Atlanta Congestion Reduction Demonstration:

National Evaluation Report

www.its.dot.gov/index.htm
March 21, 2014
FHWA-JPO-14-152

U.S. Department of Transportation

Produced by Congestion Reduction Demonstration Evaluation
U.S. Department of Transportation
Office of the Assistant Secretary for Research and Technology
Federal Highway Administration
Federal Transit Administration

Notice

Cover photo: SRTA, used with permission.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-JPO-14-152		

4. Title and Subtitle	5. Report Date / 6. Performing Organization Code
Atlanta Congestion Reduction Demonstration: National Evaluation Report	5. Report Date: March 21, 2014 6. Performing Organization Code
7. Author(s) Carol Zimmerman Jeremy Schroeder, Mike Anderson, Patricia Braschayko (Battelle); Kevin Balke, Mark Burris, Praprut Songchitruksa, Ginger Goodin, Eun Sug Park, and Nick Wood (Texas A&M Transportation Institute); Brian Pessaro (Center for Urban Transportation Research); Emily Saunoi-Sandgren, (Hubert H. Humphrey School of Public Affairs); Eric Schreffler and Barbara Joy (ESTC).	8. Performing Organization Report No.
9. Performing Organization Name And Address Battelle 505 King Avenue Columbus, OH 43201	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTFH61-06-D-00007/ORDER 07-T-08002/ WO BA07-041
12. Sponsoring Agency Name and Address U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology Federal Highway Administration Federal Transit Administration 1200 New Jersey Avenue, S.E. Washington, DC 20590	13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This document presents the final report on the national evaluation of the Atlanta Congestion Reduction Demonstration (CRD) under the United States Department of Transportation (U.S. DOT) CRD Program. The Atlanta CRD projects focus on reducing congestion by employing strategies consisting of combinations of tolling, transit, telecommuting/travel demand management (TDM), and technology, also known as the 4 Ts. The Atlanta CRD projects include the conversion of lanes for high occupancy vehicles (HOV) on approximately 16 miles of I-85 to high occupancy toll (HOT) lanes, known as Express Lanes, along with expansion and enhancement of transit service in that corridor, including new and expanded park-and-ride lots. The national evaluation of the Atlanta CRD projects is guided by the National Evaluation Framework, the Atlanta CRD National Evaluation Plan, and individual test plans for various components. This report provides information on the use of the new Atlanta CRD projects. Changes in travel speeds, travel times, trip-time reliability, park-and-ride lot use, and transit ridership are described. The results of interviews and workshops with local stakeholders, surveys of different user groups, and interviews and focus groups with enforcement personnel, bus operators, and service patrol personnel are presented. The environmental, business, and safety impacts of the Atlanta projects are examined, along with non-technical success factors that contributed to the project's success and a benefit-cost analysis. Information on changes in unemployment rates and gasoline prices during the evaluation time, which could have affected travelers' response to the CRD strategies, is also summarized.

17. Key Words	18. Distribution Statement
Urban Partnership Agreement, Congestion Reduction Demonstration, congestion pricing, tolling, HOT, congestion reduction, transit, TDM, evaluation	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
		369	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

This page intentionally left blank

Table of Contents

List of Appendices

List of Figures

List of Tables

This page intentionally left blank

List of Abbreviations

4Ts	Tolling, Transit, Telecommuting/TDM, and Technology
AADT	Average annual daily traffic
AFV	Alternative fuel vehicle
ALPR	Automatic license plate reader
ARC	Atlanta Regional Commission
AVI	Automatic vehicle identification
AVO	Average Vehicle Occupancy
C-Tran	Clayton Transit
CAC	Clean Air Campaign
CATS	Cherokee Area Transportation Services
BCA	Benefit cost analysis
CCT	Cobb Community Transit
CFC	Cash for Commuters
CP	Commuter Prize
CR	Carpool Rewards
CRD	Congestion Reduction Demonstration
CVO	Commercial vehicle operator/operations
DPS	Department of Public Safety
EL	Express Lanes
FHWA	Federal Highway Administration
GCT	Gwinnett County Transit
GDOT	Georgia Department of Transportation
Georgia Tech	Georgia Institute of Technology
GP	General purpose (lanes)
GRTA	Georgia Regional Transportation Authority

HERO	Highway Emergency Roadway Operators
HOT	High occupancy toll
HOT3+	High occupancy toll lane allowing untolled travel by vehicles with three or more occupants
HOV	High occupancy vehicle
HOV2+	High occupancy vehicle with a minimum of two occupants
ITS JPO	Intelligent Transportation Systems Joint Program Office
LOS	Level of service
MARTA	Metropolitan Atlanta Rapid Transit Authority
MOVES	Motor Vehicle Emissions Simulator
NEF	National Evaluation Framework
RFID	Radio frequency identification
SOV	Single occupant vehicle
SRTA	State Road and Tollway Authority
TDM	Travel demand management
UPA	Urban Partnership Agreement
U.S. DOT	United States Department of Transportation
VMT	Vehicle miles traveled

Acknowledgments

Many representatives from the Atlanta partnership agencies provided information critical to the development of the final report. We would especially like to express our appreciation to the following individuals: Ben Rabun and Donna Brantley, Georgia Department of Transportation (GDOT); Gena Major, Carlos Campos, and Malika Wilkins of State Road and Tollway Authority (SRTA) and Patrick Vu, formerly of SRTA; Rob Alexander and Valentin Vulov of Georgia Regional Transportation Authority (GRTA) and Jim Ritchey, formerly of GRTA; Guy Rousseau of the Atlanta Regional Commission (ARC); Mike Williams of the Clean Air Campaign (CAC); and Randy Guensler and Angshuman Guin of Georgia Institute of Technology. In addition we would like to thank all the agency representatives who participated in the in-depth interviews and stakeholder workshops.

This page intentionally left blank

Executive Summary

This report presents the final results of the national evaluation[1] of the Atlanta Congestion Reduction Demonstration (CRD) projects under the U.S. Department of Transportation (U.S. DOT) CRD program. It summarizes information from the pre-deployment period and one full year of post-deployment operation of all the Atlanta CRD projects.

Background

In 2006, the U.S. DOT, in partnership with metropolitan areas, initiated a program to explore reducing congestion through the implementation of pricing activities combined with necessary supporting elements. This program was instituted through the Urban Partnership Agreements (UPAs) and the CRDs. Within each program, multiple sites around the U.S., including Atlanta, were selected through a competitive process. The selected sites were awarded funding for implementation of congestion reduction strategies. The applicants' proposals for congestion reduction were based on four complementary strategies known as the 4Ts: Tolling, Transit, Telecommuting, which includes additional travel demand management (TDM) strategies, and Technology.

The UPA and CRD national evaluation was sponsored by the U.S. DOT. The Office of the Assistant Secretary for Research and Technology's Intelligent Transportation Systems Joint Program Office (ITS JPO) was responsible for the overall conduct of the national evaluation. Representatives from the modal agencies were actively involved in the national evaluation. The Battelle team was selected by the U.S. DOT to conduct the national evaluation through a competitive procurement process.

The purpose of the national evaluation was to assess the impacts of the UPA/CRD projects in a comprehensive and systematic manner across all sites. The national evaluation generated information and produce technology transfer materials to support deployment of the strategies in other metropolitan areas. The national evaluation also generated findings for use in future federal policy and program development related to mobility, congestion, and facility pricing. The Battelle team developed a National Evaluation Framework (NEF) to provide a foundation for evaluation of the UPA/CRD sites. The NEF was based on the 4Ts congestion reduction strategies and the questions that the U.S. DOT sought to answer through the evaluation. The NEF was used to develop the Atlanta CRD National Evaluation Strategy, the Atlanta CRD National Evaluation Plan, and multiple test plans for various types of data. These plans guided the Atlanta CRD National Evaluation.

The Atlanta CRD

The Atlanta CRD partners included the Georgia Department of Transportation (GDOT), the Georgia Regional Transportation Authority (GRTA), and the State Road and Tollway Authority (SRTA). Other partners were Atlanta Regional Commission (ARC), Georgia Department of Public Safety,

[1] National evaluation refers to evaluations of the UPA/CRD sites sponsored by U.S. DOT.

Metropolitan Atlanta Rapid Transit Authority (MARTA), Gwinnett County Government, Clean Air Campaign (CAC), and Georgia Institute of Technology (Georgia Tech).

In 2007 deteriorating performance of the high occupancy vehicle (HOV) lanes on I-85 provided the focus for development of the Atlanta CRD projects. Heavy usage had resulted in peak hour speeds in the HOV lanes of only 45 mph in the a.m. and 39 in the p.m. compared to 70 mph mid-day,[2] threatening the federal minimum performance requirement for HOV facilities. In addition, travel time reliability for all I-85 travelers during the morning and evening peaks had become among the worst in the region.[3]

To address the performance problems, the CRD partners undertook innovative and challenging approaches on I-85 intended to provide travelers with more reliable travel and enhance travel options in the corridor. The centerpiece of the Atlanta CRD was the conversion of existing HOV lanes with two or more minimum occupancy to dynamically-priced 3+ high-occupancy toll (HOT) lanes, called Express Lanes, on approximately 16 miles of I-85 northeast of Atlanta. Atlanta was unique in going to HOV3+ without also adding an additional lane. The goal was to use pricing to regulate usage of the Express Lanes for vehicles with less than three passengers and to continue to allow 3+ carpools and transit riders to use the lane at no charge.

Transit enhancements were added to provide an attractive alternative to driving and included 12 new buses enabling operation of three new routes on the corridor and four park-and-ride lots that were added or expanded. Bus riders would have the travel advantage of the Express Lanes without paying a toll. To address the conversion from HOV2+ to HOV3+ for free use of the Express Lanes and the need for registering a carpool to use the lanes, a targeted outreach effort was conducted to increase the number of 3-person carpools. Innovative technologies were applied to enforcement in the Express Lanes and included a gantry-controlled access system comprising radio frequency identification (RFID) readers and a license plate recognition system as well as mobile automatic license plate reader (ALPR) camera systems placed in vehicles of enforcement personnel.

The initial implementation of the Atlanta CRD projects in 2011 occurred against a backdrop of the highest unemployment rates in the state and in the Atlanta area in recent times. The annual seasonally adjusted unemployment rate for the state reached a high of 10.2 percent in 2010, before declining to 9.8 percent in 2011 and 9.1 percent in 2012. In addition, gasoline prices fluctuated between $2.70 and $4.00 in the year preceding and following the start of tolling. These trends in employment and the cost of fuel could have changed travel patterns observed during the evaluation period beyond the effect of the CRD projects themselves.

In addition to these general economic conditions, the post-deployment period was affected by unanticipated operational and physical changes to the Express Lanes. After the opening of the Express Lanes, low volume in the tolled lanes and congestion and slow speeds in the general purpose lanes in the first few weeks generated a negative environment of public opinion such that decision makers felt compelled to respond. Consequently, to increase demand, the peak-period tolling algorithm was altered and rates for off-peak hours were set to a minimum of $0.01 per mile. Later, an additional weave zone between the Express Lanes and general purpose lanes was added near the Boggs Road overpass of I-85 South.

[2] Atlanta CRD partners, "Georgia HOV to HOT System Proposal," Draft Submission to the U.S. Department of Transportation, August 26, 2008.

[3] Georgia Regional Transportation Authority, "2008 Transportation Metropolitan Atlanta Performance Report," undated.

Other considerations in the evaluation of the CRD projects were data and the length of the evaluation period. The amounts and quality of data available to the evaluation presented constraints for some of the analyses. Moreover, with the evaluation based on just one year of post-deployment data, traveler response to the projects over a longer period as well as operations of the facilities by the partners could be different than what was observed in the first year. For example, in the year since the end of the period of the evaluation, more Peach Passes have been assigned, usage of the Express Lanes has continued to grow, and average toll rates have increased.

Major Findings of the National Evaluation

The following points highlight the evaluation findings regarding the major 4T elements of the CRD projects that were the focus of the national evaluation. Additional impacts of the CRD with respect to congestion, safety, equity, environment, goods movement, business impacts, non-technical success factors, and benefit-cost analysis were examined and are contained in the report

- **Tolling.** For I-85 travelers, the first year of the Express Lanes produced mixed results. On October 1, 2011 the I-85 Express Lanes began operation between Chamblee Tucker Road, just south of I-285, to just north of Old Peachtree Road in Gwinnett County. Monthly Express Lane usage reached approximately 400,000 vehicle trips from March through September 2012, with tolled trips accounting for about 300,000 and HOV3+ trips accounting for about 29,300 per month. A total of 69,143 new accounts were opened and 197,044 Peach Passes were issued between June 2011 and September 2012. The median use of Peach Pass transponders was two trips per month. In all, 4.6 percent of tolled users and 3.2 percent of HOV3+ users took 20 or more trips on average per month in the Express Lanes. The use of variable pricing appeared to be effective in regulating Express Lane traffic flow in the a.m. peak. It appeared to be too early to tell how effective variable pricing was in the p.m. peak as the correlation between tolls and traffic flow was not as apparent as in the a.m. peak. However, Express Lane traffic in the p.m. peak outperformed the current general purpose and previous HOV traffic, suggesting that price could have contributed to keeping traffic below the congestion threshold.

  During the peak periods travel times and speeds improved in the Express Lanes but declined in the general purpose lanes, resulting in a travel time advantage of 3 minutes or more for Express Lane users. Post-deployment travel time data from the tolling system provided by SRTA indicated that the travel time savings were greater during the height of peak hour traffic. Travel reliability in the Express Lanes improved in the p.m. peak but not the a.m. Overall peak period vehicle throughput in the corridor declined, as did vehicle miles traveled. As expected, average occupancy levels declined in the Express Lanes as 2-person carpools shifted to the general purpose lanes. Even with an increase in transit riders, peak period person throughput declined in both the a.m. and p.m. Results of surveys and focus groups showed a perception that congestion had not improved in the corridor, although Express Lane users tended to be more satisfied with their trips.

- **Transit.** The CRD transit enhancement proved quite successful with those that chose them, although marketing and media coverage of the transit alternative to the Express Lanes were minimal. Three new Xpress bus routes funded by the CRD operated on the corridor, the first of which began in August 2010. Four CRD-funded park-and-ride lots—three new and one expanded—opened between August 2010 and August 2011. Together these additions represented a 117 percent increase in spaces in the I-85 corridor. The evaluation also included two other lots that were not funded by the CRD but that might have been impacted by the Express Lanes. Between 2010 and 2012, peak period Xpress bus ridership increased by 21 percent in the a.m. and by 17 percent in the p.m., with much of the increase occurring as CRD transit enhancements came on-line prior to tolling. Usage of CRD-funded routes and park-and-ride lots increased as non-CRD funded transit in the corridor declined. Xpress bus ridership in the region experiencing a decline overall during the evaluation period, with the exception being the I-85 CRD-funded routes. About half of new I-85 riders said tolling influenced them to start taking the bus. Xpress bus riders expressed very high satisfaction with the bus service, although post-tolling surveys suggested that some riders perceived slower bus travel time despite actual travel time being better or unchanged.
- **TDM.** To support the CRD projects, GDOT and SRTA contracted the CAC to undertake public outreach to increase the number of 3-person carpools in the I-85 Express Lanes. Through outreach to employers in meetings and events (distributing over 600 targeted brochures), and especially through targeted outreach using a database of registered carpoolers, CAC efforts focused on converting existing 2-person to 3-person carpools and on creating 3-person carpools from single-occupant vehicle (SOV) drivers. However, the outreach led to only 18 existing registered 2-person carpools adding a third person. Peak period occupancy data indicated that carpools of all sizes appeared to have declined in both the Express Lanes and general purpose lanes, while a survey of household showed some increases in carpooling for all trip purposes throughout the day. Moreover, a substantial shift from the Express Lanes to the general purpose lanes by 2-person carpools might be partially attributed to the change to HOV3+ for free usage of the Express Lanes and to the fact that an HOV2+ lane remained in place beyond the southern end of the CRD project.
- **Technology.** The CRD's enforcement technology appeared to work well, although a robust evaluation wasn't possible with available data. The gantry-controlled access system for the Express Lanes identified toll violators and resulted in 49,229 notices being mailed by SRTA from February 2012 through September 2012. There were 1,407 warning letters issued during the first three months (November 2011 through January 2012) prior to beginning the full violation notification process. In addition, SRTA operators expressed satisfaction with system features for optimizing violation detection. Automatic license plate readers installed in vehicles of Department of Public Safety (DPS) enforcement personnel provided an alert if a license plate matched the database of registered HOV3+ users thereby prompting a visual inspection by the enforcement officer for vehicle occupancy compliance. DPS personnel using the technology issued an average of 47 occupancy citations per month. DPS also issued an average of 21 citations per month to drivers crossing the double white line. Insufficient data prevented a comparison of the rate of occupancy violations in the previous HOV lane with the rate after tolling began.

Chapter 1 Introduction

This report presents the national evaluation of the Atlanta CRD sponsored by the U.S. DOT CRD program. Atlanta was one of six locations selected by the U.S. DOT to implement a suite of strategies aimed at reducing congestion under the UPA and the CRD programs.

The Atlanta CRD included multiple projects focusing on tolling, transit, telecommuting/TDM, and technology (4Ts) in the I-85 corridor in the Atlanta metropolitan area. The U.S. DOT selected a team led by Battelle to conduct an independent evaluation of the UPA projects. This document presents the final results of the Atlanta CRD National Evaluation, developed by the Battelle team in cooperation with the Atlanta CRD partners and the U.S. DOT. The report presents information from the pre- and post-deployment periods, including a full year of operation for all CRD projects.

This report is divided into five sections following this introduction. Chapter 2 summarizes the UPA and CRD programs. Chapter 3 highlights the Atlanta CRD local agency partners and projects. Chapter 4 presents the national evaluation methodology and the data used in the evaluation. Chapter 5 describes the various impacts from the projects and the major findings from the evaluation. Chapter 6 highlights the overall conclusions from the national evaluation of the Atlanta CRD projects. Appendix A through Appendix M present more detailed findings for twelve analysis areas and data on exogenous factors used in the evaluation. Appendix N contains the hypotheses and questions guiding the Atlanta CRD national evaluation.

The evaluation report is intended to serve the needs of a variety of readers. For a reader seeking an overall understanding of the strategies used in the Atlanta CRD and the key findings about their effectiveness and impact, Chapters 3 and 6 will be most useful. Readers interested in specific types of transportation projects, such as transit, should consult the pertinent project descriptions in Chapter 3, along with the associated analysis in Chapter 5. For analysis of cross-cutting effects, such as equity and benefit-cost analysis, readers will find those results in Chapter 5. Readers interested in an in-depth understanding of the evaluation should consult the appendices, each of which focuses on a different aspect of the evaluation, and the previously published evaluation planning documents.

The reader should bear in mind that, as with any evaluation of systems operating in the real world, factors beyond the control of the evaluation process could have impacted the results. These include, for example, the general economic conditions during the evaluation period and the quality and quantity of data available for the evaluation. In addition, the analysis is based on a one-year post-deployment period and assessment of travelers' response to the CRD projects over a longer period could not be made. Thus, the longer-term impacts of the CRD projects could be substantially different than what was observed in the first year.

This page intentionally left blank

Chapter 2 The UPA/CRD Programs

Atlanta was one of six sites awarded a grant by the U.S. DOT in 2007 and 2008 for implementation of congestion reduction strategies under the UPA and the CRD programs. The other areas were Los Angeles, Miami, Minnesota, San Francisco, and Seattle-Lake Washington. A set of coordinated strategies known as the 4Ts incorporate tolling, transit, telecommuting/TDM, and technology were tailored to the needs of each site.

