site #: \_\_\_\_\_

Sample #: \_\_\_\_\_

Survey Location: \_\_\_\_\_

Travel Day: \_\_\_\_\_  
Month/Day

**WORKPLACE EMPLOYEE TRAVEL SURVEY**

**PART 1: HOUSEHOLD INFORMATION**

(If you have participated in prior surveys, please fill out this form anyway.)

Employee's Home Address:

\_\_\_\_\_  
(Street Address or Nearest Intersection)

City

State

ZIP

How many people live at your home address? (Do not count guests) \_\_\_\_\_

How many people living in your household (including yourself) are employed? \_\_\_\_\_  
(Include full- and part-time.)

How many vehicles (cars, vans, light trucks, motorcycles) are available for use by members of your household? \_\_\_\_\_

Please list all vehicles available to your household (including company cars, rental cars, motorcycles, etc.) and complete the following:

Vehicle Number	Year	Make	Model	Circle One	Odometer Readings on Travel Day	
					Beginning	Ending
1				Gas Diesel		
2				Gas Diesel		
3				Gas Diesel		
4				Gas Diesel		
5				Gas Diesel		
6				Gas Diesel		
7				Gas Diesel		

If you add up the annual incomes of all members of your household, into what range does it fall? (Check one)

- |  |   |   |
|--|---|---|
| 1) <input type="checkbox"/> Less than \$5,000    | 6) <input type="checkbox"/> \$25,000 to \$29,999  | 11) <input type="checkbox"/> \$60,000 to \$74,999   |
| 2) <input type="checkbox"/> \$5,000 to \$9,999   | 7) <input type="checkbox"/> \$30,000 to \$34,999  | 12) <input type="checkbox"/> \$75,000 to \$99,999   |
| 3) <input type="checkbox"/> \$10,000 to \$14,999 | 8) <input type="checkbox"/> \$35,000 to \$39,999  | 13) <input type="checkbox"/> \$100,000 to \$124,999 |
| 4) <input type="checkbox"/> \$15,000 to \$19,999 | 9) <input type="checkbox"/> \$40,000 to \$49,999  | 14) <input type="checkbox"/> \$125,000 to \$149,999 |
| 5) <input type="checkbox"/> \$20,000 to \$24,999 | 10) <input type="checkbox"/> \$50,000 to \$59,999 | 15) <input type="checkbox"/> \$150,000 or more      |

This completes the general information needed. Please fill out the attached travel questionnaire to record the trips you make on the travel day. Thank you for your help.

## **APPENDIX D**

### **EMPLOYEE HOUSEHOLD VEHICLE USE SURVEY**

## Employee Household Vehicle Use Survey

This survey is being administered by the Texas Transportation Institute, a part of the Texas A&M University System, and sponsored by the US Department of Transportation. The survey will be used to improve transportation planning techniques for future program/infrastructure developments. Please take a few minutes to answer the questions below and return the survey in the attached envelope. Please contact Mr. K. S. Rao at (409) 845-9902 or Mr. Kevin Hall at (409) 845-9947 if you have any questions concerning this survey. Thank you for your time and assistance. Your help is appreciated.

**1** Name (Optional) \_\_\_\_\_

Home Zipcode \_\_\_\_\_

- A. Is your residence: ☐ Single family detached  
☐ Multi-unit (apartment/condo/townhouse)
- B. How many people live at this address (excluding guests)? \_\_\_\_\_
- C. How many of the people who live at this address are five years old or older? \_\_\_\_\_
- D. How many people in your household are employed: Full-time? \_\_\_\_\_ Part-time? \_\_\_\_\_

**2** Please assign a "Person Number" to each person residing in your household who is five years old or older, starting with "Person Number 1" as the designated head of the household. (Fill in appropriate question boxes for each person.)

Person Number	Sex M / F	Age	Licensed Driver? (circle one)	Relation to Person No. 1 (check box)				Employed? (circle one)
				2 Spouse	3 Child	4 Relative	5 Not Related	
Head of Household			1) Yes 2) No					1) Yes 2) No
2			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No
3			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No
4			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No
5			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No
6			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No
7			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No
8			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No
9			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No
10			1) Yes 2) No	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1) Yes 2) No

**Continue on back side of sheet**





**3** How many vehicles of each type are available for use by members of your household?

	Cars	Vans	Light Trucks	Motor Cycles
Own				
Company				
Other				

**4** If you add up the annual income of all household members, into what range does it fall? (check one)

- |  |   |   |
|--|---|---|
| 1) <input type="checkbox"/> Less than \$5,000    | 6) <input type="checkbox"/> \$25,000 to \$29,999  | 11) <input type="checkbox"/> \$60,000 to \$74,999   |
| 2) <input type="checkbox"/> \$5,000 to \$9,999   | 7) <input type="checkbox"/> \$30,000 to \$34,999  | 12) <input type="checkbox"/> \$75,000 to \$99,999   |
| 3) <input type="checkbox"/> \$10,000 to \$14,999 | 8) <input type="checkbox"/> \$35,000 to \$39,999  | 13) <input type="checkbox"/> \$100,000 to \$124,999 |
| 4) <input type="checkbox"/> \$15,000 to \$19,999 | 9) <input type="checkbox"/> \$40,000 to \$49,999  | 14) <input type="checkbox"/> \$125,000 to \$149,999 |
| 5) <input type="checkbox"/> \$20,000 to \$24,999 | 10) <input type="checkbox"/> \$50,000 to \$59,999 | 15) <input type="checkbox"/> \$150,000 or more      |

**5** Do you normally drive alone to work every day of the week? ☐ YES ☐ NO

If no, how might your vehicle be used by other family members on the day(s) you do not drive it to work (to the best of your knowledge)? Please check all that apply below:

- |  |   |
|--|---|
| <input type="checkbox"/> remains at home unused                | <input type="checkbox"/> used by someone to go to/from work (job)       |
| <input type="checkbox"/> used by someone to go to school       | <input type="checkbox"/> used by someone instead of their usual vehicle |
| <input type="checkbox"/> do not currently own a vehicle        |   |
| <input type="checkbox"/> used for other purposes such as _____ |   |

If yes, how might other family members use your vehicle if it was left at home and you went to work by other means (like bus or sharing the ride with a coworker). Provide your best guess and check all that apply below:

- |  |   |
|--|---|
| <input type="checkbox"/> remains at home unused                | <input type="checkbox"/> used by someone to go to/from work (job)       |
| <input type="checkbox"/> used by someone to go to school       | <input type="checkbox"/> used by someone instead of their usual vehicle |
| <input type="checkbox"/> do not currently own a vehicle        |   |
| <input type="checkbox"/> used for other purposes such as _____ |   |

This completes the survey information needed. **Thank you for your cooperation!**

Comments (if any):

**APPENDIX E**

**FUEL CONSUMPTION RATES**

Fuel Consumption (ml/second) (v=0 to 110fps; a=-9 to 12fpsps)  
Format (22F8.4,14)

-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	V(fps)
0.4768	0.4768	0.4768	0.4768	0.4768	0.4768	0.4768	0.4768	0.4768	0.4771	0.6500	0.6943	0.7525	0.8332	0.9040	1.0020	1.1073	1.2026	1.2515	1.2915	1.3033	1.3033	0
0.4818	0.4818	0.4818	0.4818	0.4818	0.4818	0.4818	0.4818	0.4818	0.4821	0.6431	0.7142	0.8001	0.8897	0.9710	1.0671	1.1897	1.3122	1.4020	1.5040	1.5793	1.5892	1
0.4978	0.4978	0.4978	0.4978	0.4978	0.4978	0.4978	0.4978	0.4978	0.4984	0.6488	0.7521	0.8645	0.9634	1.0606	1.1623	1.2966	1.4303	1.5297	1.6329	1.7331	1.8284	2
0.5206	0.5206	0.5206	0.5206	0.5206	0.5206	0.5206	0.5206	0.5206	0.5215	0.6625	0.7950	0.9304	1.0536	1.1720	1.2900	1.4342	1.5804	1.6914	1.8007	1.9092	2.0048	3
0.5457	0.5457	0.5457	0.5457	0.5457	0.5457	0.5457	0.5457	0.5457	0.5471	0.6801	0.8369	0.9935	1.1621	1.3007	1.4489	1.5969	1.7600	1.8856	2.0137	2.1618	2.2621	4
0.5688	0.5688	0.5688	0.5688	0.5688	0.5688	0.5688	0.5688	0.5688	0.5708	0.7036	0.8821	1.0633	1.2832	1.4397	1.6202	1.7698	1.9548	2.1003	2.2548	2.4201	2.5263	5
0.5859	0.5859	0.5859	0.5859	0.5859	0.5859	0.5859	0.5859	0.5859	0.5885	0.7361	0.9356	1.1491	1.4047	1.5827	1.7847	1.9396	2.1524	2.3248	2.5046	2.6761	2.7816	6
0.5969	0.5969	0.5969	0.5969	0.5969	0.5969	0.5969	0.5969	0.5969	0.5993	0.7779	0.9994	1.2499	1.5185	1.7278	1.9390	2.1081	2.3519	2.5563	2.7516	2.9058	3.0103	7
0.6034	0.6034	0.6034	0.6034	0.6034	0.6034	0.6034	0.6034	0.6034	0.6052	0.8261	1.0710	1.3567	1.6273	1.8722	2.0915	2.2921	2.5588	2.7928	2.9938	3.1426	3.2465	8
0.6071	0.6071	0.6071	0.6071	0.6071	0.6071	0.6071	0.6071	0.6071	0.6084	0.8798	1.1476	1.4596	1.7372	2.0122	2.2501	2.5026	2.7709	3.0328	3.2372	3.3881	3.4880	9
0.6095	0.6095	0.6095	0.6095	0.6095	0.6095	0.6095	0.6095	0.6095	0.6109	0.9349	1.2246	1.5530	1.8482	2.1465	2.4100	2.7199	2.9805	3.2756	3.4830	3.6358	3.7222	10
0.6114	0.6114	0.6114	0.6114	0.6114	0.6114	0.6114	0.6114	0.6114	0.6147	0.9874	1.2954	1.6365	1.9594	2.2785	2.5597	2.9114	3.1864	3.5110	3.7238	3.8751	3.9453	11
0.6138	0.6138	0.6138	0.6138	0.6138	0.6138	0.6138	0.6138	0.6138	0.6214	1.0378	1.3567	1.7142	2.0728	2.4072	2.6885	3.0646	3.3879	3.7309	3.9500	4.0933	4.1486	12
0.6168	0.6168	0.6168	0.6168	0.6168	0.6168	0.6168	0.6168	0.6168	0.6306	1.0955	1.4199	1.7956	2.1891	2.5297	2.8085	3.2024	3.5837	3.9383	4.1637	4.2785	4.3299	13
0.6199	0.6199	0.6199	0.6199	0.6199	0.6199	0.6199	0.6199	0.6199	0.6416	1.1659	1.4999	1.8902	2.3057	2.6462	2.9409	3.3489	3.7752	4.1387	4.3753	4.4545	4.5069	14
0.6234	0.6234	0.6234	0.6234	0.6234	0.6234	0.6234	0.6234	0.6234	0.6536	1.2659	1.5947	2.0026	2.4185	2.7560	3.0942	3.5193	3.9685	4.3356	4.5724	4.6220	4.6787	15
0.6276	0.6276	0.6276	0.6276	0.6276	0.6276	0.6276	0.6276	0.6276	0.6659	1.1085	1.7012	2.1196	2.5309	2.8691	3.2648	3.7095	4.1674	4.5373	4.7387	4.7837	4.8415	16
0.6305	0.6305	0.6305	0.6305	0.6305	0.6305	0.6305	0.6305	0.6305	0.6778	1.1636	1.7928	2.2398	2.6474	2.9996	3.4504	3.9111	4.3703	4.7525	4.9100	4.9575	4.9874	17
0.6339	0.6339	0.6339	0.6339	0.6339	0.6339	0.6339	0.6339	0.6339	0.6891	1.2014	1.5661	2.3527	2.7688	3.1560	3.6506	4.1180	4.5806	4.9737	5.0872	5.1385	5.1481	18
0.6369	0.6369	0.6369	0.6369	0.6369	0.6369	0.6369	0.6369	0.6369	0.7003	1.2455	1.6486	2.4797	2.8913	3.3320	3.8561	4.3276	4.7964	5.1797	5.2432	5.2850	5.2850	19
0.6399	0.6399	0.6399	0.6399	0.6399	0.6399	0.6399	0.6399	0.6399	0.7118	1.2617	1.7179	2.6196	3.0338	3.5179	4.0552	4.5369	5.0125	5.3125	5.3676	5.3920	5.3920	20
0.6428	0.6428	0.6428	0.6428	0.6428	0.6428	0.6428	0.6428	0.6428	0.7242	1.3037	1.7927	2.7759	3.1487	3.7021	4.2434	4.7415	5.2261	5.4423	5.4985	5.5080	5.5080	21
0.6452	0.6452	0.6452	0.6452	0.6452	0.6452	0.6452	0.6452	0.6452	0.7378	1.3340	1.8642	2.6316	3.2769	3.8707	4.4220	4.9384	5.4442	5.5823	5.6375	5.6375	5.6375	22
0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.7529	1.3728	1.9350	2.7281	3.3944	4.0120	4.5922	5.1341	5.6608	5.7175	5.7622	5.7622	5.7622	23
0.6464	0.6464	0.6464	0.6464	0.6464	0.6464	0.6464	0.6464	0.6464	0.7690	1.4148	2.0208	2.8102	3.5031	4.1407	4.7585	5.3259	5.7835	5.8425	5.8761	5.8761	5.8761	24
0.6448	0.6448	0.6448	0.6448	0.6448	0.6448	0.6448	0.6448	0.6448	0.7854	1.4575	2.0481	2.8928	3.6121	4.2722	4.9236	5.5090	5.8972	5.9574	5.9793	5.9793	5.9793	25
0.6423	0.6423	0.6423	0.6423	0.6423	0.6423	0.6423	0.6423	0.6423	0.8016	1.4955	2.0614	2.9849	3.7308	4.3977	5.0860	5.6847	5.9985	6.0586	6.0684	6.0684	6.0684	26
0.6407	0.6407	0.6407	0.6407	0.6407	0.6407	0.6407	0.6407	0.6407	0.8170	1.5346	2.1359	3.0642	3.8795	4.5244	5.2435	5.8437	6.0964	6.1547	6.1547	6.1547	6.1547	27
0.6428	0.6428	0.6428	0.6428	0.6428	0.6428	0.6428	0.6428	0.6428	0.8310	1.5768	2.2092	3.1621	4.0341	4.6552	5.3908	5.9888	6.1936	6.2417	6.2417	6.2417	6.2417	28
0.6514	0.6514	0.6514	0.6514	0.6514	0.6514	0.6514	0.6514	0.6514	0.8442	1.6016	2.2894	3.2625	4.2118	4.7855	5.5361	6.1239	6.3015	6.3408	6.3408	6.3408	6.3408	29
0.6674	0.6674	0.6674	0.6674	0.6674	0.6674	0.6674	0.6674	0.6674	0.8572	1.6281	2.3734	3.3631	4.3921	4.9251	5.6635	6.2635	6.4213	6.4507	6.4507	6.4507	6.4507	30
0.6658	0.6658	0.6658	0.6658	0.6658	0.6658	0.6658	0.6658	0.6658	0.8712	1.6454	2.4616	3.4794	4.5786	5.0807	5.8268	6.4146	6.5546	6.5728	6.5728	6.5728	6.5728	31
0.6612	0.6612	0.6612	0.6612	0.6612	0.6612	0.6612	0.6612	0.6612	0.8870	1.6677	2.5532	3.5664	4.1928	5.2417	6.0071	6.5737	6.6994	6.7074	6.7074	6.7074	6.7074	32
0.6535	0.6535	0.6535	0.6535	0.6535	0.6535	0.6535	0.6535	0.6535	0.9056	1.6749	2.6282	3.5415	4.3246	5.4197	6.1993	6.7426	6.8570	6.8570	6.8570	6.8570	6.8570	33
0.6485	0.6485	0.6485	0.6485	0.6485	0.6485	0.6485	0.6485	0.6485	0.9273	1.6845	2.7142	3.6241	4.4498	5.5979	6.4055	6.9217	7.0213	7.0213	7.0213	7.0213	7.0213	34
0.6427	0.6427	0.6427	0.6427	0.6427	0.6427	0.6427	0.6427	0.6427	0.9504	1.7162	2.7974	3.7117	4.5773	5.8085	6.5586	7.1119	7.1979	7.1979	7.1979	7.1979	7.1979	35
0.6386	0.6386	0.6386	0.6386	0.6386	0.6386	0.6386	0.6386	0.6386	0.9769	1.7504	2.8759	3.8025	4.7141	6.0256	6.7723	7.3110	7.3838	7.3838	7.3838	7.3838	7.3838	36
0.6408	0.6408	0.6408	0.6408	0.6408	0.6408	0.6408	0.6408	0.6410	1.0045	1.7868	2.9481	3.8869	4.8628	6.2540	6.9863	7.5096	7.5666	7.5666	7.5666	7.5666	7.5666	37
0.6461	0.6461	0.6461	0.6461	0.6461	0.6461	0.6461	0.6461	0.6464	1.0328	1.8226	3.0152	3.9944	5.0283	6.4853	7.1964	7.7000	7.7380	7.7380	7.7380	7.7380	7.7380	38
0.6454	0.6454	0.6454	0.6454	0.6454	0.6454	0.6454	0.6454	0.6457	1.0613	1.8599	3.0752	4.0666	5.1508	6.7159	7.3975	7.8762	7.8949	7.8949	7.8949	7.8949	7.8949	39
0.6373	0.6373	0.6373	0.6373	0.6373	0.6373	0.6373	0.6373	0.6376	1.0889	1.8972	3.1353	4.0712	5.2900	6.9503	7.6076	8.0413	8.0450	8.0450	8.0450	8.0450	8.0450	40
0.6243	0.6243	0.6243	0.6243	0.6243	0.6243	0.6243	0.6243	0.6246	1.1059	1.9342	3.1767	4.1489	5.4581	7.1964	7.7988	8.2010	8.2024	8.2024	8.2024	8.2024	8.2024	41
0.6106	0.6106	0.6106	0.6106	0.6106	0.6106	0.6106	0.6106	0.6110	1.1320	1.9717	3.2394	4.2192	5.6673	7.4111	7.9950	8.3566	8.3671	8.3671	8.3671	8.3671	8.3671	42

Fuel Consumption (ml/second) (v=0 to 110fps; a=-9 to 12fpsps)  
Format (22F8.4,14)

-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	V(fps)
0.5908	0.5908	0.5908	0.5908	0.5908	0.5908	0.5908	0.5908	0.5913	1.1581	2.0186	3.3828	4.2908	5.8230	7.6247	8.1921	8.5156	8.5358	8.5358	8.5358	8.5358	8.5358	43
0.5688	0.5688	0.5688	0.5688	0.5688	0.5688	0.5688	0.5688	0.5694	1.1838	2.0665	3.4115	4.3722	5.9607	7.8277	8.3692	8.6716	8.6966	8.6966	8.6966	8.6966	8.6966	44
0.5565	0.5565	0.5565	0.5565	0.5565	0.5565	0.5565	0.5565	0.5573	1.2090	2.0475	3.4518	4.4651	6.0848	8.0420	8.5409	8.8237	8.8519	8.8519	8.8519	8.8519	8.8519	45
0.5619	0.5619	0.5619	0.5619	0.5619	0.5619	0.5619	0.5619	0.5636	1.2345	2.0968	3.4972	4.5686	6.2497	8.2442	8.7072	8.8472	8.8482	8.8482	8.8482	8.8482	8.8482	46
0.5781	0.5781	0.5781	0.5781	0.5781	0.5781	0.5781	0.5781	0.5810	1.2610	2.1434	3.5479	4.5468	6.3844	8.4211	8.8495	8.9531	8.9535	8.9535	8.9535	8.9535	8.9535	47
0.5972	0.5972	0.5972	0.5972	0.5972	0.5972	0.5972	0.5972	0.6012	1.2895	2.1971	3.6034	4.6527	6.5188	8.5840	8.9696	9.0382	9.0382	9.0382	9.0382	9.0382	9.0382	48
0.6133	0.6133	0.6133	0.6133	0.6133	0.6133	0.6133	0.6133	0.6183	1.0011	2.2567	3.6654	4.7619	6.6506	8.7389	9.0771	9.1098	9.1098	9.1098	9.1098	9.1098	9.1098	49
0.6202	0.6202	0.6202	0.6202	0.6202	0.6202	0.6202	0.6202	0.6262	1.0794	2.3126	3.7336	4.8741	6.7793	8.8930	9.1721	9.1683	9.1683	9.1683	9.1683	9.1683	9.1683	50
0.6176	0.6176	0.6176	0.6176	0.6176	0.6176	0.6176	0.6176	0.6247	1.1711	2.3660	3.8049	4.9904	6.9368	9.0144	9.2204	9.1945	9.1945	9.1945	9.1945	9.1945	9.1945	51
0.6150	0.6150	0.6150	0.6150	0.6150	0.6150	0.6150	0.6150	0.6236	1.2513	2.4212	3.8762	5.1107	7.0242	9.0970	9.2303	9.2152	9.2152	9.2152	9.2152	9.2152	9.2152	52
0.6179	0.6179	0.6179	0.6179	0.6179	0.6179	0.6179	0.6179	0.6287	1.2955	2.2071	3.9479	5.2360	7.0869	9.1965	9.2908	9.2936	9.2936	9.2936	9.2936	9.2936	9.2936	53
0.6238	0.6238	0.6238	0.6238	0.6238	0.6238	0.6238	0.6238	0.6369	1.2912	2.2539	3.8999	5.3689	7.2344	9.2690	9.3451	9.3489	9.3489	9.3489	9.3489	9.3489	9.3489	54
0.6279	0.6279	0.6279	0.6279	0.6279	0.6279	0.6279	0.6279	0.6435	1.2572	2.2975	3.9651	5.5121	7.3743	9.3284	9.3656	9.3683	9.3683	9.3683	9.3683	9.3683	9.3683	55
0.6304	0.6304	0.6304	0.6304	0.6304	0.6304	0.6304	0.6304	0.6488	1.2202	2.3324	4.0281	5.6635	7.5128	9.3670	9.3662	9.3680	9.3680	9.3680	9.3680	9.3680	9.3680	56
0.6345	0.6345	0.6345	0.6345	0.6345	0.6345	0.6345	0.6345	0.6559	1.2029	2.3535	4.0905	5.8232	7.6545	9.3705	9.3489	9.3500	9.3500	9.3500	9.3500	9.3500	9.3500	57
0.6420	0.6420	0.6420	0.6420	0.6420	0.6420	0.6420	0.6420	0.6664	1.2128	2.3618	4.1542	5.9475	7.7911	8.9581	8.9611	8.9617	8.9617	8.9617	8.9617	8.9617	8.9617	58
0.6511	0.6511	0.6511	0.6511	0.6511	0.6511	0.6511	0.6511	0.6789	1.2415	2.3679	4.2208	6.1131	7.8769	8.8656	8.8688	8.8689	8.8689	8.8689	8.8689	8.8689	8.8689	59
0.6584	0.6584	0.6584	0.6584	0.6584	0.6584	0.6584	0.6584	0.6899	1.2796	2.3818	4.2914	6.2792	7.9879	8.7739	8.7777	8.7777	8.7777	8.7777	8.7777	8.7777	8.7777	60
0.6597	0.6597	0.6597	0.6597	0.6597	0.6597	0.6597	0.6597	0.6953	1.3184	2.4149	4.3664	6.4414	8.0866	8.6085	8.6144	8.6144	8.6144	8.6144	8.6144	8.6144	8.6144	61
0.6561	0.6561	0.6561	0.6561	0.6561	0.6561	0.6561	0.6561	0.6960	1.3525	2.4730	4.4895	6.5961	8.1774	8.6018	8.6095	8.6095	8.6095	8.6095	8.6095	8.6095	8.6095	62
0.6528	0.6528	0.6528	0.6528	0.6528	0.6528	0.6528	0.6528	0.6970	1.3778	2.5544	4.5715	6.7413	8.2595	8.5887	8.5887	8.5887	8.5887	8.5887	8.5887	8.5887	8.5887	63
0.6543	0.6543	0.6543	0.6543	0.6543	0.6543	0.6543	0.6543	0.7027	1.3908	2.6573	4.6553	6.8791	8.3259	8.5269	8.5316	8.5316	8.5316	8.5316	8.5316	8.5316	8.5316	64
0.6593	0.6593	0.6593	0.6593	0.6593	0.6593	0.6593	0.6593	0.7122	1.3922	2.7784	4.7400	7.0124	8.3460	8.4745	8.4767	8.4767	8.4767	8.4767	8.4767	8.4767	8.4767	65
0.6667	0.6667	0.6667	0.6667	0.6667	0.6667	0.6667	0.6667	0.7251	1.3919	2.9033	4.8256	7.1438	8.0635	8.1589	8.1589	8.1589	8.1589	8.1589	8.1589	8.1589	8.1589	66
0.6775	0.6775	0.6775	0.6775	0.6775	0.6775	0.6775	0.6775	0.7440	1.4019	3.0157	4.9125	7.2672	8.0749	8.1550	8.1550	8.1550	8.1550	8.1550	8.1550	8.1550	8.1550	67
0.6918	0.6918	0.6918	0.6918	0.6918	0.6918	0.6918	0.6918	0.7661	1.4332	3.1007	4.9964	7.3865	8.0965	8.1570	8.1570	8.1570	8.1570	8.1570	8.1570	8.1570	8.1570	68
0.7072	0.7072	0.7072	0.7072	0.7072	0.7072	0.7072	0.7072	0.7893	1.4846	3.1593	5.0861	7.5035	8.1348	8.1702	8.1702	8.1702	8.1702	8.1702	8.1702	8.1702	8.1702	69
0.7247	0.7247	0.7247	0.7247	0.7247	0.7247	0.7247	0.7247	0.8152	1.5446	3.2052	5.1893	7.6255	8.1378	8.1990	8.1990	8.1990	8.1990	8.1990	8.1990	8.1990	8.1990	70
0.7446	0.7446	0.7446	0.7446	0.7446	0.7446	0.7446	0.7446	0.8444	1.6010	3.2527	5.3011	7.7451	8.1985	8.2238	8.2238	8.2238	8.2238	8.2238	8.2238	8.2238	8.2238	71
0.7625	0.7625	0.7625	0.7625	0.7625	0.7625	0.7625	0.7625	0.8732	1.6443	3.3129	5.4214	7.8628	8.2671	8.2897	8.2897	8.2897	8.2897	8.2897	8.2897	8.2897	8.2897	72
0.7752	0.7752	0.7752	0.7752	0.7752	0.7752	0.7752	0.7752	0.8977	1.6778	3.3833	5.6885	7.9796	8.3505	8.3720	8.3720	8.3720	8.3720	8.3720	8.3720	8.3720	8.3720	73
0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.7848	0.8852	1.7091	3.4576	5.8184	8.0933	8.4467	8.4696	8.4696	8.4696	8.4696	8.4696	8.4696	8.4696	8.4696	74
0.7935	0.7935	0.7935	0.7935	0.7935	0.7935	0.7935	0.7935	0.7949	0.9388	1.7460	3.5284	5.9753	8.2012	8.5447	8.5606	8.5606	8.5606	8.5606	8.5606	8.5606	8.5606	75
0.8020	0.8020	0.8020	0.8020	0.8020	0.8020	0.8020	0.8020	0.8043	0.9563	1.7921	3.5926	6.1020	8.3010	8.6280	8.6376	8.6376	8.6376	8.6376	8.6376	8.6376	8.6376	76
0.8117	0.8117	0.8117	0.8117	0.8117	0.8117	0.8117	0.8117	0.8148	0.9737	1.8445	3.6524	6.2177	8.3916	8.7031	8.7102	8.7102	8.7102	8.7102	8.7102	8.7102	8.7102	77
0.8225	0.8225	0.8225	0.8225	0.8225	0.8225	0.8225	0.8225	0.8263	0.9927	1.9002	3.7113	6.3376	8.4746	8.7768	8.7817	8.7817	8.7817	8.7817	8.7817	8.7817	8.7817	78
0.8318	0.8318	0.8318	0.8318	0.8318	0.8318	0.8318	0.8318	0.8367	1.0119	1.9570	3.7737	6.4935	8.5493	8.8435	8.8456	8.8456	8.8456	8.8456	8.8456	8.8456	8.8456	79
0.8377	0.8377	0.8377	0.8377	0.8377	0.8377	0.8377	0.8377	0.8443	1.0336	2.0147	3.8401	6.6106	8.6283	8.9117	8.9129	8.9129	8.9129	8.9129	8.9129	8.9129	8.9129	80
0.8396	0.8396	0.8396	0.8396	0.8396	0.8396	0.8396	0.8396	0.8480	1.0713	2.0738	3.9337	6.7391	8.7088	8.9792	8.9802	8.9802	8.9802	8.9802	8.9802	8.9802	8.9802	81
0.8345	0.8345	0.8345	0.8345	0.8345	0.8345	0.8345	0.8345	0.8451	1.1123	2.1345	4.0065	6.8546	8.8042	9.0502	9.0511	9.0511	9.0511	9.0511	9.0511	9.0511	9.0511	82
0.8261	0.8261	0.8261	0.8261	0.8261	0.8261	0.8261	0.8261	0.8391	1.1565	2.1974	4.0796	6.9685	8.8848	9.1222	9.1231	9.1231	9.1231	9.1231	9.1231	9.1231	9.1231	83
0.8242	0.8242	0.8242	0.8242	0.8242	0.8242	0.8242	0.8242	0.8400	1.2032	2.2635	4.1512	7.0834	8.9508	9.1755	9.1764	9.1764	9.1764	9.1764	9.1764	9.1764	9.1764	84
0.8280	0.8280	0.8280	0.8280	0.8280	0.8280	0.8280	0.8280	0.8466	1.2512	2.3343	4.2208	7.1986	9.1325	9.2332	9.2340	9.2340	9.2340	9.2340	9.2340	9.2340	9.2340	85

Fuel Consumption (ml/second) (v=0 to 110fps; a=-9 to 12fpsps)  
Format (22F8.4,I4)

-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	V(fps)
0.8290	0.8290	0.8290	0.8290	0.8290	0.8290	0.8290	0.8290	0.8504	1.2987	2.4115	4.2880	7.3111	9.2018	9.2871	9.2877	9.2877	9.2877	9.2877	9.2877	9.2877	9.2877	86
0.8240	0.8240	0.8240	0.8240	0.8240	0.8240	0.8240	0.8240	0.8481	1.3431	2.4911	4.3516	7.3288	9.1878	9.2560	9.2564	9.2564	9.2564	9.2564	9.2564	9.2564	9.2564	87
0.8168	0.8168	0.8168	0.8168	0.8168	0.8168	0.8168	0.8168	0.8437	1.3845	2.5602	4.4097	7.4193	9.1544	9.2044	9.2044	9.2044	9.2044	9.2044	9.2044	9.2044	9.2044	88
0.8092	0.8092	0.8092	0.8092	0.8092	0.8092	0.8092	0.8092	0.8389	1.4241	2.6058	4.4603	7.4993	9.2244	9.2614	9.2614	9.2614	9.2614	9.2614	9.2614	9.2614	9.2614	89
0.8031	0.8031	0.8031	0.8031	0.8031	0.8031	0.8031	0.8031	0.8356	1.4622	2.6166	4.5016	7.5762	9.2865	9.3115	9.3115	9.3115	9.3115	9.3115	9.3115	9.3115	9.3115	90
0.7977	0.7977	0.7977	0.7977	0.7977	0.7977	0.7977	0.7977	0.8330	1.5000	2.6025	4.5347	7.6713	9.3183	9.3316	9.3316	9.3316	9.3316	9.3316	9.3316	9.3316	9.3316	91
0.7885	0.7885	0.7885	0.7885	0.7885	0.7885	0.7885	0.7885	0.8266	1.5404	2.5857	4.5657	7.7406	9.3305	9.3351	9.3351	9.3351	9.3351	9.3351	9.3351	9.3351	9.3351	92
0.7765	0.7765	0.7765	0.7765	0.7765	0.7765	0.7765	0.7765	0.8182	1.5872	2.5891	4.6007	9.1288	9.3455	9.3481	9.3481	9.3481	9.3481	9.3481	9.3481	9.3481	9.3481	93
0.7633	0.7633	0.7633	0.7633	0.7633	0.7633	0.7633	0.7633	0.8096	1.6426	2.6284	4.6463	9.1863	9.3911	9.3929	9.3929	9.3929	9.3929	9.3929	9.3929	9.3929	9.3929	94
0.7533	0.7533	0.7533	0.7533	0.7533	0.7533	0.7533	0.7533	0.8046	1.7028	2.6943	4.7001	9.2257	9.4712	9.4723	9.4723	9.4723	9.4723	9.4723	9.4723	9.4723	9.4723	95
0.7551	0.7551	0.7551	0.7551	0.7551	0.7551	0.7551	0.7551	0.8115	1.7614	2.7719	4.7570	9.1997	9.5102	9.5104	9.5104	9.5104	9.5104	9.5104	9.5104	9.5104	9.5104	96
0.7719	0.7719	0.7719	0.7719	0.7719	0.7719	0.7719	0.7719	0.8332	1.8119	2.8459	4.8123	9.1551	9.4870	9.4870	9.4870	9.4870	9.4870	9.4870	9.4870	9.4870	9.4870	97
0.7913	0.7913	0.7913	0.7913	0.7913	0.7913	0.7913	0.7913	0.8573	1.8522	2.9114	4.9834	9.1694	9.4597	9.4597	9.4597	9.4597	9.4597	9.4597	9.4597	9.4597	9.4597	98
0.8079	0.8079	0.8079	0.8079	0.8079	0.8079	0.8079	0.8079	0.8787	1.8872	2.9772	5.0436	8.0067	8.0731	8.0731	8.0731	8.0731	8.0731	8.0731	8.0731	8.0731	8.0731	99
0.8220	0.8220	0.8220	0.8220	0.8220	0.8220	0.8220	0.8220	0.9053	1.9229	3.0526	6.7490	8.0823	8.1379	8.1379	8.1379	8.1379	8.1379	8.1379	8.1379	8.1379	8.1379	100
0.8398	0.8398	0.8398	0.8398	0.8398	0.8398	0.8398	0.8398	0.9362	1.9641	3.1454	6.8204	8.1621	8.2086	8.2086	8.2086	8.2086	8.2086	8.2086	8.2086	8.2086	8.2086	101
0.8654	0.8654	0.8654	0.8654	0.8654	0.8654	0.8654	0.8654	0.9753	2.0110	3.2534	6.8916	8.2441	8.2827	8.2827	8.2827	8.2827	8.2827	8.2827	8.2827	8.2827	8.2827	102
0.8904	0.8904	0.8904	0.8904	0.8904	0.8904	0.8904	0.8904	1.0146	2.0613	3.3695	6.9675	8.3130	8.3446	8.3446	8.3446	8.3446	8.3446	8.3446	8.3446	8.3446	8.3446	103
0.9068	0.9068	0.9068	0.9068	0.9068	0.9068	0.9068	0.9068	1.0451	2.1127	3.4871	7.0501	8.3582	8.3842	8.3842	8.3842	8.3842	8.3842	8.3842	8.3842	8.3842	8.3842	104
0.9136	0.9136	0.9136	0.9136	0.9136	0.9136	0.9136	0.9140	1.0661	2.1648	3.5992	7.1356	8.3887	8.4093	8.4093	8.4093	8.4093	8.4093	8.4093	8.4093	8.4093	8.4093	105
0.9166	0.9166	0.9166	0.9166	0.9166	0.9166	0.9166	0.9174	1.0832	2.2188	3.7045	7.2193	8.4499	8.4662	8.4662	8.4662	8.4662	8.4662	8.4662	8.4662	8.4662	8.4662	106
0.9217	0.9217	0.9217	0.9217	0.9217	0.9217	0.9217	0.9228	1.1024	2.2744	3.8007	7.3001	8.4028	8.4159	8.4159	8.4159	8.4159	8.4159	8.4159	8.4159	8.4159	8.4159	107
0.9333	0.9333	0.9333	0.9333	0.9333	0.9333	0.9333	0.9347	1.1282	2.3286	3.8825	7.3759	8.4635	8.4735	8.4735	8.4735	8.4735	8.4735	8.4735	8.4735	8.4735	8.4735	108
0.9572	0.9572	0.9572	0.9572	0.9572	0.9572	0.9572	0.9589	1.1685	2.3835	3.9551	7.4498	8.5203	8.5277	8.5277	8.5277	8.5277	8.5277	8.5277	8.5277	8.5277	8.5277	109
0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9947	1.2181	2.4345	4.0212	7.5219	8.5711	8.5765	8.5765	8.5765	8.5765	8.5765	8.5765	8.5765	8.5765	8.5765	110

**APPENDIX F**

**EMPLOYEE SURVEY RESULTS - ALTERNATIVE MODE PREFERENCE FORM**

## Employee Survey Results - Alternative Mode Preference

Along with the travel portion of the Employee Survey Forms, you are required to ask questions about measures that you might implement at your worksite to encourage your employees not to drive alone to work. Below is a list of measures from the TNRCC approved Employee Survey Form. Please indicate by marking an "X" which measures you asked and did not ask your employees about. Calculate the percent that responded positively to each measure and place in the corresponding column. If you used other measures, please list each under "Other". Attach additional sheets for "Other" measures if necessary.

Incentive or Measure	Asked	Not Asked	Percent Responding Positively
<b>Bus Services</b>			
1. More information regarding bus routes			
2. Local bus service to your worksite			
3. Late evening bus service			
4. Employer paying for all or a portion of bus passes			
5. Park & Ride service to your worksite			
<b>Carpool/Vanpool</b>			
6. Preferential parking for carpools/vanpools			
7. Employer paying for all or some of carpool/vanpool costs			
8. Free carpool/vanpool matching or list of others to rideshare with			
9. Guaranteed Ride Home for emergencies and unscheduled overtime			
10. Mid-day shuttle bus to shopping/dining areas near your worksite			
11. Employer provided vehicles for mid-day business trips			
12. High Occupancy Vehicle (HOV) lanes			
<b>Biking/Walking</b>			
13. Biking commuting incentives			
14. Secured bike racks			
15. Walking incentives			
16. Showers/lockers provided if you walk or bike to worksite			
<b>Compressed Work Week</b>			
17. 3/36 Work Week			
18. 4/40 Work Week			
19. 9/80 Work Week			
<b>On-site Facilities</b>			
20. Banking facilities on-site			
21. Day care on-site			
22. Cafeteria on-site			
<b>General</b>			
23. Variable/flexible work hours			
24. Telecommuting			
25. Increased costs for parking			
26. Other (list)			

## **APPENDIX G**

### **SUMMARY OF TRIP REDUCTION MEASURES FORM**



## Summary of Trip Reduction Measures

The following is a list of Trip Reduction Measures that you should consider offering to employees at your worksite. For each listed, place an "X" in the space provide to tell if you plan to offer the incentive (Yes or No); the status of the incentive (is the measure New, Revised from previous offering, or already Existing); and which quarter during 1995 and 1996 you plan to implement the measure.

Trip Reduction Measure	Offered		Status			Quarter to Implement							
	Yes	No	New	Revised	Existing	1st	2nd	3rd	4th	5th	6th	7th	8th
<b>Employee Services</b>													
1. Guaranteed Ride Home													
a. Fleet car available													
b. Rental car available													
c. Taxi vouchers													
d. METRO program													
2. Personalized Assistance													
a. Computer matching													
b. In-person contact													
3. Banking Services													
a. Auto payroll deposits													
b. Payroll deductions													
c. On-site ATM's													
4. Dry Cleaning Arrangement													
5. Mail Services													
6. Child Care Information													
7. Midday Shuttle to Food/Shopping													
a. Fixed schedule													
b. On demand													
8. On-site Transit Pass Sales													
9. Commute Information Center													
10. Shuttle to Park & Ride Lot													
<b>Incentives</b>													
1. Monetary Rewards													
a. Recruitment rewards													
b. Health club membership													
c. Underwrite vanpool insurance													
d. Allowance for ridesharing													

*Appendix G: Summary of Trip Reduction Measures Form*

Trip Reduction Measure	Offered		Status			Quarter to Implement							
	Yes	No	New	Revised	Existing	1st	2nd	3rd	4th	5th	6th	7th	8th
e. Transit pass give-aways													
f. Bike products													
g. Product give-aways													
h. Gift certificates													
2. Subsidies													
a. Carpool subsidy													
b. Vanpool subsidy													
c. Vacant seat subsidy													
d. Discount/free vanpool start-up													
e. Subsidized bus passes													
f. Bike purchase subsidy													
g. Home computer subsidy													
h. Child care subsidy													
3. Recognition													
a. Luncheon for ridesharers													
b. Management recognition													
c. Commuter club													
4. Time Rewards													
a. Birthday off													
b. 1/2 day off per													
c. Leave early Friday													
<b>Facilities/Equipment</b>													
1. Bus Shelters													
2. Bicycle Parking													
a. Racks													
b. Lockers													
c. Storage room													
3. Clothes Lockers/Storage Rooms													
4. Shower Facilities													
5. Lunch-room/food service facility													
a. Refrigerator													
b. Microwave oven													
c. Hot water													

*Appendix G: Summary of Trip Reduction Measures Form*

Trip Reduction Measure	Offered		Status			Quarter to Implement							
	Yes	No	New	Revised	Existing	1st	2nd	3rd	4th	5th	6th	7th	8th
d. Tables and chairs													
e. Hot plate/toaster/toaster oven													
f. Cafeteria													
g. Vending machines													
6. Home Office Equipment													
a. Portable computer													
b. Fax machine													
c. Dedicated phone line													
d. Office supplies													
e. Phone equipment													
7. Child Care													
a. On-site child care													
b. Playground													
8. Exercise Equipment													
a. On-site health club													
b. Aerobic classes													
<b>Information/Marketing</b>													
1. Brochures													
2. Newsletters													
a. Weekly													
b. Monthly													
c. Quarterly													
3. Posters													
4. Flyers													
5. Special Events													
a. Program kick-off													
b. Transportation day													
6. Transit Schedules													
7. Pay Envelope Stuffers													
8. New Employee Orientation													
9. Give-aways/Promotion Items													
a. Type:													

*Appendix G: Summary of Trip Reduction Measures Form*

Trip Reduction Measure	Offered		Status			Quarter to Implement							
	Yes	No	New	Revised	Existing	1st	2nd	3rd	4th	5th	6th	7th	8th
b. Type:													
10. Prize Drawings													
a. Type:													
b. Type:													
<b>Employer Policies</b>													
1. Parking Management													
a. Charge for parking													
Amount:													
b. Preferential parking													
Number of spaces:													
c. Transportation allowances													
Amount:													
2. Late Meetings/Overtime Policy													
3. Leave Early Privilege													
4. Flexible Work Hours													
5. Use of Company Cars													
a. For commute													
b. Day time errands/personal													
c. Meetings/office business													
6. Compressed Work Week													
7. Telecommuting													

**APPENDIX H**  
**S.I.C. CODE TRANSLATION**

*Appendix H: S.I.C. Code Translation*

S.I.C. Code #	S.I.C. Description	S.I.C. Division
100	Agricultural Production- Crops	Agriculture, Forestry, Fishing, Hunting, and Trapping
200	Agricultural Production- Livestock	
700	Agricultural Services	
800	Forestry	
900	Fishing, Hunting, and Trapping	
1000	Metal Mining	Mining
1200	Coal Mining	
1300	Oil and Gas Extraction	
1400	Nonmetallic Minerals, Except Fuels	
1500	General Building Contractors	Construction
1600	Heavy Construction, Excluding Building	
1700	Special Trade Contractors	
2000	Food and Kindred Products	Manufacturing
2100	Tobacco Products	
2200	Textile Mill Products	
2300	Apparel and Other Textile Products	
2400	Lumber and Wood Products	
2500	Furniture and Fixtures	
2600	Paper and Allied Products	
2700	Printing and Publishing	
2800	Chemicals and Allied Products	
2900	Petroleum and Coal Products	
3000	Rubber and Miscellaneous Plastic Products	
3100	Leather and Leather Products	
3200	Stone, Clay, and Glass Products	
3300	Primary Metal Industries	
3400	Fabricated Metal Products	
3500	Industrial Machinery and Equipment	
3600	Electronic and Other Electric Equipment	
3700	Transportation Equipment	
3800	Instruments and Related Products	
3900	Miscellaneous Manufacturing Industries	

*Appendix H: S.I.C. Code Translation*

S.I.C. Code #	S.I.C. Description	S.I.C. Division
4000	Railroad Transportation	Transportation and Public Utilities
4100	Local and Interurban Passenger Transportation	
4200	Trucking and Warehousing	
4300	U.S. Postal Service	
4400	Water Transportation	
4500	Transportation by Air	
4600	Pipelines, Except Natural Gas	
4700	Transportation Services	
4800	Communications	
4900	Electric, Gas, and Sanitary Services	
5000	Wholesale Trade, Durable Goods	Wholesale Trade
5100	Wholesale Trade, Nondurable Goods	
5200	Building Materials and Garden Supplies	
5300	General Merchandise Stores	
5400	Food Stores	
5500	Automotive Dealer and Service Stations	
5600	Apparel and Accessory Stores	
5700	Furniture and Home Furnishings Stores	
5800	Eating and Drinking Places	Eating and Drinking Place and Miscellaneous Retail
5900	Miscellaneous Retail	
6000	Depository Institutions	Finance, Insurance, Real Estate
6100	Nondepository Institutions	
6200	Security and Commodity Brokers	
6300	Insurance Carriers	
6400	Insurance Agents, Brokers, and Service	
6500	Real Estate	
6700	Holding and Other Investment Offices	
7000	Hotels and Other Lodging Places	

S.I.C. Code #	S.I.C. Description	S.I.C. Division
7200	Personal services	Services
7300	Business Services	
7500	Automotive Repair, Services, and Parking	
7600	Miscellaneous Repair Services	
7800	Motion Pictures	
7900	Amusement and Recreation Services	
8000	Health Services	
8100	Legal Services	
8200	Educational Services	
8300	Social Services	
8400	Museums, Botanical, Zoological Gardens	
8600	Membership Organizations	
8700	Engineering and Management Services	
8800	Private Households	
8900	Services not Elsewhere Classified	
9100	Executive, Legislative, and General	Government
9200	Justice, Public Order, and Safety	
9300	Finance, Taxation, and Monetary Policy	
9400	Administration of Human Resources	
9500	Environmental Quality and Housing	
9600	Administration of Economic Programs	
9700	National Security and International Affairs	
9999	Nonclassifiable Establishments	Nonclassifiable



## **APPENDIX I**

### **EMPLOYEE AND EMPLOYER INFORMATION BY WORKSITE SIZE**



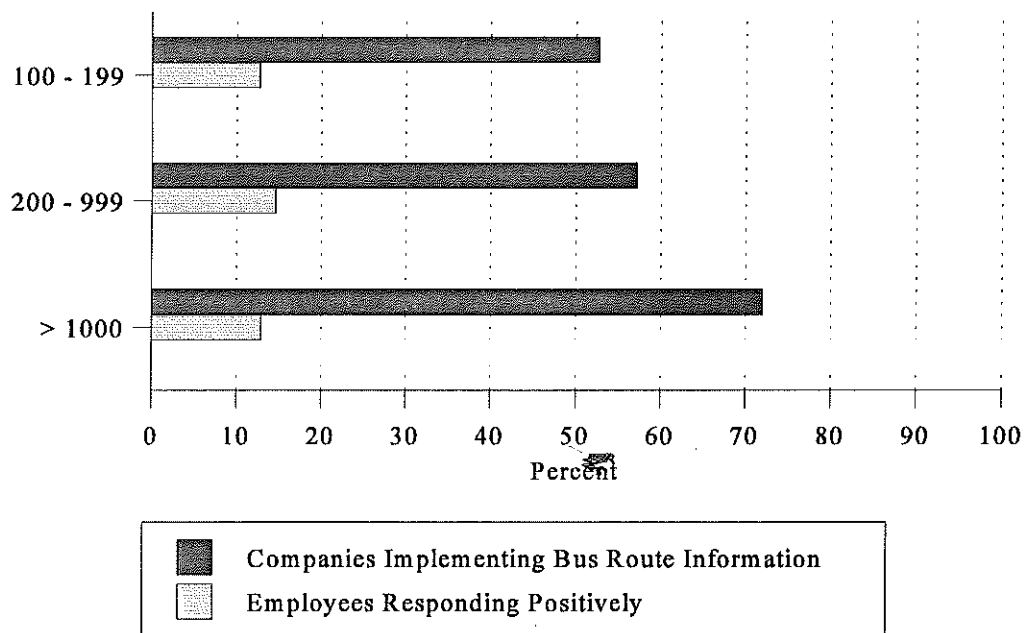


Figure I-1 Employee and employer interest in bus route information

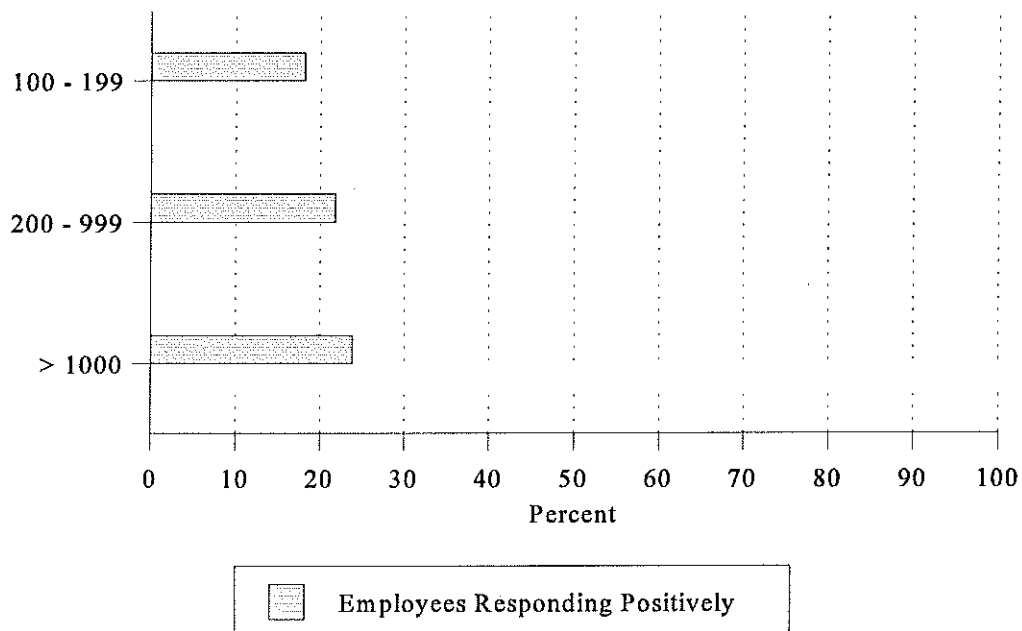


Figure I-2 Employee interest in local bus service



Figure I-3 Employee interest in late evening bus service

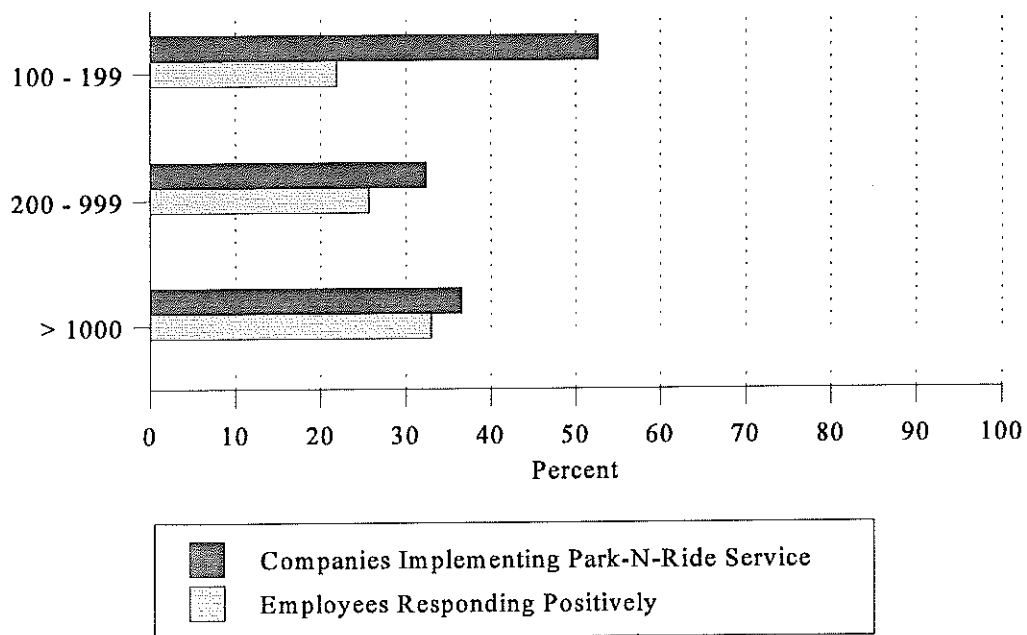


Figure I-4 Employee and employer interest in subsidizing bus fares

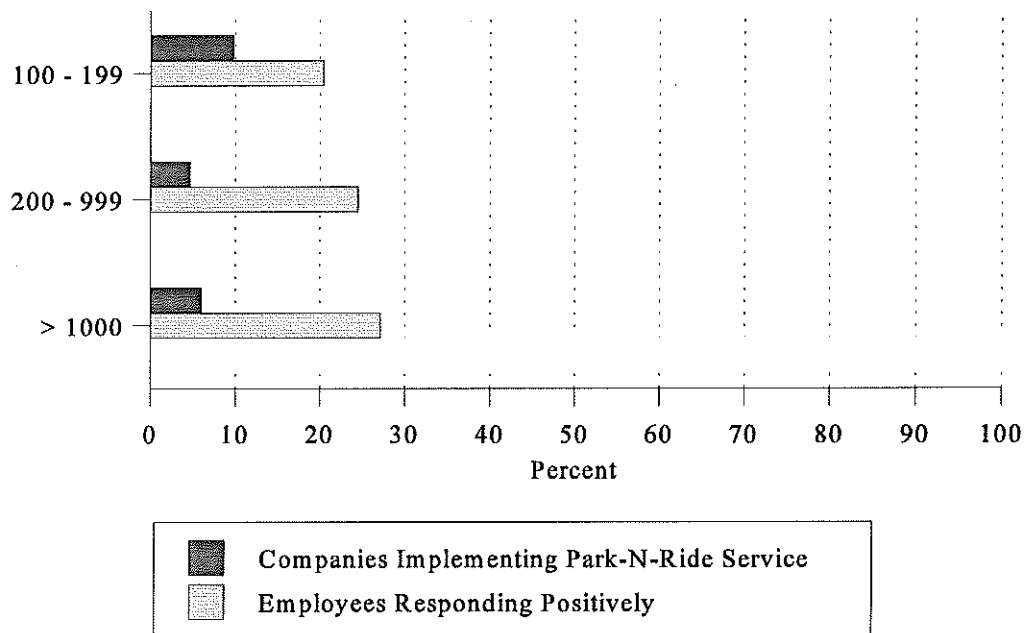


Figure I-5 Employee and employer interest in park-and-ride service

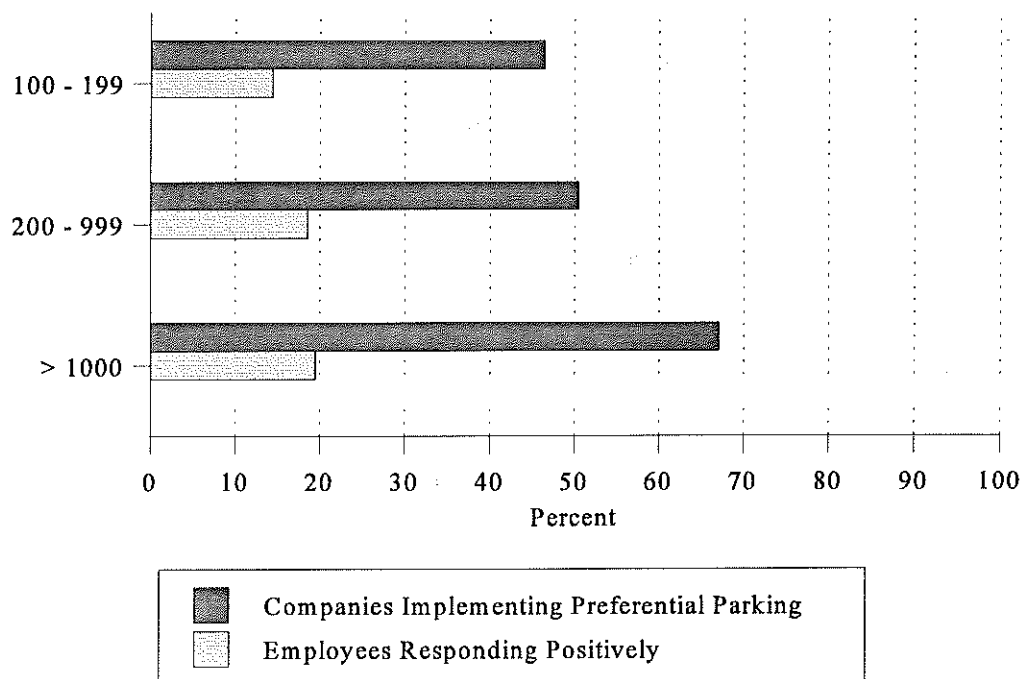


Figure I-6 Employee and employer interest in preferential carpool/vanpool parking

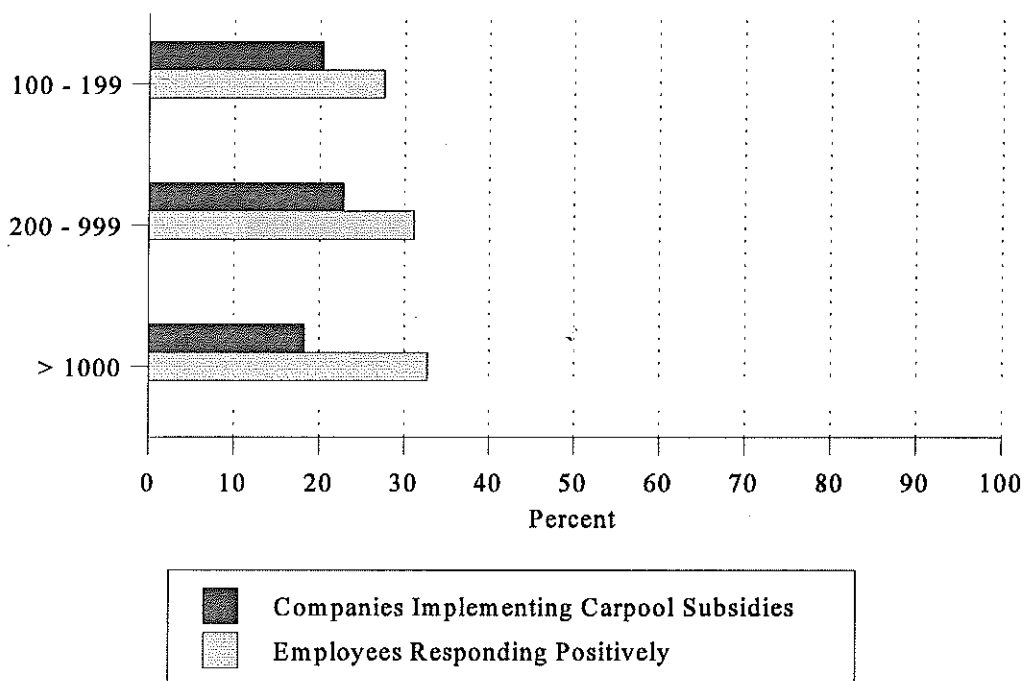


Figure I-7 Employee and employer interest in carpool subsidies

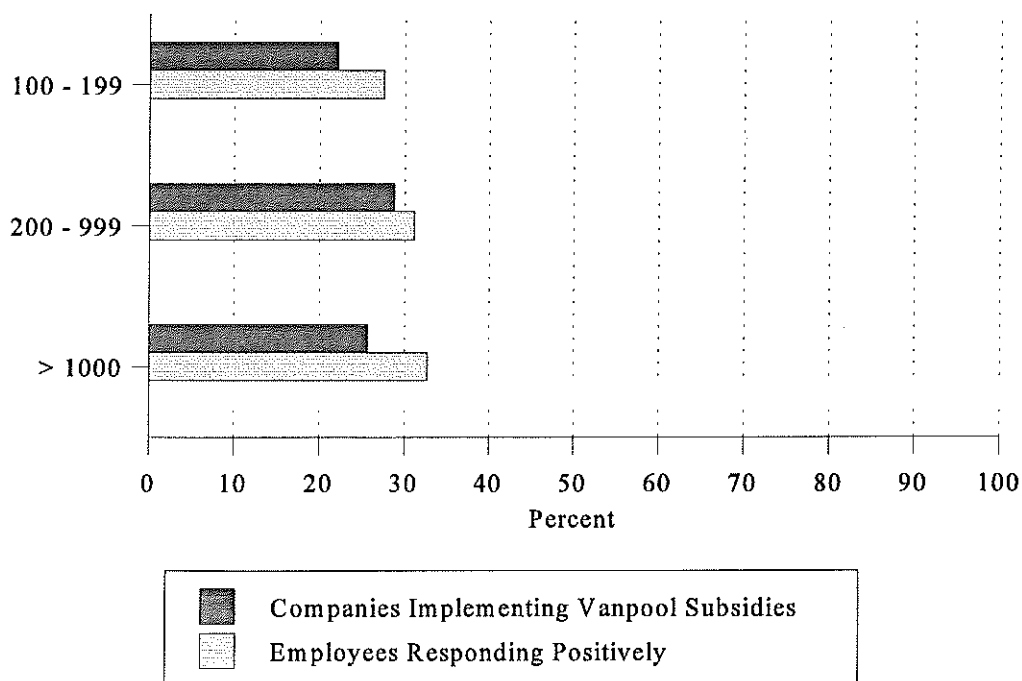
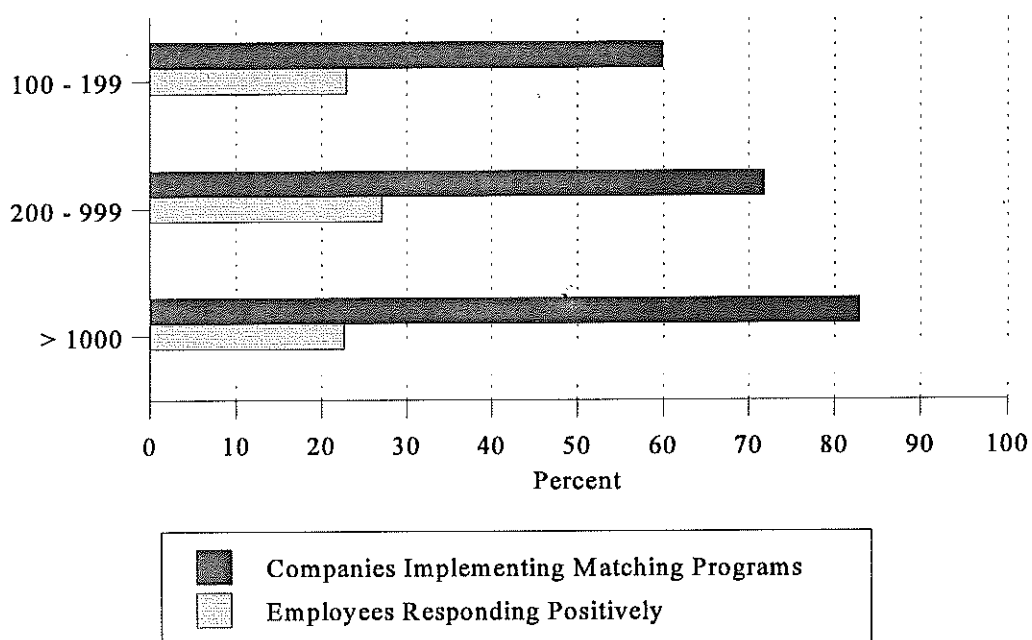
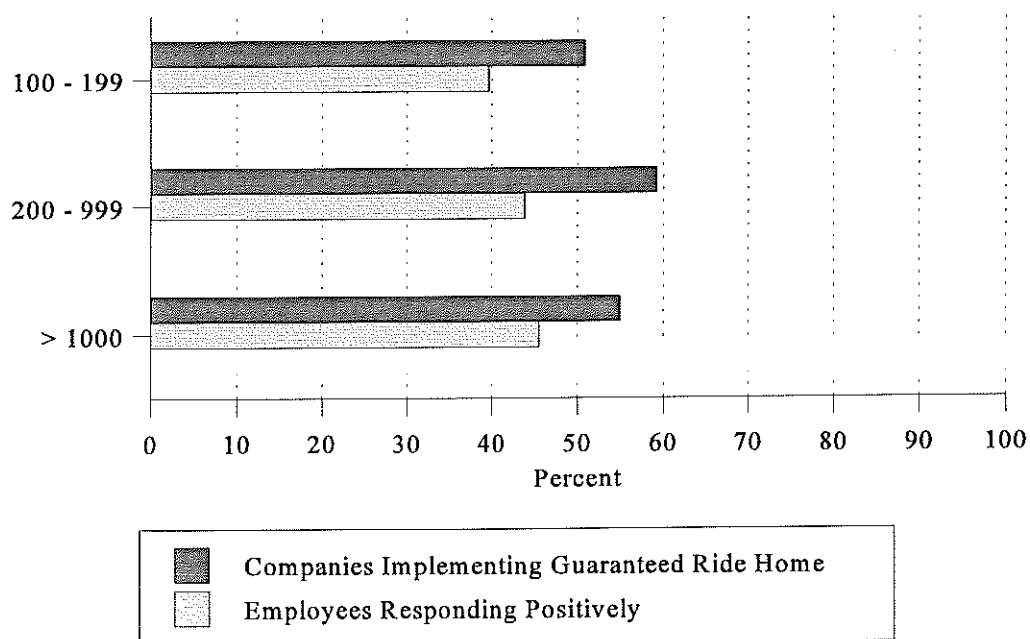


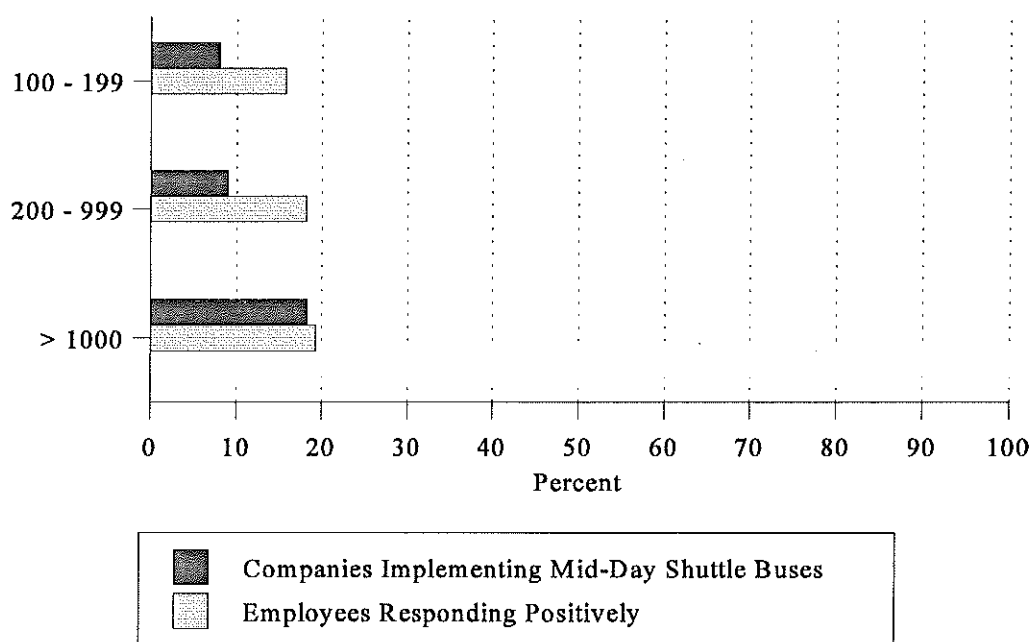
Figure I-8 Employee and employer interest in vanpool subsidies



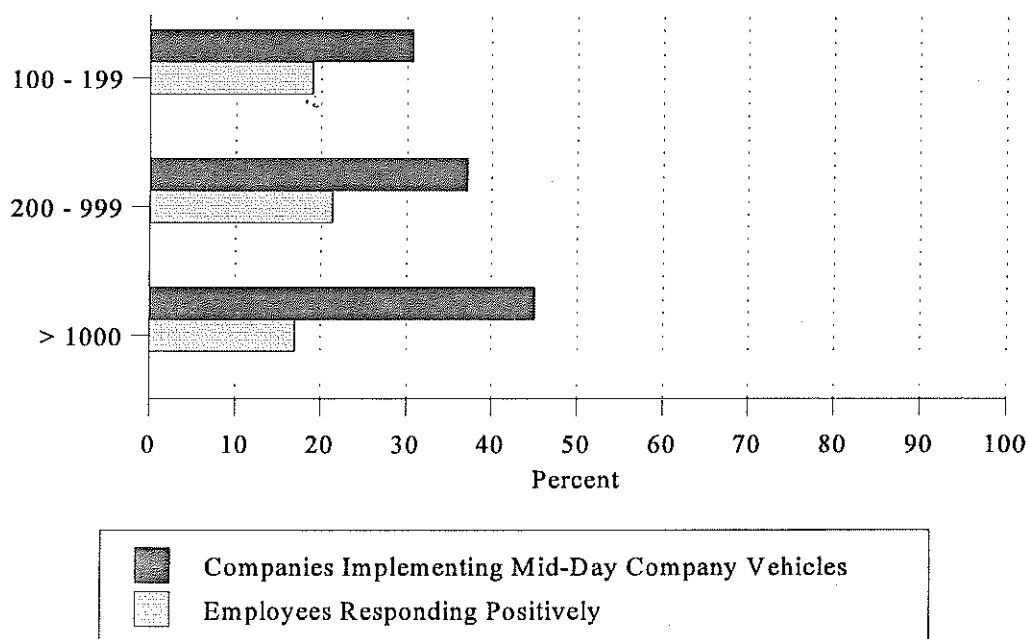
**Figure I-9** Employee and employer interest in preferential carpool/vanpool matching



**Figure I-10** Employee and employer interest in guaranteed ride home programs



**Figure I-11** Employee and employer interest in mid-day shuttle buses



**Figure I-12** Employee and employer interest in company vehicles for mid-day trips



Figure I-13 Employee interest in high occupancy vehicle (HOV) lanes

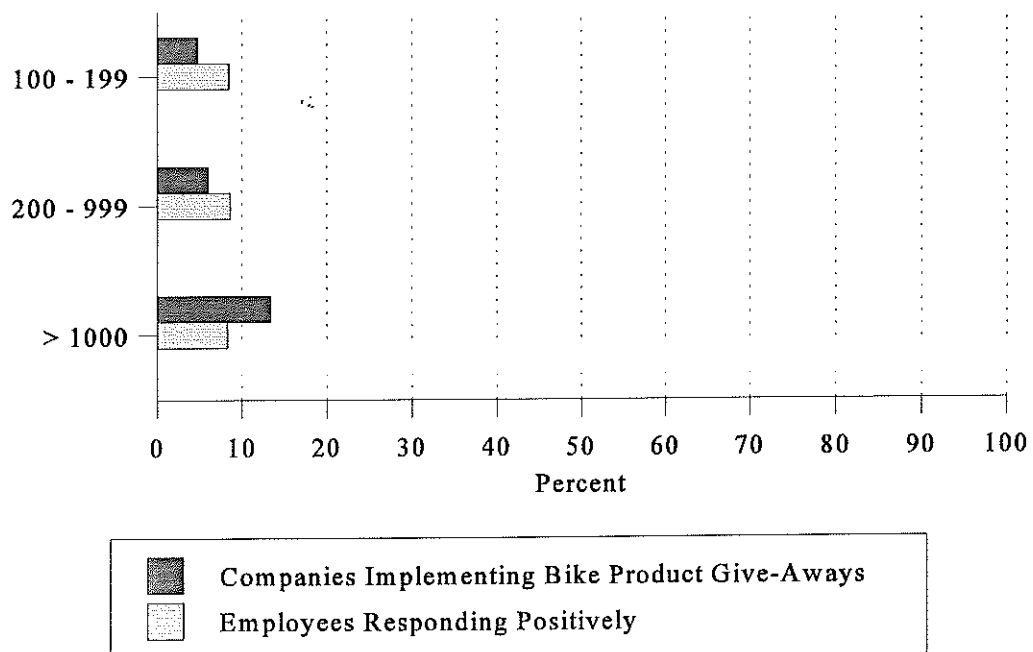
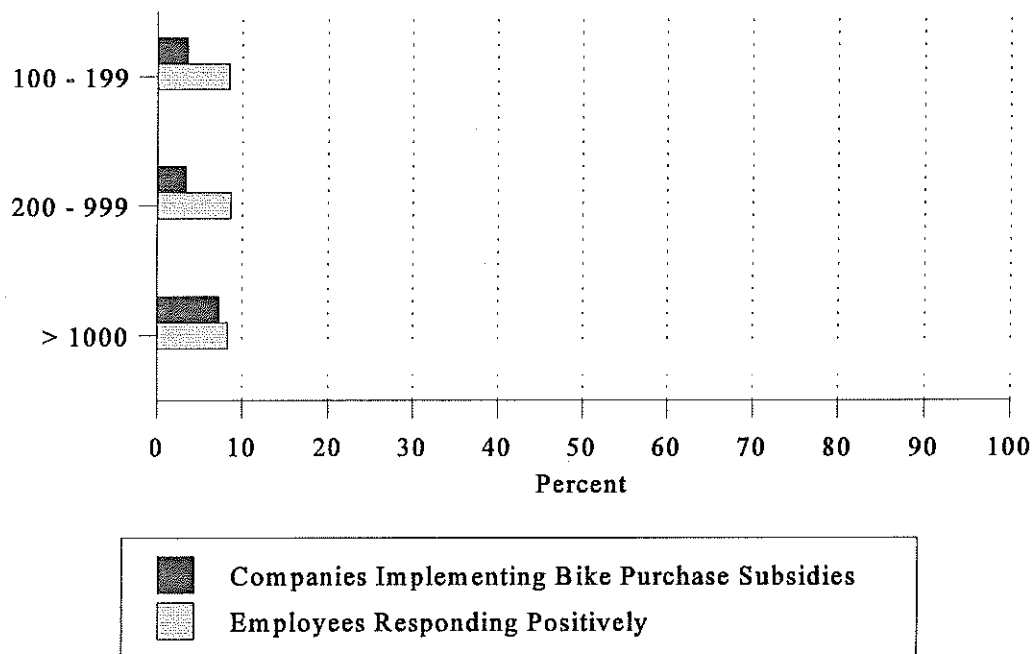
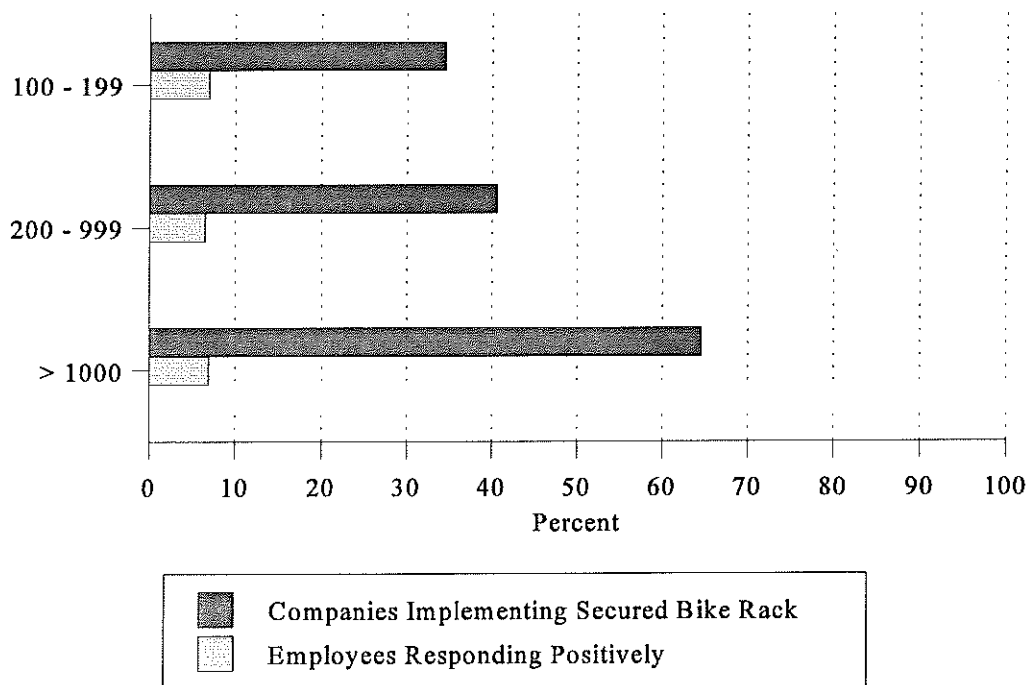