The national evaluation assessed the impacts of the UPA and CRD projects in a comprehensive and systematic manner across all sites. The objective was to document the extent to which congestion reduction is realized from the 4T strategies and to identify the associated impacts and contributions of each strategy. The evaluation also sought to determine the contributions of non-technical success factors—outreach, political and community support, and institutional arrangements—to the success of the projects and the overall net benefits relative to costs. Detailed documentation of the national evaluation framework and the evaluation planning documents specifically for the Atlanta CRD can be found at http://www.upa.dot.gov/pub.htm.

This page intentionally left blank

Chapter 3 Atlanta Congestion Reduction Demonstration

This chapter presents the Atlanta CRD, describing the Atlanta CRD partners; the transportation system and underlying congestion issues in the Atlanta metropolitan area, specifically the I-85 corridor; and the Atlanta CRD projects and deployment schedule.

3.1 The Atlanta CRD Partners

The Atlanta CRD partners included GDOT, GRTA, and SRTA. Other partners were ARC, Georgia DPS, MARTA, Gwinnett County Government, CAC, and Georgia Institute of Technology (Georgia Tech).

GDOT's role in the CRD reflected its statewide responsibility for planning, constructing, maintaining, and improving the state's roads and bridges. GDOT was responsible for all construction needed for the HOV-to-HOT conversion on I-85 and in the ongoing infrastructure maintenance and operations of all lanes in the demonstration corridor.

GRTA is the state agency responsible for improving Georgia's mobility, air quality, and land-use practices. In that capacity, GRTA operates Xpress, a public transportation service in partnership with 12 counties in metropolitan Atlanta. In the CRD, GRTA was responsible for acquiring buses to provide additional service on the I-85 corridor and for construction of new and expanded park-and-ride lots. GRTA worked in concert with Gwinnett County Transit (GCT), which operates the Xpress buses in the corridor.

SRTA is the toll operator of the I-85 Express Lanes, reflecting its responsibility throughout Georgia to operate toll roads. SRTA established the variable toll rates, selected the electronic toll technology, marketed the Express Lanes to travelers, and managed tolling operations.

3.2 The Transportation System in the Atlanta Area I-85 Corridor

The Atlanta region was the third fastest growing region in the U.S. in the last decade, adding one million residents between 2000 and 2010.[4] ARC estimated that the 10-county region's population reached 4,179,500 in 2012.[5] Much of that growth occurred in Gwinnett County where the CRD took place.

At the start of the CRD projects the population in Atlanta was served by a transportation infrastructure in the region comprising more than 350 miles of interstate in the 10-county area, six public transportation providers,[6] and a network of HOV lanes. The 44 miles of HOV lanes were on five interstate corridors, which had one HOV lane in each direction for a total of approximately 90 lane miles. Traffic congestion in the region was increasing. The Atlanta region had the second highest percent increase of vehicle miles traveled (VMT) from 1990 to 2003 (66 percent) and highest VMT per capita (~28 miles) compared to similar regions (Dallas, Houston, Phoenix, and Washington DC).[7] Texas A&M Transportation Institute estimated that the annual congestion delay for the Atlanta metropolitan area was 135 million person-hours in 2007, with the total cost of congestion close to $2.9 billion.[8]

In the I-85 corridor increased congestion led to deteriorating performance of its HOV2+ lanes, which operated during peak periods at level of service (LOS) F, the worst level. Heavy usage had resulted in peak hour speeds in the HOV lanes of only 45 mph in the a.m. and 39 in the p.m. compared to 70 mph mid-day[9] and threatened compliance with the federal minimum performance requirements for HOV facilities.[10] In addition, travel time reliability for all I-85 travelers during the morning and evening peaks had become among the worst in the region.[11]

---

[4] Atlanta Regional Commission, Nov./Dec. 2011. *Regional Snapshot, State of the Atlanta Region: 2011*.

[5] Atlanta Regional Commission website: http://www.atlantaregional.com/info-center/arc-region.

[6] These providers are MARTA, Cherokee Area Transportation Services (CATS), Cobb Community Transit (CCT), C-Tran (Clayton Transit), Gwinnett County Transit (GCT) and GRTA Xpress (Georgia Regional Transportation Authority).

[7] Georgia's HOV to HOT System Proposal, Draft Submission to U.S. DOT, August 26, 2008.

[8] Texas Transportation Institute, 2009 Urban Mobility Report, Performance Measure Summary – Atlanta, GA.

[9] Atlanta CRD partners, "Georgia HOV to HOT System Proposal," Draft Submission to the U.S. Department of Transportation, August 26, 2008.

[10] HOV facility degradation is defined in Section 166(d)(2) of the Federal Aid Highway Program as an HOV lane that does not meet minimum average operating speed of 45 mph with a speed limit of 50 mph or greater for 90 percent of the time over a 180-day monitoring period during morning and evening weekday peak hours. Source: http://ops.fhwa.dot.gov/freewaymgmt/hovguidance/chapter4.htm.

[11] Georgia Regional Transportation Authority, "2008 Transportation Metropolitan Atlanta Performance Report," undated.

To address the performance problems, the aim of the CRD projects was to provide more reliable travel in the HOV2+ lane by converting it to a tolled lane with a 3-person carpool minimum to ride for free and to enhance travel options for all travelers with improved transit in the corridor. The CRD provided the opportunity to demonstrate the effectiveness of innovative strategies for addressing Atlanta's congestion problem and to provide better mobility options for its residents. The I-85 CRD corridor was to be the first portion of what was planned as a network of Express Lanes in the region, and the lessons gained on I-85 could be applied as new portions of the planned expansion were implemented.

3.3 Atlanta CRD Projects and Deployment Schedule

This section presents the CRD projects and the deployment schedule. Figure 3-1 highlights the general location of the various Atlanta CRD projects, which are described in the following pages by the tolling, transit, telecommuting, and technology categories.

3.3.1 Tolling Projects

Atlanta's tolling strategy was to open up the capacity of HOV lanes on I-85 to other vehicles for drivers with a willingness to pay for a faster, more reliable commute. As the first phase of a regional integrated system of congestion-priced lanes, the existing HOV lanes were converted to dynamically priced HOT lanes, called Express Lanes, on approximately 16 miles of the northeast portion of I-85 from Chamblee Tucker Road, just south of I-285, to just north of Old Peachtree Road in Gwinnett County. GDOT was responsible for the construction in the HOV-to-Express Lanes conversion. SRTA operated the tolling portion of the system, which began on October 1, 2011. The Express Lanes are depicted in Figure 3-1. Not depicted in the figure is an additional weave zone near the Boggs Road overpass on I-85 South that was implemented in 2012.

The Express Lanes operated continuously for one lane in both the northbound and southbound directions. The Express Lanes were designed to be variably priced with a toll rate that changed as frequently as every 5 minutes based on the downstream segment of the corridor with the highest observed volume and the highest potential for degradation in speed. Toll amounts per vehicle could be derived by using the calculated distance between the detected entry point and exit point.

The occupancy requirement for using the Express Lanes toll-free changed from the two or more people on the previous HOV lanes (HOV2+) to three or more people (HOT3+), and registration was also required. Registered toll-exempt vehicles included vehicles with three or more people, motorcycles, alternative fuel vehicles (AFVs) with GA AFV license plates (but not hybrids), transit, and emergency vehicles. Pre-registered vehicles with less than three occupants had to pay a toll to be allowed on the Express Lanes. The combination of the change in the occupancy requirements from 2+ to 3+ and required registration appeared to have contributed to the initial low usage of the Express Lanes.

Georgia DOT, Presentation at Public Hearing Open House, November 12, 2009.

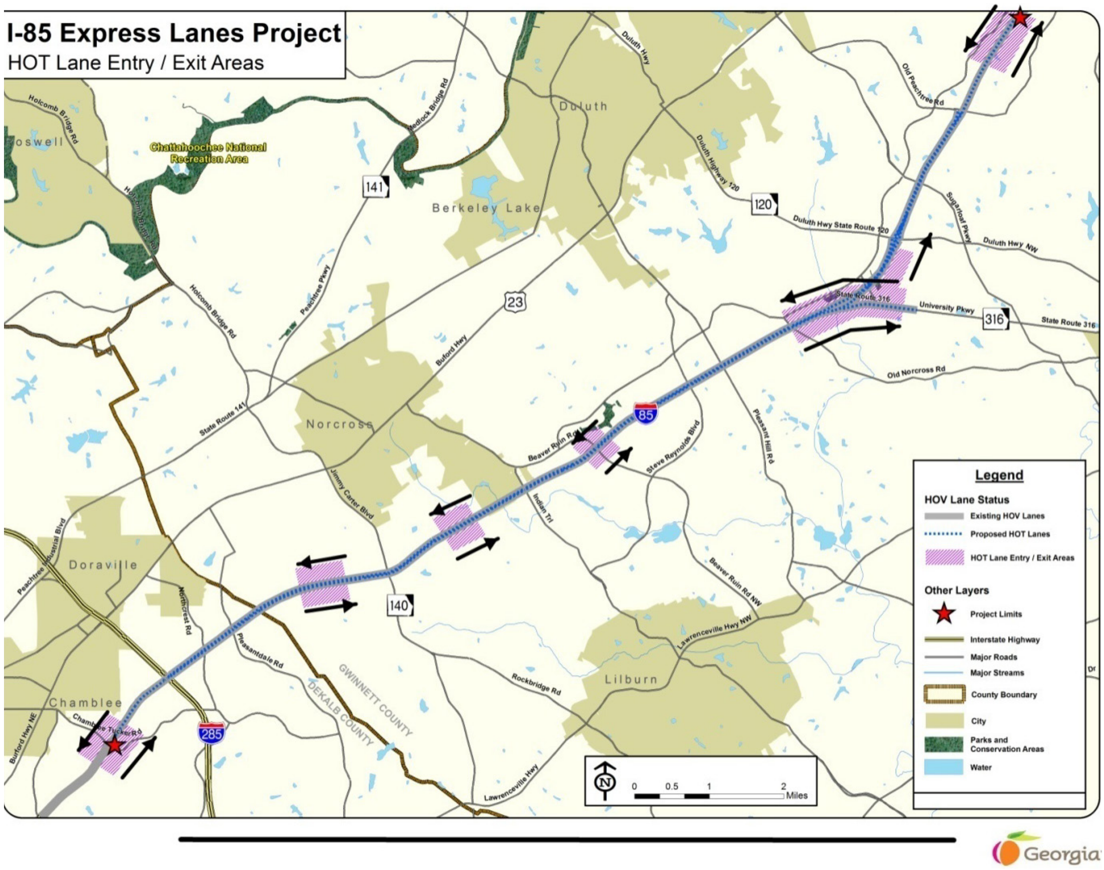


Figure 3-1. I-85 HOV-to-HOT Conversion Project

3.3.2 Transit Projects

The objective of the CRD transit projects was to expand and enhance the existing Xpress buses using I-85 to attract more riders who would benefit from improvements to the Express Lanes as non-tolled users. GRTA used CRD funding to purchase 20 new commuter buses, 12 of which operated in the I-85 corridor. The expanded fleet enabled three new routes to operate on the corridor, the first of which began in August 2010. GRTA was also responsible for the CRD-funded park-and-ride lot enhancements. These included three new lots—Mall of Georgia, Hamilton Mill, and Hebron Baptist Dacula—and one expanded lot at I-985/GA 20. The Mall of Georgia lot was the first to open in August 2010 with 750 leased spaces. Opening in June 2011 were 400 new leased spaces at Hebron Baptist Dacula. Opening in July 2011 was the expanded lot at I-985/GA 20, which added 400 spaces to the 347 that already existed previously. The Hamilton Mill lot opened in August 2011 with 918 spaces. Together these additions represented a 117 percent increase in spaces in the I-85 corridor. In addition to the CRD-funded park-and-ride lots, the evaluation included two other lots that were not funded by the CRD but could have been impacted: the Discover Mills and Indian Trail park-and-ride lots.

3.3.3 TDM

The TDM strategy of the Atlanta CRD focused on carpooling outreach. To support the CRD projects, CAC, under contract to SRTA and GDOT, undertook public outreach to increase the number of 3-person carpools in the I-85 Express Lanes corridor. Their efforts focused on converting existing 2-person to 3-person carpools and on creating 3-person carpools from SOV drivers. CAC used existing carpooler databases to identify and contact 2-person carpoolers. In conjunction with SRTA, CAC identified SOV commuters who travel in the I-85 Express Lanes and encouraged carpool formation. SOV drivers were also targeted through outreach to employers in the I-85 corridor and to employers outside the corridor who may have had employees who used the I-85 corridor. The carpooling outreach activity operated from July 2011 through February 2012.

3.3.4 Technology Projects

In addition to ITS technologies incorporated into other projects, the technology strategy of the Atlanta CRD included automated enforcement systems. The Express Lane was separated from the adjacent general purpose lane by a double white striped buffer that was enforced electronically by a series of gantries equipped with RFID readers that read transponders and by cameras used in a license plate recognition system that detected when and where a vehicle crossed into and out of the Express Lane. Vehicles that were first detected at points that were not near the legal ingress/egress points were sent violation notices through the mail.

Mobile automatic license plate readers (ALPR) camera systems installed in enforcement vehicles aided police officers with visual occupancy verification of vehicles using the Express Lane. Enforcement officials were provided with an audible or visual alert if a license plate matched the database of registered HOV3+ users to prompt a visual inspection for vehicle occupancy compliance. Officers uploaded a list of occupancy violations written during a shift to the Express Lanes back-office system.

3.3.5 Atlanta CRD Project Deployment Schedule

Table 3-1 presents the deployment timeline for the various Atlanta CRD projects. The Express Lanes on I-85, along with automated enforcement, became operational in October 2011. The new transit routes were phased in between August 2010 and August 2011, with park-and-ride lot enhancements being completed between August 2010 and August 2011. Carpooling outreach was conducted between July 2011 and February 2012.

Table 3-1. CRD Projects and Deployment Timeline

Projects	Operational Date
Express Lanes on I-85	October 2011
3 New Bus Routes	August 2010 – August 2011
Park-and-Ride Lots	August 2010 – August 2011
Automated Enforcement	October 2011
Carpooling Outreach	July 2011 – February 2012

Source: Battelle

This page intentionally left blank

Chapter 4 National Evaluation Methodology and Data

This section highlights the national UPA/CRD evaluation methodology and the data used in conducting the Atlanta CRD national evaluation. An overview of the national UPA/CRD evaluation methodology is presented first in Section 4.1. The four objective questions posed by the U.S. DOT to guide the national evaluation are described, along with the associated analyses. The major data sources used in the Atlanta CRD national evaluation are presented in Section 4.2.

4.1 Four U.S. DOT Evaluation Questions

The national evaluation assessed the impacts of the UPA/CRD projects in a comprehensive and systematic manner across all sites. The Battelle team developed a National Evaluation Framework (NEF) to provide a foundation for evaluation of the UPA/CRD sites.[12] The NEF was based on the 4T congestion reduction strategies and the questions that the U.S. DOT sought to answer through the evaluation. The NEF defined the questions, analyses, measures of effectiveness, and associated data collection for the entire UPA/CRD evaluation. The framework was a key driver of the site-specific evaluation plans and test plans, and it served as a touchstone throughout the project to ensure that national evaluation objectives were supported through the site-specific activities.

Table 4-1 presents the four U.S. DOT objective questions[13] and the analysis areas used in the Atlanta CRD evaluation to address these questions. As noted in the table, the analysis areas focused on the overall reduction in congestion, the performance of the 4Ts, and associated impacts. Elements of the analyses are presented in Chapters 5 and 6. Appendices A through L present detailed information on the 12 analyses. Appendix M summarizes information on changes in exogenous factors, and Appendix N is a compilation of all the hypotheses and questions examined in the evaluation.

[12] Battelle, Nov. 21,2008. “Urban Partnership Agreement and Congestion Reduction Demonstration: National Evaluation Framework” Pub. No. FHWA-JPO-09-011. Available at http://ntl.bts.gov/lib/30000/30700/30764/14446.pdf.

[13] “Urban Partnership Agreement Demonstration Evaluation – Statement of Work,” United States Department of Transportation, Federal Highway Administration, November 29, 2007.

Table 4-1. U.S. DOT Objective Questions and Atlanta CRD Evaluation Analyses

U.S. DOT 4 Objective Questions	Evaluation Analyses
#1 – How much was congestion reduced?	#1 – Congestion
#2 – What are the associated impacts of the congestion reduction strategies?	**Strategy Performance**
	#2 – Strategy Performance: Tolling #3 – Strategy Performance: Transit #4 – Strategy Performance: Telecommuting/TDM #5 – Strategy Performance: Technology
	Associated Impacts
	#6 – Associated Impacts: Safety #7 – Associated Impacts: Equity #8 – Associated Impacts: Environmental #9 – Associated Impacts: Goods Movement #10 – Associated Impacts: Business Impacts
#3 – What are the non-technical success factors?	#11 – Non-Technical Success Factors
#4 – What is the overall cost and benefit of the strategies?	#12 – Benefit Cost Analysis

Source: Battelle

4.2 Atlanta CRD Evaluation Process and Data

The Atlanta CRD evaluation involved several steps. Members of the national evaluation team worked closely with the local partners and U.S. DOT representatives on the following activities and products:

- Project kick-off conference call, site visit, and workshop;
- Atlanta CRD National Evaluation strategy;
- Atlanta CRD National Evaluation Plan;
- 10 Atlanta CRD data collection test plans;
- Collection of at least one year of pre-deployment and one year of post-deployment data;
- Analysis of the collected data, surveys, and focus groups; and
- An Interim Atlanta CRD National Evaluation Technical Memorandum and a National Evaluation Report (this document).

A wide range of data was collected and analyzed as part of the Atlanta CRD. Table 4-2 presents the data, the data sources, and related analysis areas used in the Atlanta CRD national evaluation. Appendices of this document present detailed descriptions of the data sources and the analysis techniques.

Members of the Battelle team worked with representatives from the Atlanta CRD partnership agencies and the U.S. DOT on all aspects of the national evaluation. This team approach included the participation of local representatives throughout the process and the use of site visits, workshops, conference calls, and e-mails to ensure ongoing communication and coordination. The local agencies were responsible for data collection and conducting surveys, focus groups, and interviews. The Battelle team was responsible for analyzing the local data and survey results.