Figure I-14 Employee and employer interest in bike products





**Figure I-15** Employee and employer interest in bike purchase subsidies



**Figure I-16** Employee and employer interest in secured bike rack

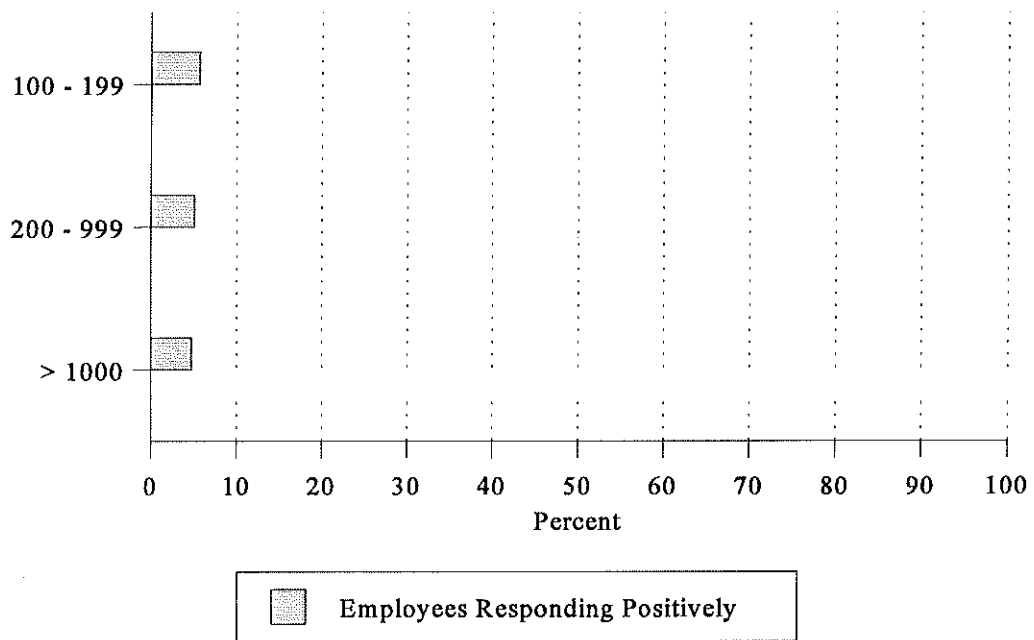


Figure I-17 Employee interest in walking incentives

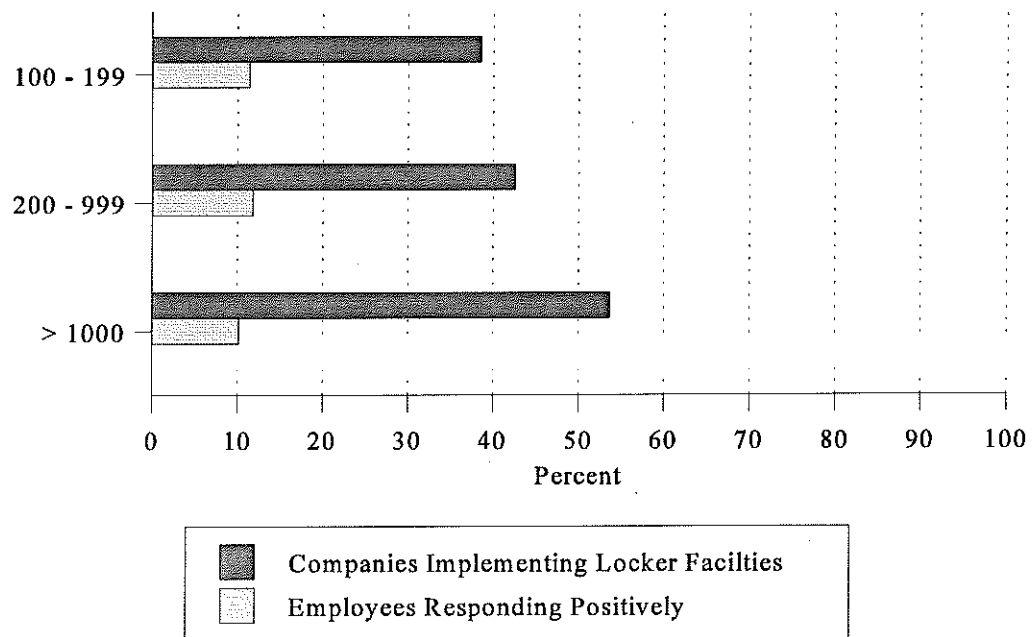


Figure I-18 Employee and employer interest in locker facilities

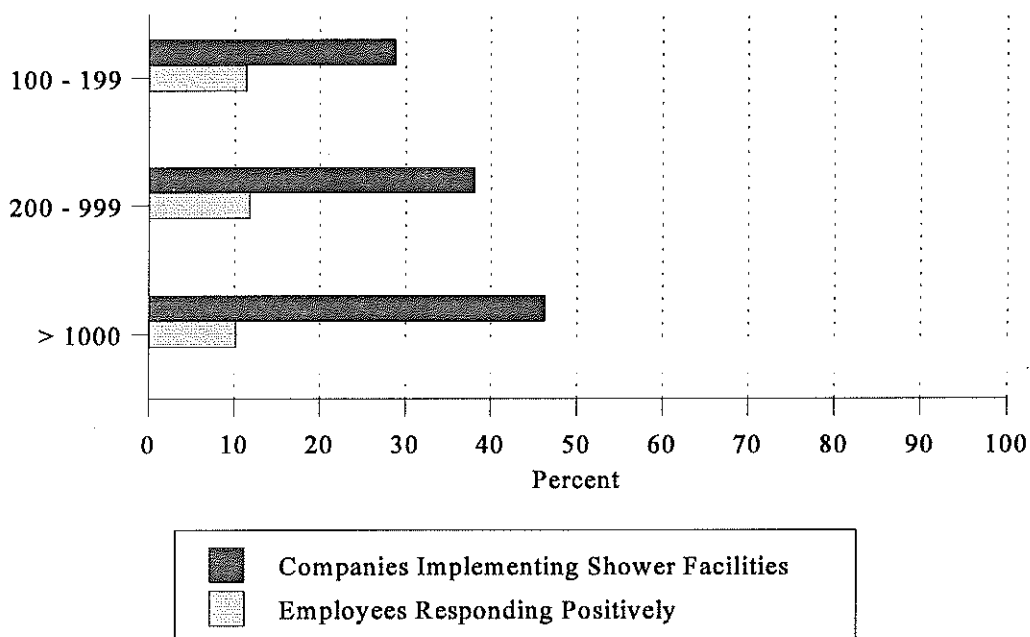


Figure I-19 Employee and employer interest in shower facilities

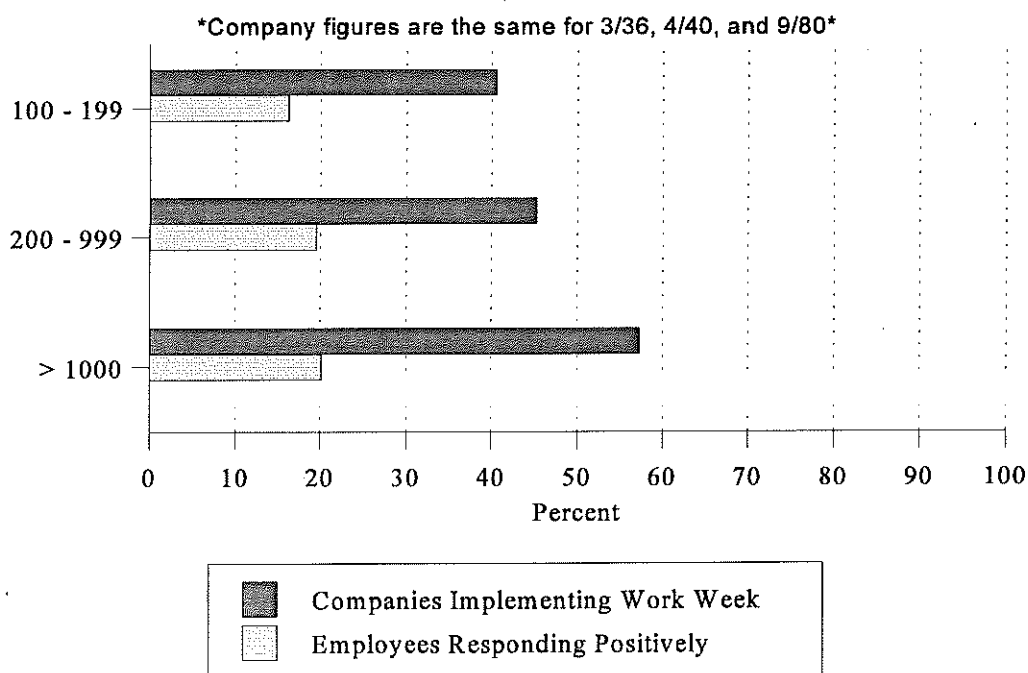


Figure I-20 Employee and employer interest in 3/36 compressed work

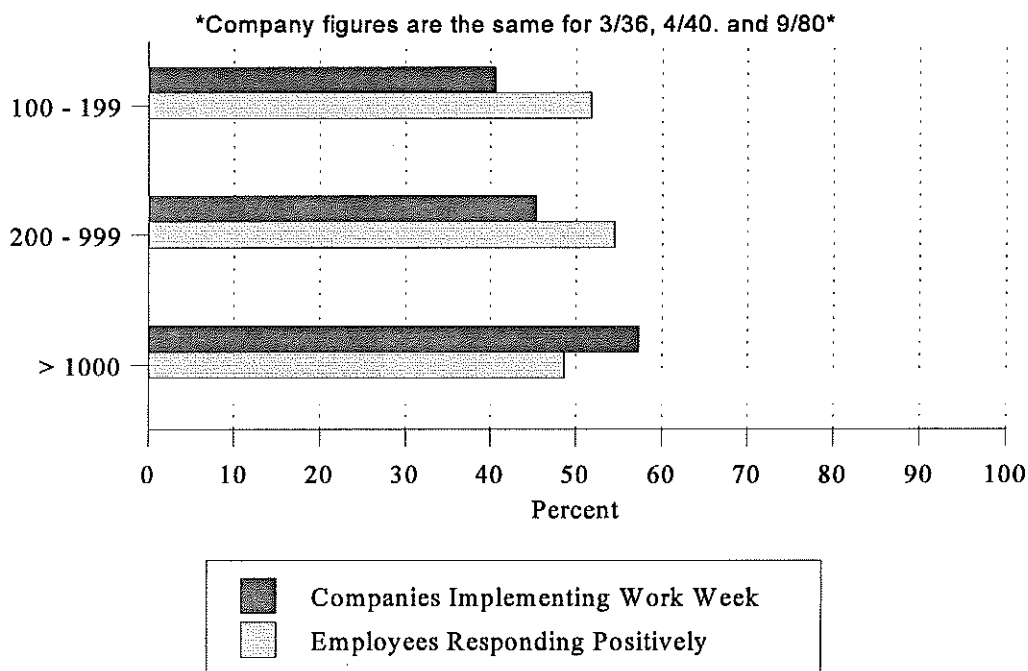


Figure I-21 Employee and employer interest in 4/40 compressed work

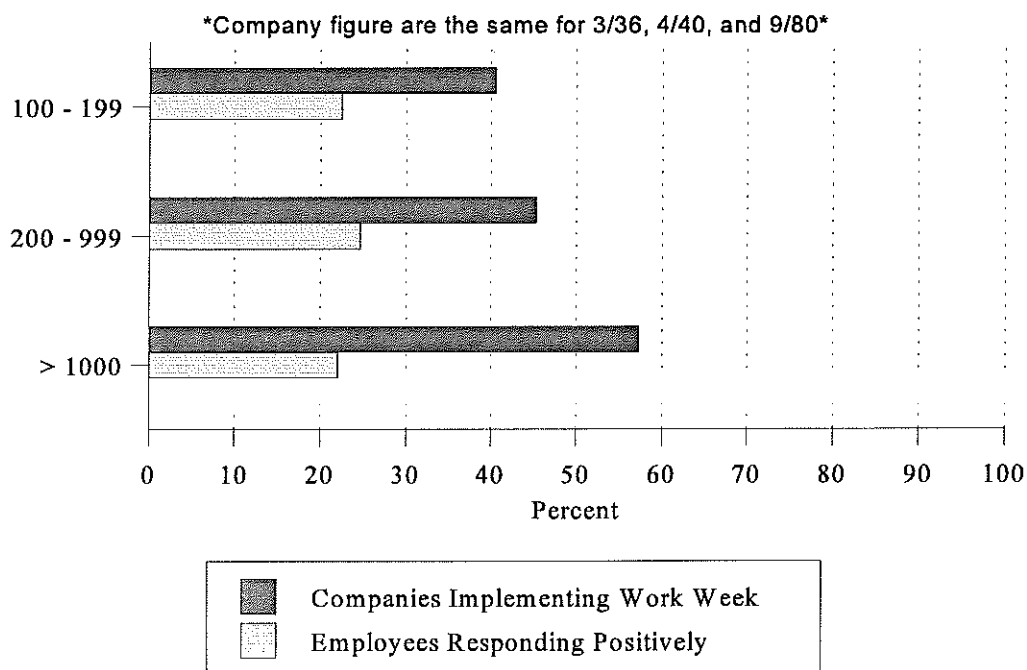


Figure I-22 Employee and employer interest in 9/80 compressed work

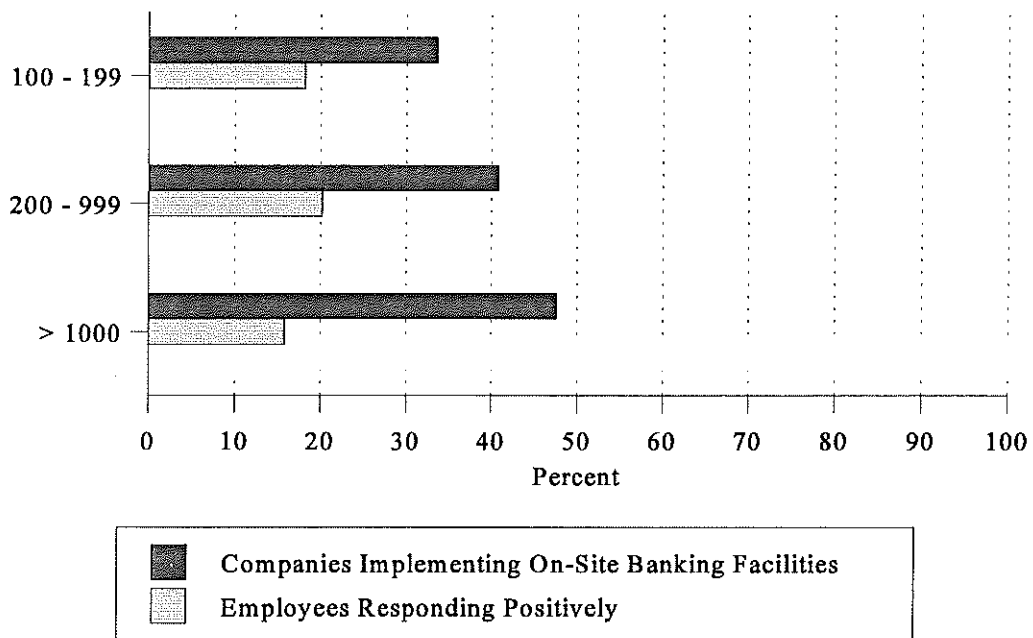


Figure I-23 Employee and employer interest in on-site banking facilities

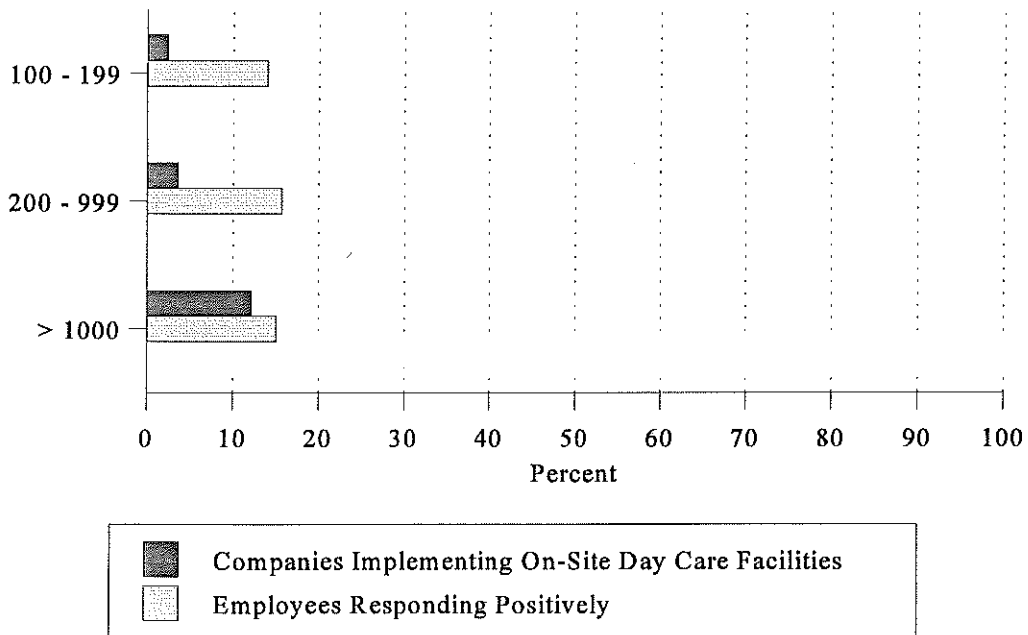


Figure I-24 Employee and employer interest in on-site day care facilities

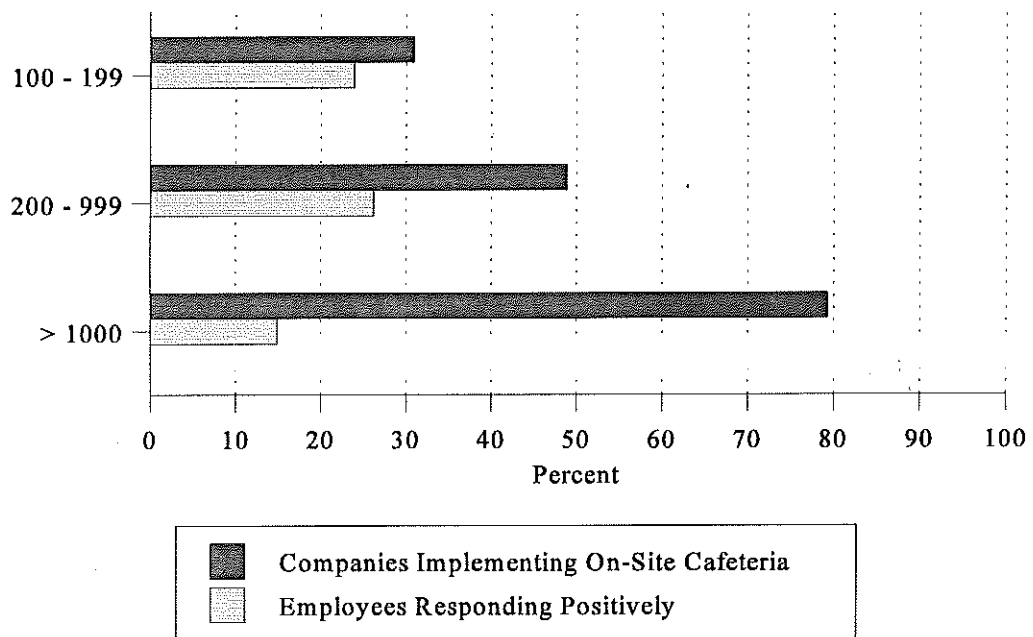


Figure I-25 Employee and employer interest in on-site cafeteria

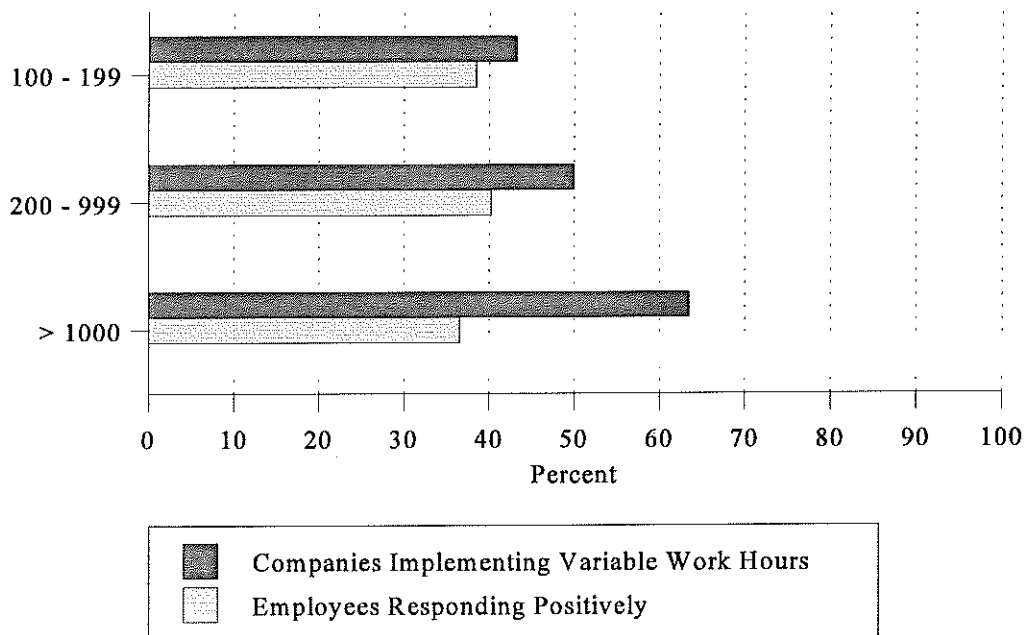


Figure I-26 Employee and employer interest in variable work hours

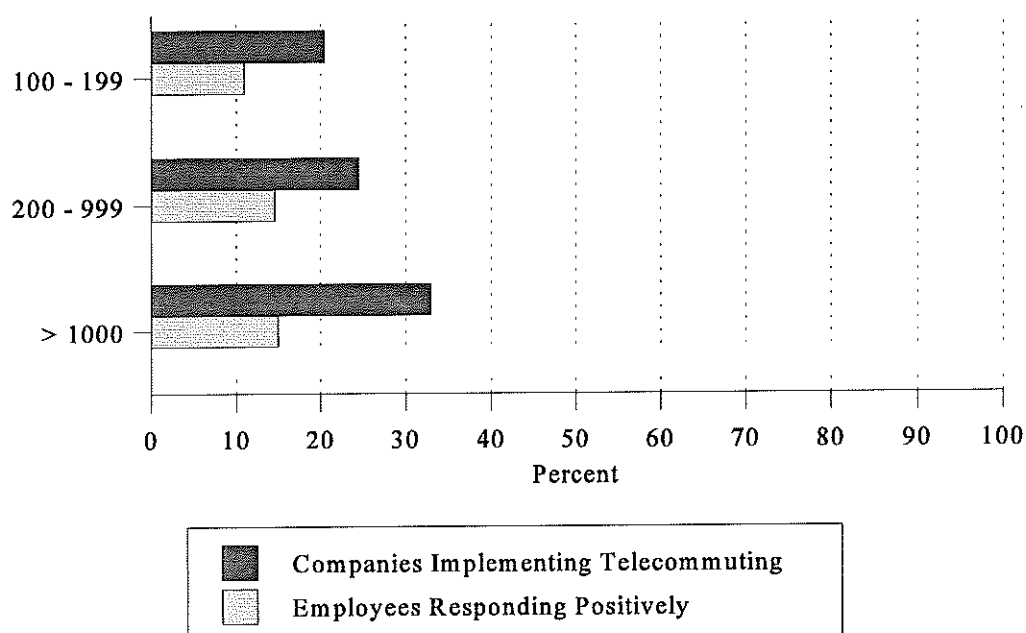


Figure I-27 Employee and employer interest in telecommuting

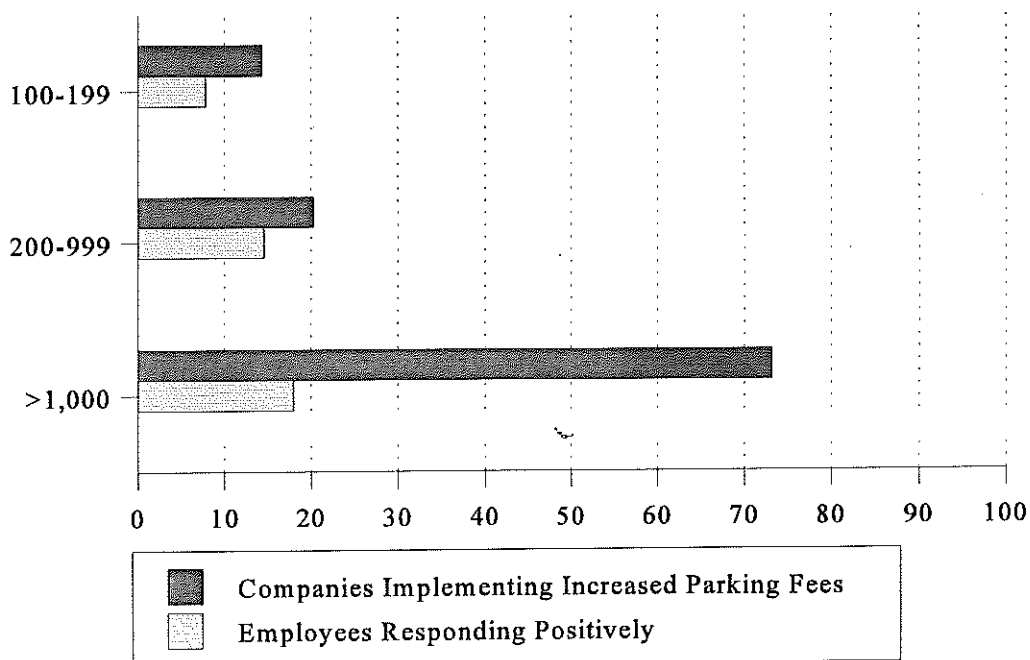


Figure I-28 Employee and employer interest in increased parking fees

## **APPENDIX J**

### **EMPLOYEE AND EMPLOYER INFORMATION BY S.I.C. CODE**



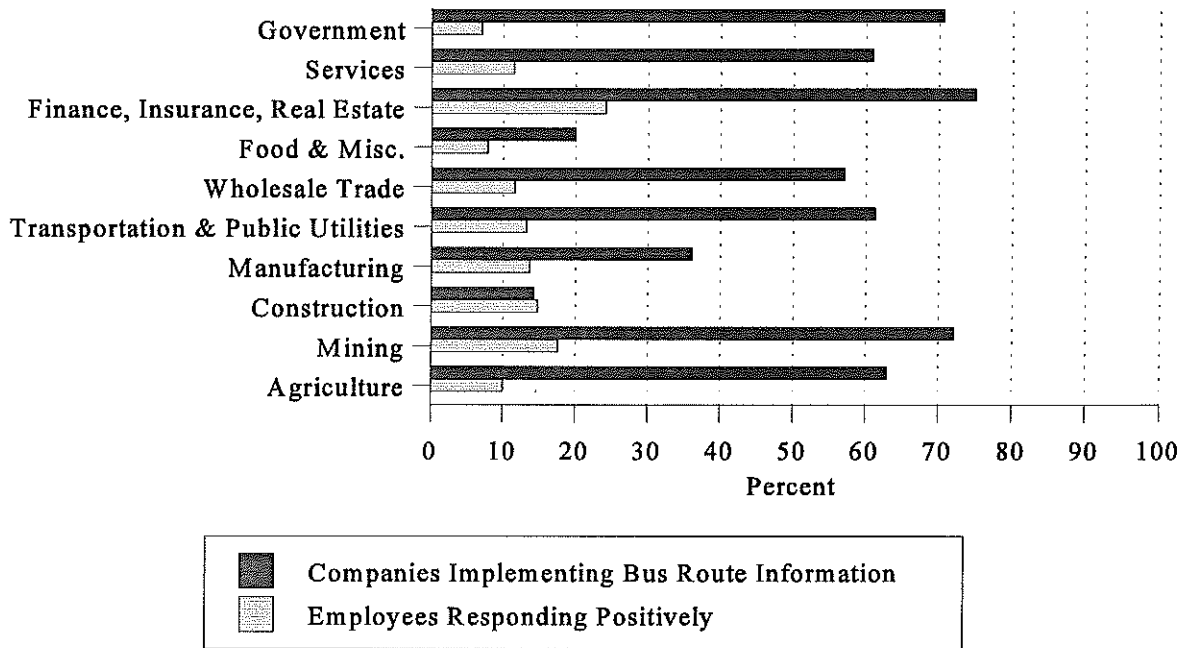


Figure J-1 Employee and employer interest in bus route information

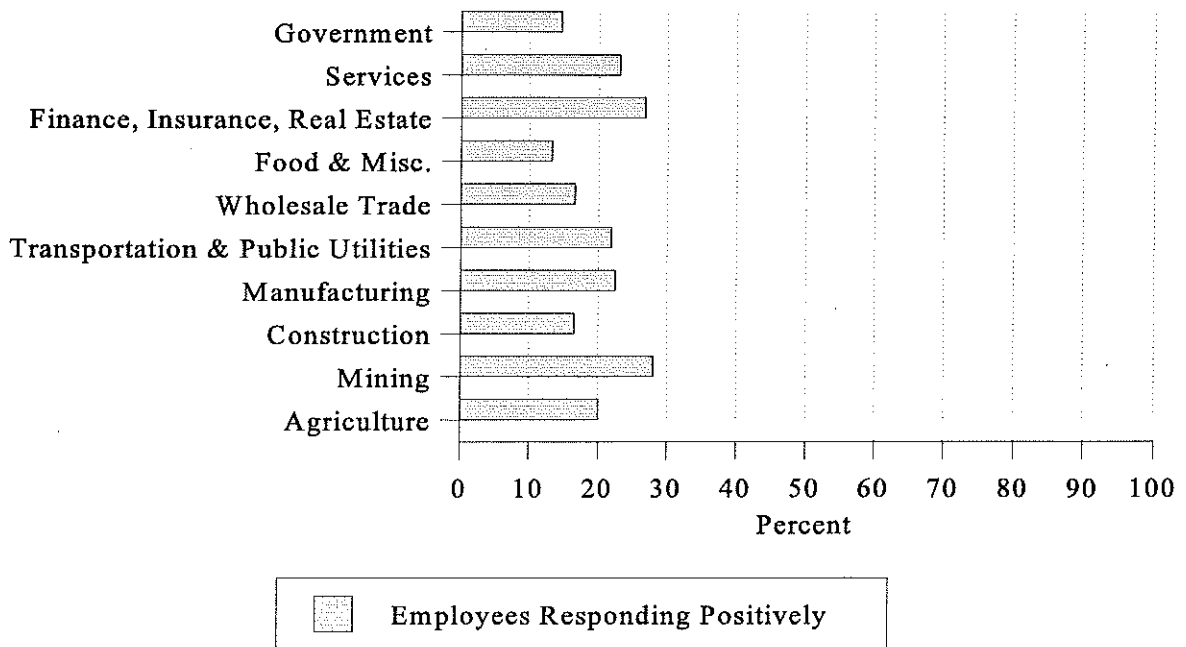


Figure J-2 Employees interest in local bus service

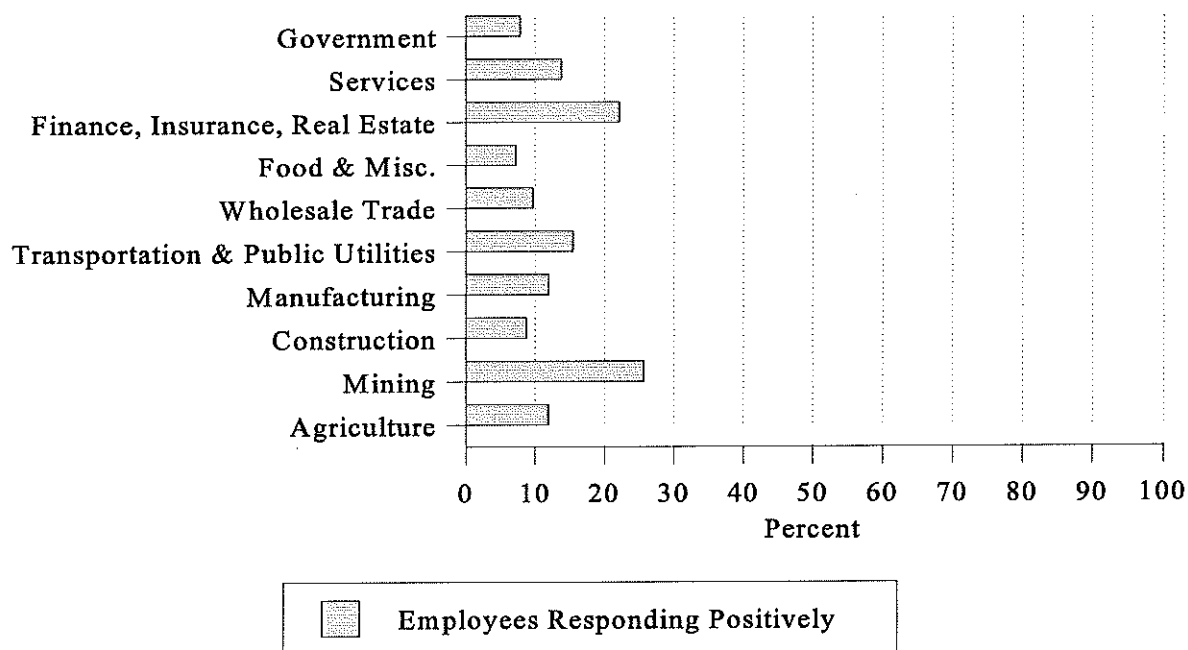


Figure J-3 Employees interest in late evening bus service

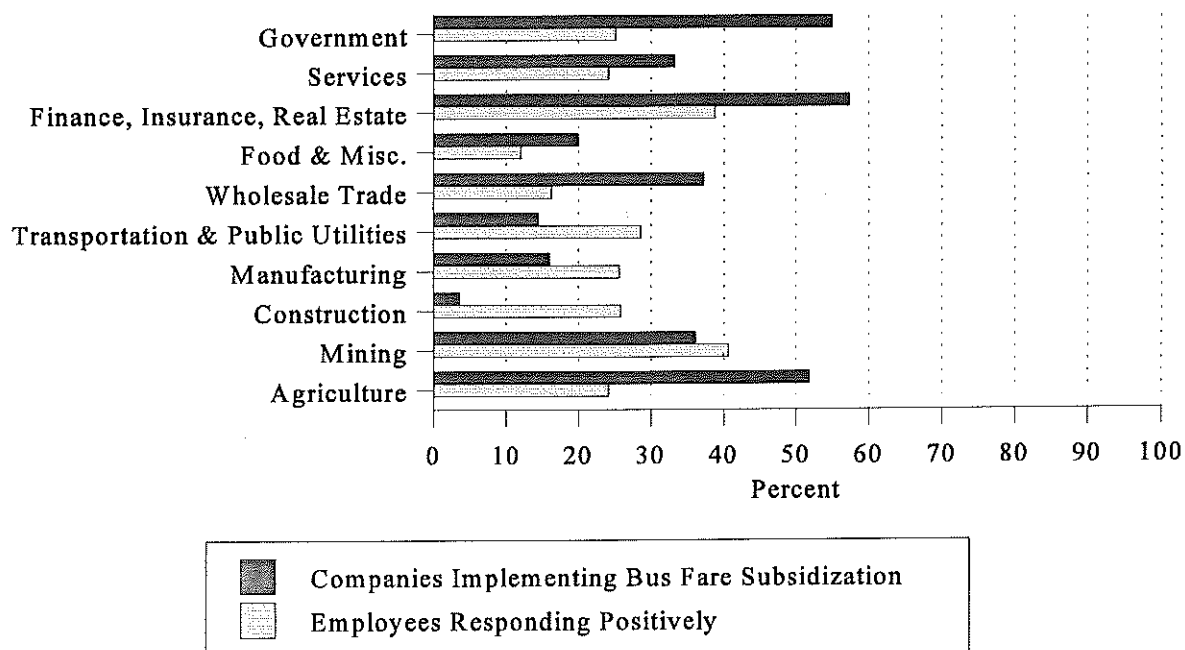


Figure J-4 Employee and employer interest in subsidizing bus fares

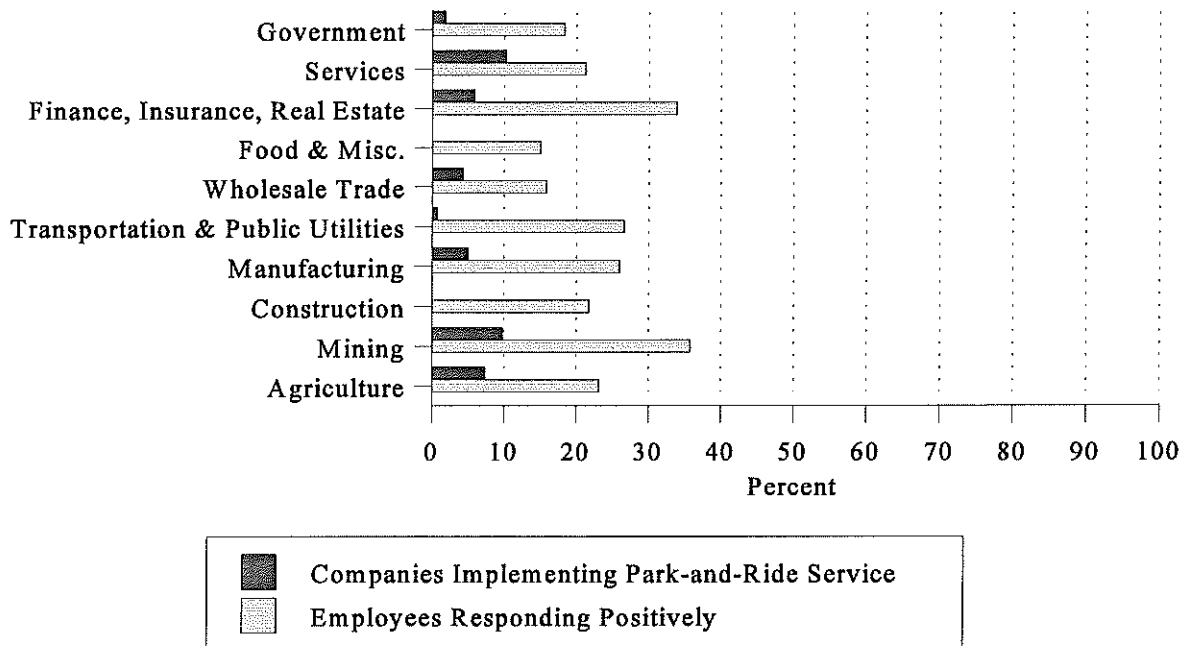


Figure J-5 Employee and employer interest in preferential park-and-ride service

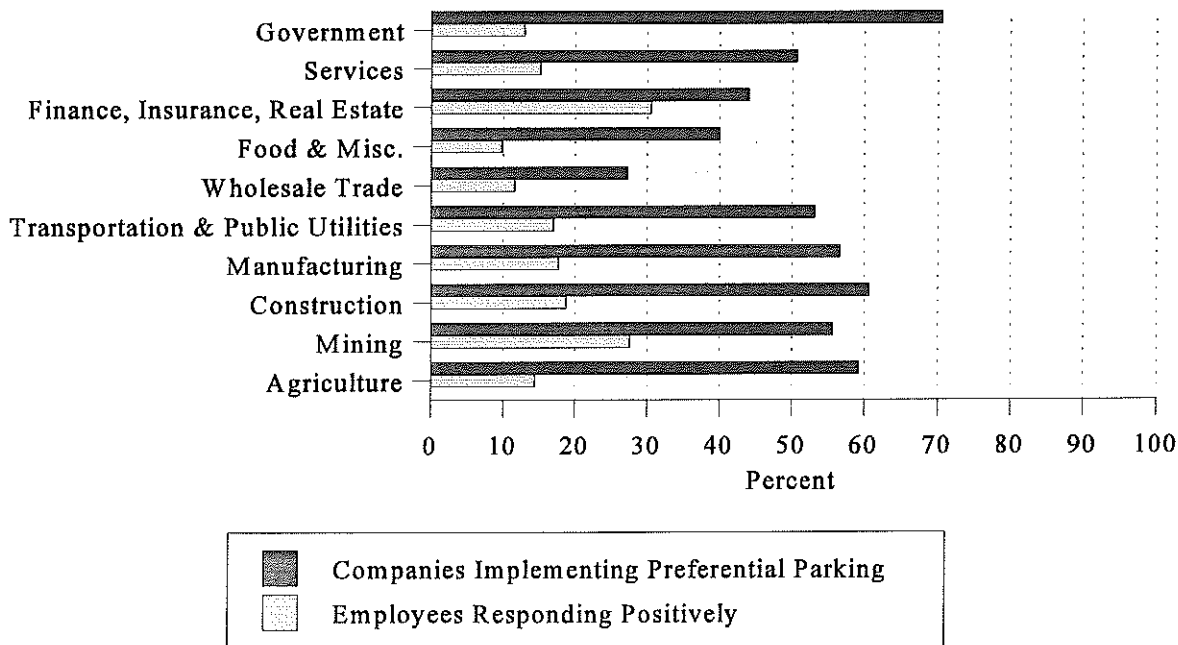


Figure J-6 Employee and employer interest in preferential carpool/vanpool parking

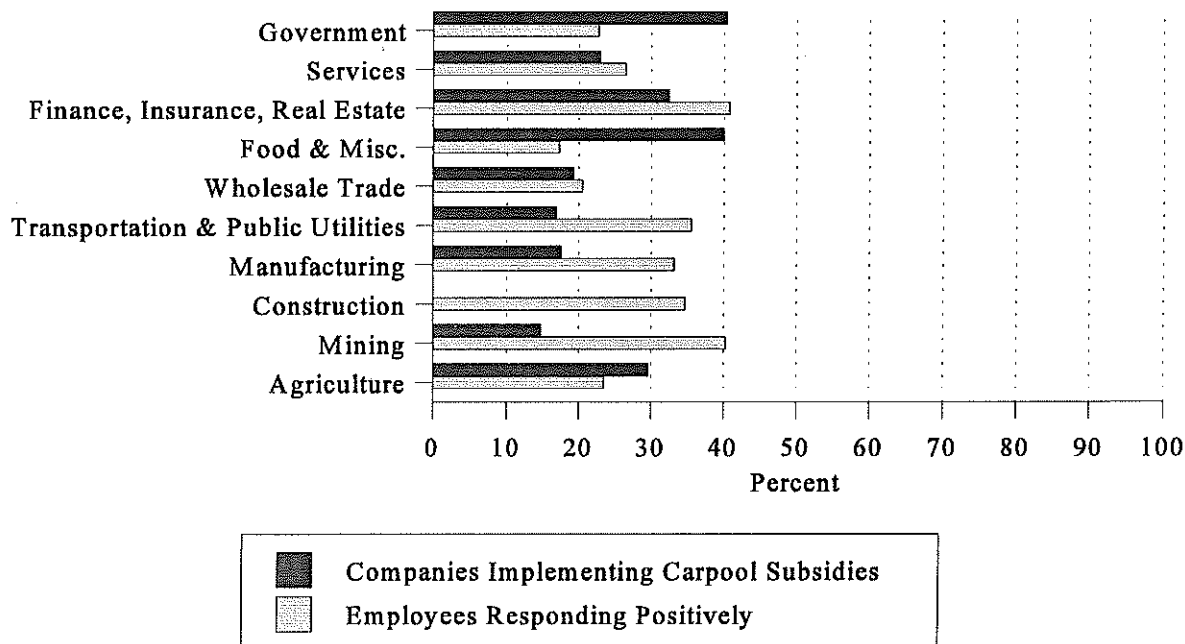


Figure J-7 Employee and employer interest in carpool subsidies

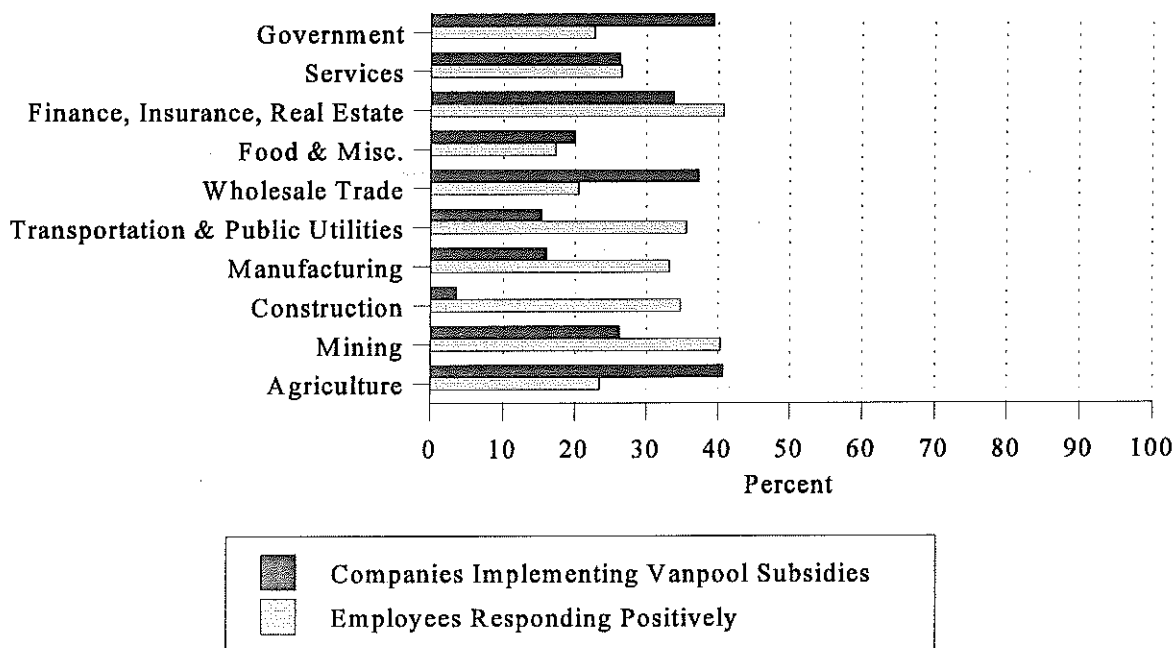
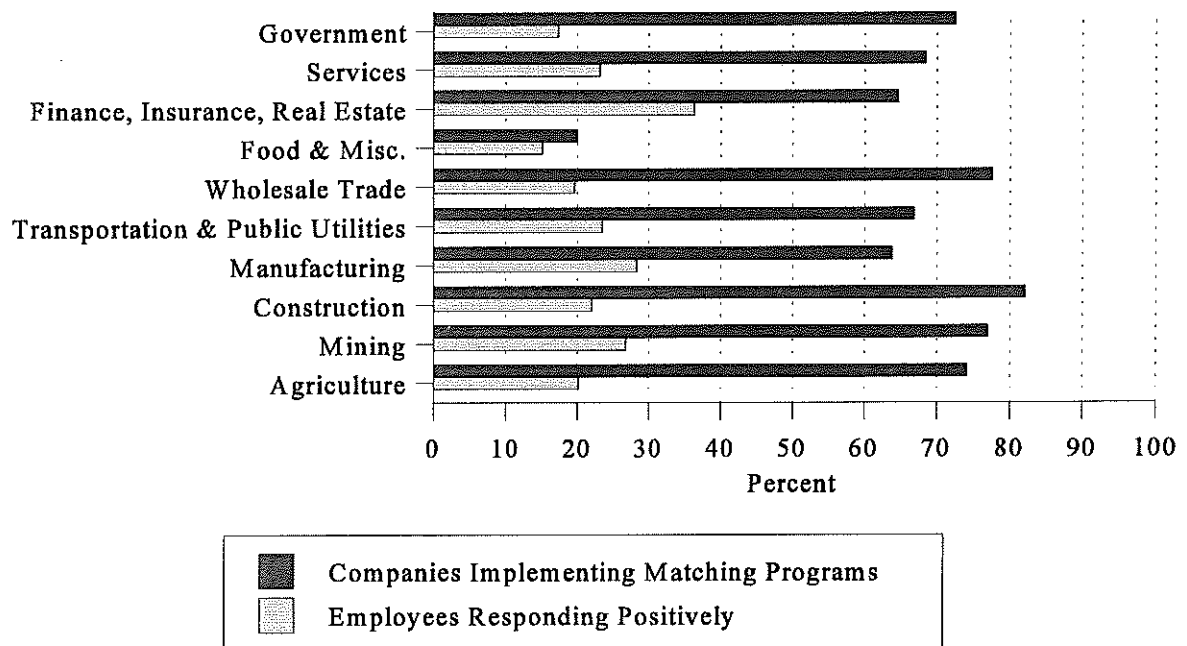
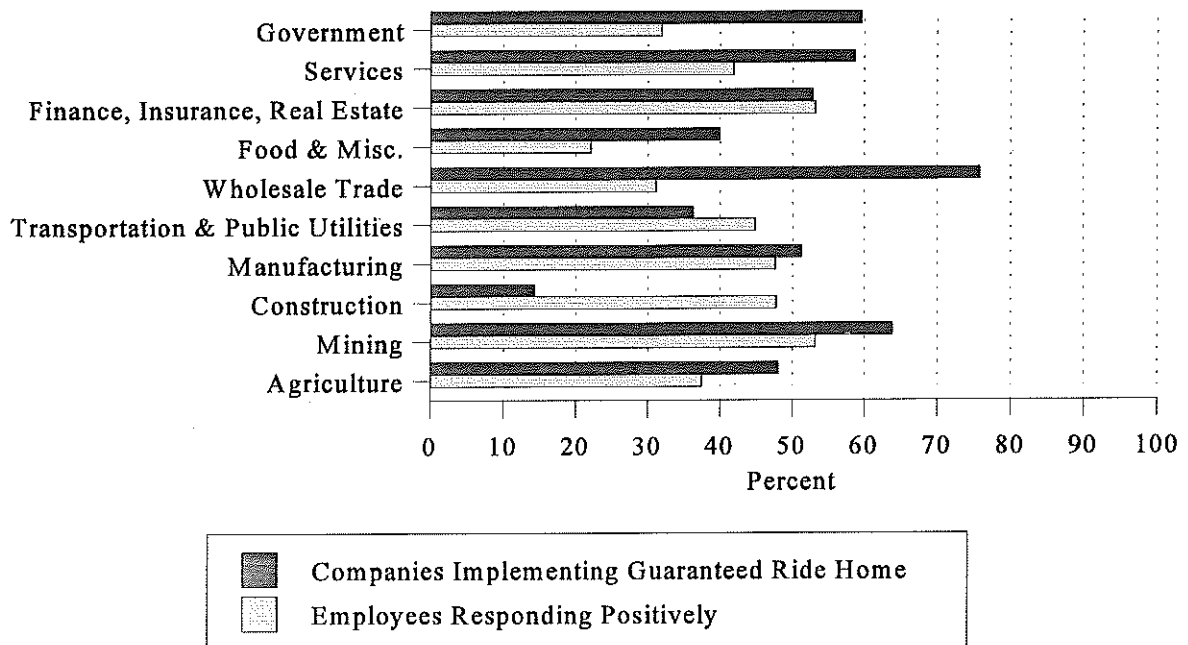