Table 4-2. Atlanta CRD National Evaluation Data Sources

Data	Source	Major Analysis Areas(s)
Freeway Traffic Sensor Data	GDOT	• Congestion Analysis • Tolling Analysis • Environmental Analysis • Equity Analysis • Benefit Cost Analysis
Crash Data	GDOT	• Safety Analysis • Benefit Cost Analysis
Transit Ridership Data	GRTA	• Transit Analysis • Equity Analysis
Transit Travel Time, Revenue Miles and Hours, and Park-and-Ride Lot Count Data	GRTA	• Transit Analysis
Peach Pass Customers, Transponders issued, Monthly Use and Revenue	SRTA	• Tolling Analysis • Equity Analysis
Toll Transaction Data and AVI Sensor Data	SRTA	• Congestion Analysis • Tolling Analysis • Goods Movement Analysis
Express Lane Violations	SRTA	• Tolling Analysis • Safety Analysis • Technology Analysis
SRTA Operations Personnel Interviews	Texas A&M Transportation Institute	• Technology Analysis
Household Travel Survey	Volpe	• Congestion Analysis • Tolling Analysis • Safety Analysis • Equity Analysis • Non-Technical Success Factors Analysis

Table 4-2. Atlanta CRD National Evaluation Data Sources (Continued)

Data	Source	Major Analysis Areas(s)
I-85 Carpooler Survey	SRTA and Noble Insight, Inc.	• Tolling Analysis • Congestion Analysis • TDM Analysis • Equity Analysis • Non-Technical Success Factors Analysis
Transit On-Board Ridership Survey	GRTA	• Transit Analysis • Non-Technical Success Factors Analysis • Equity Analysis
Carpool and Vanpool Data	CAC (GDOT)	• TDM Analysis
Vehicle Occupancy Data	Georgia Institute of Technology	• Tolling Analysis
HERO Operators, and Express Bus Drivers, Transportation-Dependent Businesses, Employer Focus Groups	GDOT and Noble Insight, Inc.	• Congestion Analysis • Tolling Analysis • Safety Analysis • Business Impacts Analysis • Goods Movement Analysis
Stakeholder Interviews and Workshops	Hubert H. Humphrey School of Public Affairs	• Non-Technical Success Factors Analysis • Equity Analysis
News Media Coverage	Hubert H. Humphrey School of Public Affairs	• Non-Technical Success Factors Analysis
CRD Deployment and Operation Costs	GDOT, SRTA, GRTA	• Benefit Cost Analysis
10-year Transportation Model Projections	ARC	• Benefit Cost Analysis
MOVES (Motor Vehicle Emissions Simulator) Emissions Rates	ARC	• Environmental Analysis • Equity Analysis • Benefit Cost Analysis
Unemployment Rates – State and Metro Area	U.S. Bureau of Labor Statistics, Georgia Department of Labor	• Exogenous Factors
Gasoline Prices	U.S. Energy Administration	• Exogenous Factors
Socio-Economic Data	U.S. Census Bureau	• Equity Analysis

Source: Battelle

Chapter 5 Major Findings

This section highlights the major findings from the national evaluation of the Atlanta CRD projects. The contextual changes that occurred in the Atlanta metropolitan area during the evaluation period—including the increase in the unemployment rate—are highlighted in Section 5.1. The Atlanta CRD's use of the 4Ts—tolling, transit, telecommuting/TDM, and technology—are described in Section 5.2. Information on changes from the pre- and post-deployment periods is also presented. A summary of the impacts of the Atlanta CRD projects according to 12 evaluation analyses is provided in Section 5.3.

5.1 Contextual Changes During the Evaluation Period

The initial implementation of the Atlanta CRD projects occurred against a backdrop of the highest unemployment rates in the state and in the Atlanta area in recent times. The annual seasonally adjusted unemployment rate for the state was 3.5 percent in 2000. It reached a high of 10.2 percent in 2010, before declining to 9.8 percent in 2011 and 9.1 percent in 2012. The annual average non-seasonally adjusted unemployment rate for the Atlanta metropolitan area was 3.0 percent in 2000, 10.1 in 2010, 9.6 in 2011, and 8.9 percent in 2012. These trends could have attenuated the CRD projects' effectiveness and been reflected in the observed travel patterns. For example, the poor economy could have caused commuter travel and traffic in general to have been lower during all or part of the evaluation period, thereby influencing the evaluation results.

In addition, gasoline prices fluctuated throughout the evaluation period. The price of a gallon of regular conventional retail gasoline in Atlanta reached a high of $4.10 per gallon in July 2008, and then fell to a low of $1.69 in January 2009. In the pre-deployment period one year before the Express Lanes opened in October 2011, the price increased from $2.70 the week of September 27, 2010, to a peak of $3.97 in May 2011 to $3.51 the week of September 26, 2011. For the post-deployment period, the price fluctuated between $3.26 and $4.00. These changes in gasoline prices may have influenced travel behavior (such as the decision to carpool, use transit, or drive alone) and use of the Atlanta CRD projects.

5.2 Use of the Atlanta CRD Projects

The implementation and use of the Atlanta CRD projects, along with their impact on the corridor, are highlighted in this section. The Atlanta I-85 CRD projects represented a set of strategies aimed at expanding mobility options for I-85 travelers with a lane offering more reliable travel to more travelers than was previously available; providing enhanced transit service as an alternative to driving the corridor; facilitating carpools especially for three or more people to take advantage of the Express Lanes; and using innovative technologies to improve operations. The local partners undertook the challenges of implementing these strategies for the first HOV-tolled facility in the region where the vast majority had limited experience with tolled facilities and where the vast majority of travel was in SOVs. The following sections reveal how the strategies performed in achieving their objectives.

5.2.1 Tolling

With the conversion of the HOV lanes to HOT lanes (depicted in Figure 5-1) starting in October 2011, I-85 travelers willing to pay a toll for the potential of a faster or more reliable trip than available in the general purpose lanes could use the Express Lanes. At the same time, two-person carpools no longer had the privilege of riding for free in the Express Lanes, unless they found a third passenger. Findings from the evaluation of data before and after the implementation of tolling revealed dramatic responses by travelers to these changes in the I-85 CRD corridor.

The decision to implement the change to the 3+ vehicle occupancy was based on congestion levels in the HOV at the 2+ level. The limited national experience with increasing occupancy levels from 2+ to 3+ meant that the Atlanta CRD would be one of the early innovators, especially when combined with other innovations the partners undertook. The project represented the first effort in the country to increase occupancy levels from 2+ to 3+ and simultaneously to require registration and transponders for 3+ carpools and expand from HOV to HOT operation without adding capacity. As a result of combining all of these new approaches, it could be anticipated that some assumptions turned out correct and some did not. The learning experience with these groundbreaking approaches provides valuable information for other areas considering alternatives to HOV lanes operating at capacity with 2+ occupancy requirements.

SRTA, used with permission

Figure 5-1. Express Lanes in Operation

An indicator of interest in using the Express Lanes was the number of accounts and transponders acquired by I-85 travelers. All users of the Express Lanes in either tolled or non-tolled status were required to register for an account and obtain a Peach Pass transponder, illustrated in Figure 5-2, for placement in the windshield of each vehicle associated with the account. In addition, accounts and toll tags that had been used on the Georgia 400 Toll Road were brought under the Peach Pass umbrella. SRTA opened registration for Peach Pass in June of 2011 and implemented an intense marketing campaign prior to the opening of the Express Lanes in the fall of that year. As shown in Table 5-1, 69,143 new accounts were opened and 197,044 Peach Passes were issued between June 2011 and September 2012. Personal toll accounts represented 95 percent of new accounts, while commercial toll accounts represented 3 percent. Toll-exempt accounts represented 1.5 percent of the new accounts and post-paid accounts, non-revenue accounts, and emergency accounts combined to account for the remaining 0.5 percent of the new accounts.

SRTA, used with permission

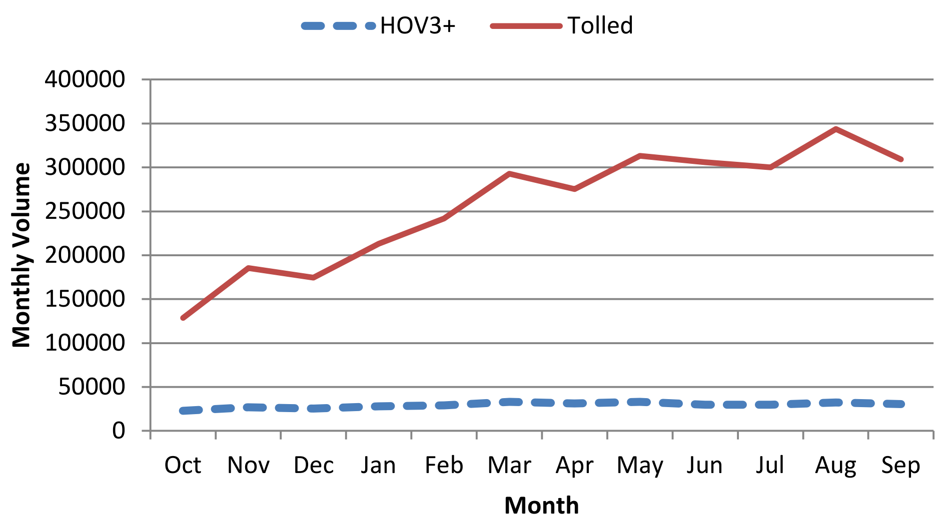
Figure 5-2. Peach Pass Transponder

Table 5-1. New Accounts Opened and Peach Passes Issued by Month

Month	New Accounts Opened	New Peach Passes Issued
June 2011	235	14,704
July 2011	4,054	8,521
August 2011	4,786	33,978
September 2011	7,769	19,182
October 2011	13,349	23,013
November 2011	5,209	13,866
December 2011	3,463	9,253
January 2012	4,071	9,643
February 2012	3,583	8,252
Mar 2012	3,699	9,105
April 2012	3,242	8,296
May 2012	3,407	8,879
June 2012	3,415	8,341
July 2012	3,118	7,068
August 2012	3,154	8,180
September 2012	2,589	6,763
Total	69,143	197,044

Source: Texas A&M Transportation Institute, based on SRTA data.

Once opened in October of 2011, usage of the Express Lanes grew incrementally, as travelers adapted to the new system. By March 2012 trips or transactions for tolled and non-tolled vehicles per month began to exceed 400,000 and remained in that range through the end of the evaluation period. (Non-tolled transactions were for trips taken by vehicles that traveled in a one of several statuses that did not require a toll, such as HOV3+ or emergency vehicles.) As shown in Figure 5-3, the monthly volume of trips by tolled vehicles grew to about 300,000 starting in March 2012, six months after the Express Lanes opened, whereas carpoolers of three or more (HOV3+) remained fairly constant in the post-deployment period, averaging 29,300 trips per month.



Texas A&M Transportation Institute, based on SRTA data.

Figure 5-3. Monthly Transactions of Tolled and HOV3+ Vehicles, October 2011 – September 2012

Vehicles taking tolled trips had a median of two trips per month. This occasional use of the Express Lanes was consistent for most tolled and toll-exempt Peach Pass holders. Of the 100,790 tolled passenger vehicles, 21.7 percent took an average of 5 or more trips per month, and 4.6 percent took 20 or more trips per month. HOV3+ vehicles took a median of two trips per month in the HOV mode. Of the 14,477 vehicles that used the Express Lanes at least once as an HOV 3+, 18.5 percent took an average of 5 or more trips per month, and 3.2 percent took 20 or more trips a month. The vast majority of Express Lane users traveled in only one toll status, although the system allowed for HOV3+ vehicles to change between toll-exempt or tolled (if they notified the system 15 minutes in advance of travel), when they did not have three or more persons in the car.

The introduction of dynamic pricing was meant to regulate the flow of traffic in the Express Lanes. Figure 5-4 shows the relationship between the average toll price and flow rate during the a.m. peak period at Indian Trail, which had the highest mean flow rate of all tolling segments for the weekday morning peak direction (southbound). Figure 5-5 shows the relationship during the p.m. peak period at Jimmy Carter Boulevard, which had the highest mean flow rate for the weekday afternoon peak direction (northbound). The relationship between toll price and flow rate was more correlated in the a.m. peak than in the p.m. peak, suggesting the tolls changed more frequently in order to manage the higher and more consistent demand for the Express Lanes in the morning than for the lower demand in the afternoon.

Texas A&M Transportation Institute, based on SRTA data.

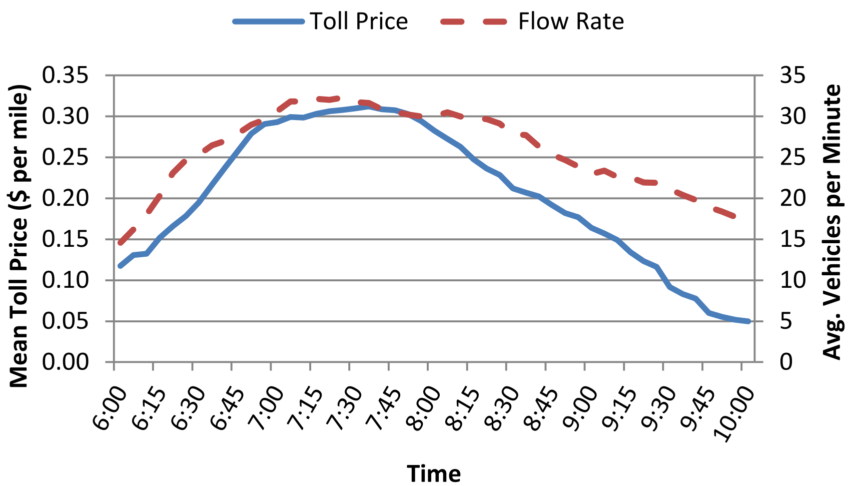


Figure 5-4. Average Toll Price and Flow Rate at Indian Trail, A.M. Peak Period from February to September 2012

Texas A&M Transportation Institute, based on SRTA data.

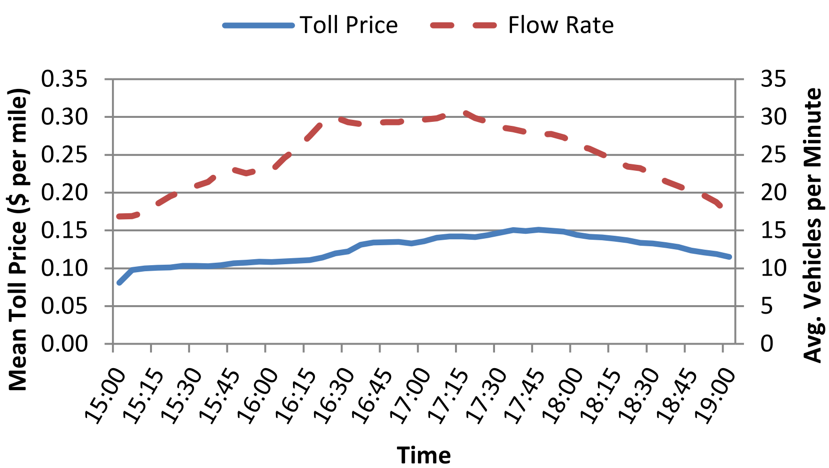


Figure 5-5. Average Toll Price and Flow Rate at Jimmy Carter, P.M. Peak Period from June to September 2012

The Express Lanes offered the potential for a faster and more reliable trip during the peak period. For purposes of the analysis, peak period was defined as 6:00 to 10:00 a.m. and 3:00 to 7:00 p.m. Comparison of the pre-deployment and post-deployment data in Table 5-2 revealed that the time it took to travel the corridor in the Express Lane in the peak direction changed little after tolling—about half a minute faster. Vehicles in the general purpose lanes, on the other hand, experienced a slight increase (but less than 1 minute) in average travel time in the a.m. peak after tolling, but almost 2 minutes in the p.m. peak.

Table 5-2. Pre- and Post-Deployment Mean Corridor Peak-Period Travel Times (in Minutes) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel[1]

Peak Period (Direction of Flow)	Lane Type	Mean Corridor Travel Time (Minutes)					
		Pre-Deployment	Post-Deployment	Change	Percent Change	t-value	Significant?[2]
A.M. Peak (Southbound) (6 a.m. to 10 a.m.)	General Purpose	16.1	16.9	0.8	5.10%	8.5	Yes
	Express	14.1	13.8	-0.3	-2.20%	-6.2	Yes
P.M. Peak (Northbound) (3:00 p.m. to 7 p.m.)	General Purpose	16.1	17.8	1.7	10.20%	21.3	Yes
	Express	14.3	13.8	-0.5	-3.80%	-12.1	Yes

[1] Based on NaviGAtor II data only. These travel times are for approximately 11.5 miles of I-85 covered by the NaviGAtor II system for April 2011-August 2011 and April 2012-August 2012.

[2] Statistically significant at the 95 percent confidence level.

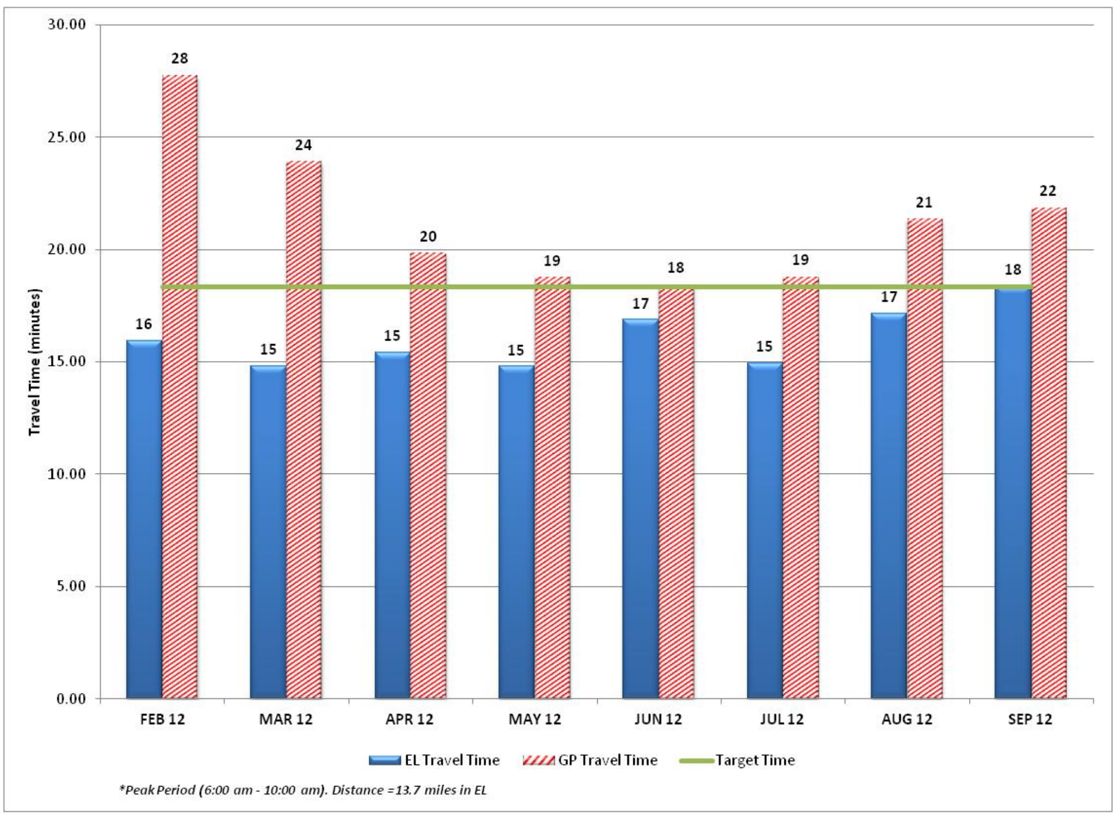
Source: Texas A&M Transportation Institute based on data provided by Georgia Department of Transportation.

Table 5-2 also shows that drivers choosing the Express Lane could expect a faster peak-period trip than in the general purpose lane. The Express Lane travel time advantage was about 3 minutes in the a.m. and 4 minutes in the p.m. These findings were based on data for Monday through Friday from GDOT's NaviGAtor II network of traffic sensors during the months of April through August of 2011 (pre-deployment) and 2012 (post-deployment).

A statistical comparison of the travel times in the Express Lanes was performed on each 30-minute interval during the peak periods. The analysis showed that, during the morning peak period, from 6:30 a.m. to 8:00 a.m. and again from 9:00 a.m. to 10:00 a.m., travel times in the southbound Express Lanes were statistically lower by approximately 1 minute in the post-deployment period compared to the pre-deployment period. At all other times (from 6:00 a.m. to 6:30 a.m. and again from 8:00 a.m. to 9:00 a.m.), no statistical difference existed in the travel times in the Express Lanes in the a.m. peak. Travel times in the general purpose lanes were determined to be statistically lower by approximately 1 minute only during the early portions of the a.m. peak (i.e., from 6:00 a.m. to 7:30 a.m.). During all other times in the a.m. peak, no statistical evidence was found to suggest that travel times in the general purpose lanes changed significantly between the pre- and post-deployment evaluation periods.