Figure J-8 Employee and employer interest in vanpool subsidies

*Appendix J: Employee and Employer Information by S.I.C. Codes*



**Figure J-9** Employee and employer interest in preferential carpool/vanpool matching



**Figure J-10** Employee and employer interest in guaranteed ride home programs

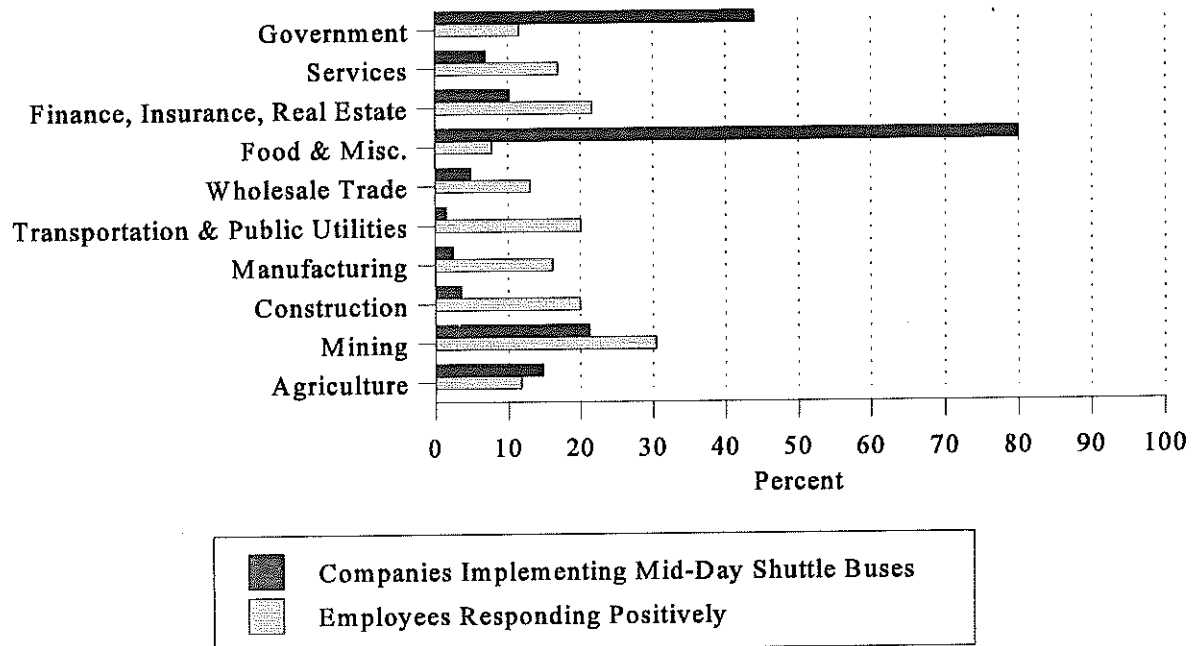


Figure J-11 Employee and employer interest in mid-day shuttle programs

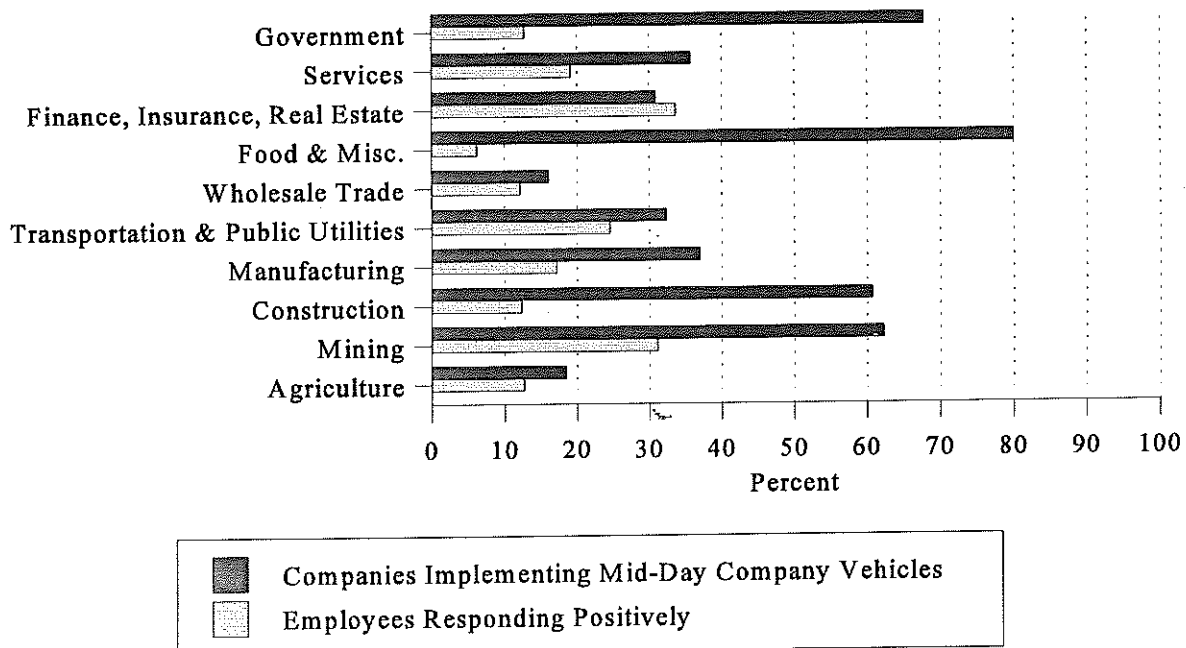


Figure J-12 Employee and employer interest in company vehicles for mid-day trips

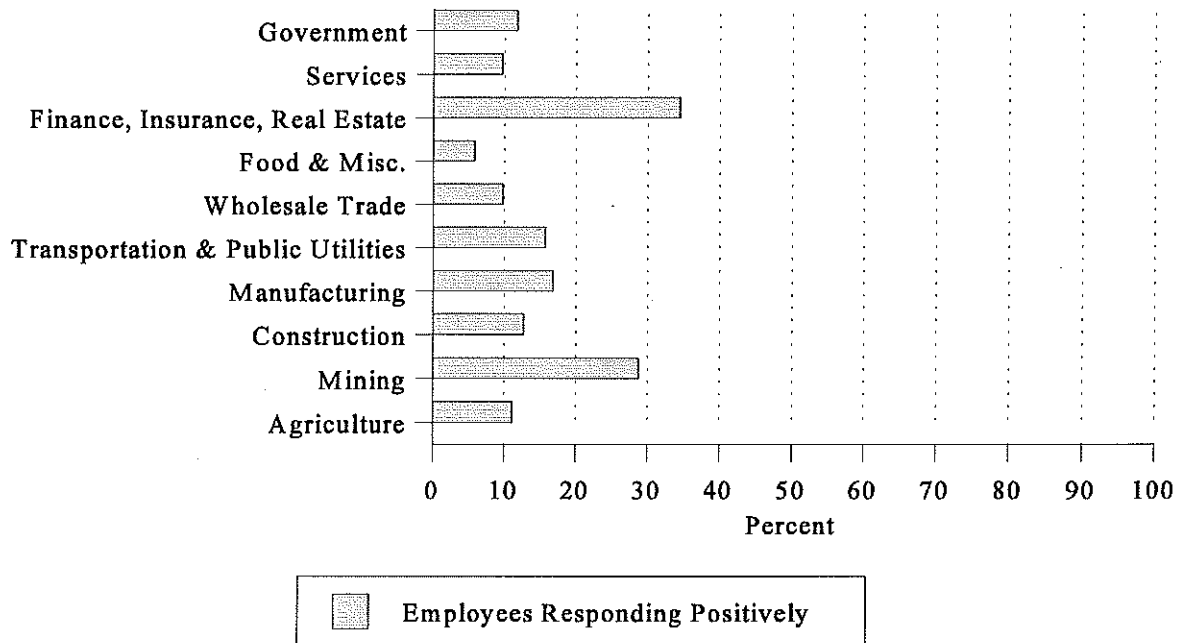


Figure J-13 Employee interest in high occupancy vehicle (HOV) lanes

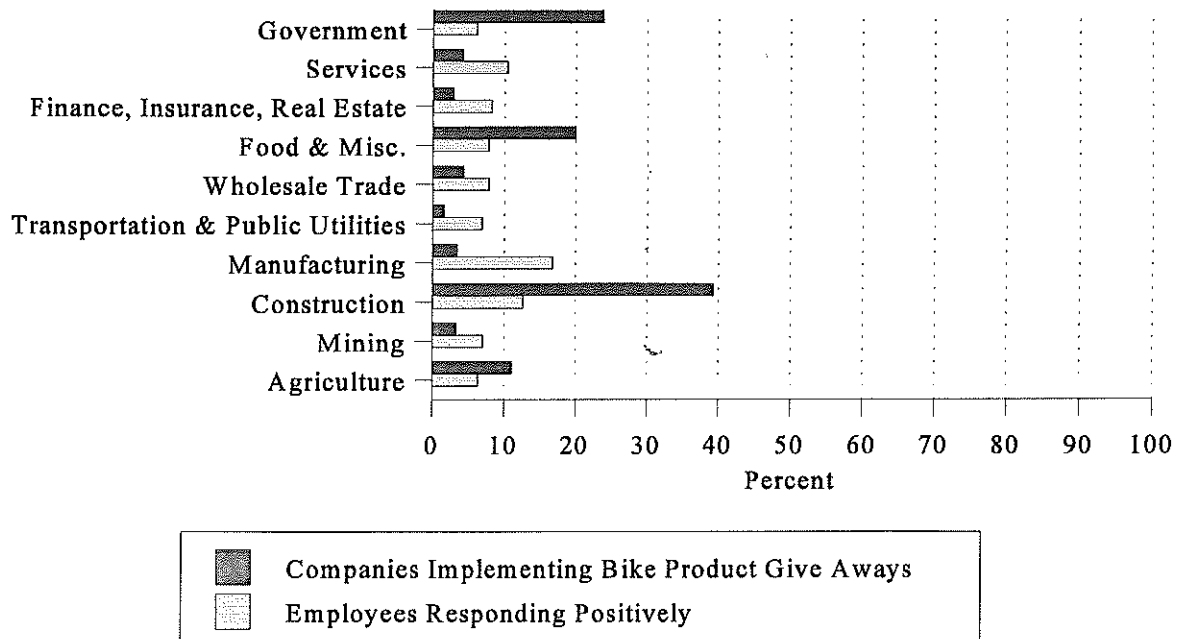


Figure J-14 Employee and employer interest in bike products

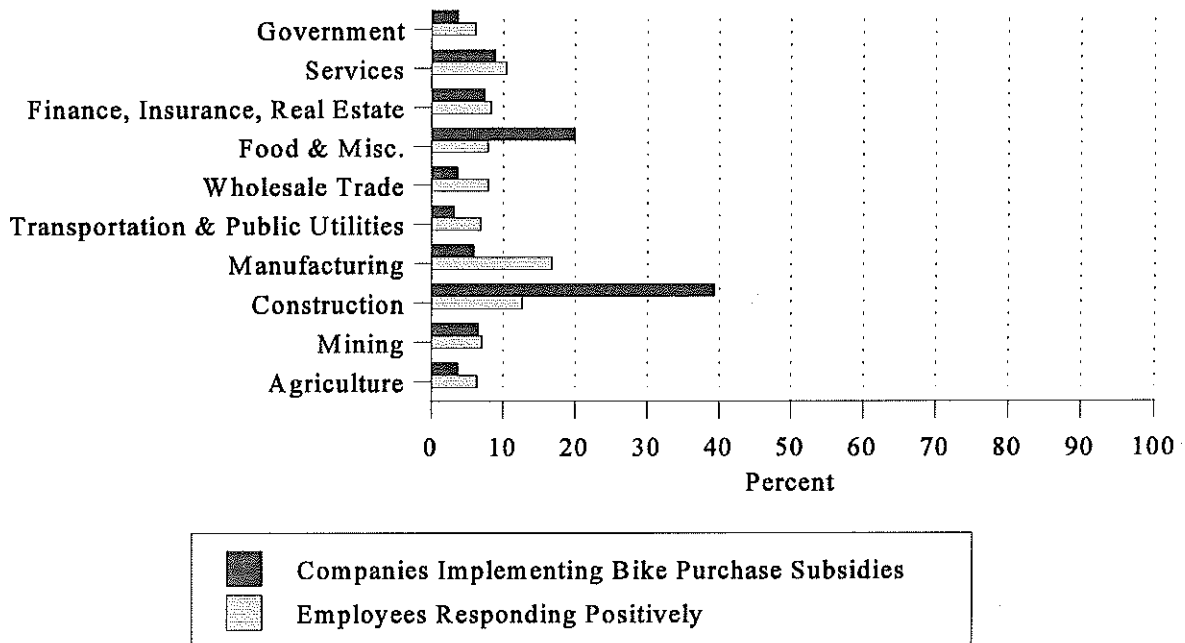


Figure J-15 Employee and employer interest in bike purchase subsidies

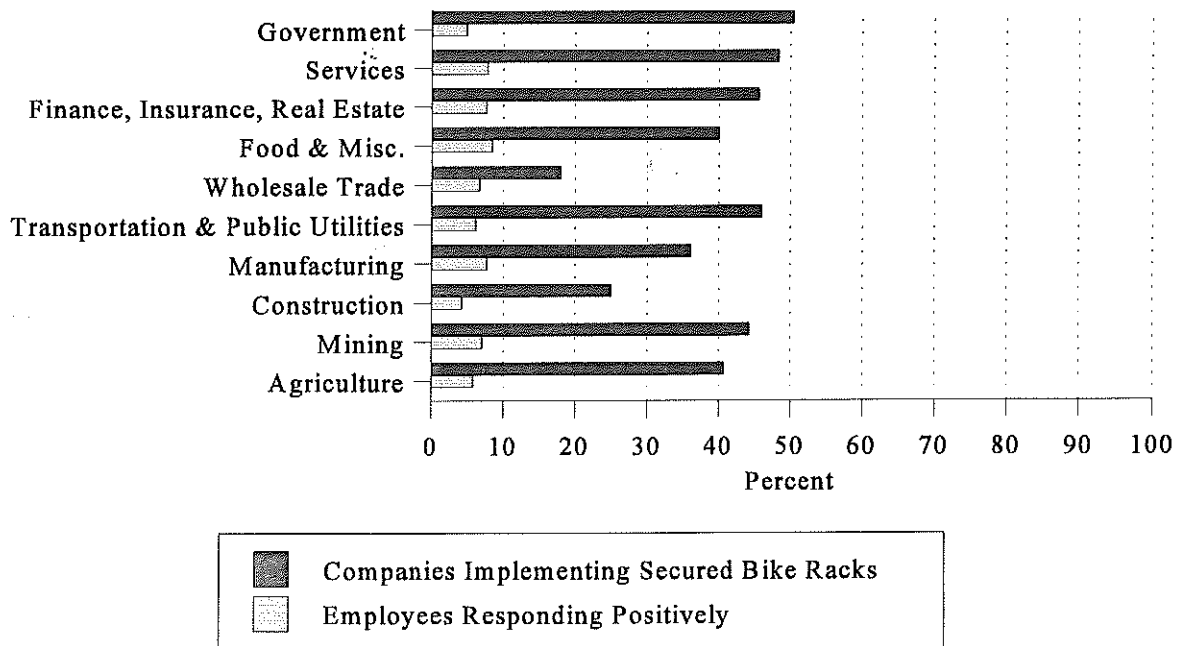


Figure J-16 Employee and employer interest in secured bike racks



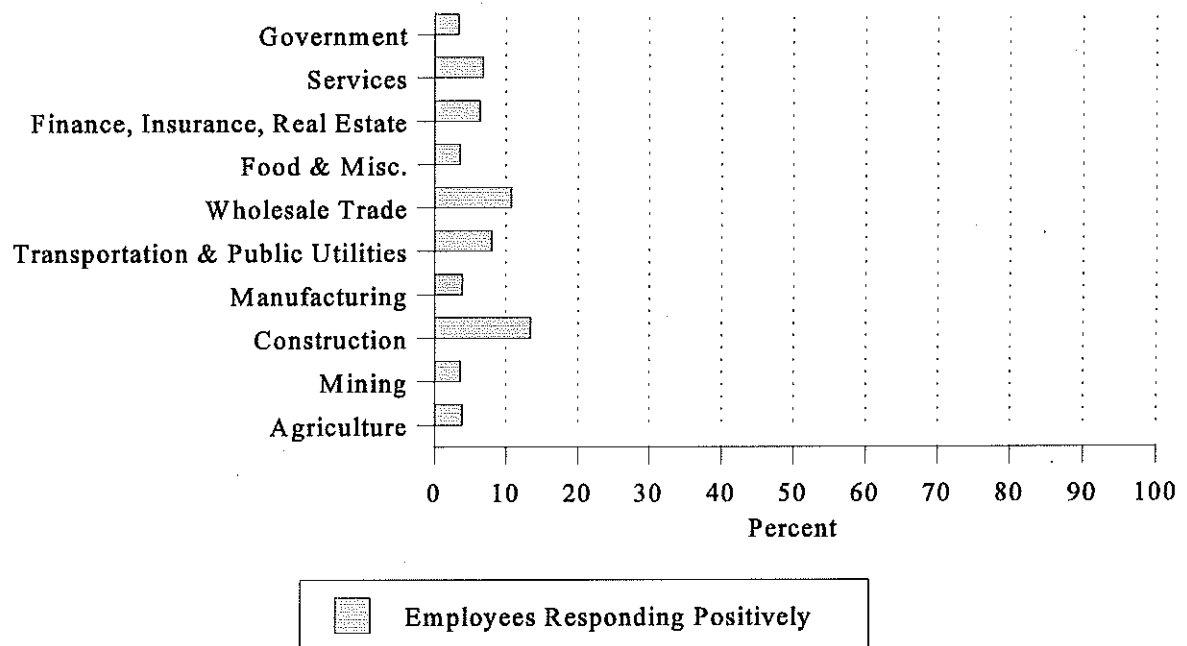


Figure J-17 Employee interest in walking incentives

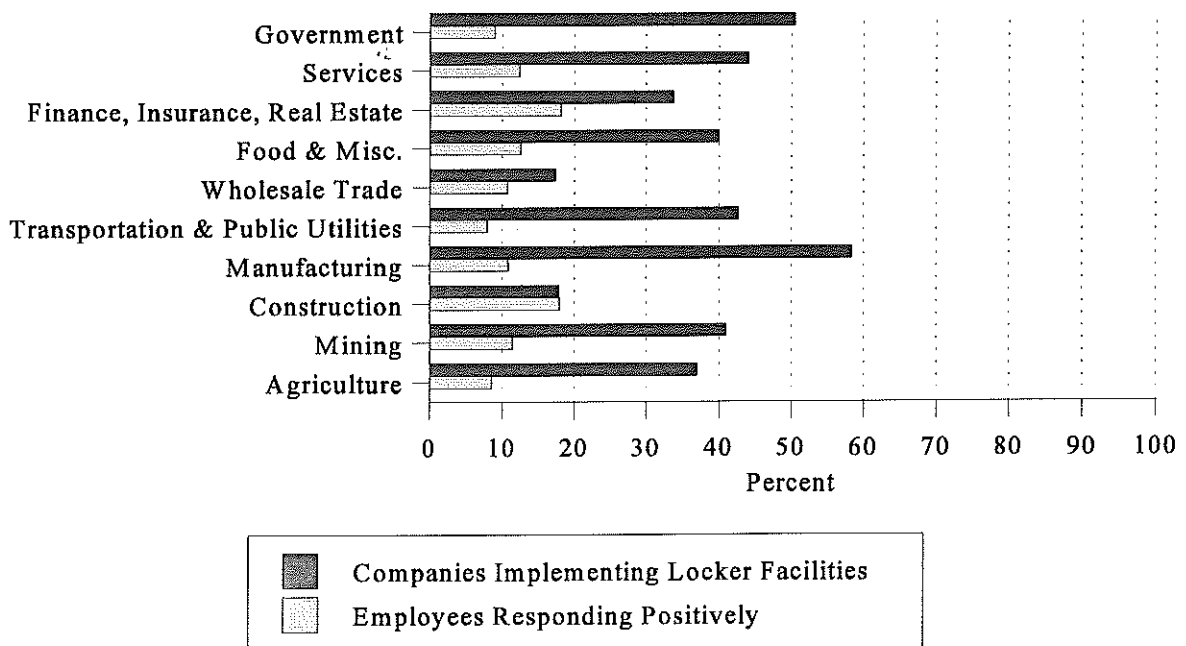


Figure J-18 Employee and employer interest in locker facilities

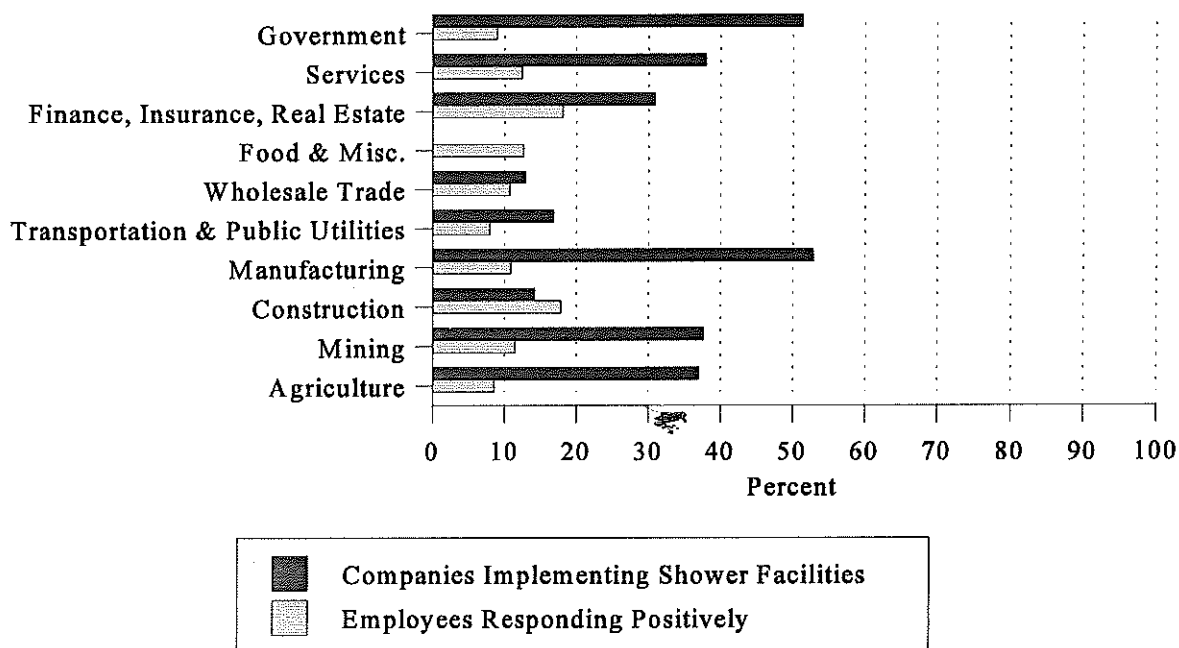


Figure J-19 Employee and employer interest in shower facilities

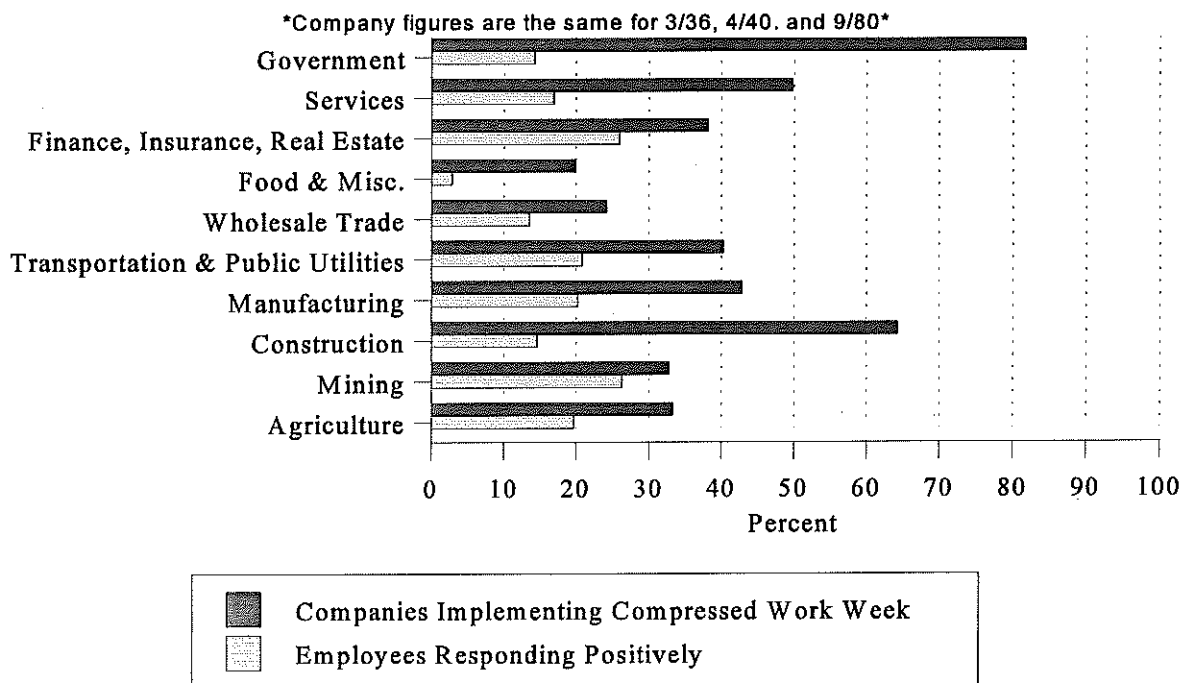


Figure J-20 Employee and employer interest in 3/36 compressed work week

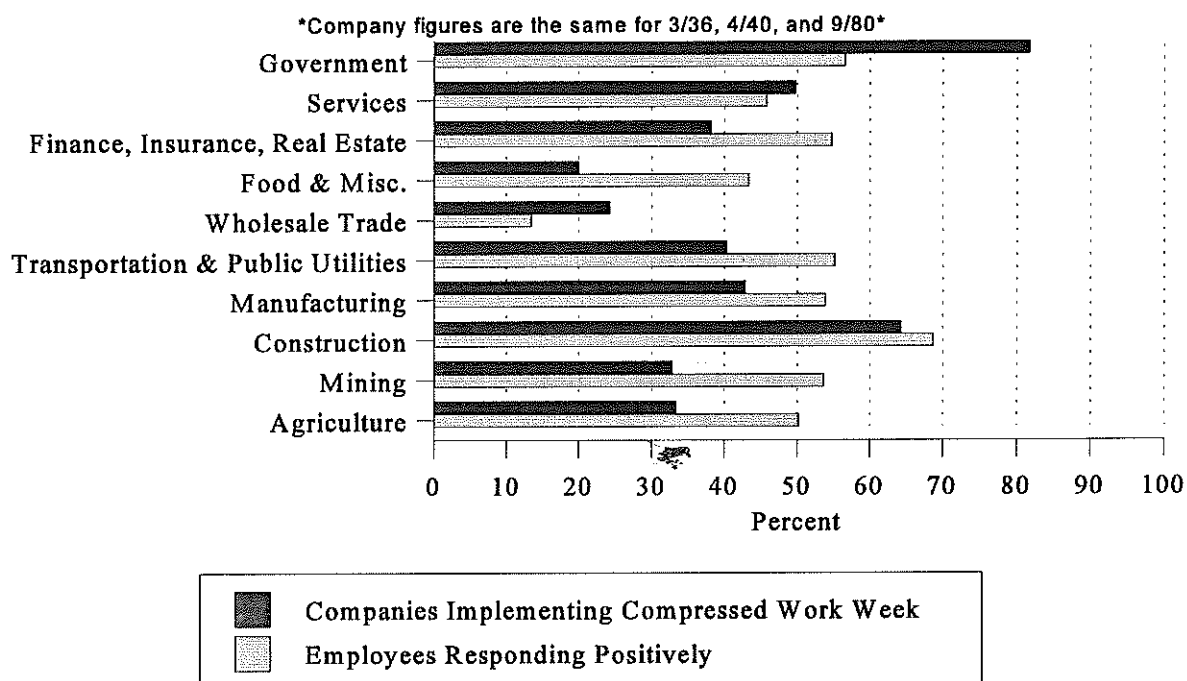