The analysis also showed that during the evening peak period, except for the very edge of the peak, the estimated mean travel times in the general purpose lanes were all statistically higher in the post-deployment period compared to the pre-deployment period. For the general purpose lanes, travel times were over 2 minutes higher early in the peak (i.e., before 5:00 p.m.), and less than 1.5 minutes higher later in the evening (i.e., after 5:00 p.m.). On the other hand, travel time in the Express Lanes was between 2 to 4 minutes lower consistently in the p.m. peak. Only early in the p.m. peak (between 3:00 p.m. and 3:30 p.m.) and late in the peak (from 6:30 p.m. to 7:00 p.m.) were travel times not statistically different in the post-deployment period compared to the pre-deployment period. This suggests that introducing HOT operations led to improvements in travel times in the Express Lanes during some portions of both the morning and evening peaks, compared to the pre-deployment condition.

An alternate source of data available in the post-deployment period was SRTA's automatic vehicle identification (AVI) system that reads the Peach Pass transponders of vehicles in both the Express Lanes and general purpose lanes. Figure 5-6 was provided by SRTA to show the travel time advantage of the Express Lanes in the a.m. for Tuesdays, the heaviest travel day of the week. The data suggested that the Express Lane travel time advantage is higher – 4 minutes versus 2 minutes – based on AVI data than on NaviGAtor data over approximately the same distance as the NaviGAtor data. Similar differences were observed for the p.m. and can be found in Appendix A – Congestion Analysis. One explanation for the differences in the travel times based on AVI and NaviGAtor was that there were fewer NaviGAtor detector stations on the Express Lanes than on the general purpose lanes and travel speeds from each station were extrapolated for longer segment distances, thereby affecting travel time estimates for the entire corridor. In addition the AVI readings covered 13.7 miles whereas the NaviGAtor data were for 11.5 miles. It should also be recognized that travel time derived from AVI data tend to be more accurate than data derived from video detection systems like those used by Navigator II. Consequently, Express Lane users may have enjoyed a greater savings in travel time than represented by the NaviGAtor data. Unfortunately, AVI data were not available for the pre-deployment period to allow a before/after comparison.



State Road and Tollway Authority.

Target Time = travel time necessary to meet Federal HOV requirement of 45 mph over the detector to detector distance of approximately 13.5 miles.

Figure 5-6. Tuesday A.M. Peak Period Average Travel Times on I-85 Express Lanes versus General Purpose Lanes

Table 5-3 shows that average travel speeds in the general purpose lanes declined slightly in the peak direction of travel in both the a.m. and p.m. peaks. Mean peak period travel speed in the general purpose lanes dropped by 2 mph in the a.m. peak and by 4 mph in the p.m. peak. Mean travel speeds in the Express Lanes in both the a.m. and p.m. peaks increased by approximately 1 mph resulting from the CRD improvements.

Table 5-3. Pre- and Post-Deployment Mean Travel Speed (in mph) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Peak Period (Direction of Flow)	Lane Type	Mean Travel Speed (mph)[1]			
		Pre-Deployment	Post-Deployment	Change	Percent Change
A.M. Peak (Southbound)	General Purpose	46.1	43.9	-2.2	-4.7%
(6 a.m. to 10 a.m.)	Express	50.1	51.5	1.4	2.7%
P.M. Peak (Northbound)	General Purpose	45.1	41.0	-4.1	-9.0%
(3:00 p.m. to 7 p.m.)	Express	50.3	51.6	1.3	2.6%

[1] Based on NaviGAtor II data only. These average travel speeds are for approximately 11.5 miles of I-85 covered by the NaviGAtor II system.

Source: Texas A&M Transportation Institute based on data provided by Georgia Department of Transportation.

Improved travel reliability was one of the objectives of the Express Lanes, and travel time variability is a measure of the level of consistency of travel conditions. The 95th percentile travel time is the time at which 95 percent of travelers were measured traveling at or below. It is a good measure of travel reliability and represents the travel time on some of the heaviest traffic days. Figure 5-7 presents the recorded 95th percentile travel time computed from the NaviGAtor data for both the general purpose lanes and the Express Lanes for the peak direction of travel for both the a.m. peak (6:00 to 10:00) and p.m. peak (3:00 to 7:00).

As shown in Figure 5-7 small changes occurred in the peak period 95th percentile travel times after tolling began. In the a.m. peak, the peak period 95th percentile changed little to none for the general purpose and Express Lanes. In the p.m. peak, the 95th percentile travel times in the general purpose lanes increased by less than 2 minutes in the post-deployment period, while the 95th percentile travel times in the Express Lanes actually declined by 3 minutes in the post-deployment period. Thus, after tolling began the Express Lanes offered greater reliability in the afternoon peak but not in the morning peak.

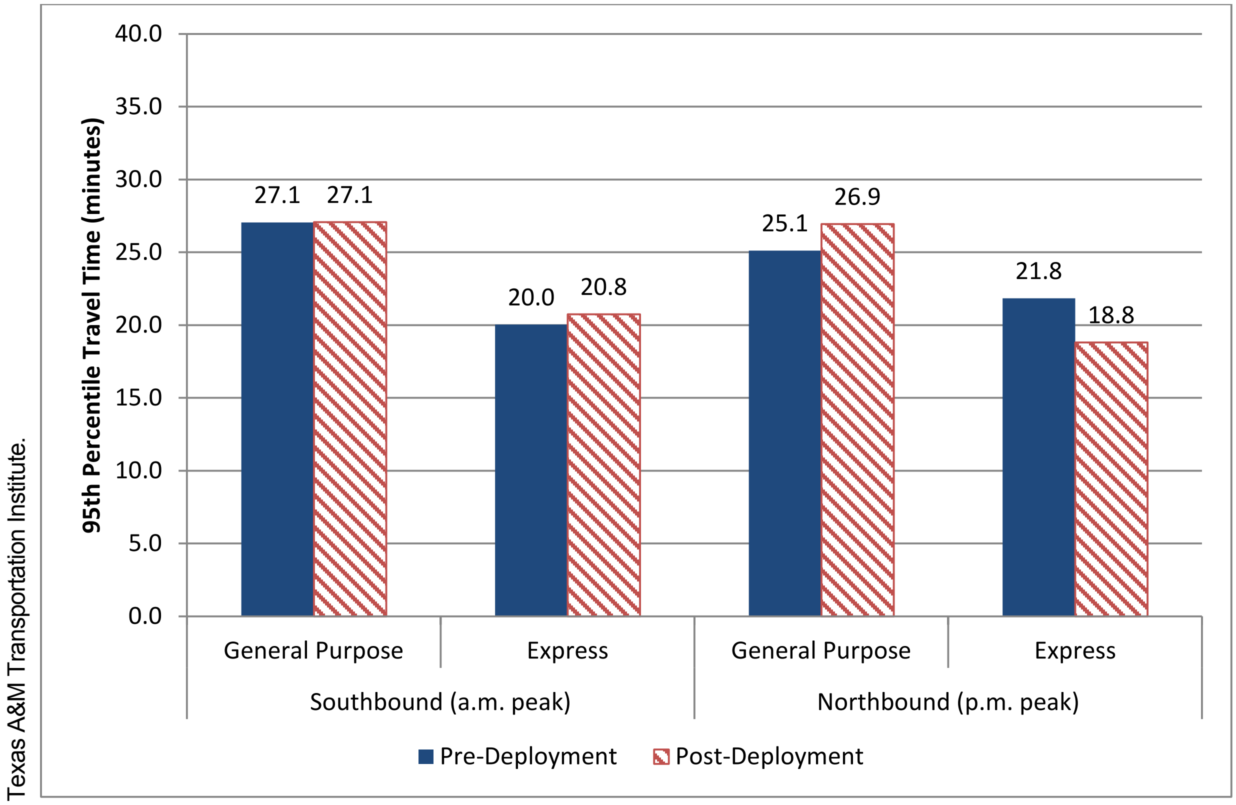


Figure 5-7. 95th Percentile Travel Times (in Minutes) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Table 5-4 shows the changes in person throughput in the corridor after implementing HOT operations in the Express Lanes as well the transit improvements in the corridor. In the a.m. peak, total person throughput declined by approximately 6 percent in the post-deployment period. In the p.m. peak the decline was about 8 percent. Given that person throughput in the general purpose lanes did not decline and transit ridership in the Express Lanes increased, the overall decline in person throughput in the both the a.m. and p.m. peak periods can be attributed to the major drop in average vehicle occupancy in the Express Lanes after tolling began.

Table 5-4. Pre-and Post-Deployment Total Daily Peak Period Person Throughput by Vehicle Occupant Class

Vehicle Occupant Class	Total Peak Period Person Throughput			
	Pre-Deployment	Post-Deployment	Change	Percent Change
A.M. Peak (6:00-10:00 a.m.) -- Southbound				
Single Occupant Vehicles	32,657	32,863	206	0.6%
2-person Vehicles	10,589	7,711	-2,878	-27.2%
3-person Vehicles	602	507	-95	-15.8%
4+ person Vehicles	547	546	-1	-0.2%
Transit	1,385	1,464	79	5.7%
Total	**45,780**	**43,091**	**-2,689**	**-5.9%**
P.M. Peak (3:00 - 7:00 p.m.) -- Northbound				
Single Occupant Vehicles	35,237	34,792	-445	-1.3%
2-person Vehicles	13,568	10,112	-3,456	-25.5%
3-person Vehicles	1,253	888	-365	-29.1%
4+ person Vehicles	938	965	27	2.9%
Transit	1,374	1,452	78	5.6%
Total	**52,370**	**48,209**	**-4,162**	**-7.9%**

Source: Texas A&M Transportation Institute.

Table 5-5 shows the change in VMT within the limits of the CRD corridor as a result of the CRD deployment. Overall, VMT in both the general purpose lanes and the Express Lanes declined in the post-deployment period in both the a.m. and p.m. peaks. In the a.m. peak, VMT declined by 8.6 percent, while in the p.m. peak VMT was reduced by 2.1 percent. The majority of the change in the a.m. peak was attributed to reductions in VMT in the general purpose lanes. In the p.m. peak period, the reduction in VMT was greater in the in the Express Lanes compared to the general purpose lanes. Given that there was a decline in VMT in all lanes, factors other than tolling in the Express Lanes may explain some of the drop.

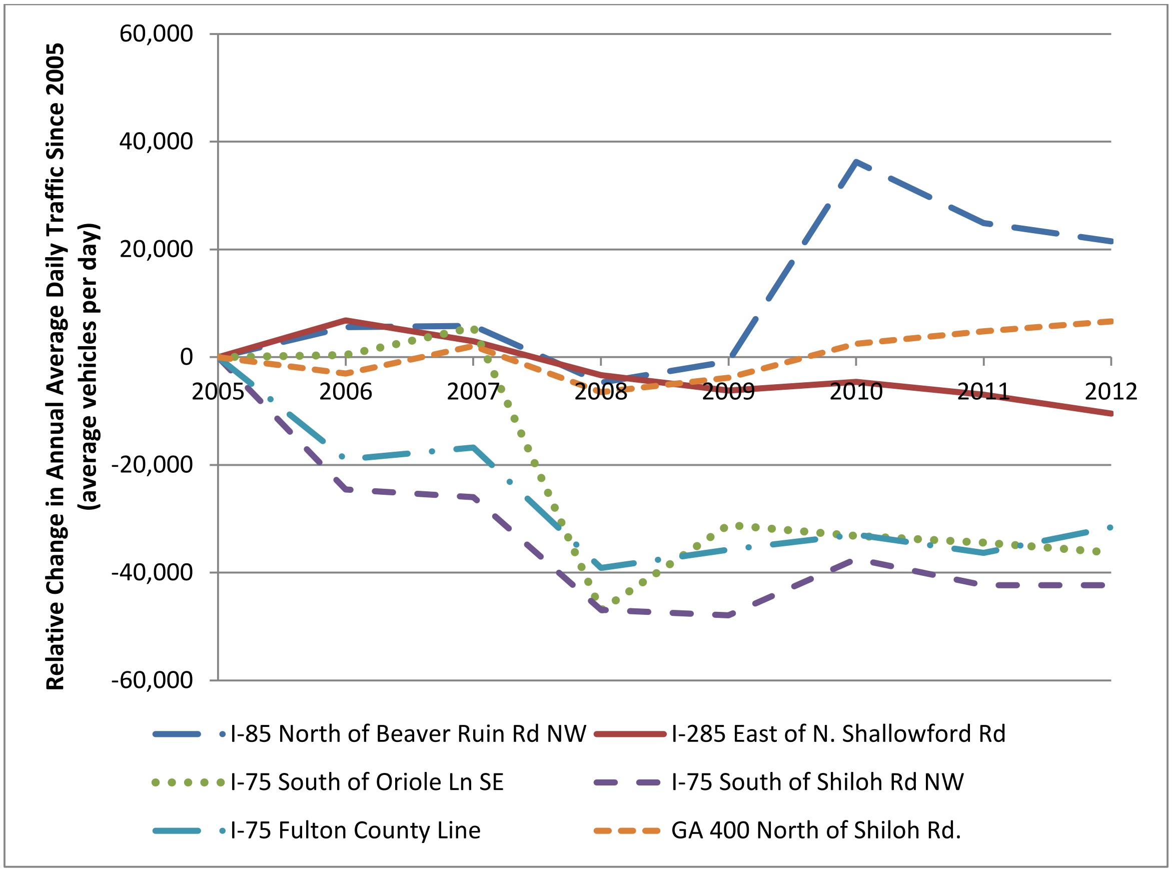
Table 5-5. Pre-and Post-Deployment of VMT in the General Purpose and Express Lanes within the CRD Corridor

Peak Period	Lane Type	Vehicle Miles Traveled in the CRD Corridor[1]			
		Pre-Deployment	Post-Deployment	Change	Percent Change
A.M. Peak (Southbound) (6 a.m. to 10 a.m.)	General Purpose	379,018.2	345,241.9	-33,776.3	-8.9%
	Express Lanes	46,225.6	43,470.4	-2,755.2	-6.0%
	Total	**425,243.8**	**388,712.3**	**-36,531.5**	**-8.6%**
P.M. Peak (Northbound) (3:00 p.m. to 7 p.m.)	General Purpose	415,061.8	410,430.5	-4,631.3	-1.1%
	Express Lanes	5,2434.1	47,377.5	-5,056.6	-9.6%
	Total	**467,495.9**	**457,808.0**	**-9,687.9**	**-2.1%**

[1] Based on NaviGAtor II data for approximately 11.5 miles of I-85 covered by the NaviGAtor II system

Source: Texas A&M Transportation Institute.

A comparison of annual average daily traffic (AADT) values was made for selected corridors in the region as shown in Figure 5-8. Average daily traffic on I-85 in the study corridor remained relatively constant between 2005 and 2009 before dramatically rising in 2010 and then declining slightly in 2011 and 2012. (Construction on I-85 was completed in 2009, and most likely accounts for the sharp upswing to 2010.) AADT values on I-75 steadily declined between 2005 and 2008, before stabilizing at around the 2008 values. In contrast, AADT volumes on I-285 and GA 400 remained relatively constant since 2005. It should be noted that AADT values in the study corridor dropped by 5 percent between 2010 and 2011 and by 1 percent between 2011 and 2012. This drop in AADT may have had an influence on the changes in vehicle throughputs and VMTs observed in the peak periods on I-85.



Texas A&M Transportation Institute.

Figure 5-8. Comparison Change in Annual Average Daily Traffic since 2005 on Control Corridors

Another source of data for measuring the impact of the CRD projects came from the Volpe household travel survey, with the methodology described in Appendix A – Congestion Analysis. Travelers who either drove or rode the bus were asked to use a seven-point scale to rate their level of satisfaction with different aspects of their trips, including travel speed, driving time, and predictability of their driving time. For those who drove, the analysis of trip satisfaction focused on travel during the morning peak period from 7:00 a.m. to 9:00 a.m., since pricing is supposed to provide the greatest benefits during the most congested time periods.[14] Comparison of pre-deployment (wave 1) with post-deployment (wave 2) satisfaction in Table 5-6 reveals a significant difference across waves for the Express Lanes on all three measures, with trips in wave 2 receiving more positive ratings. ("Positive" or "satisfactory" ratings are defined as those to the right of the "neutral" rating, considered together in the table below.) The percentage of trips rated as satisfactory for travel time increased from 32 percent in wave 1 to 43 percent in wave 2. For the travel speed measure the satisfactory ratings increased from 35 percent in wave 1 to 43 percent in wave 2. For trip-time predictability the satisfactory ratings increased from 30 percent to 36 percent. Overall, a larger percentage of users surveyed were dissatisfied than satisfied over all three measures in both waves 1 and 2. However, the variance between the percentage of users identifying as dissatisfied versus satisfied was smaller for wave 2, indicating improvement post-deployment.

Table 5-6. Satisfaction with A.M. Peak Hour HOV/Express Lane Trips (Wave 1: N=93 Trips; Wave 2, N=169 Trips)

	Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Very Satisfied	
Travel Time								
Wave 1	12%	18%	27%	11%	8%	21%	3%	Chi-sq=40.1
Wave 2	13%	15%	20%	9%	18%	19%	6%	sig <0.0001
Travel Speed								
Wave 1	12%	15%	29%	9%	11%	20%	4%	Chi-sq=34.2;
Wave 2	15%	16%	15%	10%	20%	18%	5%	sig <0.0001
Predictability								
Wave 1	14%	10%	20%	27%	6%	21%	3%	Chi-sq=23.1;
Wave 2	13%	9%	23%	19%	12%	18%	6%	sig 0.0008

Source: Volpe, used with permission.

[14] For purposes of the survey Volpe defined the morning peak period as 7:00 a.m. to 9:00 a.m., whereas the peak period for analysis of the NaviGAtor data was 6:00 to 10:00 a.m.

5.2.2 Transit

As illustrated by Figure 5-9 and Figure 5-10, the CRD-funded transit enhancements in the form of new Xpress buses, added routes, and new or expanded park-and-ride lots were meant to attract commuters to transit as an alternative to paying a toll in the Express Lane or traveling in the slower general purpose lanes. The evaluation found that many I-85 travelers took advantage of the transit alternative.

Georgia Regional Transportation Authority, used with permission.

Figure 5-9. Xpress Bus Serving I-85 CRD Corridor

Georgia Regional Transportation Authority, used with permission.

Figure 5-10. CRD-funded Park-and-Ride Lot at Hamilton Mill

The essential question about the impact of the CRD transit enhancements was whether transit ridership in the corridor increased. Table 5-7 shows that average daily ridership increased by 21 percent in the a.m. peak period and 17 percent in the p.m. peak period between the spring of 2010 and the spring of 2012. Spring was chosen for the analysis to control for potential seasonal variations in ridership. Since the first of three new routes began in the summer of 2010, spring of 2010 represented the period prior to any CRD transit enhancements. With tolling in the Express Lanes starting in October of 2011, the spring of 2012 represented the post-tolling level of transit usage.

Table 5-7. Average Daily Riders I-85 Xpress Bus in the CRD Corridor

Service	Apr-Jun 2010	Apr-Jun 2011	Apr-Jun 2012	% Change 10 to 12
A.M. Peak	1,210	1,366	1,459	21%
P.M. Peak	1,239	1,364	1,454	17%

Source: Center for Urban Transportation Research

The increase in ridership is noteworthy for the following reasons. First, much of the increase occurred several months prior to the start of tolling, when most of the transit enhancements were in place. A second consideration is that Xpress bus ridership in the region declined during the 2010 to 2012 period, likely reflecting the nationwide economic downturn. Additional analysis of the ridership data for I-85 buses, reported in Appendix C – Transit Analysis, revealed that the sustained ridership on I-85 was attributable to the three CRD-funded routes. Had it not been for these new routes, there would have been a decline in transit ridership. External factors unrelated to the CRD such as gasoline prices and unemployment may have also influenced ridership. During the three-year evaluation period, gasoline prices rose and unemployment fell (though it was still high). A statistical analysis revealed a moderate correlation between I-85 bus ridership and gasoline prices and a weak correlation with unemployment. The former was statistically significant at the 99 percent confidence level. The latter was not statistically significant. More detailed information can be found in Appendix C – Transit Analysis.

Surveys of Xpress bus riders conducted by GRTA provided additional perspective on the impact of the CRD on their use of transit. In May of 2012, seven months after the start of tolling, riders were asked about the influence of the conversion of the HOV lane to an HOT lane on their decision to ride the bus. Table 5-8 shows their responses. While only 13.5 percent of riders who had starting riding prior to tolling said they were influenced to take transit because of the conversion of the lane to tolling, 48.9 percent of riders who began transit after tolling said they were influenced.

Table 5-8. Did the HOV Conversion Influence Your Decision to Ride a Bus?

Type of Rider	Yes		No	
	Freq.	%	Freq.	%
All riders	162	19.6%	663	80.4%
Pre-toll riders	92	13.5%	590	86.5%
Post-toll riders	69	48.9%	72	51.1%

Results statistically significant at 95% confidence level based on Fisher's Exact test.

Source: May 2012 GRTA Xpress Survey (post-toll)

A promising indicator for Xpress buses to maintain and possibly grow ridership levels in the corridor was that riders were very enthusiastic about the Xpress bus service. As illustrated in Table 5-9, more than 90 percent of surveyed riders said they either liked or loved I-85 Xpress bus service.

Table 5-9. How Riders Describe I-85 Xpress Bus Service

Response	Freq.	%
I will never ride it again	0	0.0%
I don't like it	2	0.2%
It is OK	123	9.3%
I like it	585	44.2%
I love it	614	46.4%
Total	**1,324**	**100.0%**

Source: August 2011 GRTA Xpress Survey (pre-toll)

To understand the overall impact of increased transit ridership on travel in the corridor, person throughput was estimated. Table 5-10 shows transit and non-transit person throughput before and after tolling. Non-transit is comprised of non-tolled (e.g., HOV3+) and toll-paying vehicles. While transit's share of total person throughput was small (less than 4 percent), its share did increase slightly after tolling from 3.0 to 3.4 percent in the a.m. peak southbound and from 2.6 to 3.0 percent in the p.m. peak northbound. In that sense, the CRD transit enhancements contributed slightly to congestion mitigation in the corridor.

Table 5-10. Transit's Contribution to Person Throughput

Peak Period	Person Throughput (Non-Transit)		Person Throughput (Transit)		Total Person Throughput	
	Pre-Deployment					
Southbound (a.m. peak)	44,395	97.0%	1,385	3.0%	45,780	100.0%
Northbound (p.m. peak)	50,993	97.1%	1,374	2.6%	52,370	100.0%
	Post-Deployment					
Southbound (a.m. peak)	41,627	96.6%	1,464	3.4%	43,091	100.0%
Northbound (p.m. peak)	46,758	97.0%	1,451	3.0%	48,209	100.0%

Source: Texas A&M Transportation Institute

To evaluate the impact of the additional spaces at park-and-ride lots made possible by the CRD, surveys of space utilization were conducted four times during the evaluation period by GRTA's contracted operators in the I-85 corridor. In addition to the four CRD-funded lots, other lots not receiving CRD funds but used by Xpress buses in the corridor were surveyed. The results are shown in Table 5-11. Of note is that utilization increased at the lots served by the three new CRD-funded routes, while utilization decreased at the lots served by the non-CRD-funded routes. The only exception was the Indian Trail Park and Ride lot.

Table 5-11. Park-and-Ride Lot Utilization in the I-85 Corridor

Lot	CRD-funded Lot	Served by CRD-funded Route	Oct 2010	Apr 2011	Oct 2011	Apr 2012
Mall of Georgia (Opened Aug-10)	Yes	Yes	n/a[1]	112	280	312
Hebron Baptist Church (Opened Jun-11)[2]	Yes	Yes				215
I-985/GA 20 (Expanded Jul-11)	Yes	No	302	292	219	269
Hamilton Mill (Opened Jul-11)[2]	Yes	Yes			286	316
Discover Mills GCT (Expanded 2010)	No	No	469	278	609	269
Discover Mills GRTA	No	No	257	493	347	458
Indian Trail	No	No	194	196	268	215

[1] The October 2010 park-and-ride lot count data for the Mall of Georgia lot were lost in the mail, and there were no additional copies of the data.

[2] Data collection began after the park-and-ride lot opened.

Source: Center for Urban Transportation Research

The CRD-funded lots and the routes serving them included the following:

- Mall of Georgia lot was served by the Route 411, which had seen ridership grow steadily since it began in August 2010. Lot usage increased 178.6 percent from April 2011 to April 2012.
- Hebron Baptist Church lot was served by the Route 416, which had seen steady growth since service began in July 2011. From the one count performed for this lot in April 2012, roughly half of the 400 leased spaces were occupied.
- The expanded I-985 lot was served by the Route 101, a non-CRD-funded route on which ridership declined steadily since April 2011. Occupied spaces at the lot dropped by 7.9 percent between April 2011 and April 2012.
- Hamilton Mill lot was served by the Route 413, a CRD-funded route that had seen ridership grow steadily since it started in August 2011. Lot utilization increased 10.5 percent in 6 months from October 2011 to April 2012.

Since the Xpress buses were able to use the Express Lanes, the evaluation sought to determine whether there was an improvement in the performance of the buses in terms of travel time after tolling. Table 5-12 and Table 5-13 show bus travel times for the I-85 CRD corridor portion of each route. For all routes combined, travel times improved by 2.4 percent in the a.m. peak period and 5.0 percent in the p.m. peak period.

Table 5-12. Xpress Bus Travel Times A.M. Peak Period

Route	Apr-Jun 2011	Apr-Jun 2012	% Change	p Value
101	00:47:09	00:42:21	-10.2%	0.000*
102	00:23:52	00:24:08	1.1%	0.748
103	00:36:27	00:37:39	3.3%	0.091
410	00:35:05	00:35:17	0.6%	0.829
411	00:46:48	00:41:50	-10.6%	0.000*
412	00:40:01	00:40:28	1.2%	0.620
413[1]		00:43:58	n/a	
416[1]		0:44:30	n/a	
Overall Percent Change			**-2.4%**	

* Statistically significant at the 95 percent confidence level.

[1] Route began operations after the 2011 data collection period, and only data for 2012 are available.

Source: Center for Urban Transportation Research

Table 5-13. Xpress Bus Travel Times P.M. Peak Period

Route	Apr-Jun 2011	Apr-Jun 2012	% Change	p Value
101	00:51:33	00:48:00	-6.9%	0.001*
102	00:31:36	00:30:15	-4.3%	0.217
103	00:46:05	00:41:51	-9.2%	0.000*
410	00:44:07	00:38:36	-12.5%	0.000*
411	00:44:22	00:46:02	3.8%	0.285
412	00:42:29	00:42:05	-0.9%	0.782
413		00:54:41	n/a	
416		00:57:22	n/a	
Overall Percent Change			**-5.0%**	

* Statistically significant at the 95 percent confidence level.

Source: Center for Urban Transportation Research

For individual routes the results showed that in five of the seven instances where there was a decrease in travel time, the change was statistically significant. In all five instances where there was an increase in travel time, the change was minimal (less than 2 minutes) and not statistically significant. Of particular note are Route 101 and Route 411. Unlike some of the other Xpress routes, these two routes traveled the full 16 mile length of the I-85 Express Lanes. Upon further analysis, discussed in Appendix C – Transit Analysis, the downward trend during the a.m. period began well before the start of tolling. Therefore, the tolls cannot be considered the primary cause of the reduction. It is possible that the economic recession contributed to fewer vehicles on the road, which in turn would have led to shorter travel times prior to tolling.

In the pre-tolling on-board survey, riders were asked to rate their level of satisfaction with 13 aspects of the bus service as well as their overall level of satisfaction. The ratings were scaled from 1 to 5 with 1 being poor and 5 being excellent. The mean scores are shown in Table 5-14. Overall satisfaction was rated 4.1 (very good). Eight of the 13 service aspects were rated over 4.0 as well, including travel time and buses arriving on time.

Table 5-14. Service Aspect Ratings

Service Aspect	Freq.	Mean*	Std. Dev.
Travel Time	978	4.3	0.8
Buses Arriving on Time	1,325	4.3	0.8
Driver Courtesy	1,323	4.3	0.8
Cost of Service	1,313	3.2	1.1
Directness of the Route	1,321	4.3	0.8
Availability of Schedule Info	1,327	3.9	1.0
Comfort	1,330	4.1	0.8
Ride Quality	1,329	4.2	0.8
Safe Operation	1,329	4.3	0.7
Safety and Security at Park and Ride Lots	1,327	3.9	1.0
Cleanliness	1,328	4.3	0.8
XpressGA.com website	1,218	3.7	0.9
Customer Service	1,288	3.7	1.0
Overall Satisfaction	**1,320**	**4.1**	**0.7**

*Scale: 1 = Poor ; 2 = Fair; 3 = Good; 4 = Very Good; 5 = Excellent

Source: August 2011 GRTA Xpress Survey (pre-toll)

Curiously, when surveyed in 2012 after tolling, nearly half the riders (49.1 percent) thought their travel was slower than before. This was despite the fact that travel times had actually improved on most routes or not changed. The Volpe household travel survey echoed these findings, with the large majority of those taking transit trips expressing satisfaction, but a few registering a perception of an increase in travel time for transit trips. The share of trips with travel time rated as satisfactory slipped from 84 percent before tolling to 81 percent after tolling, accompanied by a 7 percent increase in the share of trips rated as unsatisfactory on travel time. Riders' perceptions may have been affected by a general mood of dissatisfaction with the Express Lanes that persisted six months after tolling started.

One final observation to be made is that there was a missed opportunity to draw more attention to the transit investments that were made in the I-85 corridor and the benefits of transit as an untolled alternative in the Express Lanes. The national evaluation team found little mention of the transit investments. Instead, as noted in Appendix K – Non-technical Success Factors, the focus of the communications and outreach was on tolling, and there was little mention of transit by the news media. It is possible that the increase in ridership would have been greater had more people known about the new express bus service.

5.2.3 TDM

Objectives of the TDM component of the CRD were to increase the number of HOV3+ carpools in the CRD corridor and to minimize the impact of the CRD on existing carpools. After conversion of the HOV lane to an HOT lane, carpools of three or more would continue to ride for free, whereas 2-person carpools would not.

The CAC was responsible for conducting the outreach about carpooling for the CRD. Through its ongoing employer and employee outreach, CAC encouraged formation of new 3-person carpools from drivers who rode by themselves. A special I-85 brochure was distributed at meetings with employer representatives and at CAC functions. A total of 600 brochures were distributed during the pre- and post-deployment evaluation period. Overall, however, TDM outreach, and information on alternative mode options in general, were not widely implemented as the focus of project information was on obtaining and using a transponder and not on carpooling options to use the lane for free.

Under a special contract to SRTA and GDOT, the CAC used its database of carpoolers to conduct targeted outreach to I-85 commuters to encourage 2-person carpools to add another member. Out of 3,205 carpoolers who had previously registered with CAC, CAC was able to make direct contact with 1,261 to inform them about the Express Lanes' requirements for HOV3+ carpools and to provide information on carpool incentives including Carpool Rewards (CR), Cash for Commuters (CFC), and Commuter Prize (CP). In follow-up contacts, 700 respondents said they had not formed a 3-person carpool, whereas 18 said they had added a third carpooler to be able to use the Express Lanes for free.

Comparison of pre- and post-deployment use of each of the carpool incentives was conducted, and details are presented in Appendix D – TDM Analysis. The impact of these incentives in the I-85 corridor was calculated to be 7.3 million miles of travel reduced, 750,000 of which is attributable to mode shift during the post-deployment period. However, interpretation of the results was confounded by changes made to the pre-deployment and post-deployment numbers available to the national evaluation. A normal updating of the CAC database occurred in April 2012, at which time the number of program registrants rose from the baseline number of 3,086 for October 2010 to 4,149 in March 2012. Some of the changes in the use of carpool incentives appear to be more attributable to the database update than to effect of the special CRD outreach.

A more definitive determination of the effect of the CRD on carpooling was obtained from data sources other than the CAC outreach. These included field observation of vehicle occupancy, data from the SRTA carpooler survey, and data from the Volpe household travel survey.

The before and after vehicle occupancy study (a field observation study conducted by Georgia Tech), as described in Appendix A – Congestion Analysis, identified the number of persons in the vehicles traveling on I-85 in the year before and year after tolling began. Table 5-15 shows the percent of vehicles carrying 1, 2, 3, or 4 or more people before and after tolling in the HOV/Express Lanes and the general purpose lanes during a 2-hour morning peak and 2-hour afternoon peak period used in the Georgia Tech study. Table 5-16 translates those percentages into an estimate of the number of vehicles in each occupancy category for the 4-hour peak period. After tolling, the data in these tables showed not only a dramatic shift by 2-person carpools from the Express Lanes to the general purpose lanes, but also a net decline in 2-person carpools. More surprising were the same shift and net decline in carpools of three or more people, considering that they still could have traveled for free in the Express Lanes. The average vehicle occupancy in the Express Lanes (excluding transit vehicles) decreased from an average of 1.99 occupants per vehicle to 1.22 occupants per vehicle.

Table 5-15. Percent of Vehicles by Occupancy Level (Excluding Transit), Before and After Opening of I-85 Express Lanes

Lane Type	Time Period	Percent of Vehicles by Occupancy			
		1	2	3	4+
Southbound Morning Peak Period (7:00 – 9:00 a.m.)					
HOV/Express Lanes	Before	7.4	87.1	3.1	2.4
	After	85.3	12.1	0.9	1.7
General Purpose	Before	95.1	4.6	0.2	0.1
	After	89.2	10.2	0.4	0.2
Northbound Afternoon Peak Period (4:30 – 6:30 p.m.)					
HOV/Express Lanes	Before	8.0	83.7	5.2	3.1
	After	83.4	13.5	1.0	2.2
General Purpose	Before	92.7	6.6	0.4	0.2
	After	86.5	12.4	0.7	0.4

Source: Texas A&M Transportation Institute based on GDOT data.

Table 5-16. Number of Vehicles by Occupancy Level (Excluding Transit), Before and After Opening of I-85 Express Lanes

Lane Type	Time Period	Estimated Vehicle Throughput by Occupancy				
		1	2	3	4+	Total
Southbound Morning Peak Period (6:00– 10:00 a.m.)						
HOV/Express Lane	Before	317	3,730	133	103	4,283
	After	3,555	504	38	71	4,168
General Purpose	Before	32,341	1,564	68	34	34,007
	After	29,308	3,351	131	66	32,856
Total	Before	32,658	5,294	201	137	38,290
	After	32,863	3,855	169	137	37,024
Northbound Afternoon Peak Period (3:00 – 7:00 p.m.)						
HOV/Express Lane	Before	412	4307	268	160	5,146
	After	3,698	598	43	97	4,436
General Purpose	Before	34,825	2,477	150	75	37,597
	After	31,093	4,457	252	144	35,946
Total	Before	35,237	6,784	418	235	42,673
	After	34,792	5,056	296	241	40,386

Source: Texas A&M Transportation Institute

A cross-sectional survey of carpoolers registered with CAC that was conducted by SRTA tended to confirm the changes in carpool behavior observed in the occupancy data. No information existed on how representative the CAC-registered carpoolers are of carpoolers in the I-85 corridor. Nevertheless, the survey was the best available for comparison of pre- and post-tolling carpooling. Table 5-17 shows what carpoolers said they would do when surveyed before tolling and what they said they actually had done when surveyed after tolling. A large proportion (25 percent) switched to driving alone. Some 2-person carpools (10 percent) stayed in the Express Lanes and paid the tolls, but this was four and a half times as large as planned. Fewer 3+ carpools stayed in the Express Lanes than planned (13 percent vs. 21 percent), and an approximately equal proportion of 2-person carpools added a third person to use the Express Lane for free than planned (7 percent vs. 8 percent). These behavior changes, among carpoolers registered with CAC, provide more evidence that most 2-person carpools were displaced from the HOV lanes upon conversion to Express Lanes, although many shared-ride arrangements survived by shifting to the GP lanes (after which they could continue to use the existing HOV2+ lane at the southern terminus of the Express Lanes).

Table 5-17. Planned and Actual Carpooler Response to Tolling

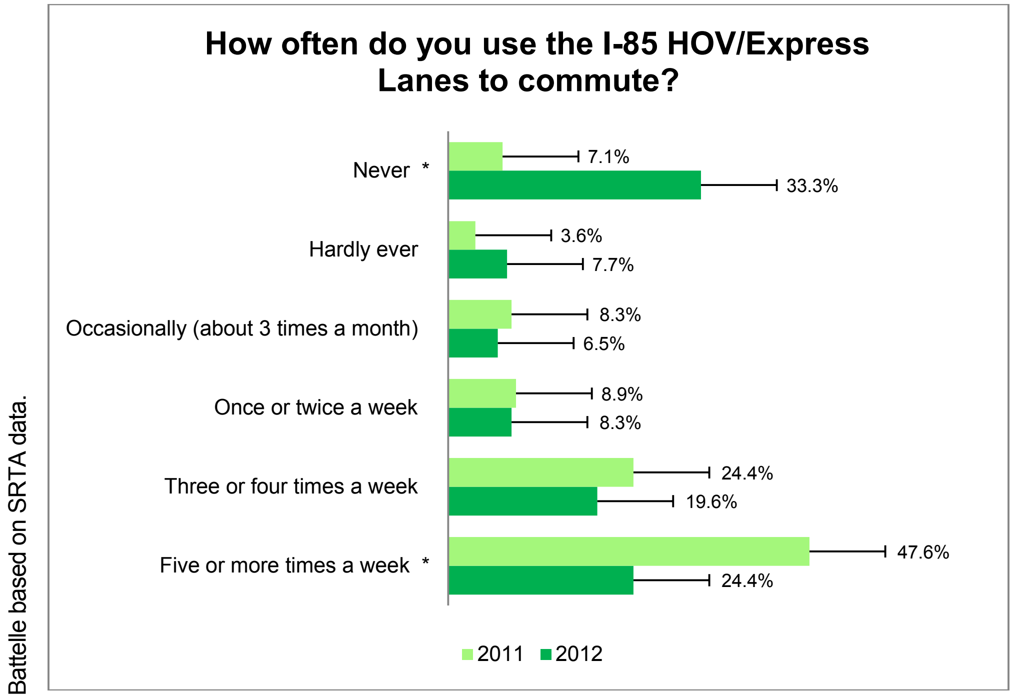
Planned and Actual Carpooler Response to Tolling	Before Tolling (planned %) N=381	After Tolling (actual %) N=408
Continue as 2-person carpool in the Express Lanes	2	10
Shift as 2-person carpool in the general purpose lanes	45	41
Continue as 3+ carpool in the Express Lanes	21	13
Add a third person to use Express Lanes for free	8	7
Switch to transit	6	4
Telecommute	<1	<1
Switch to driving alone	17	25
Total*	99	100

* Total does not sum to 100 due to rounding

The chi-square test of the distribution of data was significant and had a p value of <0.0001.