Figure J-21 Employee and employer interest in 4/40 compressed work week

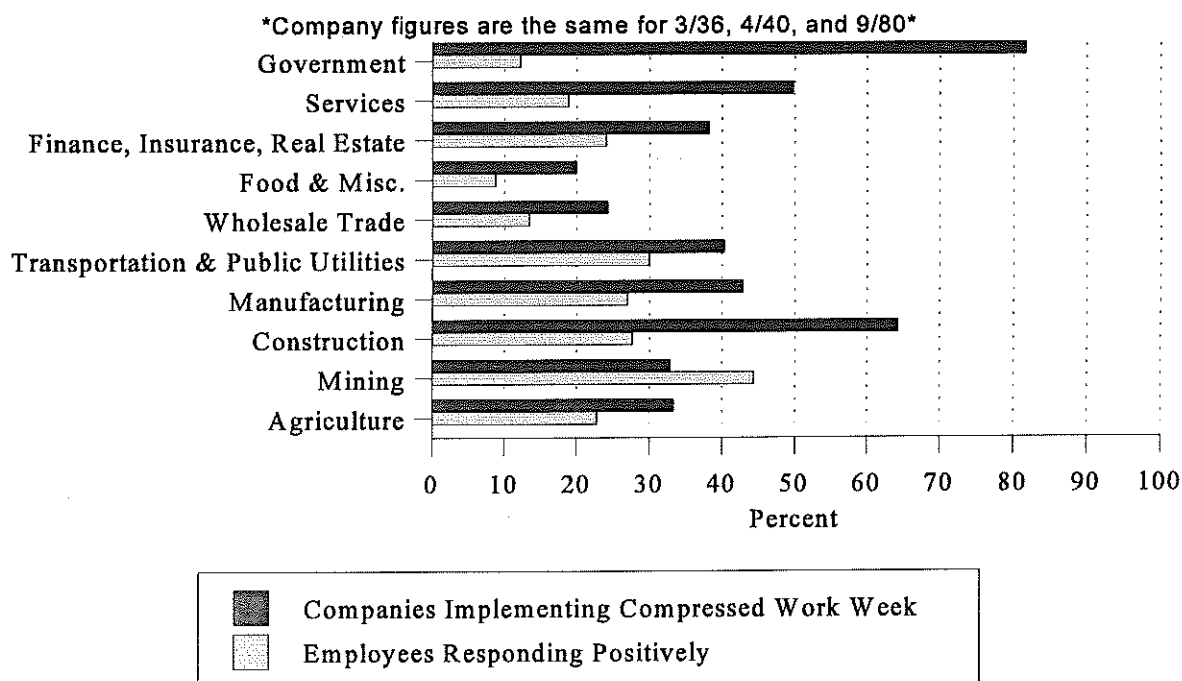


Figure J-22 Employee and employer interest in 9/80 compressed work week

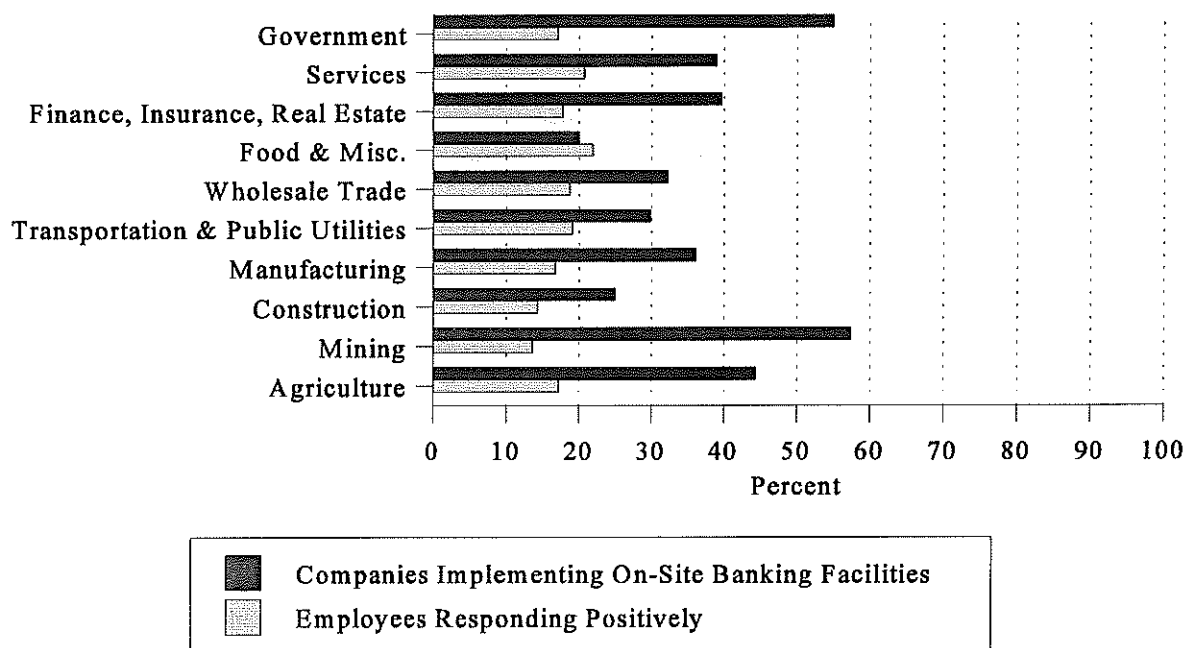


Figure J-23 Employee and employer interest in on-site banking facilities

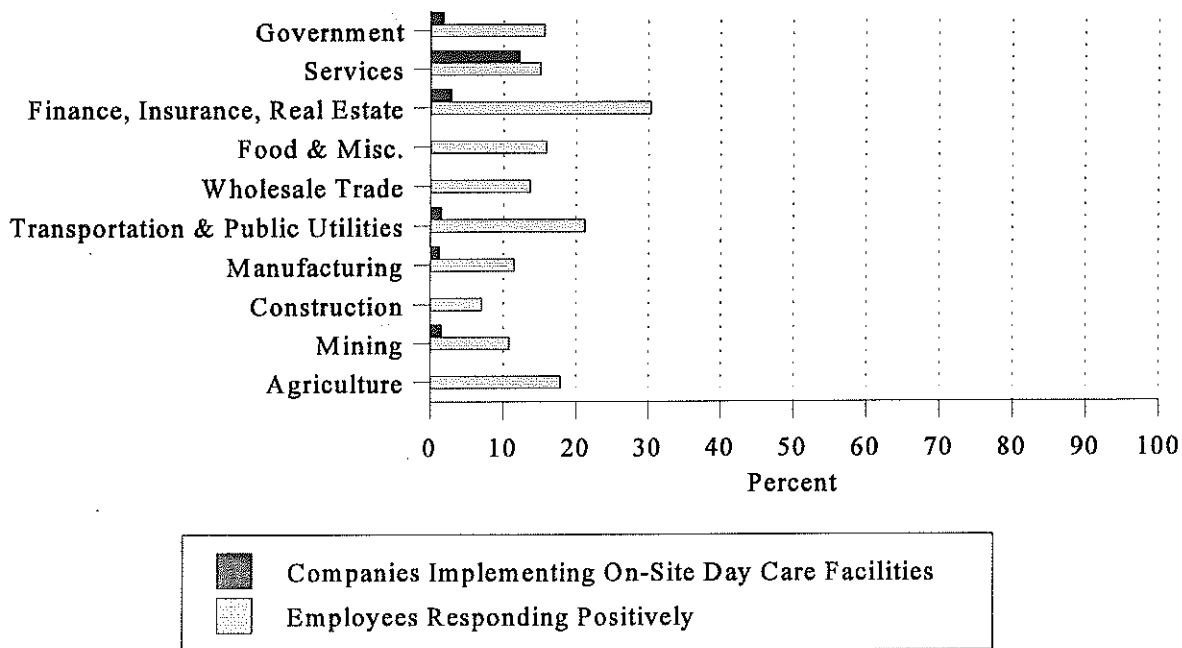


Figure J-24 Employee and employer interest in on-site day care facilities

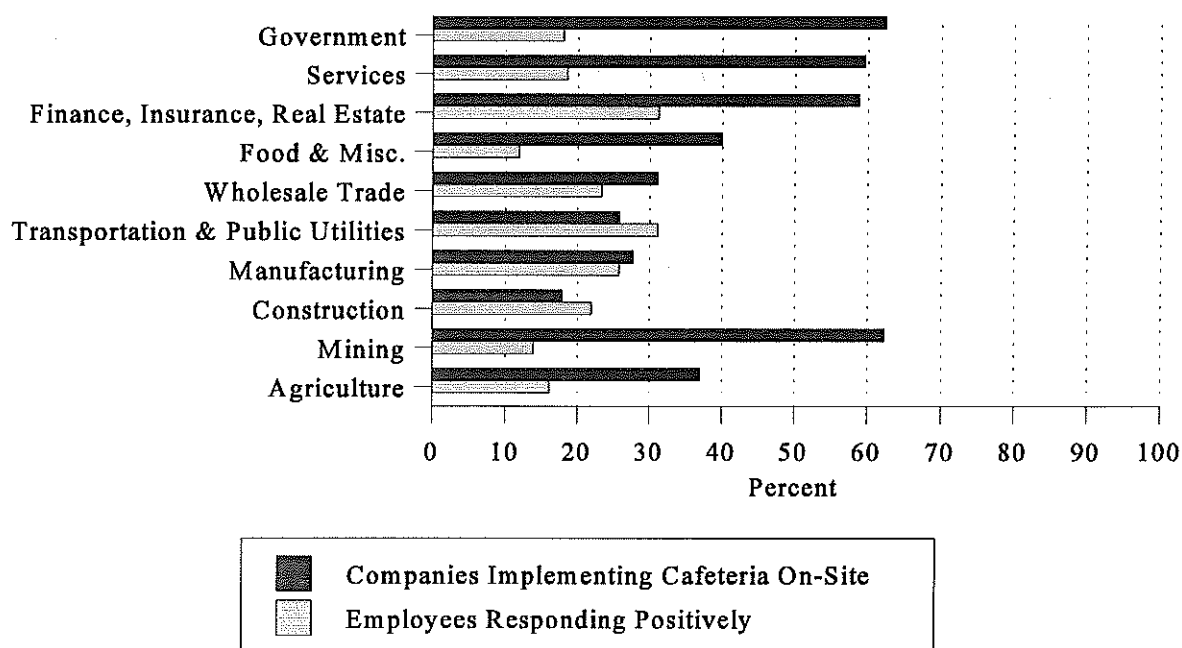


Figure J-25 Employee and employer interest in cafeteria on-site

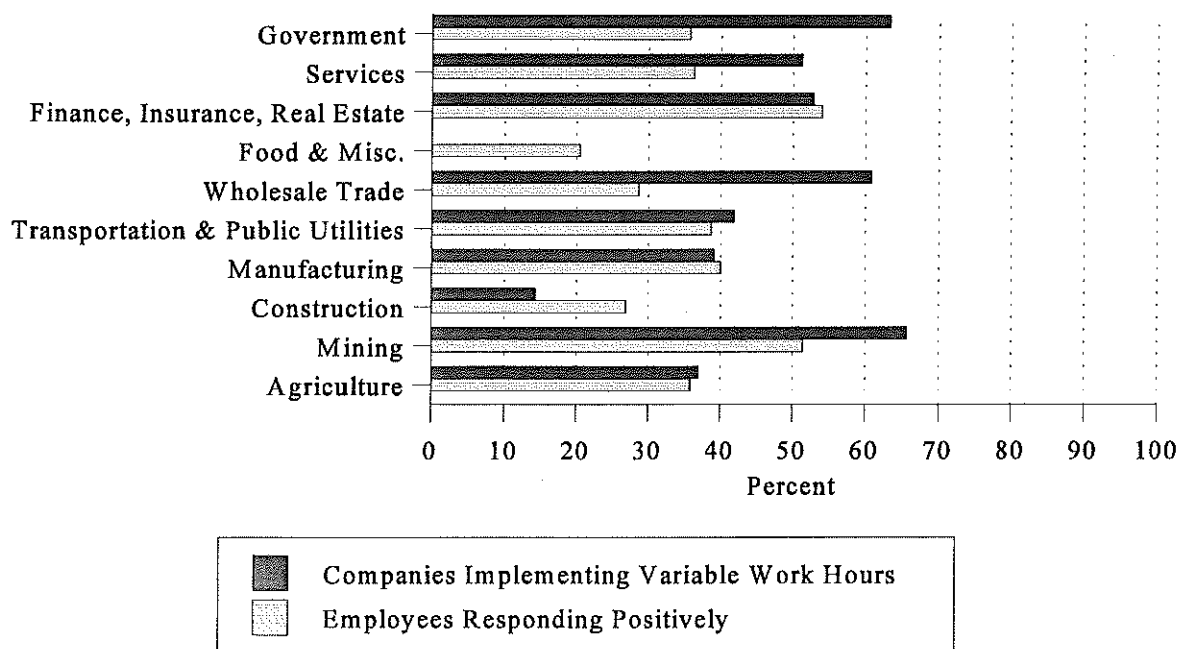


Figure J-26 Employee and employer interest in variable work hours

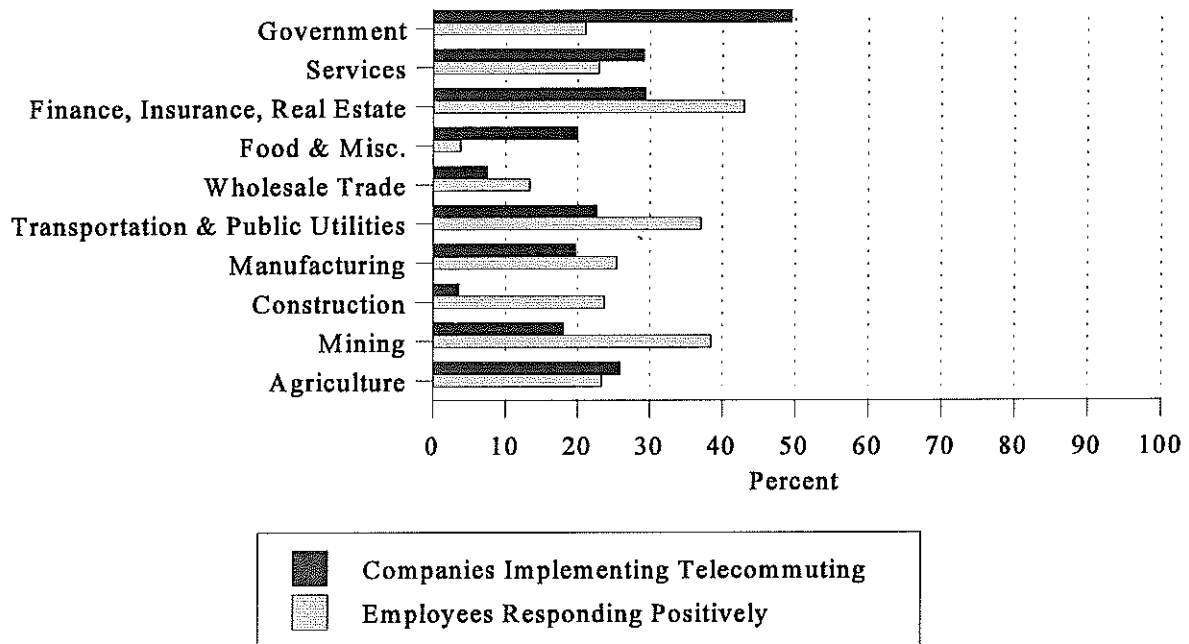


Figure J-27 Employee and employer interest in telecommuting

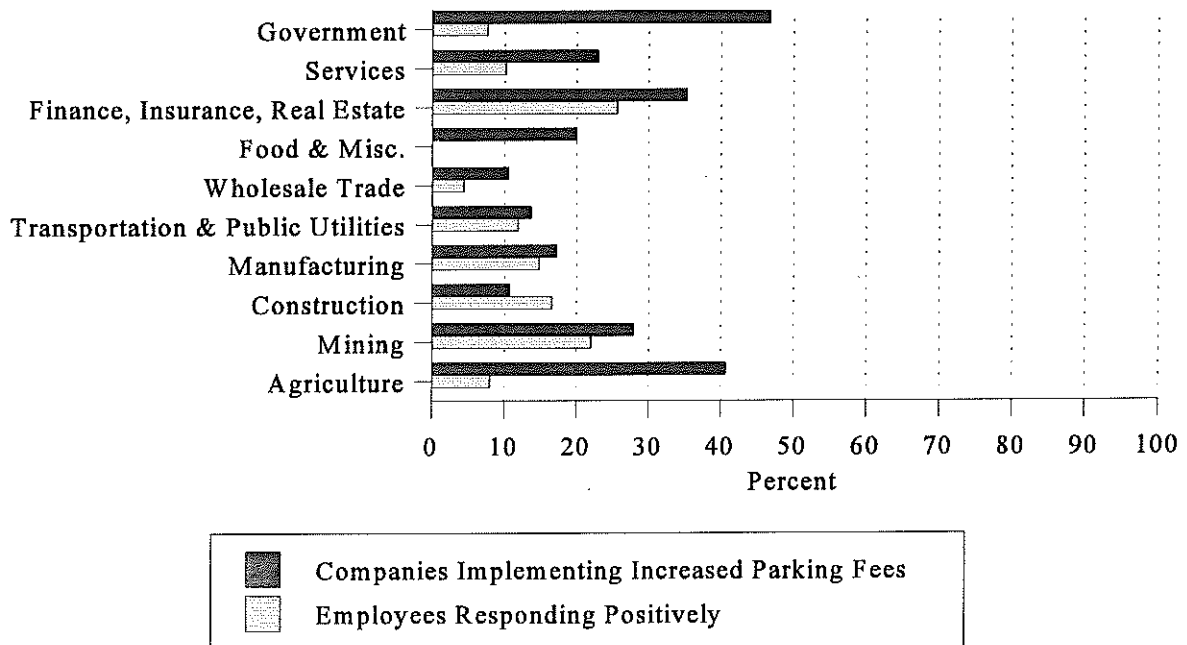


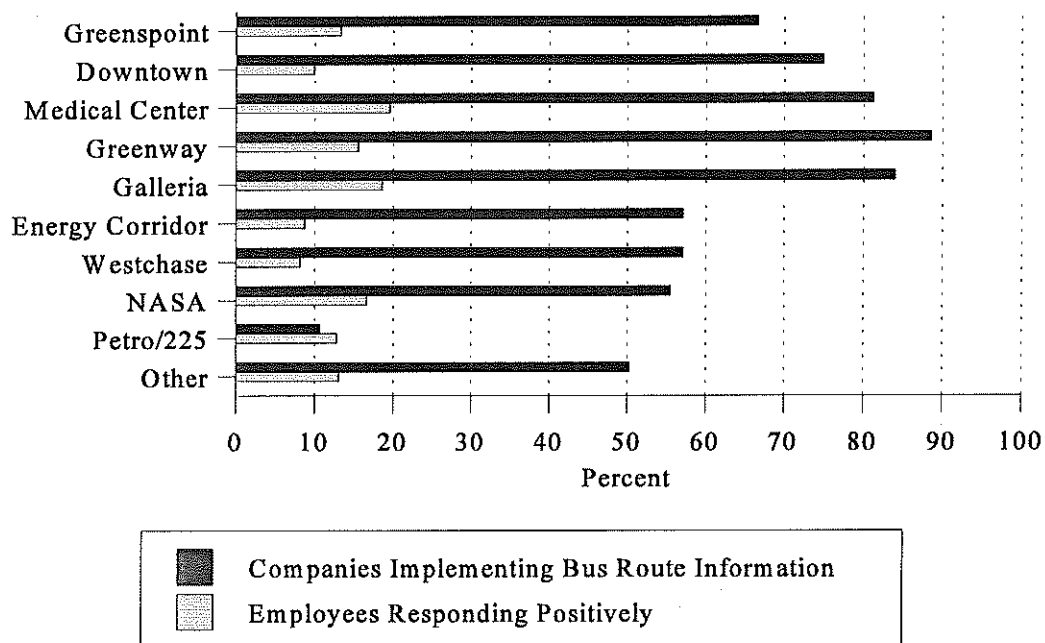
Figure J-28 Employee and employer interest in increased parking fees

## **APPENDIX K**

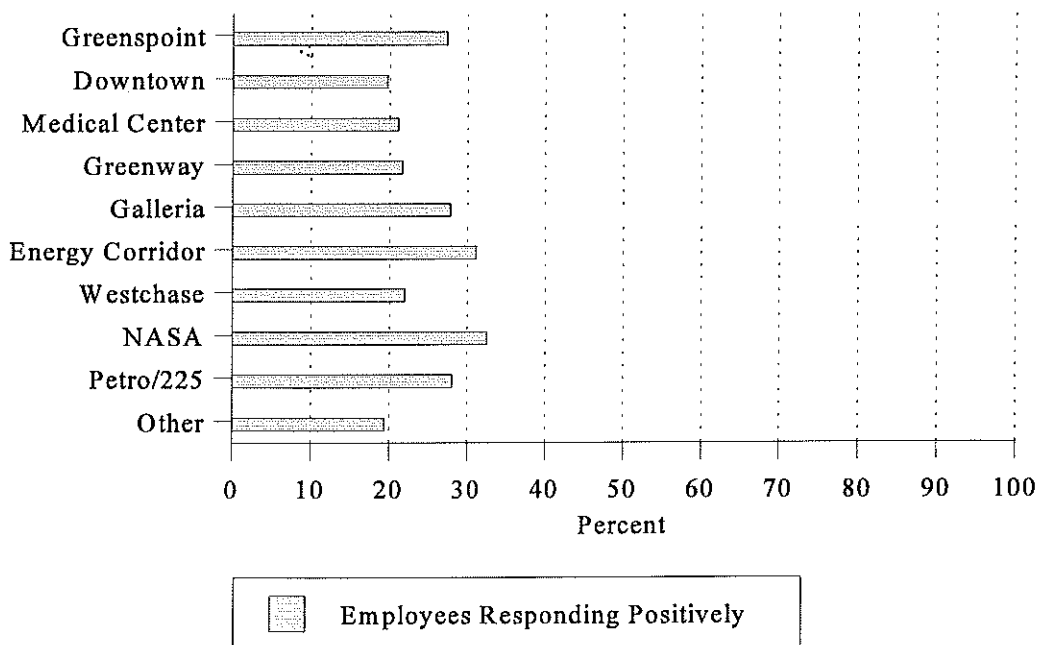
### **EMPLOYEE AND EMPLOYER INTEREST BY EMPLOYEMENT CENTER**

*Appendix K: Employee and Employer Information by Employment Center*

---



**Figure K-1** Employee and employer interest in bus route information



**Figure K-2** Employee interest in local bus service



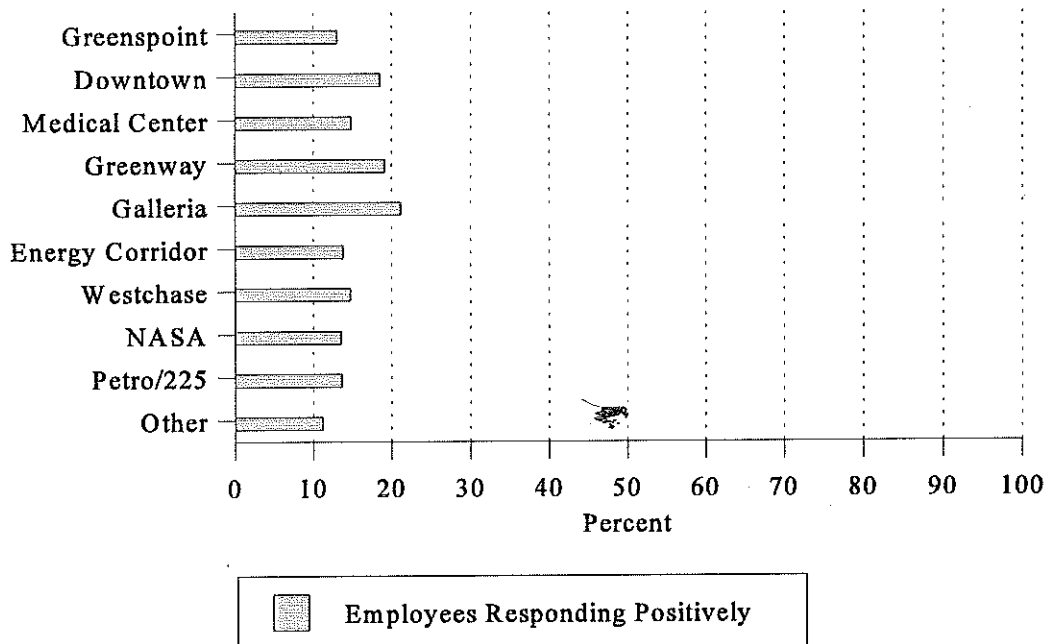


Figure K-3 Employee interest in late evening bus service

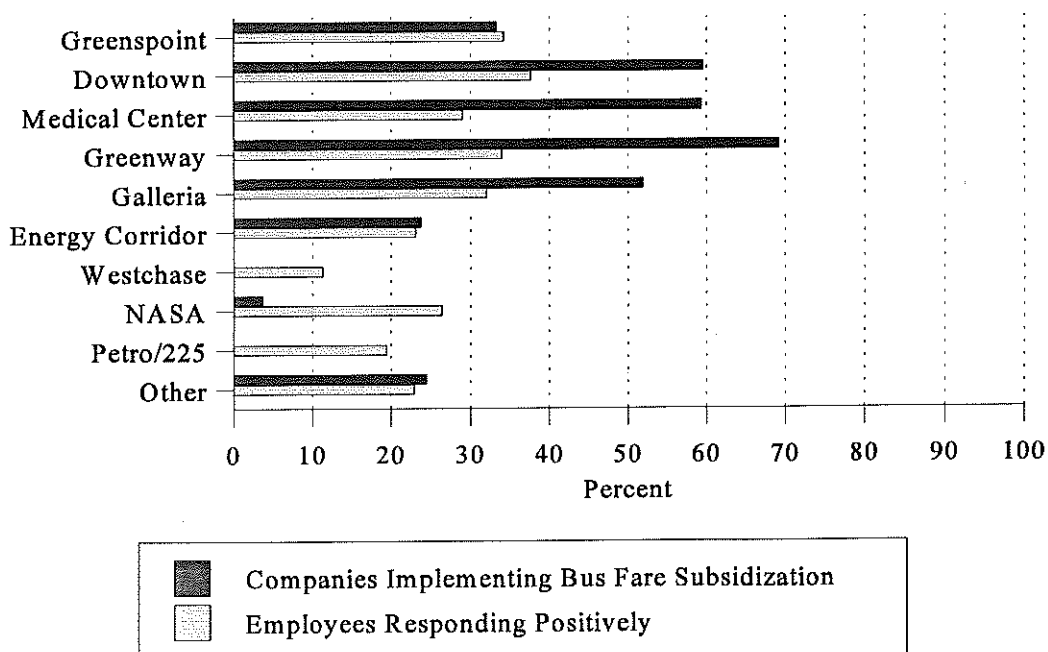
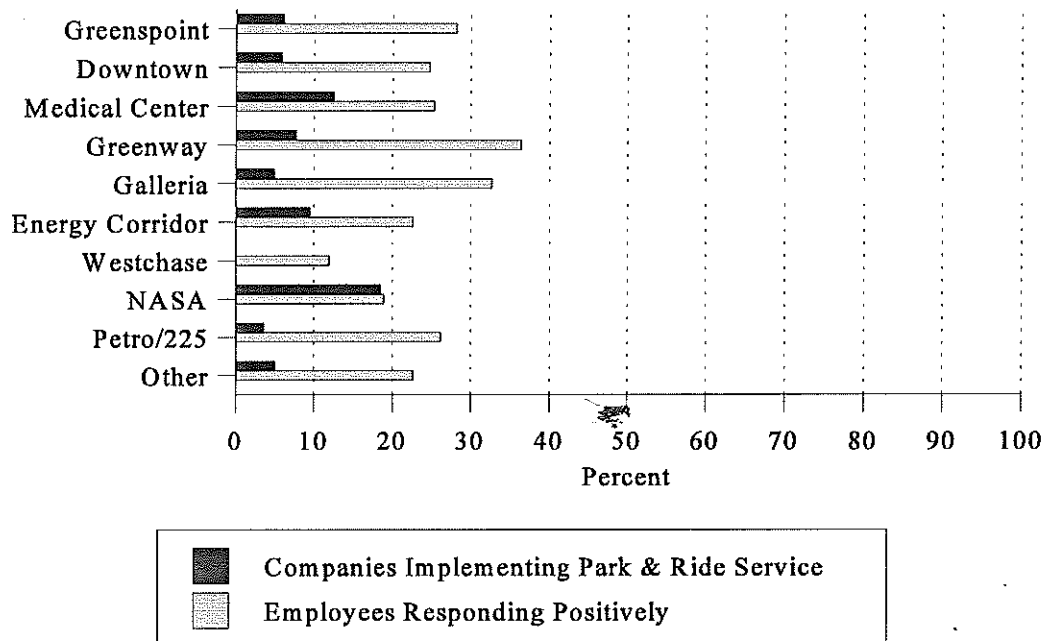
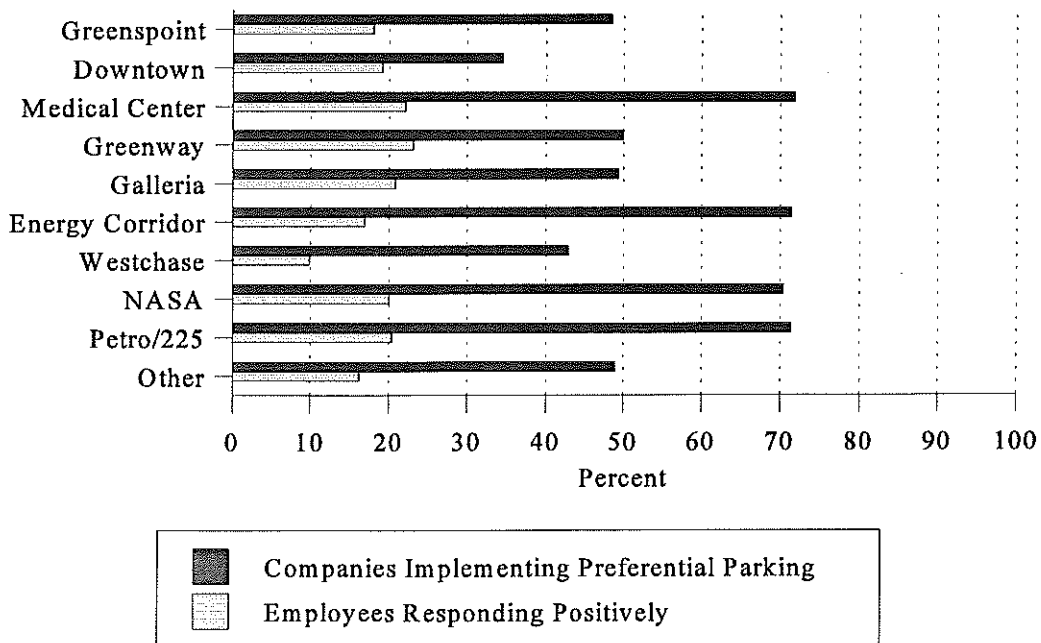