Source: Battelle based on SRTA data

Figure 5-11 further illustrates the decline in frequency of use of the Express Lanes by survey respondents who continued to carpool after tolling. The biggest changes were among those who never used the Express Lanes and those who used it the most frequently, i.e., 5 or more times per week. In 2012 after tolling, there were more carpoolers who never used the I-85 Express lanes to commute compared to the HOV lanes in 2011. In 2011, nearly half of carpoolers (47.6 percent) used the I-85 HOV lanes at least five times per week, compared to less than a quarter of carpoolers (24.4 percent) on the Express Lanes in 2012.



* Fisher's Exact test was significant at the 0.05 level.

Figure 5-11. Frequency of Use of I-85 HOV/Express Lanes by Carpoolers in Both Pre- and Post-Deployment Surveys

The Volpe household travel survey provides a slightly different picture based on their analysis of trip diaries of a panel of households before and after tolling. As evidenced by average vehicle occupancy (AVO), the survey confirmed the drop in carpooling in the Express Lanes (AVO 2.22 before and 1.18 after tolling) and an increase in carpooling in the general purpose lanes (AVO 1.07 before and 1.18 after tolling). However, the survey indicated that the relative proportion of carpooling increased after tolling. As shown in Table 5-18, among the trips taken on I-85 at all times of day the number of trips overall declined after tolling, but those in carpools increased from 9 to 13 percent while drive-alone trips declined from 88 to 83 percent. Further analysis indicates that a substantial part of the increase in carpooling is by members of the same household. It should be noted that the two data sources, vehicle occupancy observations reported in Table 5-12 and Table 5-13 and the mode shares reported in Table 5-15 are derived from different populations of travelers. The occupancy counts focused on peak period travelers (largely commuters) while the Volpe survey focused on households who reported travel for all trip purposes and all times of day.

Table 5-18. Modes and Number of Trips on I-85 Trips Before and After Tolling

	Wave 1 (Before Tolling)	Wave 2 (After Tolling)
Drive alone*	88%	83%
Carpool (2+ persons)*	9%	13%
Any transit (bus or rail)	3%	4%
All other modes	0%	1%
Number of Trips	6334 trips	5530 trips

*Statistically significant (Chi-square test $p<0.0001$)

Source: Battelle from Volpe data

5.2.4 Technology

Evaluation of CRD-funded technological enhancements focused on innovative approaches to enforcement of the Express Lanes. The gantry-controlled access system enables automatic identification of vehicles that are first detected at points that are not near the legal ingress/egress points. SRTA sent violators notices through the mail.

In addition, vehicles of DPS personnel were equipped with mobile ALPR camera systems as shown in Figure 5-12. The ALPR communicates with a database to identify HOV3+ registered vehicles so that the DPS officer could visually verify that a vehicle had the appropriate number of occupants for use of the Express Lane in non-tolled status. DPS issued citations to occupancy violators. They also issued citations for double white line violations they observed.

State Road and Tollway

Figure 5-12. Department of Public Safety Automatic License Plate Readers

SRTA issued a total of 49,229 violation notices based on the gantry-controlled access system from February 2012 through September 2012. Additionally, SRTA issued 1,207 warning letters during the first three months of operation (November 2011 through January 2012), a grace period prior to beginning the full violation notification process. Analysis of the data was complicated by the fact that the violations do not differentiate between I-85 Express Lanes and the Georgia 400 Toll Road, which was also managed by SRTA. In addition, a temporary hold was twice placed on issuing notices, and when the hold was lifted the backlog resulted in spikes in notices issued in May and August. Thus, while the gantry-controlled access system enabled violators to be identified, the evaluation could not ascertain a trend in notices to determine if the violation rate on the Express Lanes changed over the post-deployment period.

With respect to the ALPR use by DPS enforcement personnel, Table 5-19 shows the distribution of citations issued by DPS each month in the post-deployment period. The values in the table represent the number of citations issued during spot enforcement activities and do not represent the total number of violations that occurred in the corridor. Also, a single vehicle may be issued two or more citations for a single stop.

Table 5-19. Number of Spot Enforcement Citations Issued by the Department of Public Safety in the Post Deployment Period

	Type of Citation						Total
	Occupancy		Double White Lines		Other		
	Number	Percent	Number	Percent	Number	Percent	
December 2011	24	16%	7	5%	117	79%	148
January 2012	25	17%	8	5%	118	78%	151
February 2012	39	12%	19	6%	276	83%	334
March 2012	80	23%	27	8%	244	70%	351
April 2012	36	15%	2	1%	207	84%	245
May 2012	21	9%	24	10%	187	81%	232
June 2012	63	21%	13	4%	229	75%	305
July 2012	65	17%	83	24%	204	58%	352
August 2012	79	31%	21	8%	158	61%	258
September 2012	42	23%	6	3%	134	74%	182

Source: State Road and Tollway Authority.

The vast majority of the total 2,558 citations were for citations other than those associated with operations of the Express Lane (such as insurance violations, driver license violations, license plate violations, etc.) These citations showed an overall level of enforcement in the corridor which was intended to change driver behavior in accordance with the rules of the roadway. Misrepresenting the number of occupants in the vehicle (i.e., occupancy violations) was the second highest reported type of citation issued by DPS – a total of 474 citations reported in a 10-month period. Although not assisted by the ALPR technology, a total of 210 citations were issued for unlawfully entering the Express Lanes by crossing over the double solid line. Disregarding the “other” types of citations, DPS reported an average of 47 citations per month for failing to correctly self-report the number of occupants in the vehicle and 21 citations per month for unlawfully entering the Express Lane by crossing the double white lines.

While the number of occupancy requirement and double white line citations issued each month varied from month to month, the percentage of citations by type remained relatively constant. In the post-deployment period, occupancy violations comprised about 19 percent of the total number of citations issued by DPS while unauthorized entry into the Express Lanes represented about 8 percent of the total citations issued by DPS. Unfortunately, citation data for the pre-deployment time period (November 2010 through October 2011) were not available to the evaluation team.

An important source of evaluation data came from interviews performed by the national evaluation team with SRTA administrative and enforcement personnel. The following points about the technology were made in the interviews:

- With regard to the gantry-controlled access system, the operators expressed satisfaction with the performance of the system for discouraging potential violators. One of the advantages cited was the flexibility for fine-tuning how violation zones were established. Operators could define the number of gantry points that users can bypass before being classified as being in violation, which enabled operators to optimize performance of the system.
- System reliability had not been an issue. Technologies seemed to be working well and functioning as designed, and no significant maintenance issues were reported.
- Daily reliability testing of the technologies was conducted to ensure that the system continued to function at optimal performance.
- Daily checks of real-time transaction data from each transponder station were performed to ensure that the system was functioning properly. Most inaccuracies had been attributed to the placement of the transponder tags inside vehicles or inaccurate account information.

Interviewees offered a number of “lessons learned” to date about operation of the tolling system with respect to violations:

- The media could be a valuable resource in terms of disseminating operational changes to the public. SRTA found that when the media were involved in announced changes in operations or tolling policies, violation rates dropped after the change.
- It was important to treat violators as potential customers. SRTA found that many violators were unclear or misinformed about the way the tolling operations in the Express Lane worked. SRTA encouraged their customer service representatives to work frequently with violators to help them establish new accounts or clarify rules so as to turn them into customers of the system.
- It was also critical that agencies establish a policy for what to do when the system was not functioning correctly. SRTA’s policy was to have “zero fares/zero violations” when outages occurred in the tolling system or communications network.
- Similarly, coordination between emergency response personnel and tolling operations staff was critical during incident events. Tolling agencies needed to know when incident responders were forcing traffic into or out of the Express Lane so that Express Lane users were not issued citations when they were directed to leave or enter the Express Lane.

5.3 Assessment of Four U.S. DOT Objective Questions

The four U.S. DOT objective questions and the associated 12 analysis areas used in the Atlanta CRD evaluation were presented and discussed in Chapter 4 of this report. Appendices A though L present detailed information on the 12 analyses. This section summarizes the impacts by the hypotheses/questions for each of the 12 analysis areas.

5.3.1 Summary of Congestion Impacts

Table 5-20 highlights the impacts of the Atlanta CRD projects on congestion. For the general purpose lanes, mean peak period travel times remained the same or increased in the post-deployment period in both the a.m. and p.m. peaks, while for the Express Lanes, mean peak period travel times were slightly lower in the post-deployment period in both the a.m. and p.m. peak. The relative travel time advantage of using the Express Lanes increased in the post-deployment period (up to 2.1 minutes in the a.m. peak and up to 3.2 minutes in the p.m. peak). Similar observations were made for mean travel speeds. Mean speeds in general purpose lanes were lower during each peak; however, mean speeds in the Express Lanes increased slightly, generally less than 2 mph in both peaks. The CRD improvements did not appear to have an impact on the travel time variability in general purpose lanes in either peak period, and in the Express Lanes travel time variability improved only in the p.m. peak. Total peak period vehicle throughput in the general purpose lanes and the Express Lanes was generally lower in both the a.m. and p.m. peaks in the post-deployment period.

The CRD improvements had an impact on the occupant levels of vehicles in the Express Lanes: the average number of occupants per vehicle in the Express Lanes declined from approximately two occupants per vehicle to approximately 1.25 in the post-deployment period, while this value increased from 1.06 to 1.11 in the a.m. peak and from around 1.10 to 1.15 in the p.m. peak in the general purpose lanes. This increase could be attributed to the increase in 2-person carpools shifting from the Express Lanes to the general purpose lanes. Including the effects of the transit improvements, total peak period person throughput was still impacted: declining 6 percent in the a.m. peak and 9 percent in the p.m. peak in the post-deployment period. VMT in both the general purpose lanes and in the Express Lanes decreased in both the a.m. and p.m. peak periods in the post-deployment period.

The results from the Volpe household travel survey and the focus groups of Highway Emergency Response Operators (HEROs), GRTA and Gwinnett operators, and representatives from businesses in the corridor indicated a perception that congestion levels on I-85 have not improved with the implementation of the Express Lanes and other CRD projects. The percentage of trips rated as satisfactory for travel time increased from 32 percent in the pre-deployment period to 43 percent in post-deployment period. For the travel speed measure the satisfactory ratings increased from 35 percent in pre-deployment period to 43 percent in in post-deployment period. For trip-time predictability the satisfactory ratings increased from 30 percent to 36 percent. However, a greater percentage in the post-deployment period was dissatisfied than satisfied on all three measures (travel time, travel speed and reliability). Respondents reported increased satisfaction with travel in the Express Lanes, however. Participants in the focus groups suggested that the Express Lanes were less congested, but they perceived the general purpose lanes to be more congested in the post-deployment period. Additional details on the congestion analysis can be found in Appendix A.

Table 5-20. Summary of Congestion Impacts Across CRD Hypotheses

Hypotheses	Result	Evidence
• Converting the I-85 HOV lanes to HOT operations will improve travel time and average travel speeds on both the general purpose and high occupancy lanes on I-85.	Partially Supported	For the general purpose lanes, mean peak period travel times remained the same or increased in the post-deployment period in both the a.m. and p.m. peaks. For the Express Lanes, mean peak period travel times were slightly lower in the post-deployment period in both the a.m. and p.m. peak. Mean speeds in general purpose lanes were lower during each peak. Mean travel speeds in the Express Lanes increased in the post-deployment period; however, these increases were minimal, generally less than 2 mph in both peaks. Post-deployment data from the tolling system show larger travel timings savings between the Express Lanes and the general purpose lanes than travel times derived from Navigator II data.
• Converting the I-85 HOV lanes to HOT operations will improve travel-time reliability and reduce variability on both the general purpose and high occupancy lanes on I-85.	Partially Supported	The CRD improvements did not appear to have an impact on the travel-time variability in general purpose lanes in either the a.m. or p.m. peak periods. Travel-time variability in the Express Lanes seemed to be improved for only the p.m. peak.
• Deploying the CRD improvements will result in more vehicles and persons being served on I-85.	Not Supported	Total peak period vehicle throughput in the general purpose lanes and the Express Lanes was generally lower in both the a.m. and p.m. peaks in the post-deployment period. The average number of occupants per vehicle in the Express Lanes declined from approximately two occupants per vehicle to approximately 1.25 in the post-deployment period. The average number of occupants per vehicle in the general purpose lanes increased from 1.06 to 1.11 in the a.m. peak and from 1.10 to 1.15 in the p.m. peak. Even after the effects of the transit improvements were included, total peak period person throughput was still impacted, with a 6 percent decline in the a.m. and 8 percent decline in the p.m. It is expected that over the long-term, person throughput in the corridor will increase as users become more familiar with how the Express Lanes work, new carpools are formed, and changes in traveler behavior become solidified.
• Implementing the CRD improvements in the I-85 corridor will reduce the spatial and temporal extent of congestion.	NA	Issues associated with available sensor data prevented an analysis the spatial and temporal distribution of congestion within the corridor. Travel-time variability in the Express Lanes seemed to improve for only the p.m. peak.

Table 5-20. Summary of Congestion Impacts Across CRD Hypotheses (Continued)

Hypotheses	Result	Evidence
• As a result of the CRD improvements, the perception of travelers is that congestion has been reduced in the I-85 corridor.	Somewhat Supported– Mixed Results	The results from the household travel survey and the focus groups of HEROs, bus operators, and business representatives indicated a general perception that congestion had not been reduced in the I-85 corridor. Traffic congestion in the general purpose lanes had gotten worse, while congestion levels in the Express Lanes had improved slightly. Users of the Express Lanes were more positive in their assessment than users in general.

Source: Texas A&M Transportation Institute.

5.3.2 Summary of Tolling Impacts

Table 5-21 shows the hypotheses and questions regarding the tolling aspects of the Atlanta CRD and conversion of HOV lanes on I-85 to the Express Lanes. Evidence is drawn not only from the tolling analysis, but also from the Appendix A and Appendix D reporting the congestion and TDM analysis respectively. Overall, the findings indicated that the hypotheses were somewhat supported, but that the impacts of the first year of Express Lanes operations were mixed. The exact changes varied slightly depending on the data sources used. Few HOV2 vehicles added a third person to allow them to use the Express Lanes toll-free. Based on the data from the occupancy study, average vehicle occupancy in the Express Lanes declined between the pre- and post-deployment periods. The TDM analysis in Section 5.2.3 showed that the number of weekday HOV2 trips during the morning and afternoon peak periods (6:00 a.m. to 10:00 a.m. and 3:00 p.m. to 7:00 p.m.) in the peak direction of travel declined from 8,037 in the pre-deployment period to 1,102 toll paying HOV2s in the post-deployment period. HOV3+ vehicles dropped from 664 in the pre-deployment period to 249 in the Express Lanes in the post-deployment period for the combined morning and afternoon peak periods in the peak direction of travel. Based on the toll-transaction data, the usage of the Express Lanes by HOV3+ vehicles (peak and non-peak) remained fairly constant throughout the post-deployment period. A total of 69,143 new accounts and 197,044 Peach Passes were issued from June 2011 to September 2012. Monthly trips in the Express Lanes continued to increase over the first year of operation. The highest number of trips was recorded in August, with 429,964 trips. The flow rate and toll rate analysis indicated that the relationship between the two was fairly close in the morning peak period, but slightly less in the afternoon when congestion levels were lower. Additional details on the tolling analysis can be found in Appendix B.

Table 5-21. Summary of Tolling Impacts Across CRD Hypothesis and Questions

Hypotheses/ Questions	Result	Evidence
• Tolling will increase vehicular throughput on the I-85 Express Lanes and improve travel reliability.	Throughput not supported. Reliability somewhat supported	• The Congestion Analysis in Appendix A indicated that vehicular throughput on the Express Lanes decreased slightly – 2.7 percent – in both the morning and afternoon peak periods. • Travel-time reliability, measured by buffer time and 95th percentile travel time, either remained the same or slightly worsened during the a.m. peak period, but improved during the p.m. peak period.
• What changes in usage will occur as a result of the conversion of the HOV2+ lanes to HOT3+ lanes?	HOV2 users are primarily paying tolls or moving to general purpose lanes. HOV3+ usage dropped from their pre-deployment levels during the peak periods, but total HOV3+ usage in the post-deployment period remained fairly constant.	• Average vehicle occupancy in the Express Lanes (excluding transit vehicles) decreased from an average of 1.99 occupants per vehicle to 1.22 occupants per vehicle. • Two-person carpools using the Express Lanes dropped from 8,037 in the pre-deployment period to 1,102 after tolling in the combined peak a.m. and p.m. periods in the peak direction of travel. • The percent of vehicles in the general purpose lane that were two-person carpools increased from 4.6 percent southbound and 6.6 percent northbound to 10.2 percent and 12.4 percent, respectively. • Monthly HOV3+ use of the Express Lanes (peak and non-peak) remained about 29,300 vehicles in the post-deployment period. • According to the SRTA-sponsored survey of registered carpoolers, 6.0 percent added a third person to their carpool, 2.2 percent joined a vanpool, and 4.0 percent switched to transit. However, 29.4 percent of the same sample switched from carpooling to driving alone.
• How much will travelers utilize the I-85 Express Lanes system?	The number of transponders, revenue, and transactions grew substantially during the one-year post-deployment period.	• A total of 69,143 new accounts and 197,044 Peach Passes were issued from June 2011 to September 2012. • Monthly Express Lanes trips continued to increase with a high of 429,964 trips in August of 2012.
• Variable pricing on the I-85 Express Lanes will regulate vehicular access so as to improve the operation of the lanes.	Somewhat Supported	• The relationship between toll rates and flow rates was found to be fairly close in the morning peak period and slightly less in the afternoon peak period when congestion levels were lower.

Source: Battelle

5.3.3 Summary of Transit Impacts

As highlighted in Table 5-22, the hypotheses and question related to the transit-related aspects of the Atlanta CRD were mostly or partially supported. The analysis of the data presented a mixed picture indicating that the CRD transit enhancements had a generally positive impact on travel in the I-85 corridor but some improvements were partially offset by other factors. Overall bus travel times in the Express Lanes were shorter, although a.m. peak period bus travel times began to shorten prior to tolling. Transit ridership in the Express Lanes increased overall, although ridership on pre-existing routes fell. Finally, the percentage of total person throughput due to transit was small, although its percentage share increased. Additional details on the transit analysis can be found in Appendix C.

Table 5-22. Summary of Transit Impacts Across CRD Hypotheses and Question

Hypotheses/Question	Result	Evidence
• The Atlanta CRD projects will enhance transit performance in the I-85 corridor.	Mostly Supported	Overall bus travel times in the I-85 Express Lanes were 2.4 percent shorter in the a.m. peak period and 5.0 percent shorter in the p.m. peak period. However, the a.m. bus travel times began to shorten even before tolling.
• The Atlanta CRD projects will increase ridership and facilitate a mode shift to transit within the I-85 corridor.	Somewhat supported	Transit ridership in the I-85 Express Lanes increased by 21 percent in the a.m. peak period and 17 percent in the p.m. peak period. Much of the growth came from the new CRD-funded routes. Ridership on many of the pre-existing routes fell. Statistical tests on ridership patterns suggest that the new CRD-funded routes were tapping new riders, whereas the existing routes had already reached their maximum potential. Utilization increased at all the park-and-ride lots serviced by the CRD-funded routes.
• Increased ridership/mode shift to transit will contribute to congestion mitigation within the I-85 corridor.	Somewhat supported	The percentage of total person throughput due to transit was small (less than 4 percent). However, its percentage share did increase during post-deployment.
• What was the relative contribution of each Atlanta CRD project element to increased ridership and/or mode shift to transit within the I-85 corridor?	Transit ridership on CRD-funded routes increased by 10.2 percent but fell on non-CRD routes.	Almost 49 percent of the new riders who began taking the bus after the start of tolls said the tolls influenced them to take transit. The main reason why post-deployment ridership was higher than the baseline was because of the 3 CRD-funded routes. Had it not been for these new routes, ridership in the corridor would have been lower than the baseline.

Source: Battelle

5.3.4 Summary of TDM Impacts

Table 5-23 presents the findings for the hypotheses and question related to TDM in the national evaluation. With the primary focus of the TDM programs being encouragement of alternate modes, and with particular attention on 3-person carpool formation, the data showed that carpooling was negatively impacted during the post-deployment period. This finding was likely affected by the limited level of alternative mode promotion and TDM outreach activities beyond those undertaken by the Clean Air Campaign. Data showed a decrease in 3-person carpools for both the Express Lanes and general purpose lanes during peak periods. Only 18 3-person carpools were formed through CAC's outreach efforts. Fewer carpools used the Express Lanes and many 2-person carpools that persisted more frequently used the general purpose lanes. The Volpe household survey trip diaries showed a decrease in average vehicle occupancy for the Express Lanes from 2.22 to 1.18, but an increase in this value for the general purpose lanes from 1.07 to 1.18. This indicated a shift for commuters seeking the free alternative. Additional details on the TDM analysis can be found in Appendix D.

Table 5-23. Summary of TDM Impacts Across CRD Hypotheses and Question

Hypotheses/Question	Result	Evidence
Promotion of commute alternatives removes trips and vehicle miles traveled from I-85.	Supported, but likely not due to Express Lanes	The incentive programs were estimated by CAC to have reduced vehicle trips and VMT from I-85. During the demonstration period, the incentives were responsible for reducing 7.3 million miles, about 750,000 miles coming from new mode shift. However, the VMT reduction impacts from CAC cannot be attributed to the CRD projects.
CAC incentives support formation of 3+ carpools and vanpools on I-85.	Not supported	Only 18 3-person carpools were formed by CAC's direct outreach efforts, among CAC registered carpoolers. Overall, 3-person carpools declined in the Express Lanes during peak periods compared to the previous HOV lane. Vanpooling remained static in the I-85 corridor.
What was the relative contribution of the Atlanta CRD TDM initiatives on reducing I-85 vehicle trips/VMT?	None detected	Any changes in vehicle volumes and VMT were likely due to tolling and exogenous variables and not to the TDM element of the CRD project.

Source: ESTC

5.3.5 Summary of Technology Analysis

As noted in Table 5-24, results for the hypothesis of the technology analysis were inconclusive. The analysis in Appendix E suggests that the technology aided enforcement but some results were inconclusive. SRTA operators felt the enforcement technologies operated as envisioned and were reliable. However, data were not sufficient to determine actual number of violations, but only those that were detected manually or with the enforcement technology. The analysis indicated that recorded violations and manual citations remained fairly constant throughout the evaluation period. A total of 474 violations were reported in a 10-month period, with a vast majority of these being unrelated to Express Lanes operations (e.g., insurance violations, driver license violations, etc.). Disregarding these “other” types of violations, an average of 47 violations per month were recorded for failing to correctly self-report the number of occupants in the vehicle and 21 violations per month were recorded for unlawfully entering the Express Lane by crossing the double white lines. Additional details on the technology analysis can be found in Appendix E.

Table 5-24. Summary of Technology Impacts for the CRD Hypothesis

Hypothesis	Result	Evidence
• Using advanced technology to enhance enforcement will reduce the rate and type of violators in the corridor.	Inconclusive	Recorded violations and manual citations remained fairly constant throughout the evaluation period. Data were not sufficient to determine actual number of violations, but only those that were detected manually or with the enforcement technology. SRTA operators felt the enforcement technologies operated as envisioned and were reliable.

Source: Texas A&M Transportation Institute

5.3.6 Summary of Safety Impacts

As indicated in Table 5-25, the findings related to the hypotheses on safety impacts of the Atlanta CRD projects, principally the I-85 Express Lanes, were either inconclusive or unable to be determined. The analysis indicates that crashes have increased on the I-85 CRD corridor in the categories of injury and property- damage-only, while fatal crashes decreased. However, owing to the small number of fatal crashes in the post-deployment period the decrease was not statistically significant The results from the household travel survey and the focus groups with different user groups indicate some safety concerns with the operation of the Express Lanes and the impacts on travel in the general purpose lanes. Analysis of data on the I-85 Express Lanes section over a longer post-deployment period than available for this evaluation is needed to better assess the safety impacts of the I-85 CRD projects. An assessment over 3-years is suggested. Additional details on the safety analysis can be found in Appendix F.

Table 5-25. Summary of Safety Impacts Across the CRD Hypotheses

Hypotheses	Result	Evidence
• The collective impacts of the CRD improvements will be safety neutral or safety positive.	Inconclusive	The number of crashes in the Express Lane corridor of I-85 increased after implementation of the CRD projects for injury and property-damage-only crashes and decreased for fatal crashes. Analysis of data on the I-85 Express Lanes section over a longer post-deployment period (at least 3 years) than currently available for this evaluation is needed to fully assess the safety impacts of the I-85 CRD projects. The results from the household travel survey and the focus groups with different user groups indicate some safety concerns with the operation of the I-85 Express Lanes and general purpose lanes.
• Gantry-controlled access technology will reduce incidents related to violations for crossing the double white line.	Inconclusive	The number of manual citations for crossing the double white line varied during the eight months in 2012 of on-site enforcement, but did not decline significantly over time. Analysis of additional crash data such as side-swipe and angle crashes specific to the Express Lanes is needed to fully assess the impacts of the GCA system on reducing incidents related to vehicles illegally crossing the double white line.
• Tolling strategies that entail unfamiliar signage will not adversely affect highway safety.	Not able to determine	No data were available to assess the potential impact of unfamiliar signage due to the tolling strategies on safety on I-85.

Source: Texas A&M Transportation Institute

5.3.7 Summary of Equity Analysis

Table 5-26 presents a summary of the equity analysis across the four questions. Details about the findings can be found in Appendix F – Equity Analysis. With regard to the first question, among the four user groups examined, it could be argued that Xpress bus riders benefited the most as they had the lowest cost and benefited from faster travel on the Express Lanes. Other users of the Express Lanes benefited from faster travel, but unless they were in carpools of 3 or more persons their costs increased by the cost of the toll (average of $2.27 in the p.m. and $3.95 in the a.m. peaks for the entire corridor trip) compared to users in the slower general purpose lanes.

I-85 travelers in general as well as transit riders who were surveyed continued to perceive I-85 tolling as unfair toward people with limited income, although Gwinnet County in which most of the CRD corridor is located has higher average income than the region in general. However, carpoolers do not mind sharing the Express Lanes with those willing to pay the toll to gain a faster ride. Analysis of geographic equity showed that proximity made a difference in usage of the CRD-funded enhancements in the I-85 corridor. Gwinnett County, where the CRD corridor is located, contributed the greatest percent of Xpress bus riders on the new routes (85 percent) as well as the most frequent users of the Express Lanes (68 percent). However, the Express Lanes drew from a wider area, especially from towns beyond the northern terminus. In addition, it was observed that I-85 travelers from more remote locations relied to a greater extent on Express Lanes when they traveled on I-85 than households closer to the corridor.

Regarding environmental justice—whether air quality impacts varied by location or socio-economic status—all along the corridor the estimated impacts were judged to be positive or neutral in terms of VMT-based emissions. The northernmost section of the corridor experienced the greatest decline in VMT and the associated emissions. No adverse impacts on minority or low-income groups were discerned. Finally, the impact of reinvestment of toll-generated revenues was examined. No revenues in excess of operating expenses have been generated to date, and, thus, the issue has not been faced so far. SRTA does not currently have a policy regarding how excess revenues will be used, and in one-on-one interviews with local partners some concern was raised about potential institutional barriers to developing a policy.

Table 5-26. Summary of Equity Impacts Across the CRD Questions

Questions	Result	Evidence
How do the impacts from the I-85 CRD projects affect the different user groups?	Before/after variation in peak period travel times and travel costs by user group. Majority concerned about fairness of tolling on limited-income groups, but carpoolers not concerned about SOVs paying toll to use Express Lane.	General purpose lane users experienced slower travel as did 2-person carpoolers that switched to the general purpose lane to avoid paying a toll; 3-person carpools using the Express Lanes had faster travel at no additional cost; transit riders had the least cost and lower travel time as buses use the Express Lanes; Express Lane toll payers had the highest cost but faster travel than their general purpose lane counterparts. 57 percent of households in the Volpe survey that used I-85 in 2012 agreed that tolls were unfair to people with limited incomes as did 52 percent of Xpress bus riders in the transit survey. However, a majority in the carpooler survey agreed it was fair to allow SOVs to use the Express Lanes, which was consistent across socio-economic groups.
How do the impacts from the I-85 CRD differ across geographic areas?	CRD transit enhancements used by the nearest population. Express Lanes used primarily by nearest population, but also by more dispersed users. Reliance on the Express Lanes for I-85 trips varied by proximity to the CRD corridor.	85 percent of Xpress bus riders were from Gwinnett County, the closest to the new bus routes and park-and-ride lots. In all, 68 percent of Express Lane trips originated in Gwinnett County, with the remainder from towns throughout the region or state. As a percent of all trips taken on I-85, households in closest proximity used I-85 more frequently but with a lower percentage of trips in the Express Lanes than households farther away from the corridor.
Are the air quality impacts from the I-85 CRD projects different across geographic and socio-economic groups?	Northernmost sections of corridor experienced greatest decline in vehicle miles traveled and associated emissions. No adverse air quality impacts on minority or low-income groups.	While VMT-based emissions either improved or did not change significantly, two northeast segments of the corridor had VMT reductions of 8.3 percent and 11.7 percent. Those sections had higher black/African American and Asian populations, lower Hispanic or Latino populations, median income in the middle, and unemployment rates slightly higher than the norm for the corridor.
How does reinvestment of potential revenues from the I-85 Express Lanes impact various transportation system users?	No impact	Operating costs have been higher than revenues, and as a result there have been no excess revenues to reinvest. In addition, no policy currently exists for how excess revenues, when they occur, will be invested.

Source: Battelle

5.3.8 Summary of Environmental Analysis

Table 5-27 highlights the positive environmental impacts of the conversion of the I-85 HOV lanes to Express Lanes. The Atlanta CRD projects had mostly positive impacts on air quality, and energy consumption. The analysis of the I-85 CRD corridor indicated generally positive impacts on air quality (0.8 to 6 percent reduction in emissions of everything except $PM_{2.5}$, which increased by 1 percent). Fuel consumption declined by 0.2 percent. The emission and fuel use reductions are predominant in the Express Lanes, ranging from 7.6 to 9.0 percent. The adjacent general purpose lanes in this section experienced both increases and decreases in emissions and energy use, depending on the pollutant. Additional details on the environmental analysis can be found in Appendix H.

Table 5-27. Summary of Environmental Impacts Across the CRD Questions

Questions	Result	Evidence
What are the impacts of the Atlanta CRD strategies on air quality?	Positive impacts overall	Positive impacts in the Express Lanes ranging from 7.6 to 9.0 percent decreased air pollutant emissions. The combination of Express and general purpose lanes also exhibits positive impacts with the exception of a 1 percent increase in one pollutant ($PM_{2.5}$). The other four pollutants all decrease.
What are the impacts on energy consumption?	Positive impacts in Express Lanes, and overall	Reduction in fuel use of 8.4 percent in the Express Lanes. Increased fuel consumption (0.8 percent) in the general purpose lanes. Overall combined reduction of 0.2 percent.

Source: ESTC

5.3.9 Summary of Goods Movement Analysis

Table 5-28 presents a summary of the goods movement analysis across the four hypotheses. The Atlanta CRD projects seemed to have had negligible or negative impacts on goods movement. Examination of travel times and buffer times for the general purpose lanes and Express Lanes indicated mixed results on the impacts on goods movement. Based on anecdotal evidence from focus groups conducted in September 2012, small business owners held mostly negative perceptions of the Express Lanes citing either the same or worse congestion levels since the conversion from HOV lanes. Regarding the third hypothesis, about half of the small business owners in the focus groups that had small and/or large commercial trucks registered for Peach Passes to enable them to use the Express Lanes, believing the time savings to be more valuable than the additional cost, while others thought the Express Lanes were too expensive despite worsened congestion. Additionally, small business owners reported making changes in route choice or timing of trips if they chose not to use the Express Lanes. Finally, transponder and toll transaction data from commercial and post-paid accounts indicated that the Express Lanes were being utilized by corporate vehicles that may be involved with goods movements. Additional details on the goods movement analysis can be found in Appendix I.

Table 5-28. Summary of Impact on Goods Movement Across the CRD Hypotheses

Hypotheses	Result	Evidence
Commercial vehicle operators (CVOs) will experience reduced travel time by reduced congestion on general purpose lanes.	Partially supported	For small commercial vehicles permitted in the Express Lanes, travel time improved. However, for CVOs using the general purpose lanes, travel time increased in the general purpose lanes by 5.1 percent in the a.m. and 10.2 percent in the p.m. Aiding on-time delivery, buffer time was less in the general purpose lanes in both peaks and in the p.m. peak in the Express Lane.
Operators with light-duty trucks will prefer to use HOT lanes to general purpose lanes for faster travel times.	Neutral	Focus group participants were not uniform in their companies' use of the Express Lanes, as they differed in their assessment of time and cost.
Operators delivering goods will perceive the net benefit of tolling strategies (e.g., benefits such as faster service and greater customer satisfaction outweigh higher operating costs due to tolls).	Neutral	Half of the respondents felt that the travel time benefits exceeded the cost and used the Express Lanes.
Operators report changing operational decisions due to use of HOT lanes (e.g., changing delivery times).	Supported	Adaptations included use of back roads or making trips prior to peak traffic times.

Source: Battelle

5.3.10 Summary of Business Impacts Analysis

Table 5-29 presents a summary of the business impacts analysis across the three questions. The Atlanta CRD projects seemed to have had negligible or negative impacts on small businesses, based on anecdotal evidence from focus groups. Small business owners participating in focus groups in September 2012 perceived congestion levels to be either the same or worse since the conversion of the HOV lanes to Express Lanes, leading to mostly negative perceptions of the Express Lanes and resulting in no change of employee morale. No small business owner in the focus groups felt that the CRD changes had any positive or negative effects on attracting employees or customers. Finally, about half of the small business owners who had small or large commercial trucks utilized Peach Passes for the Express Lanes, believing the time savings to be more valuable than the additional cost. The other half thought the Express Lanes were too expensive despite worsened congestion. Given the small number of respondents, these findings are only anecdotal in nature and cannot be extrapolated to all business owners. Additional details on the business impacts analysis can be found in Appendix J.

Table 5-29. Summary of Business Impacts Across the CRD Questions

Questions	Result	Evidence
• What is the impact of the strategies on employers? e.g., o Employee satisfaction with commute (HOT, transit) o Increased employment-shed to downtown/midtown Atlanta	Partially negative	Respondents had mostly negative perceptions of the Express Lanes, as congestion had either been the same or gotten worse than before the Express Lanes were converted from HOV lanes. Employee satisfaction was unchanged, although some had lost employees due to increased congestion issues. No respondents felt that the Express Lanes or transit system changes had any positive or negative effects on attracting employees.
• What is the impact of the strategies on businesses that rely on customers accessing their stores, such as retail and similar establishments?	No impact	No respondent felt that the Express Lanes or transit changes had any positive or negative effects on attracting customers.
• How are businesses that are particularly impacted by transportation costs affected (e.g., taxis, couriers, distributers, tradesmen)?	Neutral	Half of the respondents had Peach Passes to use the Express Lanes believing the time savings to be more valuable than the cost, while others felt the Express Lanes were too expensive and congestion had worsened.

Source: Battelle

5.3.11 Summary of Non-Technical Success Factors

As highlighted in Table 5-30, people, process, structures, the media, and competencies all played supporting roles in the implementation, deployment, and operation of the Atlanta CRD projects. The multi-organizational structure, with its well-articulated roles and responsibilities, supported the implementation, deployment, and operations of the CRD projects. A team of competent staff who respected each other's work were able to lead the region through the implementation of a technologically complex and politically difficult project. The local partners deployed an ambitious communications and outreach plan, recognizing their responsibility in effectively communicating to the public a project that would significantly change the culture of transportation in the region – a region previously unfamiliar with dynamically priced tolling. Local partners had to balance the challenges of delivering a complex project under tight time constraints with a communications strategy that informed the public of the changes tolling would bring as well as attempt to educate the public on the purpose and potential benefits of congestion pricing. It seemed that the media played a role in shaping public opinion of the CRD projects, especially the coverage occurring just after the tolling deployment that emphasized the views of those that vehemently opposed tolling. Surveys also indicated that travelers using the I-85 corridor generally had a negative perception of the Express Lanes, although users of the Express Lanes tended to be more positive about the benefits. One missed opportunity was the limited promotion of the CRD transit enhancements as an attractive alternative to I-85 commuters. Although most interviewees hesitated to use the word "success" when describing the CRD, they all spoke with pride and satisfaction when reflecting on the outcome of the CRD projects as well as a commitment to continuing tolling in the region, as new tolling projects were already underway during the second round of interviews and post-deployment workshop. Additional details on the non-technical success factors analysis can be found in Appendix K.

Table 5-30. Summary of Non-Technical Success Factors Across the CRD Questions

Questions	Results	Evidence
What role did the following areas play in the success of the Atlanta CRD projects?		
1. People 2. Processes 3. Structures 4. Media 5. Competencies	1. Effective 2. Effective 3. Effective 4. Problematic 5. Effective	1 and 5. Agency staff held technical expertise and project management skills needed to successfully implement the projects. Staff held their colleagues in high regard. 1 and 5. Agency leadership influenced policy and process to keep projects on track. 2. Frequent communication and information sharing among agency partners kept everyone on the same page. 3. Clearly defined roles and responsibilities within the multi-agency organizational structure. 4. Media kept the projects in the public eye, although their contribution to public opinion leaned toward negative during the critical period of the opening of the Express Lanes. Lack of media coverage of transit enhancements reflected agencies' missed opportunity to communicate transit's role as an attractive alternative to commuters.
Does the public support the CRD strategies as effective and appropriate ways to reduce congestion?	Negative	Surveys showed that I-85 travelers in general had a negative attitude toward the Express Lanes, but Express Lane users tended to be more positive about the benefits.

Source: University of Minnesota

5.3.12 Summary of Benefit Cost Analysis

Table 5-31 depicts the findings of the benefit cost analysis for the Atlanta CRD projects using a ten-year post-deployment time frame ending in September 2021. The benefits of the Atlanta CRD projects are summarized as follows:

- Travel time savings: $3,964,324
- Reduced auto fuel use: $1,552,330
- Reduced emissions: $1,769,048
- TOTAL: $7,285,702

Most benefits from transportation projects are derived from reduced travel time (and thus reduced fuel use and reduced emissions). In the case of the Atlanta CRD there was little change in travel times and, thus, the societal benefits as measured by the BCA were relatively small. However, as noted in Section 3.2, the Express Lanes were implemented to address the deteriorating performance of the previous HOV lanes that would have continued to worsen without the CRD projects.