Figure K-4 Employee and employer interest in subsidizing bus fees

*Appendix K: Employee and Employer Information by Employment Center*



**Figure K-5** Employee and employer interest in park-and-ride service



**Figure K-6** Employee and employer interest in preferential carpool/vanpool

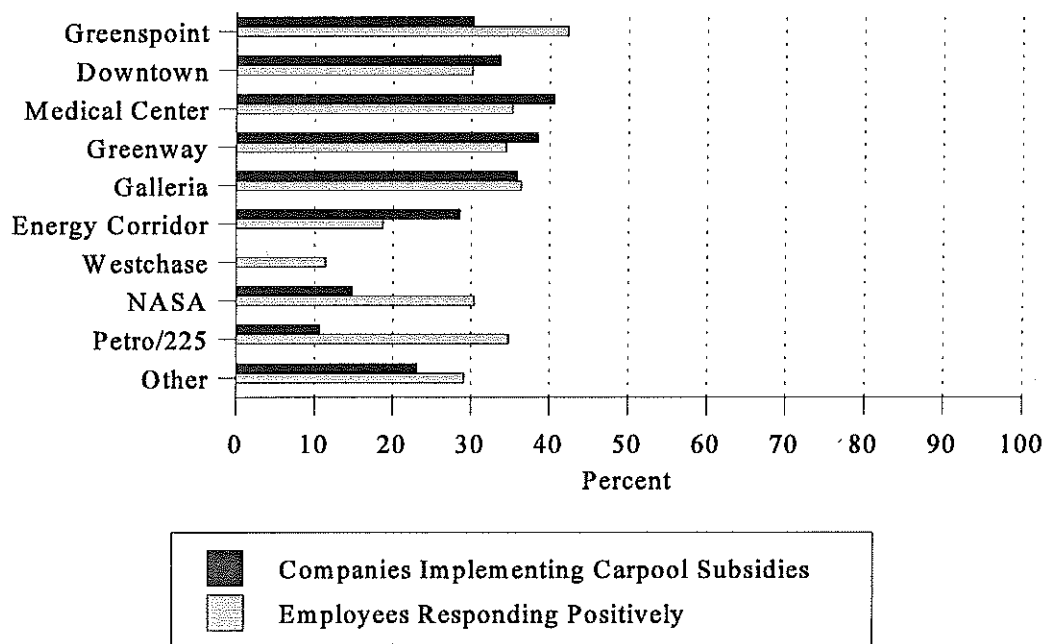


Figure K-7 Employee and employer interest in carpool subsidies

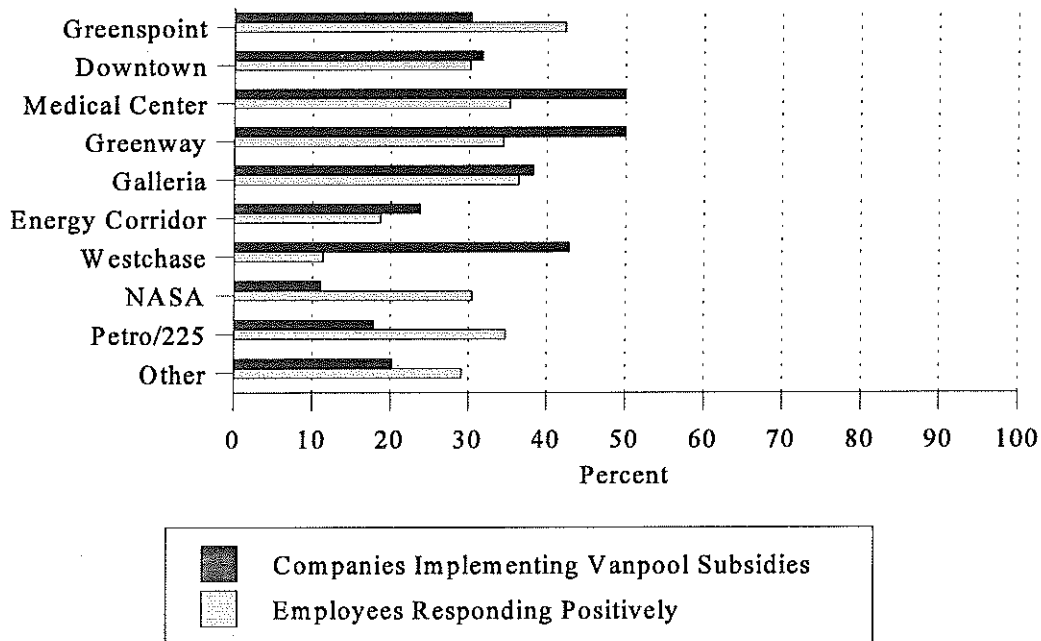
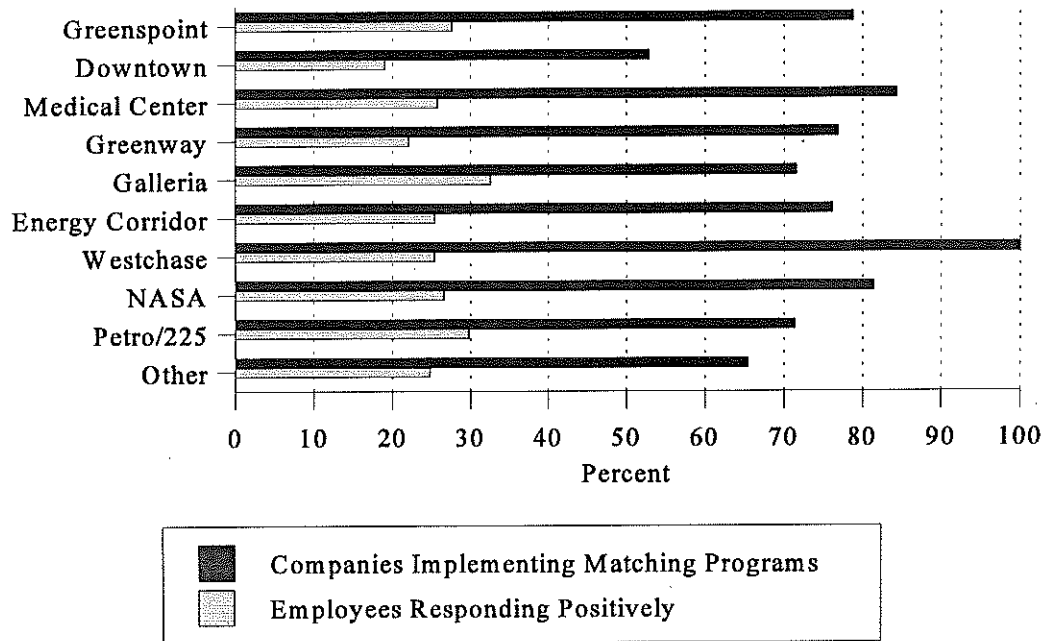
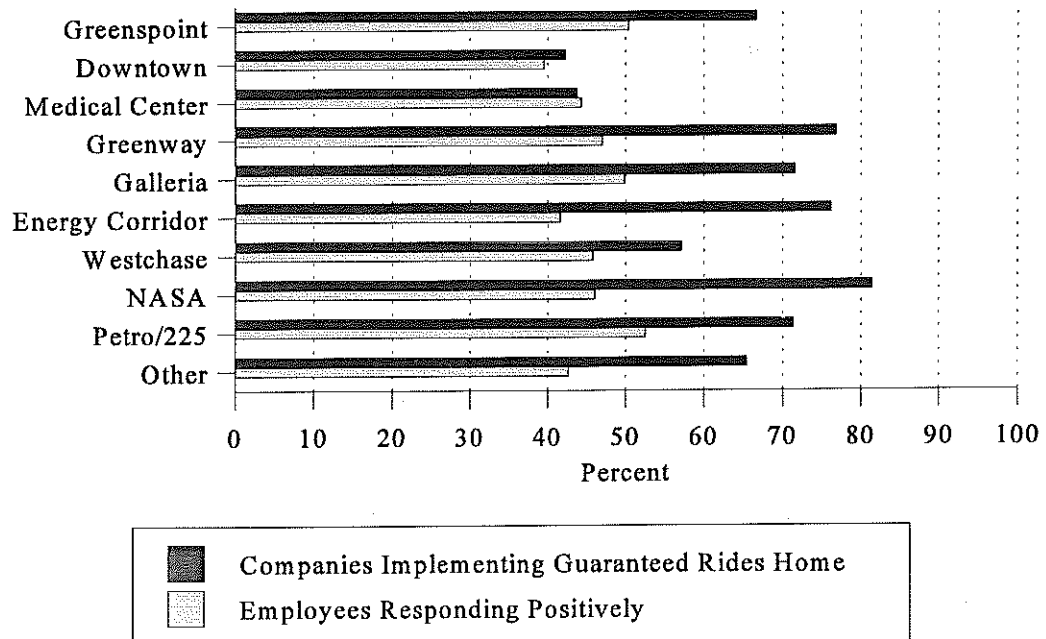


Figure K-8 Employee and employer interest in vanpool subsidies

*Appendix K: Employee and Employer Information by Employment Center*



**Figure K-9** Employee and employer interest in free carpool/vanpool matching



**Figure K-10** Employee and employer interest in guaranteed ride home programs

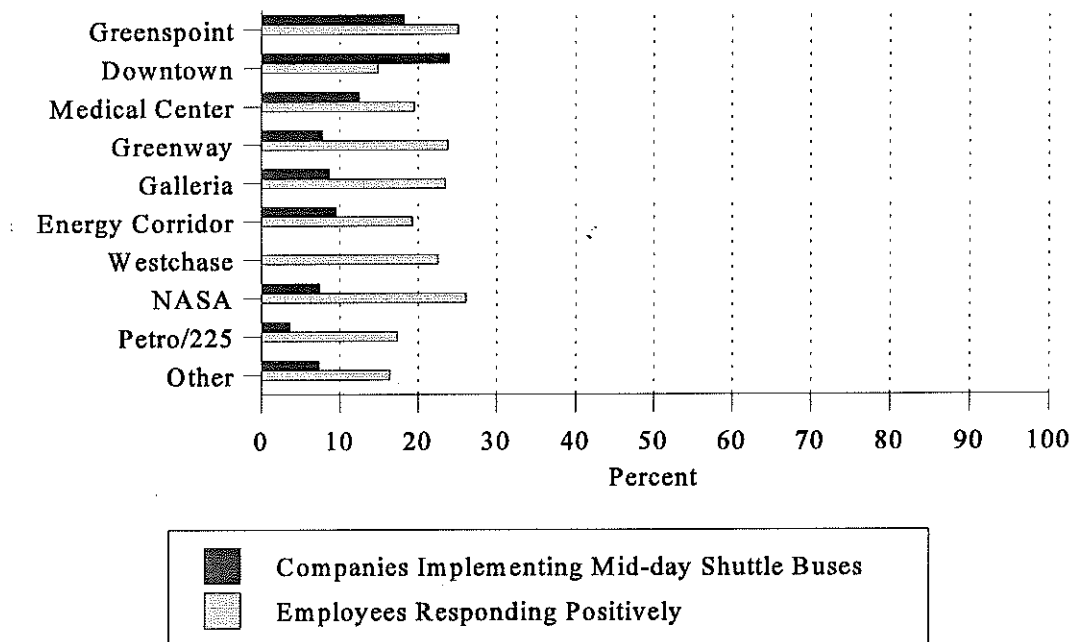


Figure K-11 Employee and employer interest in mid-day shuttle buses

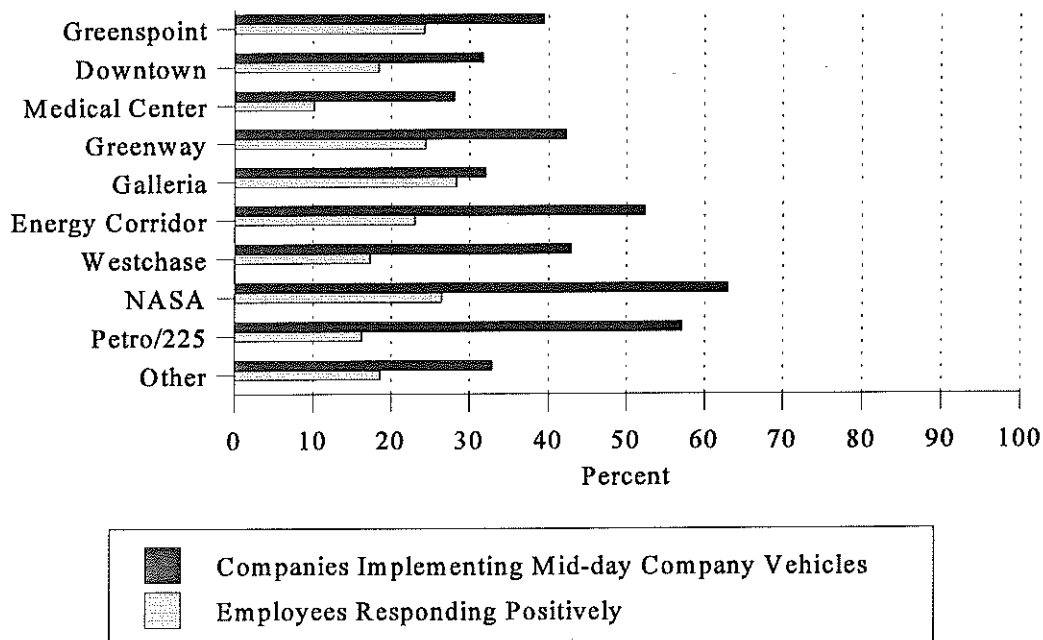


Figure K-12 Employee and employer interest in company vehicles for mid-day trips



Figure K-13 Employee interest in high occupancy vehicle (HOV) lanes

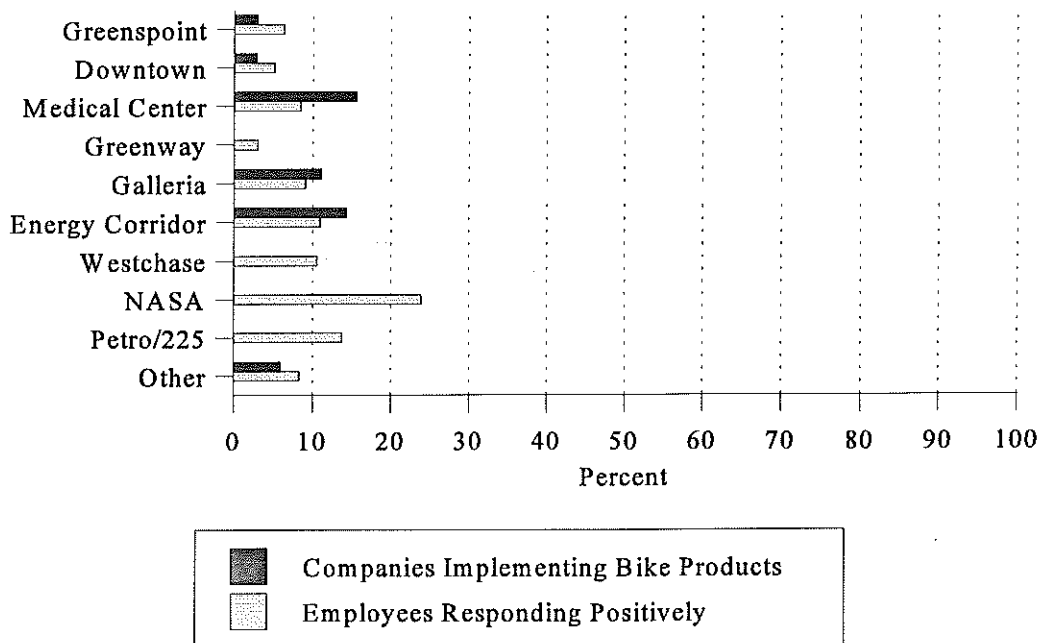


Figure K-14 Employee and employer interest in bike products

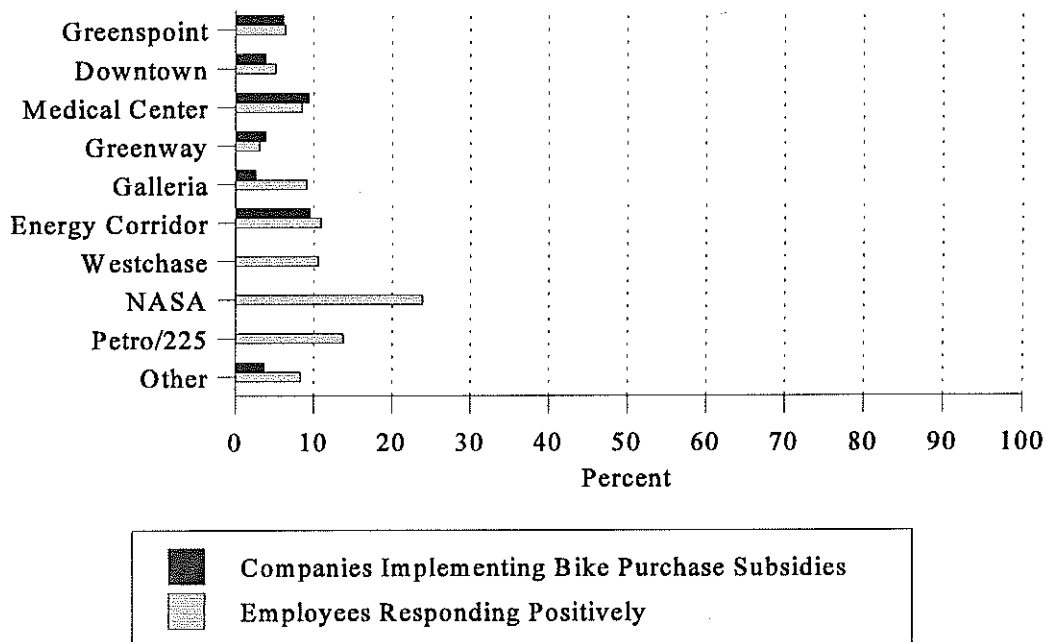


Figure K-15 Employee and employer interest in bike purchase subsidies

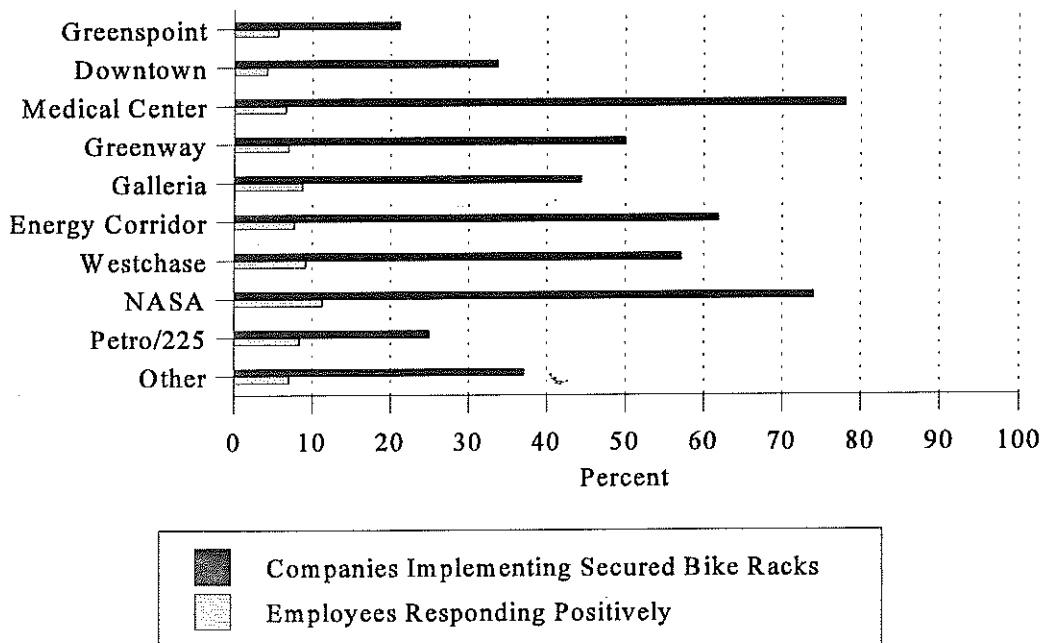


Figure K-16 Employee interest in secured bike racks

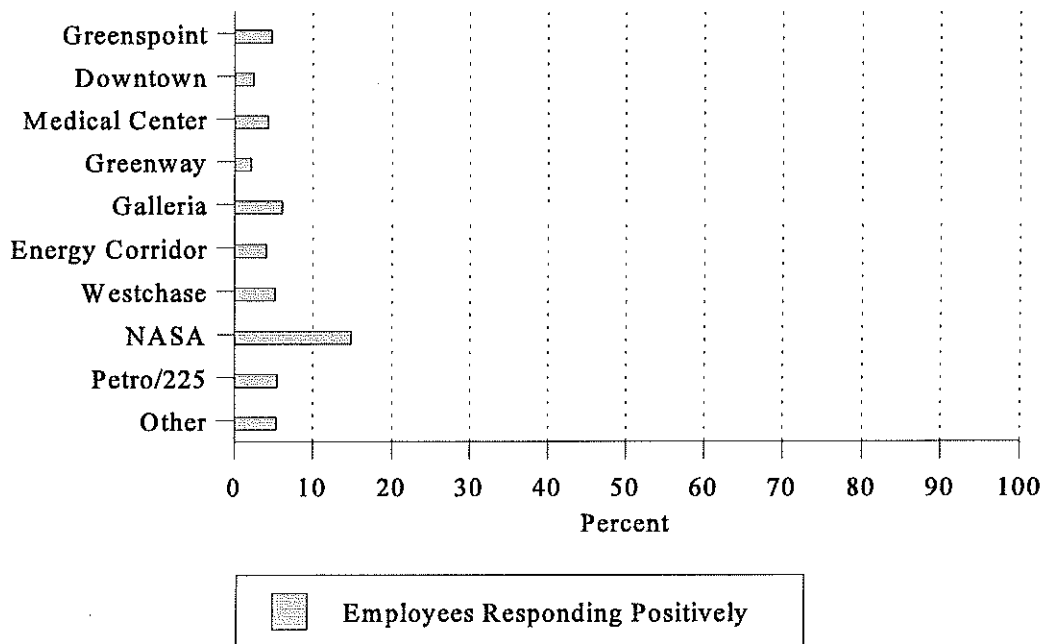


Figure K-17 Employee interest in walking incentives

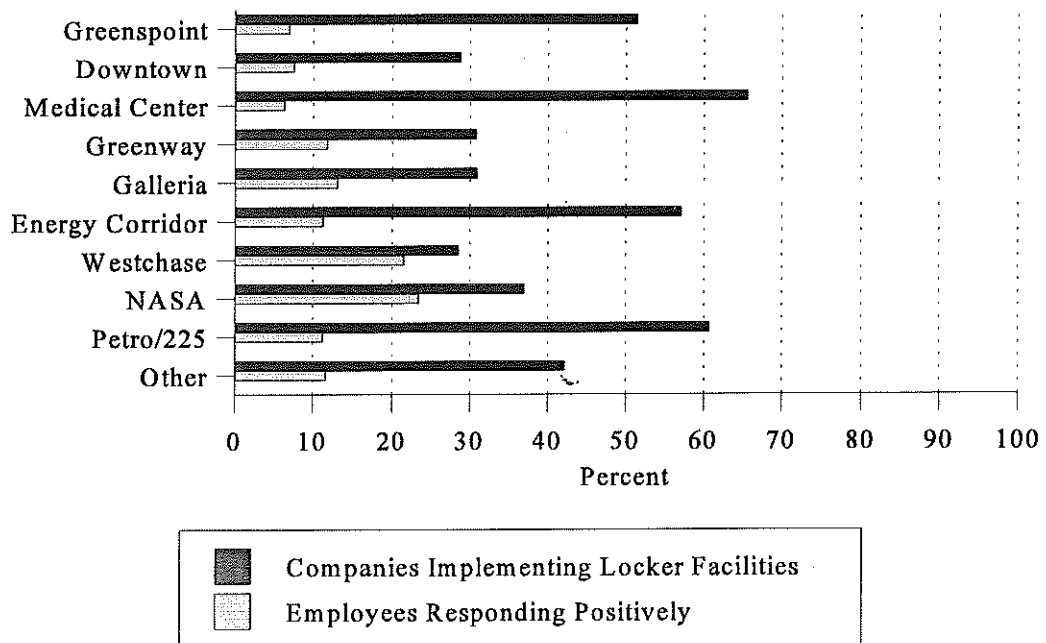


Figure K-18 Employee and employer interest in locker facilities



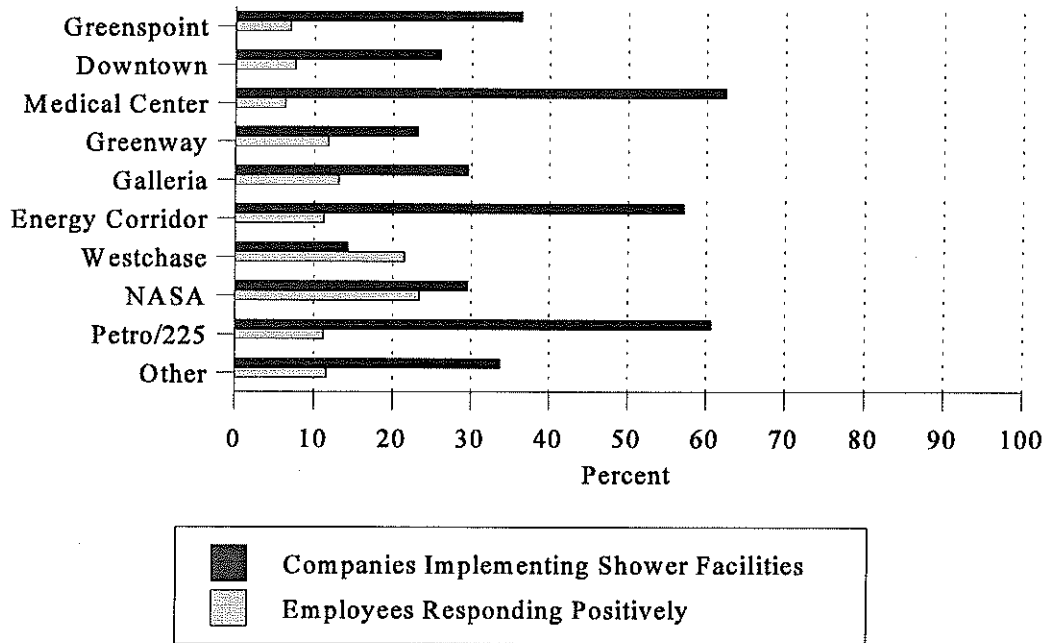


Figure K-19 Employee and employer interest in shower facilities

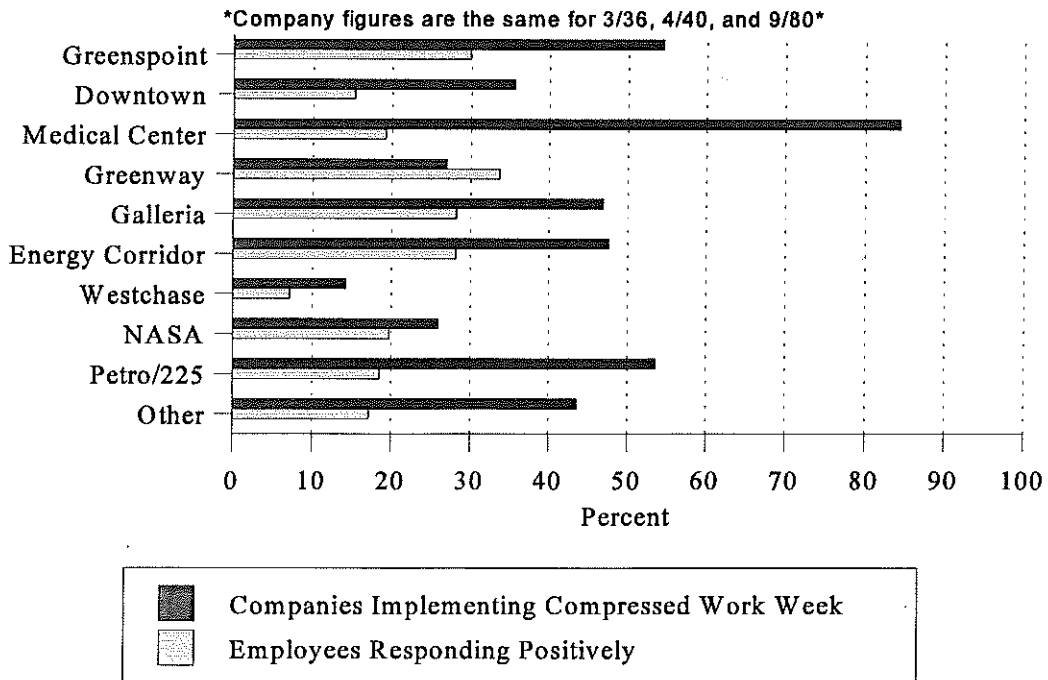
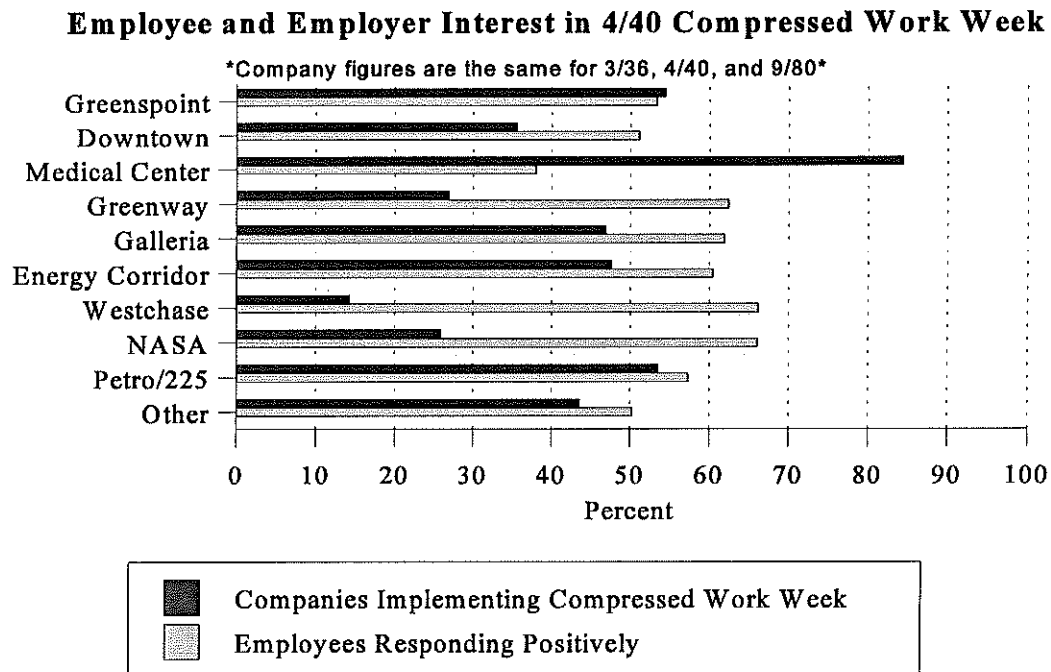
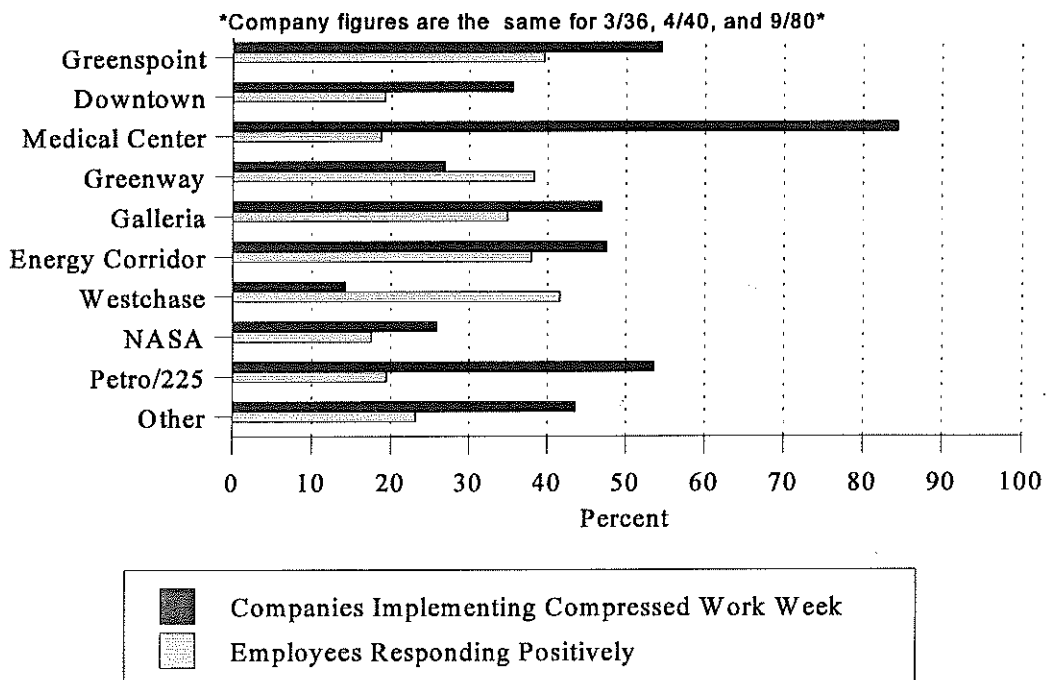


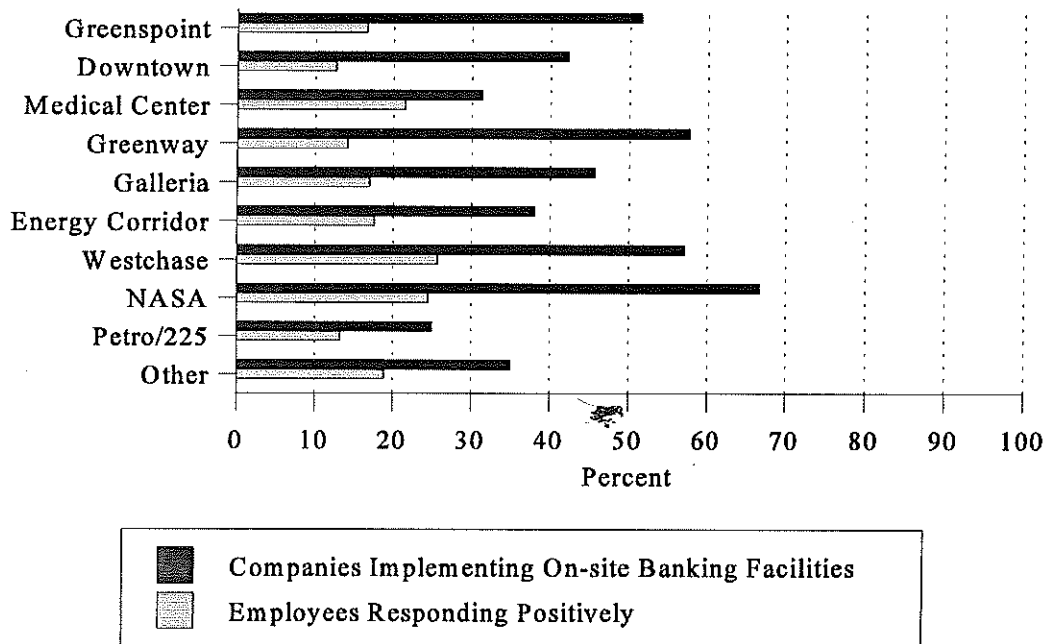
Figure K-20 Employee and employer interest in 3/36 compressed work week



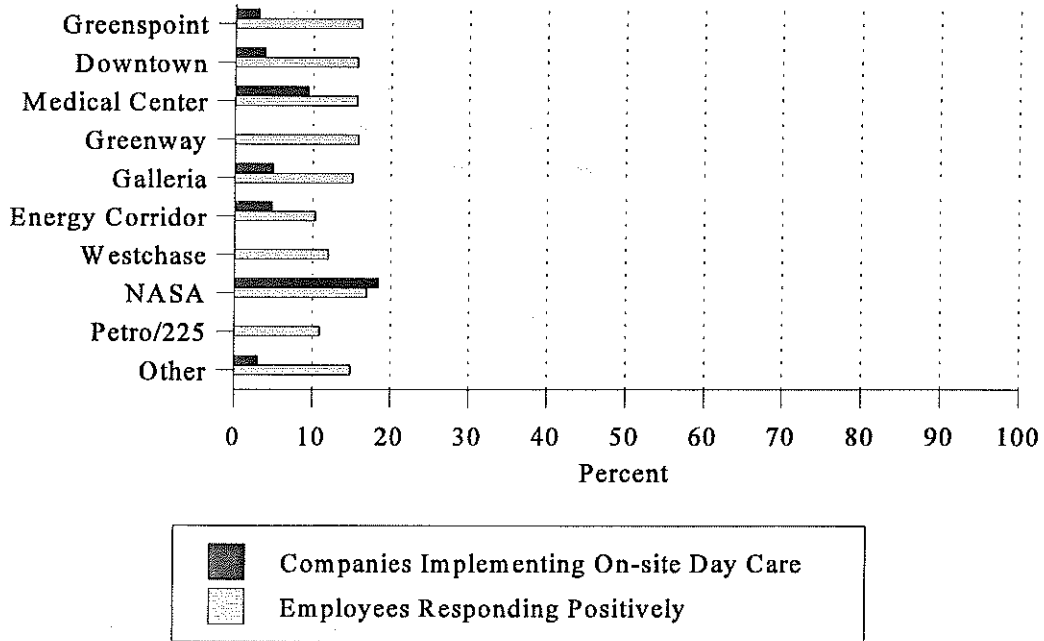
**Figure K-21** Employee and employer interest in 4/40 compressed work week



**Figure K-22** Employee and employer interest in 9/80 compressed work week

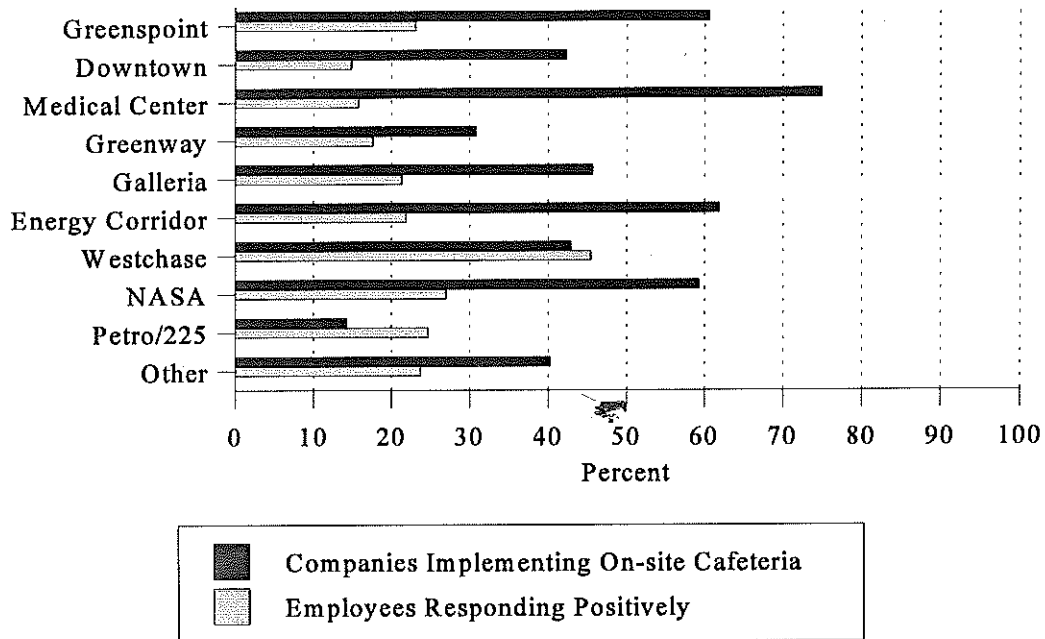


**Figure K-23** Employee and employer interest in on-site banking facilities

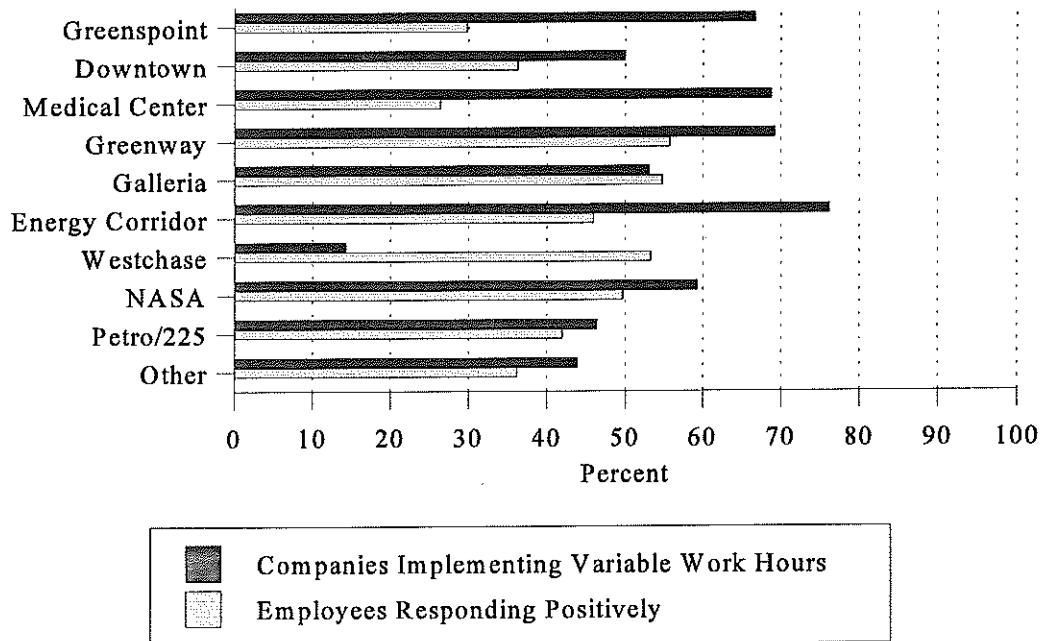


**Figure K-24** Employee and employer interest in on-site day care facilities

*Appendix K: Employee and Employer Information by Employment Center*



**Figure K-25** Employee and employer interest in on-site day cafeteria



**Figure K-26** Employee and employer interest in variable work hours

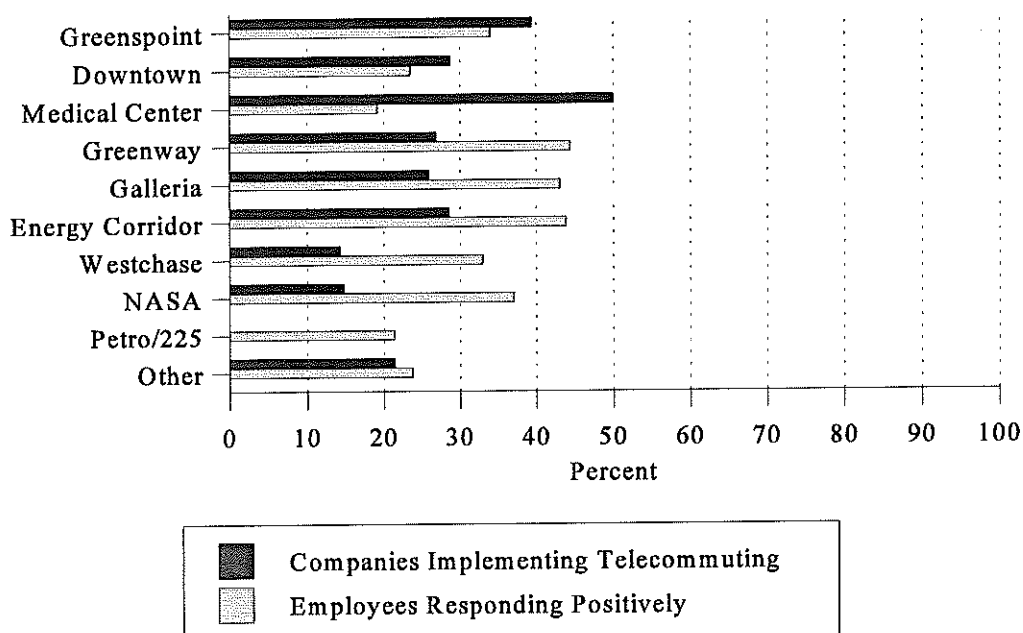


Figure K-27 Employee and employer interest in telecommuting

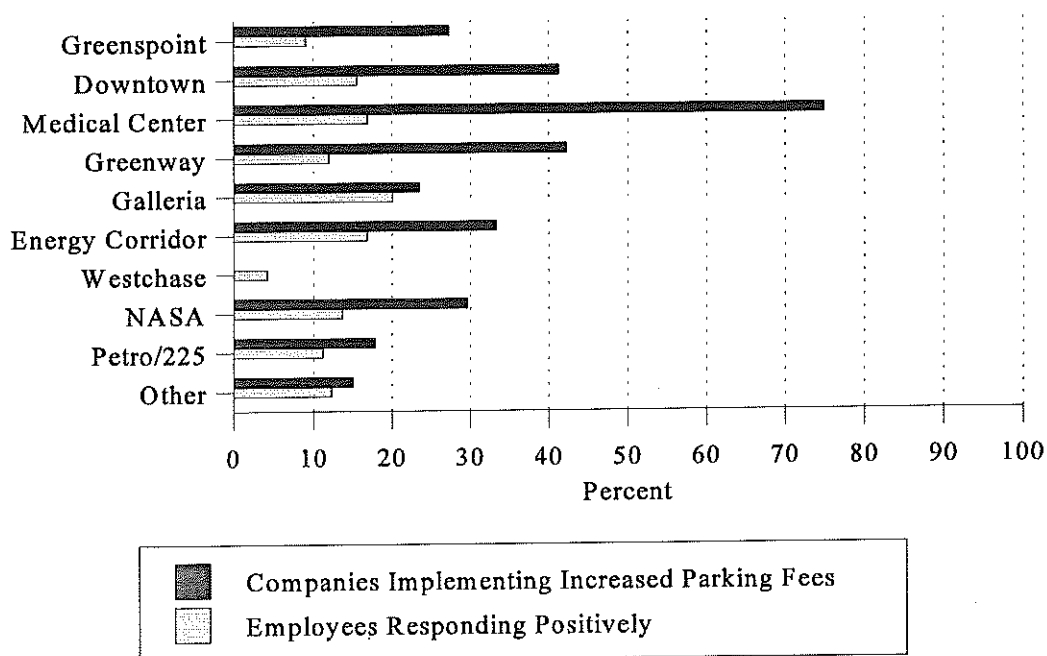


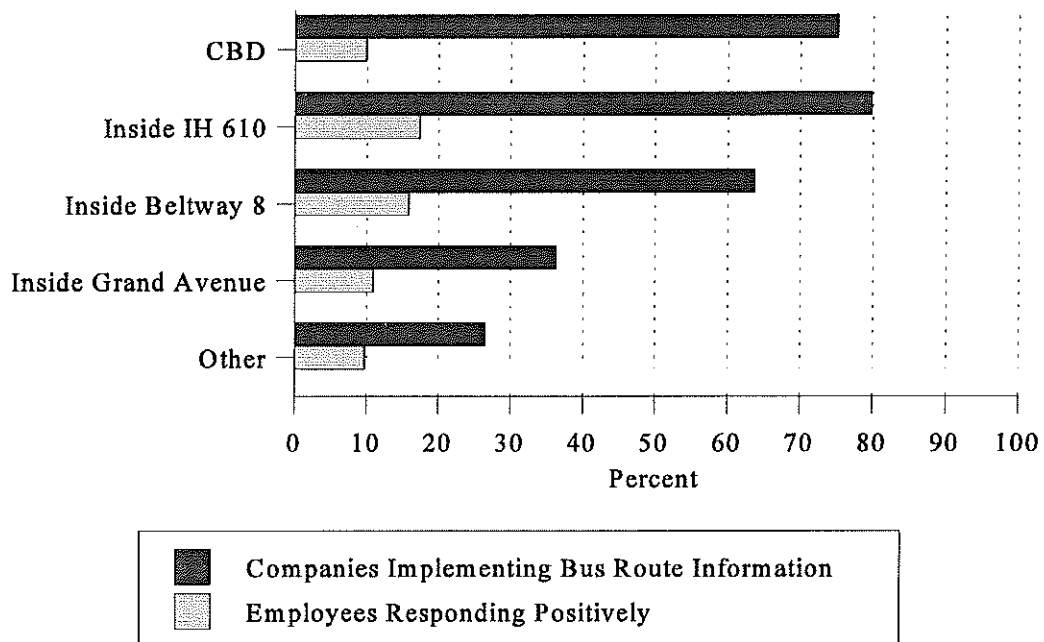
Figure K-28 Employee and employer interest in increased parking fees

## **APPENDIX L**

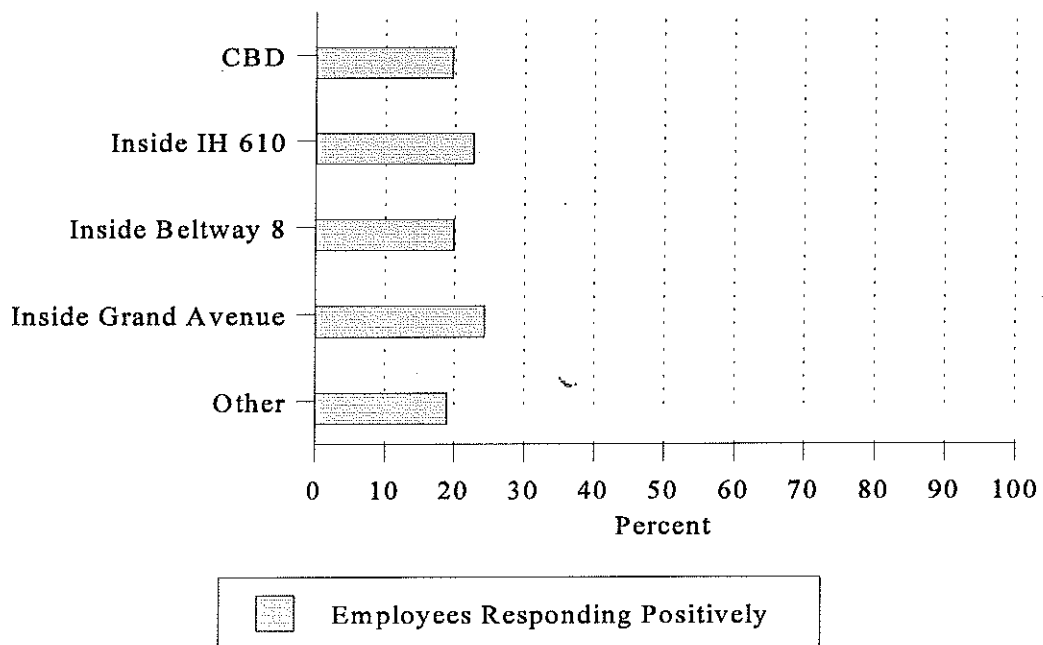
### **EMPLOYEE AND EMPLOYER INFORMATION BY REGION**

*Appendix L: Employee and Employer Information by Region*

---



**Figure L-1** Employee and employer interest in bus route information



**Figure L-2** Employee interest in local bus service

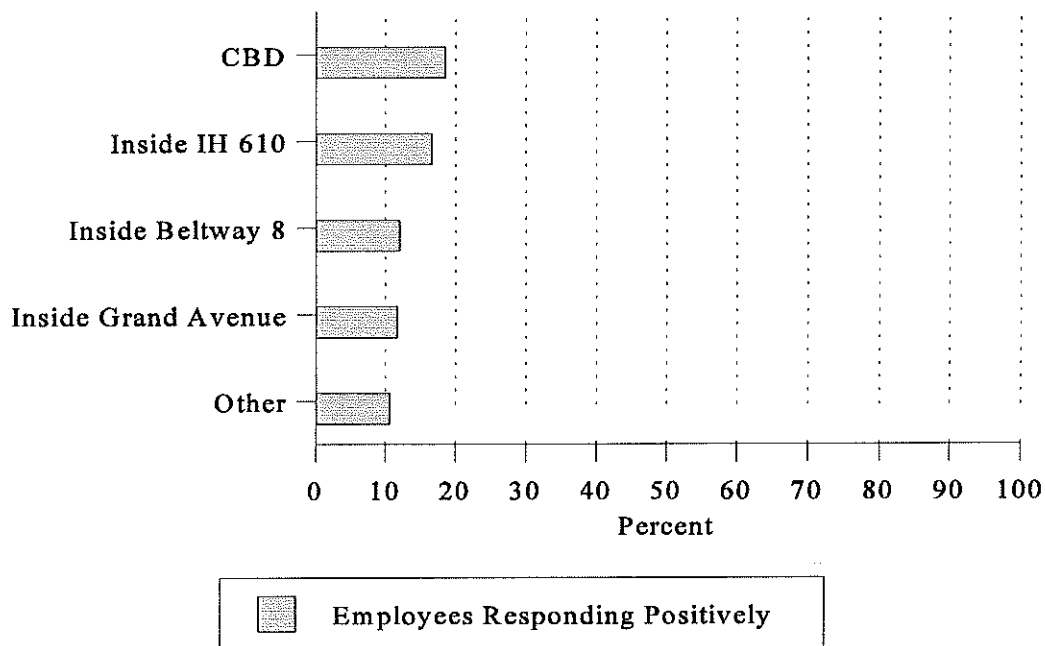


Figure L-3 Employee interest in late evening bus service

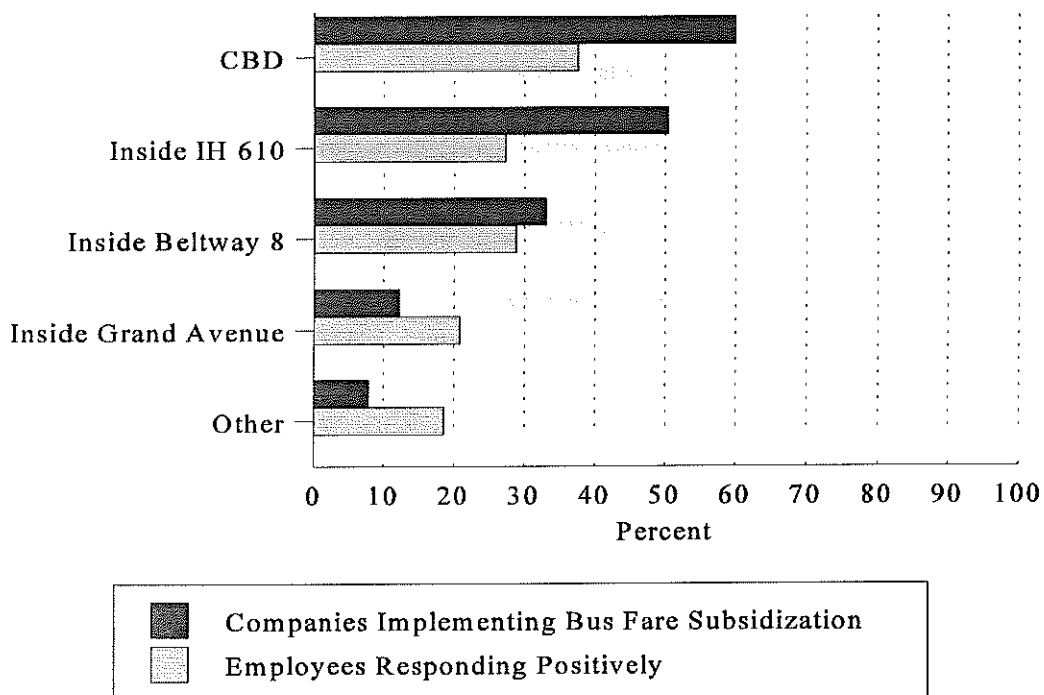


Figure L-4 Employee and employer interest in subsidizing bus fees



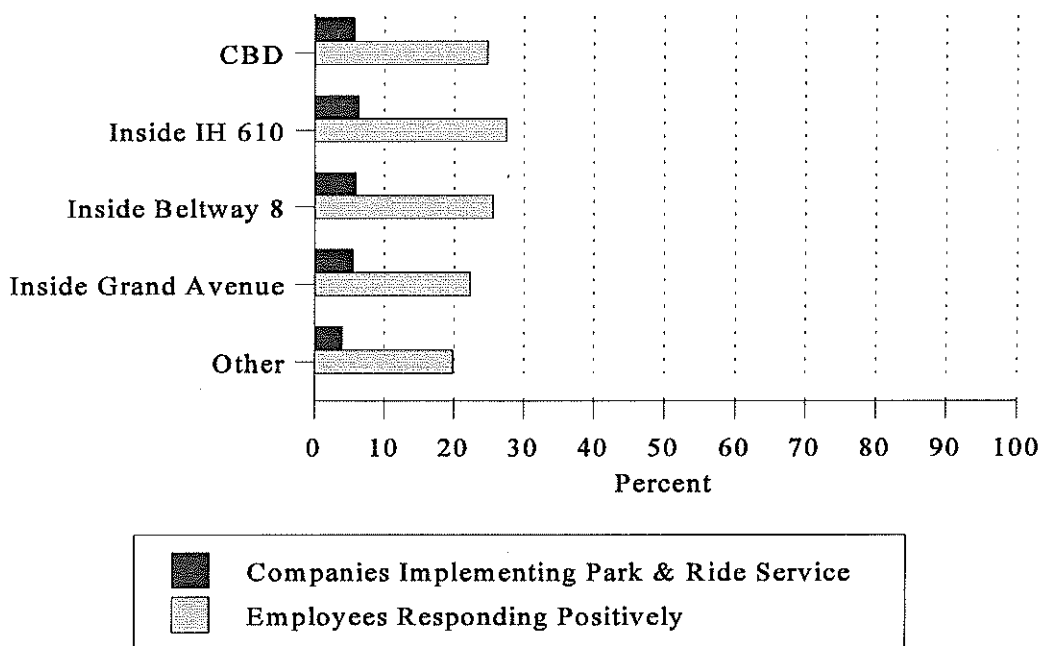


Figure L-5 Employee and employer interest in park-and-ride service

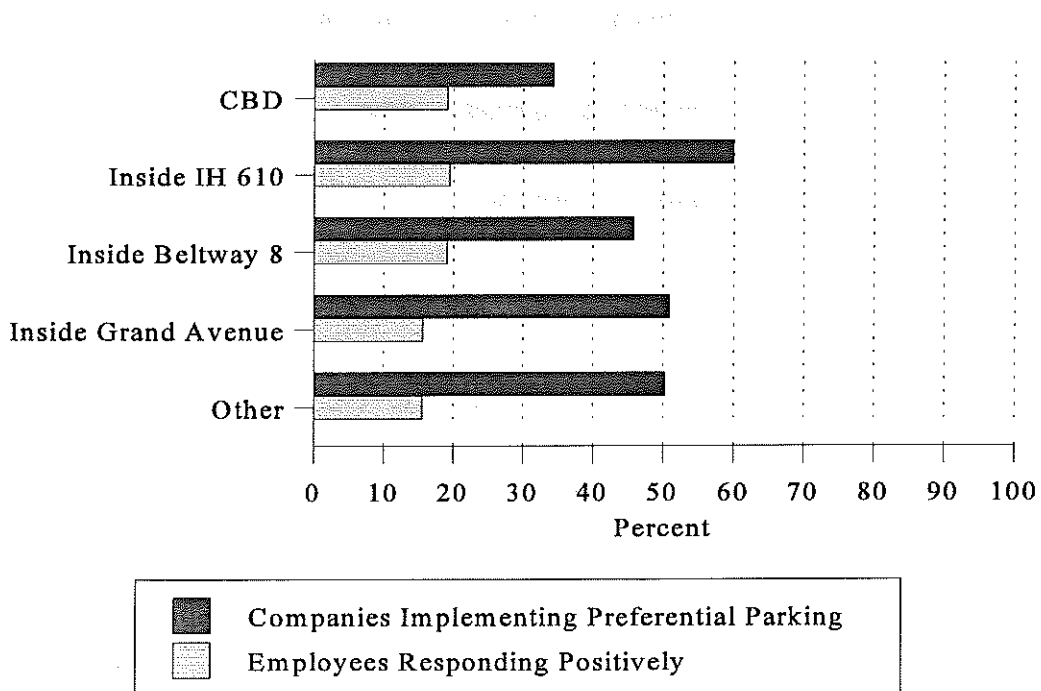


Figure L-6 Employee and employer interest in preferential carpool/vanpool parking

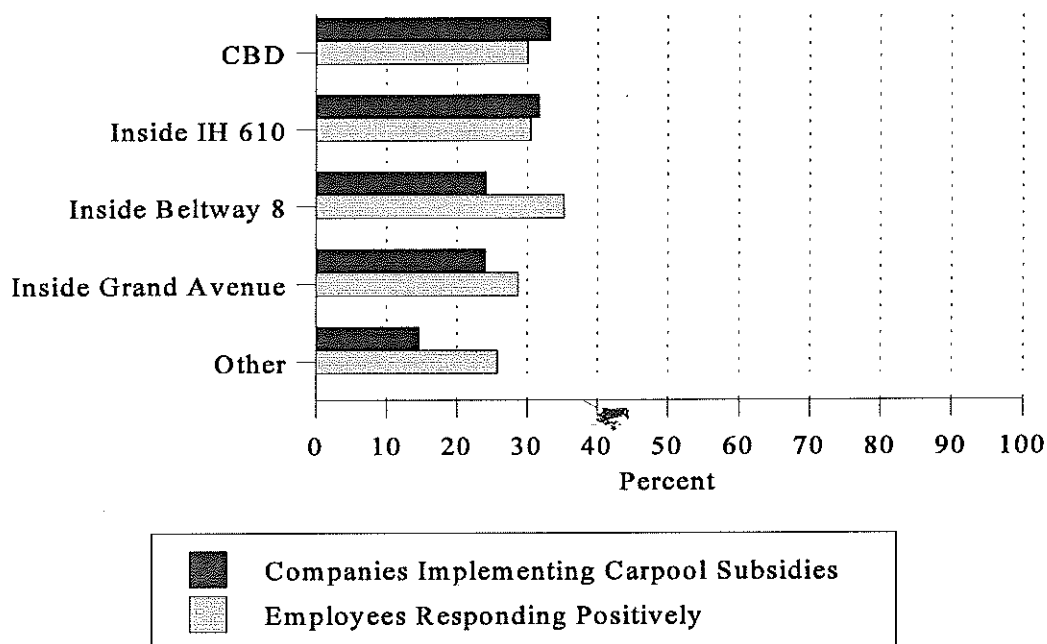


Figure L-7 Employee and employer interest in carpool subsidies

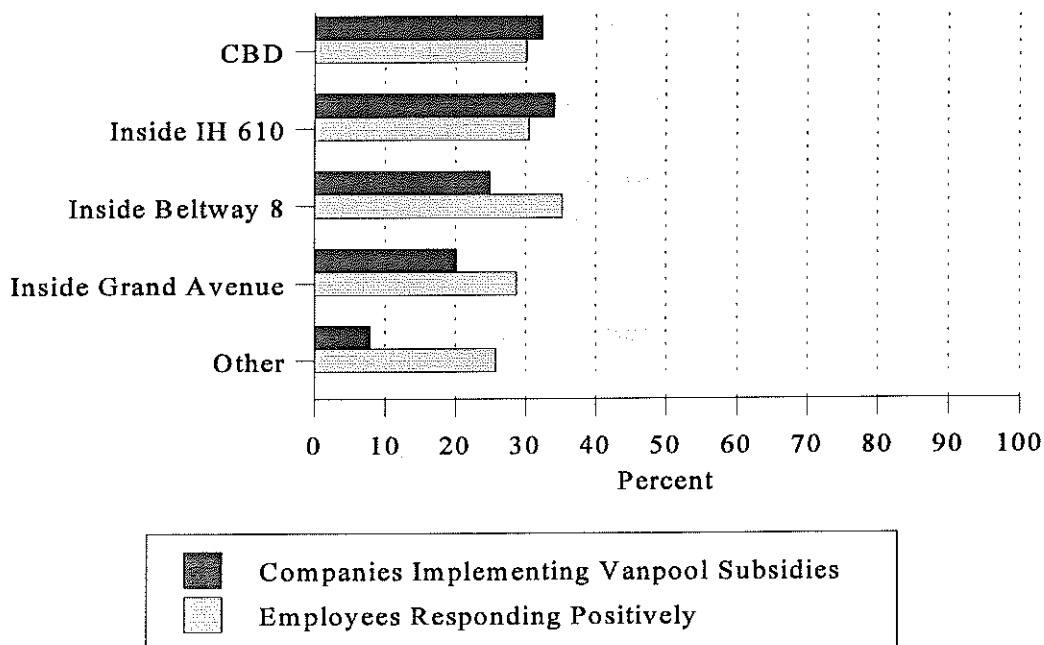


Figure L-8 Employee and employer interest in vanpool subsidies

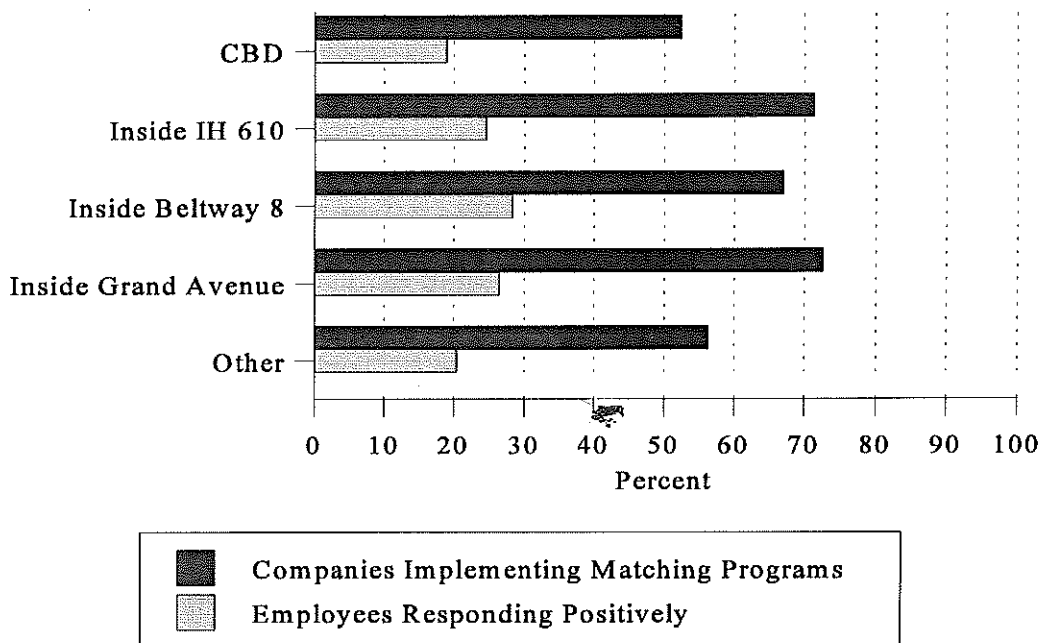


Figure L-9 Employee and Employer interest in free carpool/vanpool matching

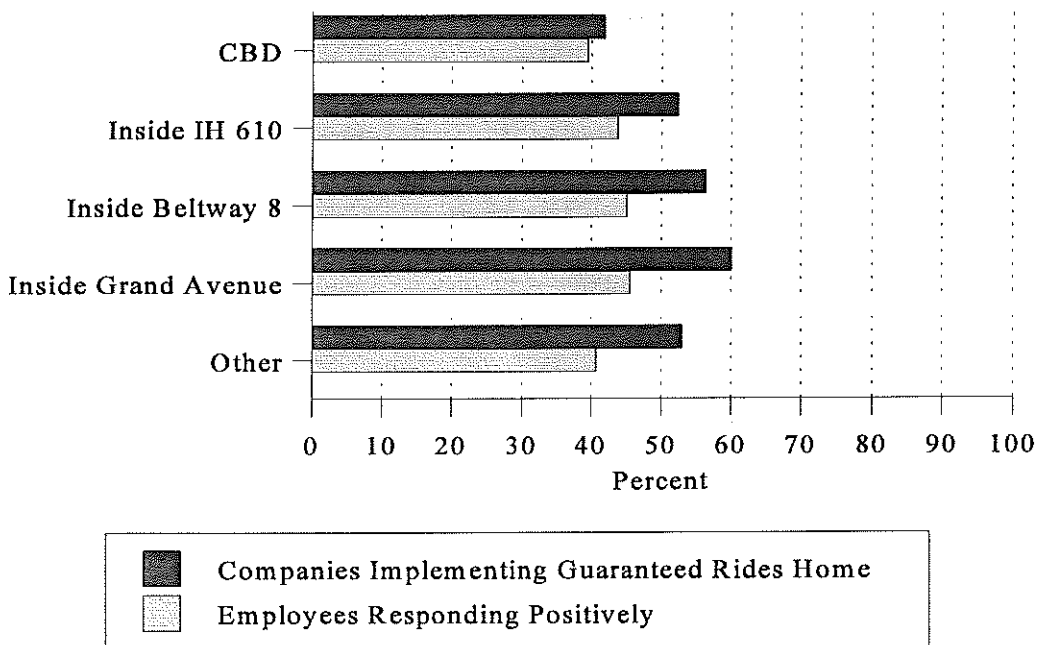


Figure L-10 Employee and employer interest in guaranteed ride home programs

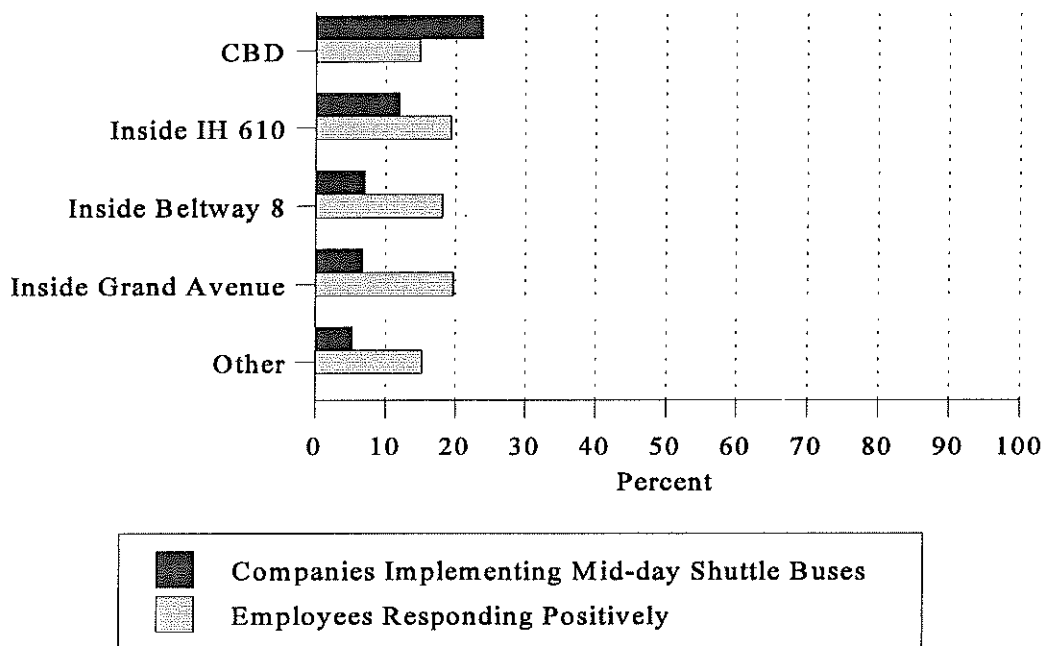


Figure L-11 Employee and employer interest in mid-day shuttle buses

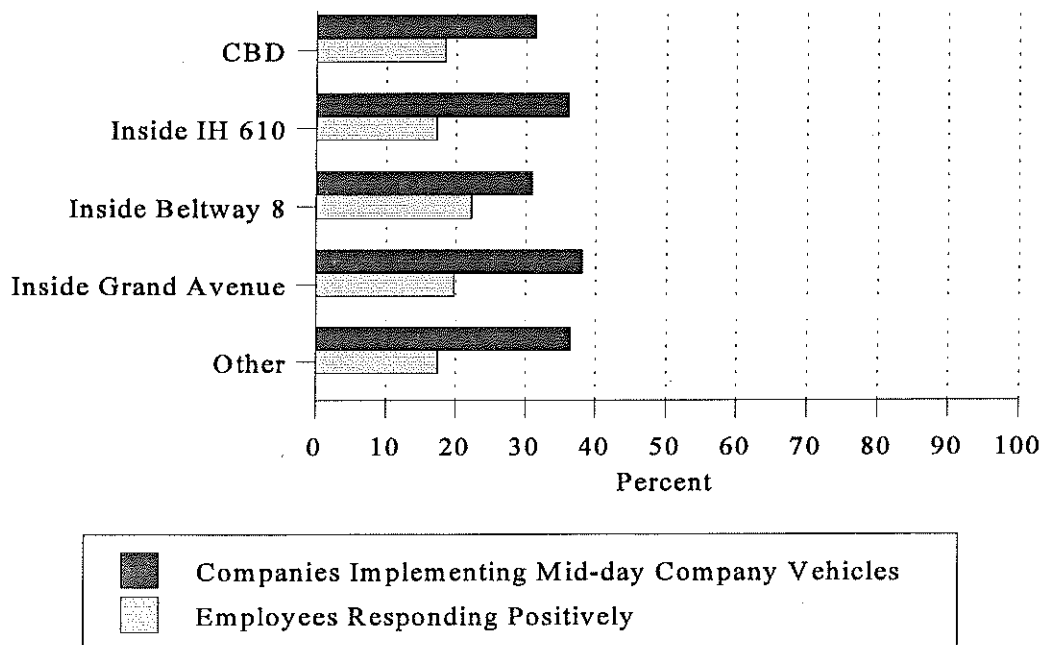


Figure L-12 Employee and employer interest in company vehicles for mid-day trips

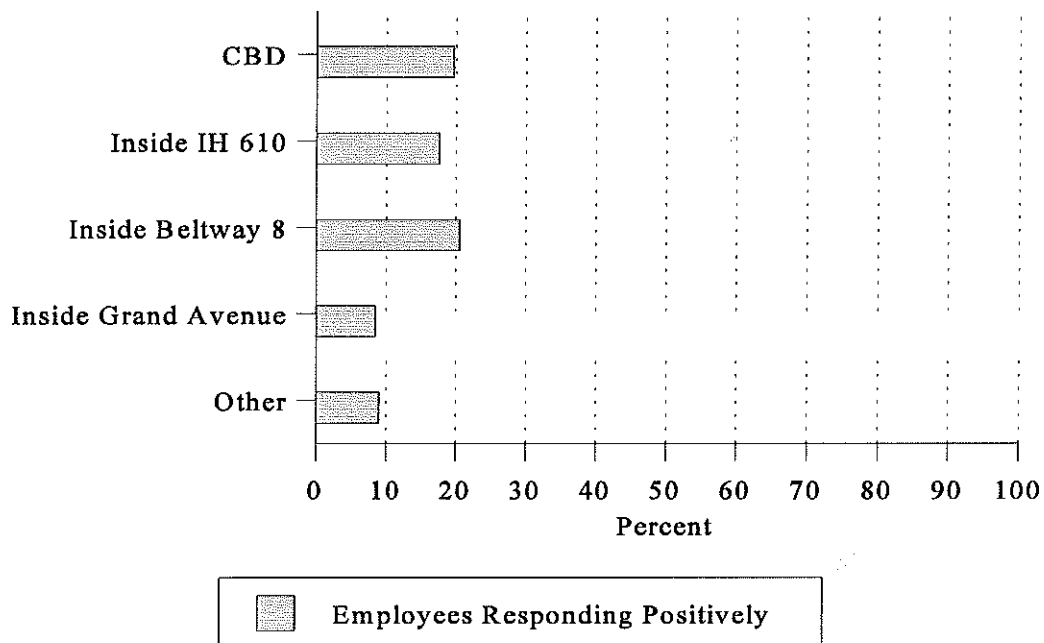


Figure L-13 Employee interest in high occupancy vehicle (HOV) lanes

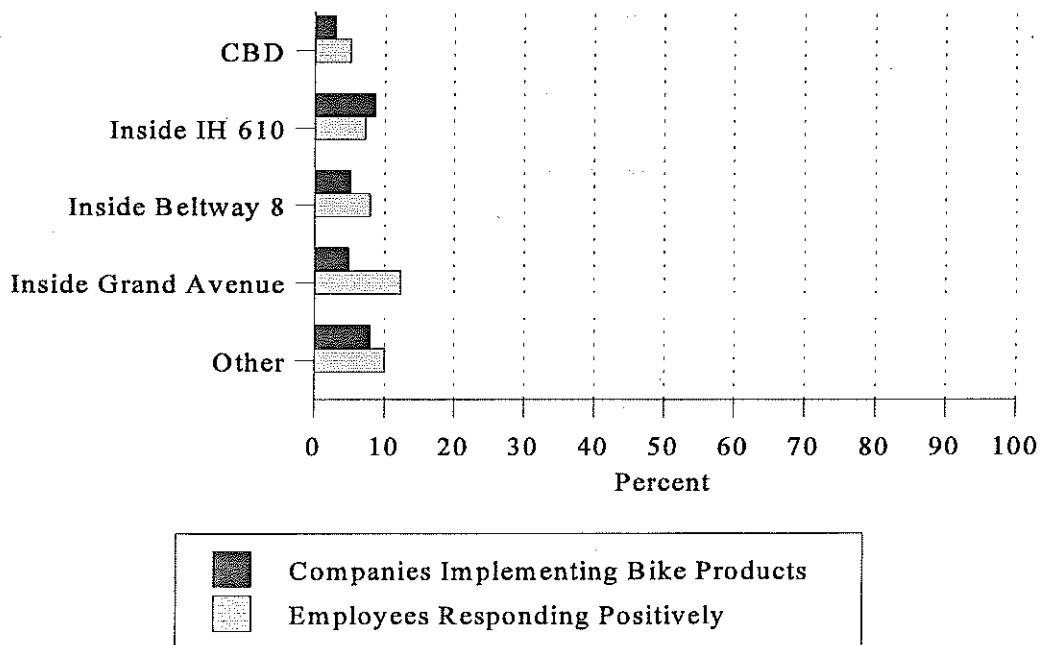


Figure L-14 Employee and employer interest in bike products

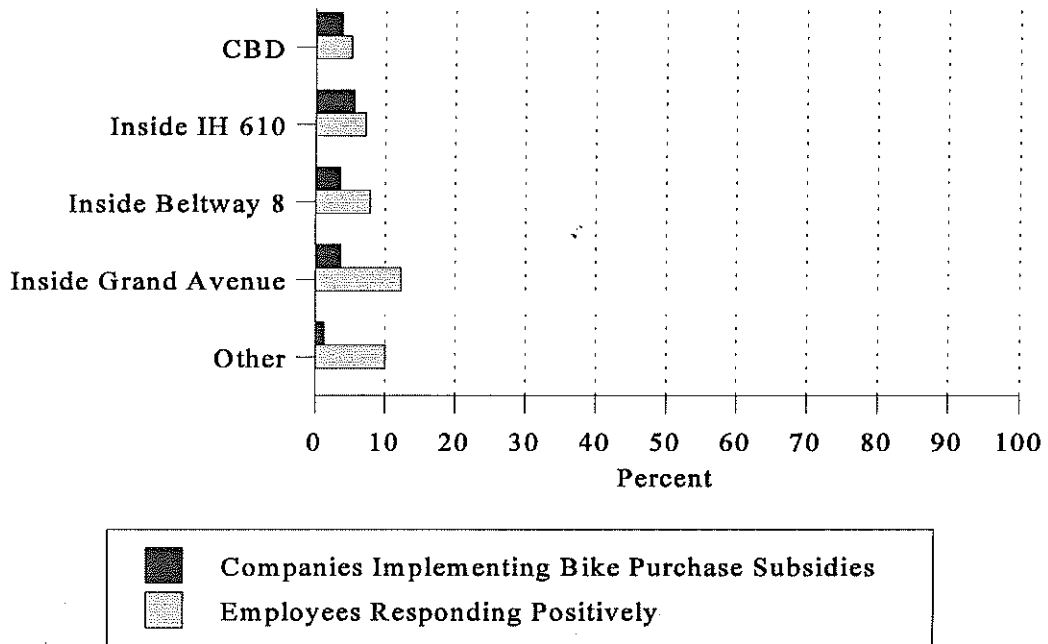


Figure L-15 Employee and employer interest in bike purchase subsidies

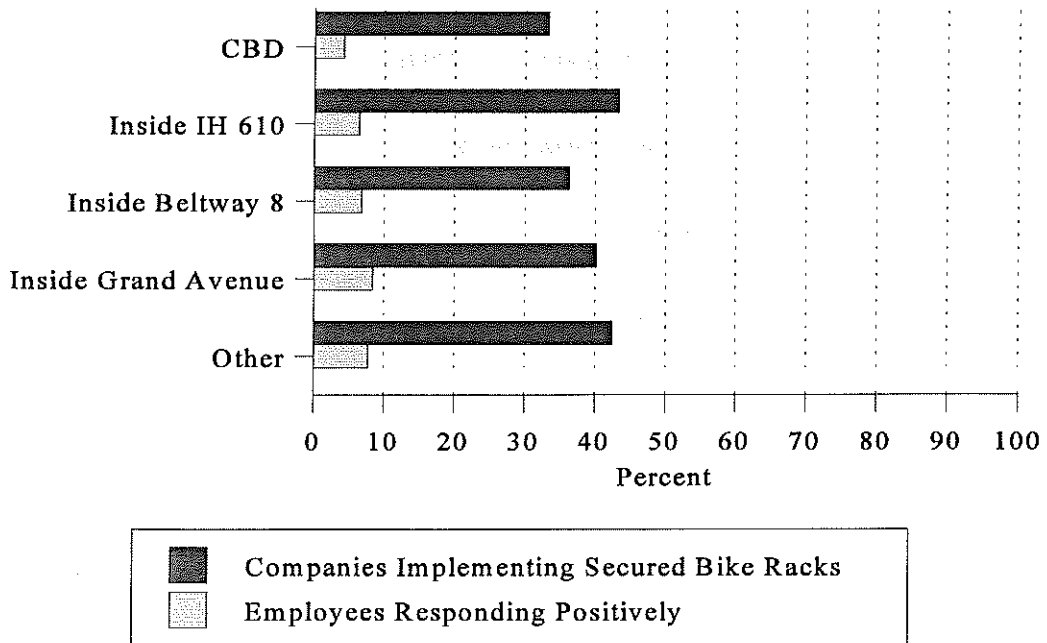


Figure L-16 Employee and employer interest in secured bike racks

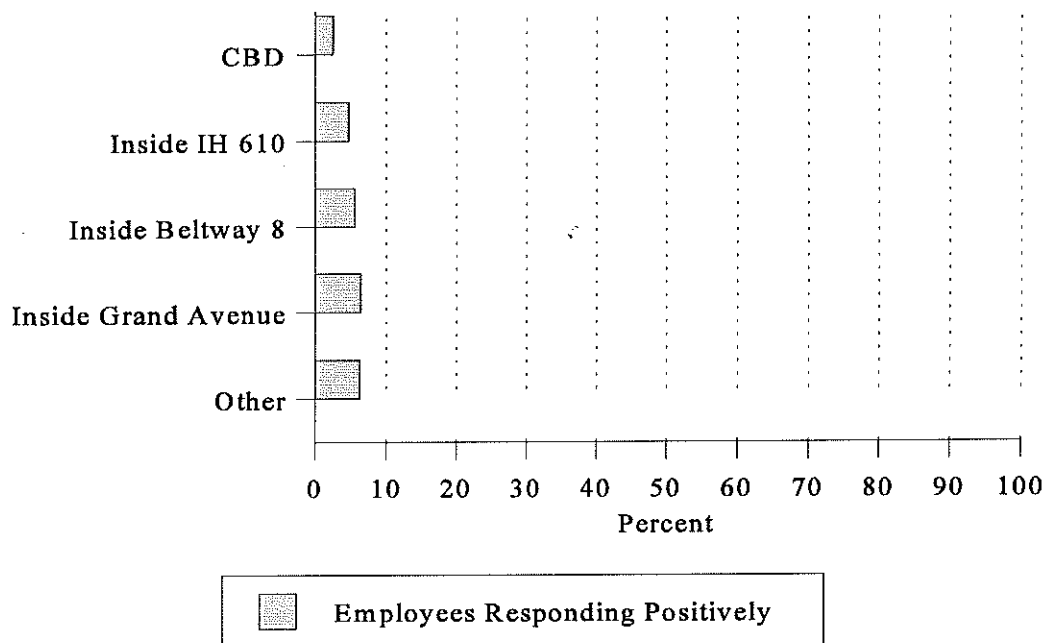


Figure L-17 Employee interest in walking incentives

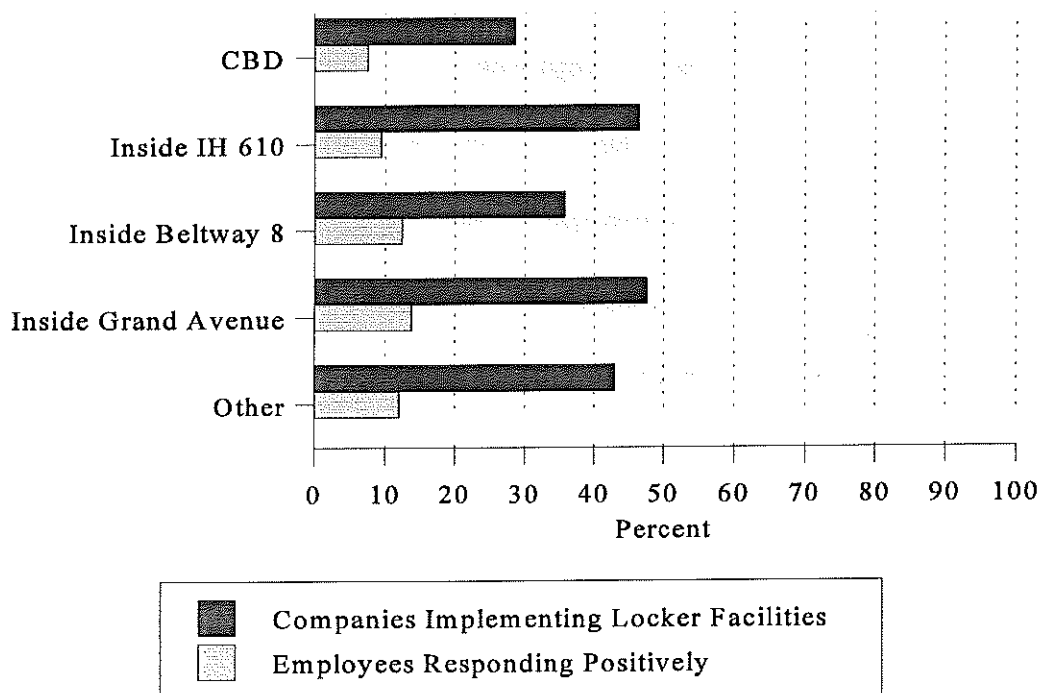


Figure L-18 Employee and employer interest in locker facilities

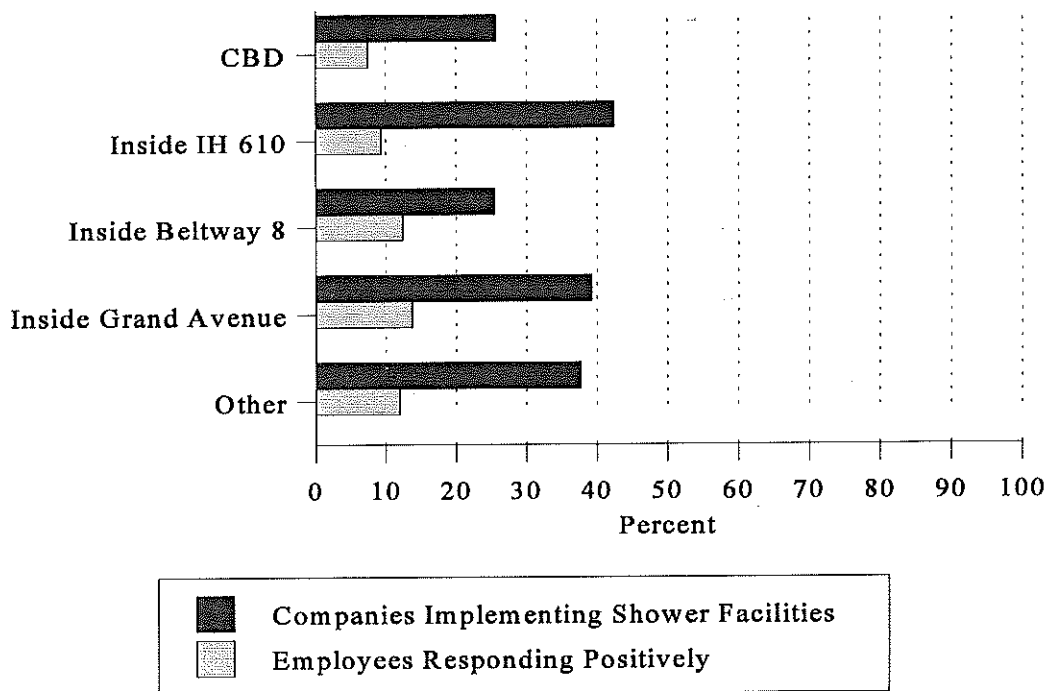


Figure L-19 Employee and employer interest in shower facilities

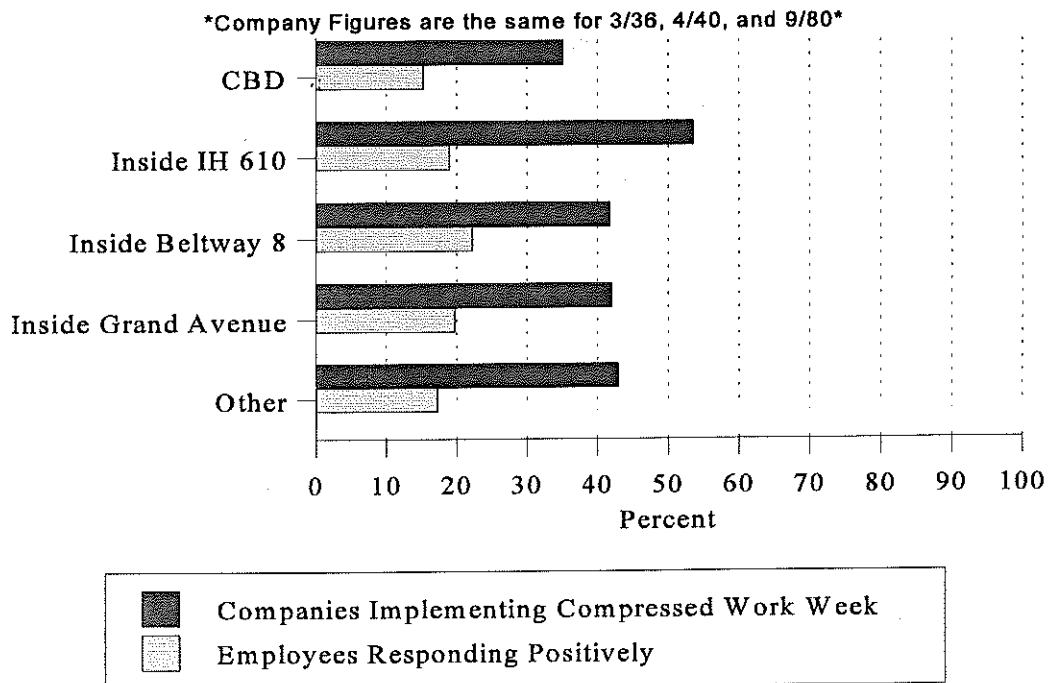
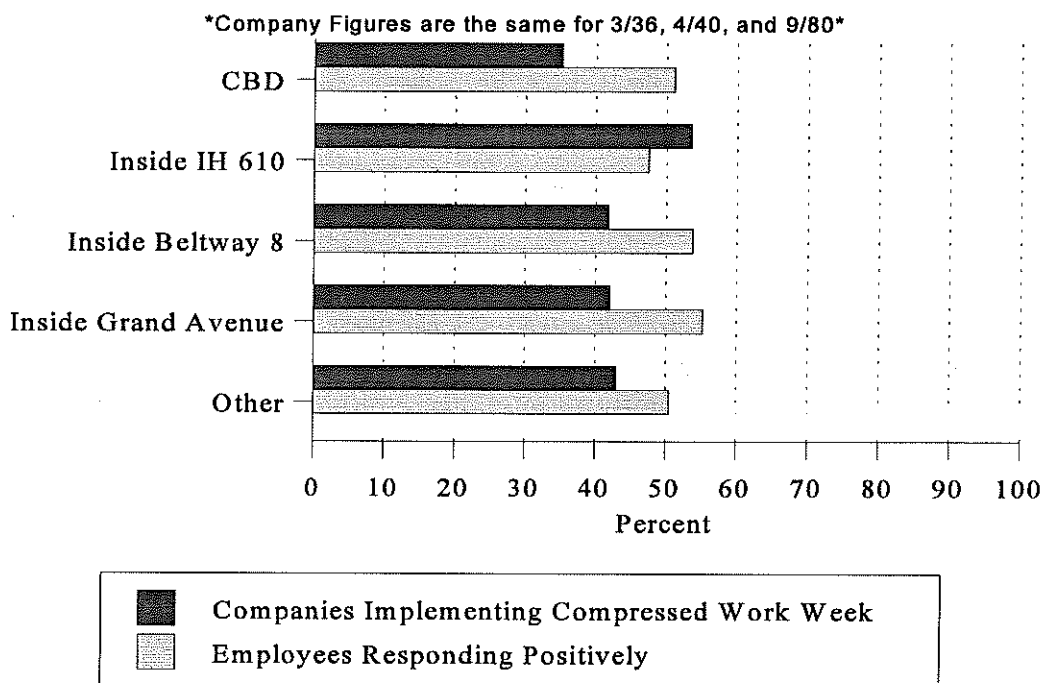


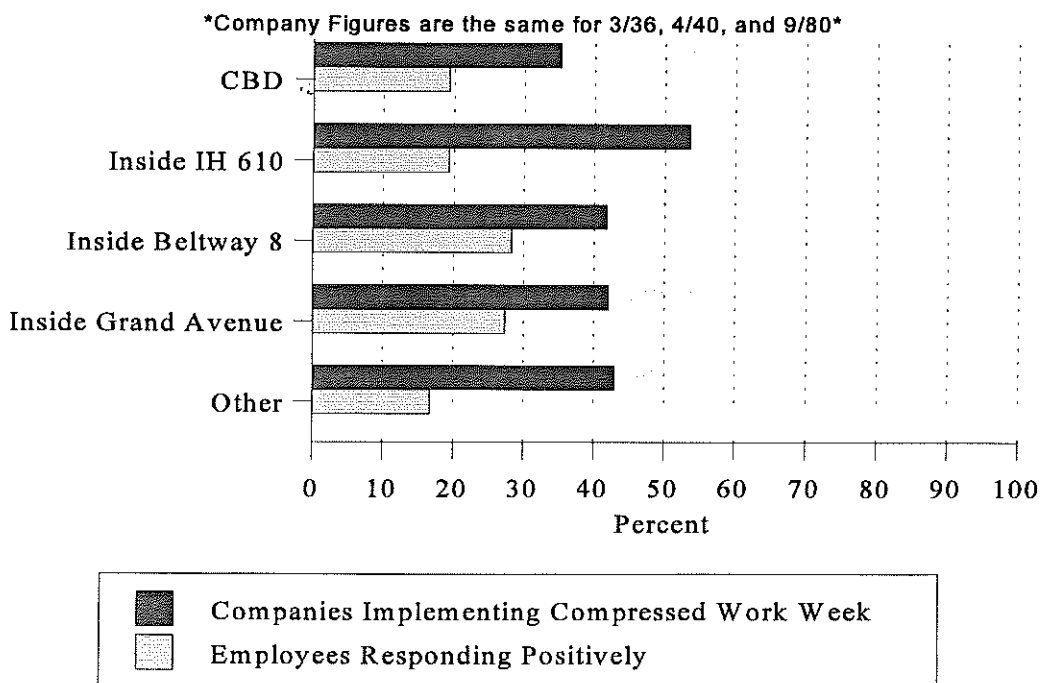
Figure L-20 Employee and employer interest in 3/36 compressed work week



*Appendix L: Employee and Employer Information by Region*



**Figure L-21** Employee and employer interest in 4/40 compressed work week



**Figure L-22** Employee and employer interest in 9/80 compressed work week

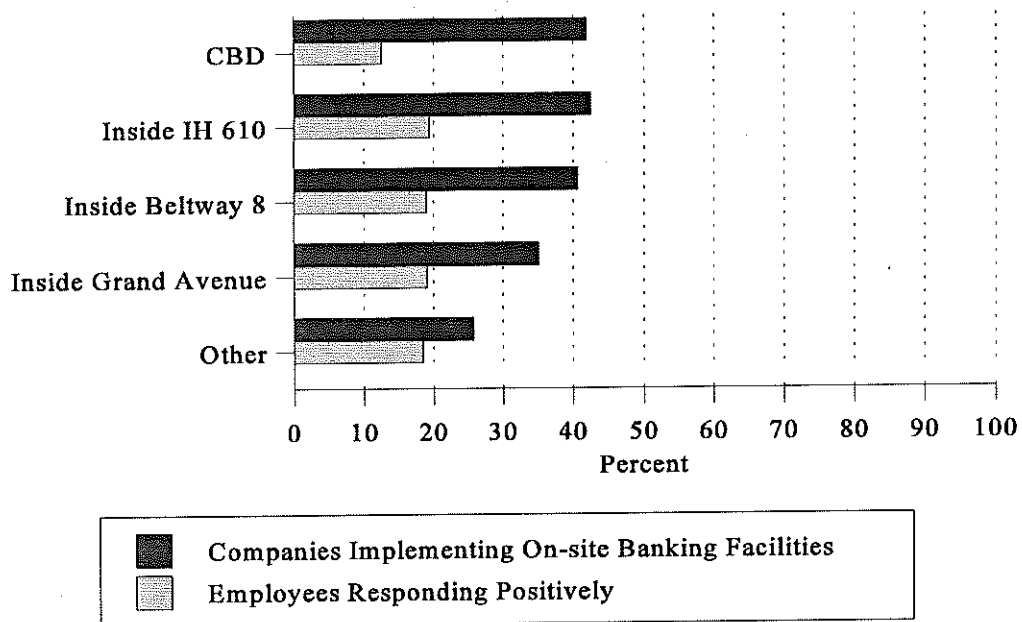


Figure L-24 Employee and employer interest in on-site banking facilities

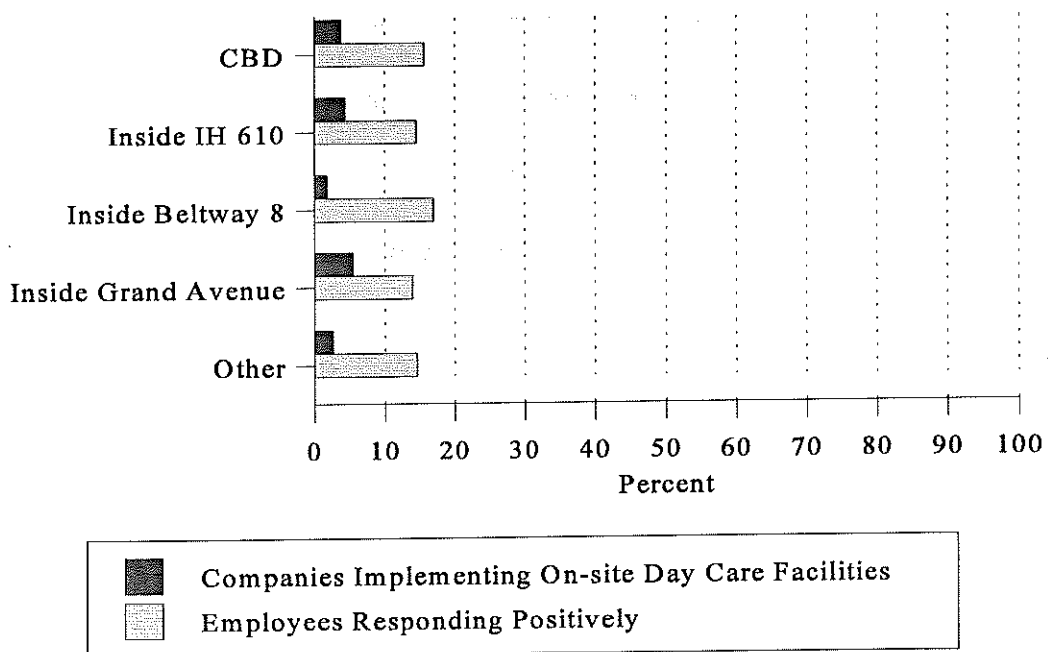


Figure L-23 Employee and employer interest in on-site day care facilities

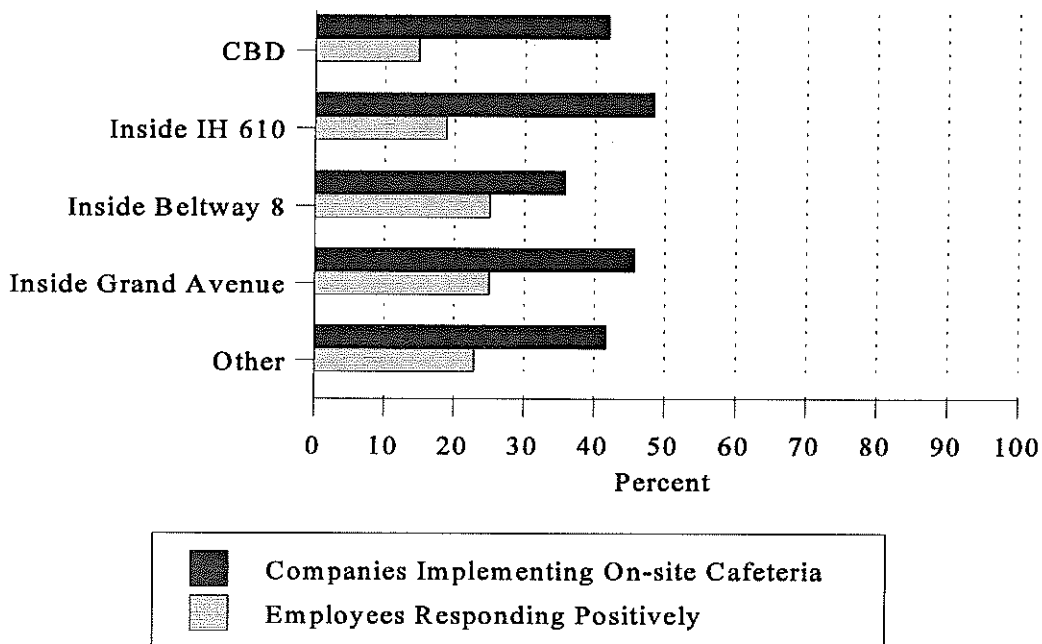


Figure L-25 Employee and employer interest in on-site cafeteria

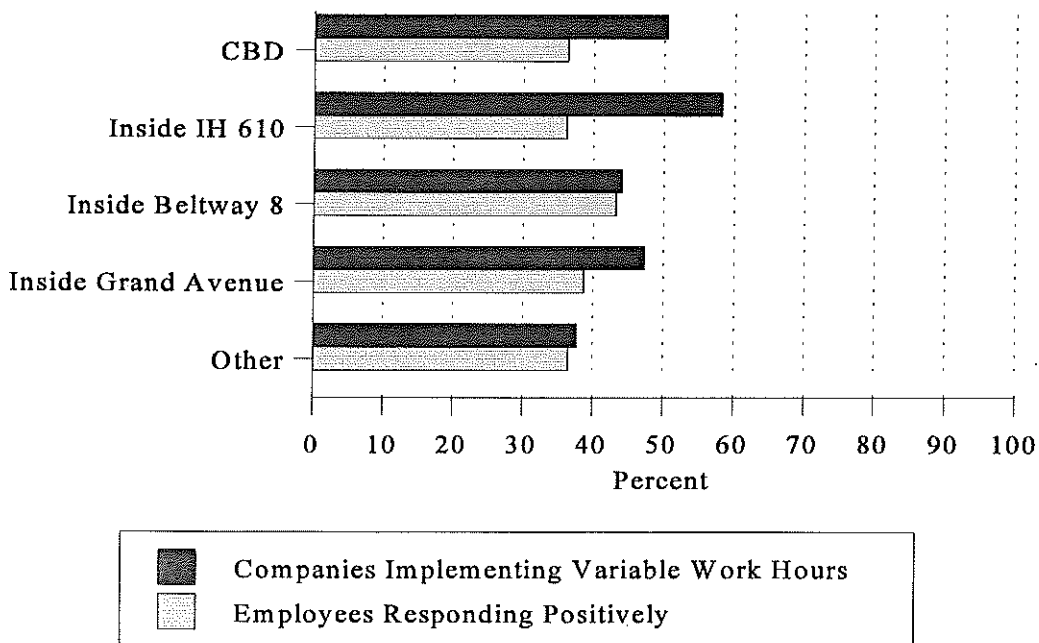


Figure L-26 Employee and employer interest in variable work hours

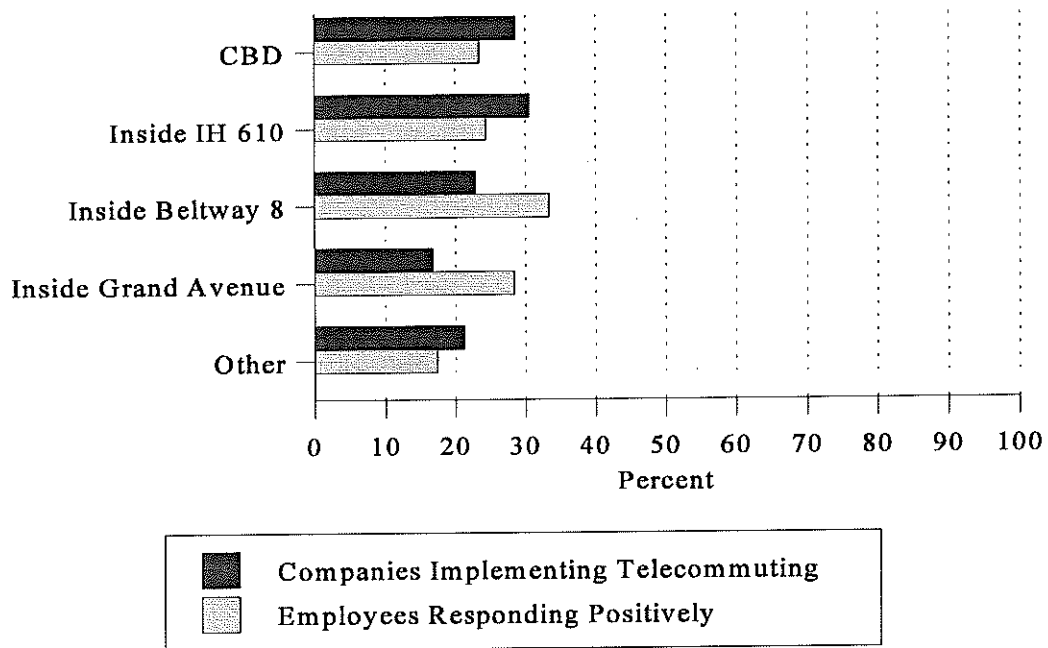


Figure L-27 Employee and employer interest in telecommuting

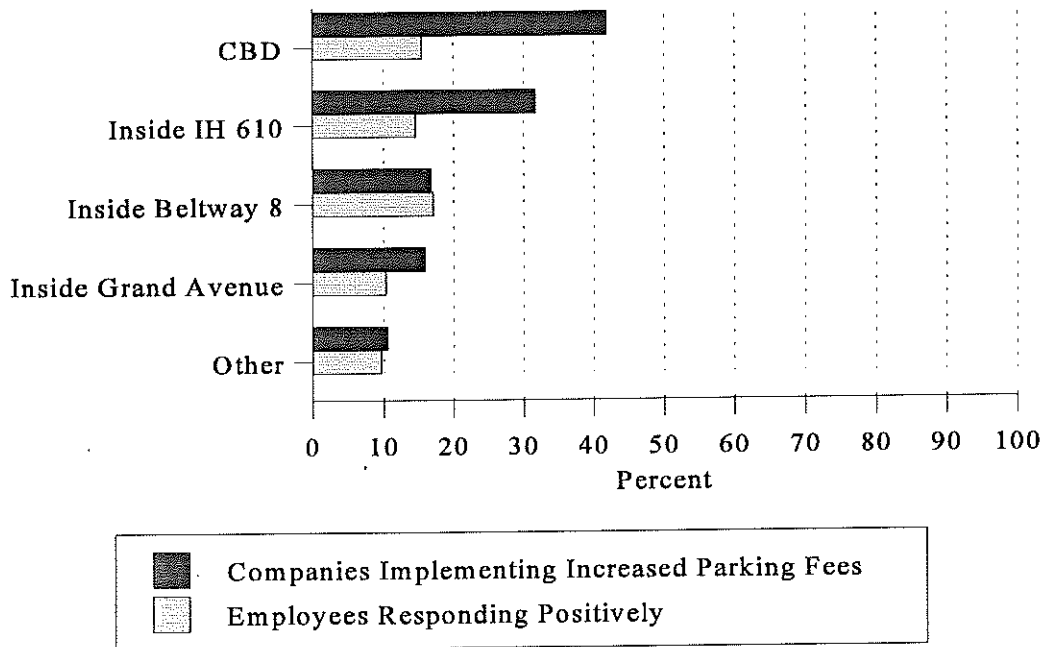


Figure L-28 Employee and employer interest in increased parking fees