The cost of the CRD projects, in 2011 dollars, was $106,296,834. The total cost included all development and implementation and 10 years of estimated operations and maintenance expenses. The cost was reduced by the salvage value for items that still had value in 2021.

This BCA examined the net societal costs and benefits of the Atlanta CRD projects. The benefit-to-cost ratio for the Atlanta CRD projects was 0.07 and the net societal benefit was -$99,011,132. The analysis had several limitations and required numerous assumptions. First, safety data was not included in the BCA as crash data over a longer period of time are needed to more fully assess possible changes in crashes, which would greatly influence the BCA. In addition, vehicle operating costs included only reduced fuel consumption for automobile and truck travel. Data on possible reduction in fuel used by buses were not available. The future year costs and benefits represent the best estimates available, but they are only estimates, and the actual costs and benefits may vary. Additional details on the BCA can be found in Appendix L.

Table 5-31. Question for the BCA

Hypotheses/Questions	Result	Evidence	
What are the overall benefits, costs, and net benefits from the Atlanta CRD projects?	Negative societal benefits	Benefits:	$7,285,702
		Costs:	$106,296,834
		Net Benefits:	-$99,011,132
		Benefit-to-cost ratio:	0.07

Source: Texas A&M Transportation Institute

This page intentionally left blank

Chapter 6 Summary and Conclusions

This report has presented the results from the national evaluation of the Atlanta CRD projects. The report included a summary of the UPA and CRD programs, the Atlanta CRD partners and projects, and the evaluation process and data. The major findings from the evaluation were presented. Appendices A through L contain more detailed descriptions of the 12 analysis areas. This section summarizes the major findings from the evaluation and presents overall conclusions on the Atlanta CRD project.

6.1 Summary of Major Findings

Table 6-1 highlights the key findings from the national evaluation of the Atlanta CRD projects based on the U.S. DOT's four objective questions.

Table 6-1. U.S. DOT Objective Questions and Atlanta CRD Impacts

U.S. DOT 4 Objective Questions Evaluation Analyses
How much was congestion reduced?
Congestion. During the peak periods travel times and speeds improved slightly in the Express Lanes (EL) but grew worse in the general purpose (GP) lanes, resulting in a travel time advantage of 3 minutes or more for EL users. Travel reliability in the EL improved in the p.m. peak but not the a.m. Vehicle throughput declined as did VMT in the corridor. Average occupancy levels declined in the EL as 2-person carpools shifted to the GP lanes. Even with an increase in transit, peak period person throughput declined in the a.m. and the p.m. Results of surveys and focus groups showed a perception that congestion had not improved in the corridor. Tolling. Monthly EL usage reached approximately 400,000 from March through September 2012, with tolled trips accounting for about 300,000 and HOV3+ trips for about 29,300 per month. In the first year of tolling variable pricing was more effective in regulating EL traffic flow in the a.m. peak than in the p.m. peak. A total of 197,044 new transponders were issued through September 2012. Usage was occasional with the median being two trips per month. In all, 4.6 percent of tolled users and 3.2 percent of HOV3+ users took 20 or more trips in the EL per month. Transit. Peak period Xpress bus ridership increased by 21 percent in the a.m. and by 17 percent in the p.m., although much of the increase occurred as CRD transit enhancements came on-line prior to tolling. Usage of CRD-funded routes and park-and-ride lots increased as non-CRD funded transit in the corridor declined. About half of new riders said tolling influenced them to start taking the bus. Xpress riders expressed very high satisfaction with the bus service, although post-tolling surveys suggested that some riders perceived slower bus travel time despite actual travel time being better or unchanged. TDM. Targeted outreach to carpoolers resulted in only 18 carpools adding a third person to be able to use the EL for free. Carpools of all sizes appeared to have declined in both the EL and GP lanes. A substantial shift from the EL to the GP lanes by 2-person carpools can be attributed to the change to HOV3+ for free usage of the EL.

Table 6-1. U.S. DOT Objective Questions and Atlanta CRD Impacts (Continued)

U.S. DOT 4 Objective Questions Evaluation Analyses
Technology. Violations detected by the gantry-controlled access system resulted in 50,636 citations being issued by SRTA. SRTA operators expressed satisfaction with system features for optimizing violation detection. Department of Public Safety personnel using the automatic license plate reader in their vehicles issued an average of 47 occupancy citations per month. DPS also issued an average of 21 citations to drivers crossing the double white line.
What are the associated impacts of the congestion reduction strategies?
Safety. Crashes increased on the I-85 corridor in the categories of property-damage-only and injury. Fatalities declined, but the change was not statistically different than zero due to the small number of fatalities in one year of post-deployment data. The increase in total number of crashes in the post-deployment period could have resulted from vehicles crossing the double white line. Citation data indicated that the number of monthly manual citations for crossing the double white line varied but did not decline significantly over time. Equity. Transit riders benefit the most in terms of lowest cost and faster travel on I-85. Unfairness of I-85 tolling on people with limited income continues to be a perception. Proximity affected usage of the CRD-funded enhancements, with Gwinnett County contributing 85 percent of Xpress bus riders on new routes and most frequent users of the Express Lanes. No adverse air quality impacts on minority or low income groups were discerned. Environmental. Generally positive impacts on five air quality measures were identified, with all but one pollutant showing a net decrease. Fuel consumption also declined slightly. Express Lanes outperformed the general purpose lanes owing to their faster travel speeds, but across all lanes the total impact was still positive. Goods Movement. Travel time improved for small commercial vehicles that could qualify for the Express Lanes, but the travel in the general purpose lanes was slower. Commercial vehicle operators had mixed assessment of the benefit of the Express Lanes to their businesses. Business Impacts. Small business owners held mostly negative perceptions of the Express Lanes citing the same of worse congestion levels since conversion from the HOV lane. They were neutral about the impact on attracting customers or employees.
What are the non-technical success factors?
Non-Technical Success Factors. An effective multi-organizational structure and a competent staff that worked well together and aided the local partners in implementation, deployment, and operations of the CRD projects. An ambitious communications and outreach plan sought to address the significant change to transportation in the region that the CRD represented. Media coverage leaned toward negative during the opening of the Express Lanes and missed telling the public about the transit enhancements. Post-deployment surveys showed that I-85 travelers tended to have a negative view of the Express Lanes, although users of the Express Lanes tended to be more positive.
What is the overall cost and benefit of the strategies?
Benefit Cost Analysis. The benefit-to-cost analysis for the Atlanta CRD projects was well below 1.0. The benefit cost ratio was 0.07, indicating much greater net societal costs than benefits. The net societal benefit was -$99,011,132. However, it should be noted that the travel time performance of the HOV lanes, a major component to benefit measurement, would have continued to deteriorate without the investment in the CRD projects,

Source: Battelle

6.2 Conclusions

The Atlanta CRD was designed to demonstrate the effectiveness of innovative strategies for addressing Atlanta's congestion problem and provide better mobility options for its residents. This report documents the evaluation of the projects by the national evaluation team sponsored by U.S. DOT. The following conclusions can be drawn from the experience in deploying the CRD projects and in assessing the effectiveness of the different projects:

- The findings of this report are based on data that represented only one year of full operation of the Express Lanes ending in September 2012. Thus, some findings may have changed if examined over a longer period of time in which both the local partners would gain more experience with operations in the corridor and travelers would have more time to modify their travel behavior. In addition, exogenous factors such as a more stable increase of gasoline prices in the post-deployment period and a slow but steady economic recovery potentially impacted the results of the CRD projects
- The Atlanta CRD partners worked effectively within their own agencies but also as a team to plan and deliver their individual projects in a coordinate fashion. They professionally addressed not only technical issues along the way but handled difficult operational and public relations challenges that arose during the opening of the Express Lanes.
- The Express Lanes may not have reached their full potential during the period of the evaluation. They provided a travel time advantage but in part at the expense of slower travel in the general purpose lanes, and the goal of more reliable Express Lane travel was only partially successful in the first year. In the future higher tolls during congested periods may be acceptable with travelers, as evidenced by the national evaluation team's analysis of willingness to pay presented in Appendix B – Tolling Analysis. This may help address performance of the Express Lanes.
- The introduction of a HOT lane in the Atlanta region represented a change in the transportation culture. While there had been experience with a flat toll on the GA 400 that was soon to be removed, the concept of congestion pricing was new to the state. Thus, introduction of congestion pricing was going to be a challenge under the best of circumstances, and the local partners worked to meet the challenge through an extensive outreach campaign prior to tolling. However, difficulties in the first few weeks of Express Lane operation drew negative media attention, which might be expected in a state with minimal experience with tolling. A negative attitude about the Express Lanes persisted in the minds of travelers surveyed several months later, although travelers who used the Express Lanes held a slightly more favorable opinion than those who did not. Going forward, improvements in Express Lane performance and communication of improvements to the public may help change the prevailing opinion.
- The vast majority of travelers that did not want to pay a toll did not adapt their travel behavior by shifting to 3-person carpools or taking transit. While behavior can take a long time to change, and attempts were made in the CRD to support 3-person carpool formation, the advantages of Xpress bus service in the corridor could be promoted more to build on the roughly 20 percent increase in riders recorded one

year after tolling. The CRD-funded transit improvements were very successful and provide a basis for future transit growth in the corridor.

- The conversion of an HOV2+ lane that is already near capacity to an HOT3+ lane can generate only limited mobility improvements without additional supporting changes such as carpooling and transit. For example, the I-85 corridor still has an HOV2+ lane at the terminus of the Express Lanes approaching downtown Atlanta. Thus, local partners should still promote 2-person carpools on I-85 since they can still derive benefit from that HOV2+ section of I-85 even though they must pay a toll in the Express Lanes section or use the slower general purpose lanes.
- Special attention is required for recording data elements that are critical measures of success. Data quality issues may have affected the findings of this evaluation. Having higher-quality data that covers a longer period of time than was available for parts of this evaluation may provide more nuanced results in the future. In particular, the evaluation had to adapt to limitations with the pre- and post-deployment traffic sensor data. In addition, a longer duration of post-deployment crash data will also help filter out year-to-year fluctuations.

Appendix A. Congestion Analysis

This appendix presents the congestion analysis of the Atlanta Congestion Reduction Demonstration (CRD) projects. The analysis focused on assessing the extent to which overall traffic congestion was reduced in the I-85 corridor by converting the existing high-occupancy vehicle (HOV) lanes on I-85 to high-occupancy toll (HOT) operations with the Express Lanes and the changes in transit service.

Table A-1 presents the five hypotheses for the congestion analysis. The first hypothesis focused on improvements in travel time and average travel speeds on the I-85 general purpose lanes and the Express Lanes due to converting the existing HOV lanes to HOT operations. The second hypothesis related to the CRD projects improving travel-time reliability and reducing travel-time variability on the I-85 Express Lanes and general purpose lanes. The third hypothesis was that the CRD projects would result in more vehicles and more persons served on I-85. The fourth hypothesis was that the CRD projects would reduce the spatial and temporal extent of congestion on I-85. The final hypothesis focused on the perception of travelers that congestion had been reduced on I-85.

Table A-1. National Evaluation Congestion Analysis Hypotheses

Hypotheses
• Converting the I-85 HOV lanes to HOT operations will improve travel time and average travel speeds on both the general purpose and Express Lanes on I-85.
• Converting the I-85 HOV lanes to HOT operations will improve travel-time reliability and reduce variability on both the general purpose and high occupancy lanes on I-85.
• Deploying the CRD improvements will result in more vehicles and persons being served on I-85.
• Implementing the CRD improvements in the I-85 corridor will reduce the spatial and temporal extent of congestion.
• As a result of the CRD improvements, the perception of travelers is that congestion has been reduced in the I-85 corridor.

Source: Atlanta CRD Congestion Test Plan, FHWA, 2011.

The remainder of this appendix is divided into nine sections. The data sources used in the analysis are described next in Section A.1, followed by the traffic analysis methods in Section A.2. Changes in travel time and travel speeds on the I-85 Express Lanes and the general purpose lanes are presented in Section A.3, including the travel time index (TTI). Changes in travel-time variability, including the 95th percentile travel time and the buffer index, are examined in Section A.4. Section A.5 explores vehicle-occupancy levels on I-85 before and after implementation of the Express Lanes. Section A.6 examines changes in vehicle and person throughput on I-85 pre- and post-deployment of the Express Lanes, and Section A.7 describes changes in vehicle miles of travel (VMT). Section A.8 summarizes the results from congestion-related questions included in surveys and focus groups of different I-85 user groups. Section A.9 presents a summary of the congestion analysis in relation to the hypotheses.

A.1 Data Sources

Several data sources were used in the congestion analysis. First, data from the Georgia Department of Transportation (GDOT) Freeway Management System, the NaviGAtor System, were obtained and used in the analysis of pre- and post-deployment travel times, travel speeds, travel variability, and person and vehicle throughput on I-85. Second, the State Roadway and Tollway Authority (SRTA) provided summaries of post-deployment average travel speeds and travel times for the I-85 Express Lanes and general purpose lanes from the SRTA tolling automatic vehicle identification (AVI) data. Third, Georgia Tech provided data from on-site vehicle-occupancy counts. Fourth, the responses from congestion-related questions in the Atlanta household travel survey, sponsored by the Volpe National Transportation System Center, were reviewed and analyzed. Fifth, the summary of the GDOT-sponsored focus groups with HERO operators, Georgia Regional Transportation Authority (GRTA) operators, Gwinnett bus operators, and representatives from I-85 corridor businesses were reviewed and analyzed. The potential limitation with some of these data sources were discussed in the relevant sections.

A.2 Traffic Data Analysis Methods

Data for the evaluation were provided by GDOT's Freeway Management System – the NaviGAtor System. This system uses video detection cameras spaced at regular intervals in the corridor to measure speed and volume in both the general purpose lanes and the Express Lanes. During the middle of the pre-deployment period, GDOT performed an upgrade of the NaviGAtor software system – converting from NaviGAtor I to NaviGAtor II. This conversion was completed in February 2011.

Prior to using the data in the analysis, the national evaluation team first performed a series of checks to assess the quality of GDOT's data. These checks included filtering the data through the following rules to ensure its reasonableness:

- Speed > 0 and Volume = 0;
- Speed = 0 and Volume > 0;
- Speed ≥ 80 miles per hour (mph); and
- Flow Rate > 3000 vehicles per hour per lane (vphpl).

To improve data quality, only detector stations that provided a high degree of data availability and realistic speed distributions, as well as producing a standard speed-flow relationship, were used in the analyses. The stations were separately analyzed between the general purpose and the Express Lanes.

An initial review indicated that significant issues existed with the quality of the data, particularly with data from NaviGAtor I. The national evaluation team's investigation of data availability on a station-by-station basis revealed that more data were generally available in the NavigGAtor II period. Some detectors were re-configured/calibrated with the switch from NaviGAtor I to NaviGAtor II; however, no detailed information on what was specifically modified as part of the change was available. Therefore, only NaviGAtor II data were retained for the analysis to avoid inconsistencies. Because of concerns about the quality of data associated with the NaviGAtor I software, the evaluation was performed using only the data from NaviGAtor II. Therefore, the pre-deployment period reflects only those times when NaviGAtor II was operational – February 2011 through the end of August 2011. The post-deployment period represented data collected from October 2011 through September 2012. There were significant invalid/missing data during the months of February and March 2011. Therefore, only data from April 2011-August 2011 and April 2012-August 2012 were retained for the pre- and post-deployment evaluation to ensure that the data were comparable and did not include seasonal traffic variations from the months without valid traffic data. However, the reduced comparison window for the analysis might impact the results by not representing before/after differences in other months of the year which could be greater than those observed from April to August.

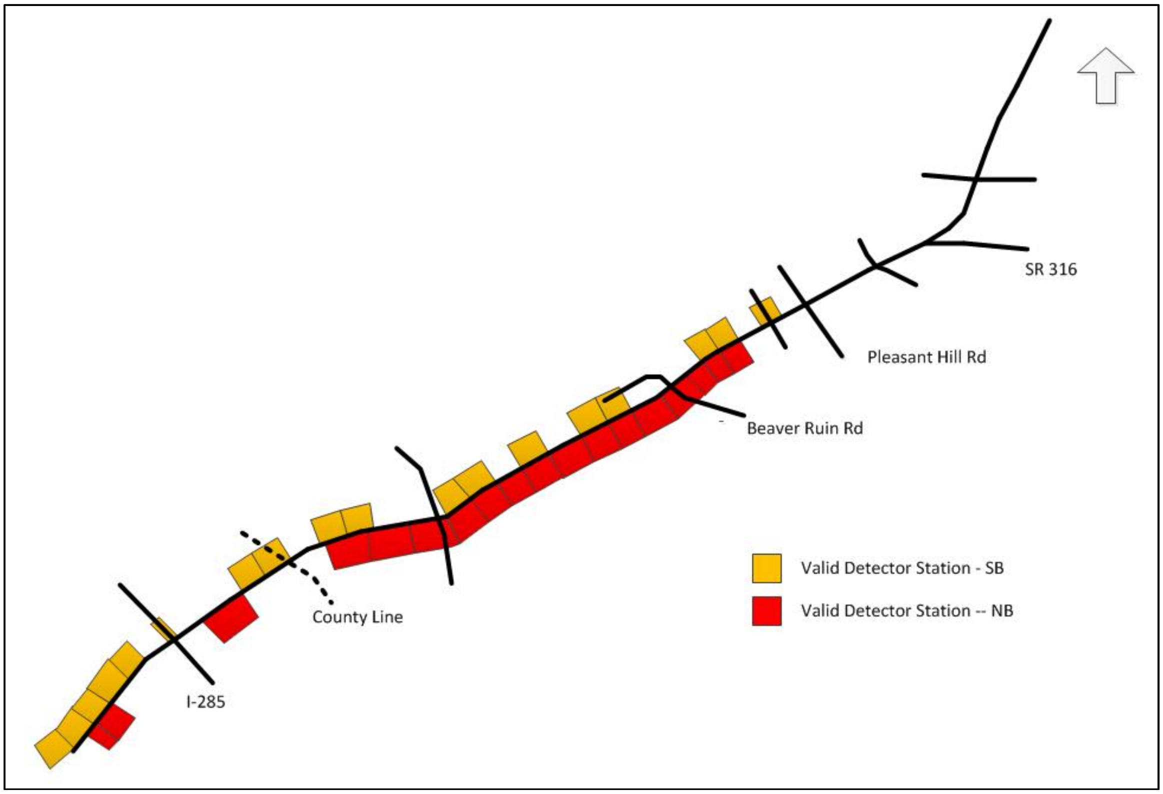
The review of the data showed that significant issues still existed with some of the NaviGAtor II data. Many of the detector stations in the corridor did not provide data suitable for use in the evaluation on a consistent basis. These detector stations were also eliminated from the evaluation data set and data from surrounding detectors were used to fill in the gaps for these detector stations, and the use of imputed data may reduce the accuracy of the travel time calculations.

Table A-2 presents the number and percentage of detector stations used in computing the general purpose lanes and the Express Lanes performance for each direction. Table A-2 also presents the average, maximum, and minimum distance between sensor stations that were used in computing corridor travel times. Figure A-1 shows the location of the valid general purpose lane detector stations used in the Congestion Analysis, and Figure A-2 shows the location of the valid Express Lane detectors.

Table A-2. Number and Distance between Sensors Used to Compute Corridor Travel Times

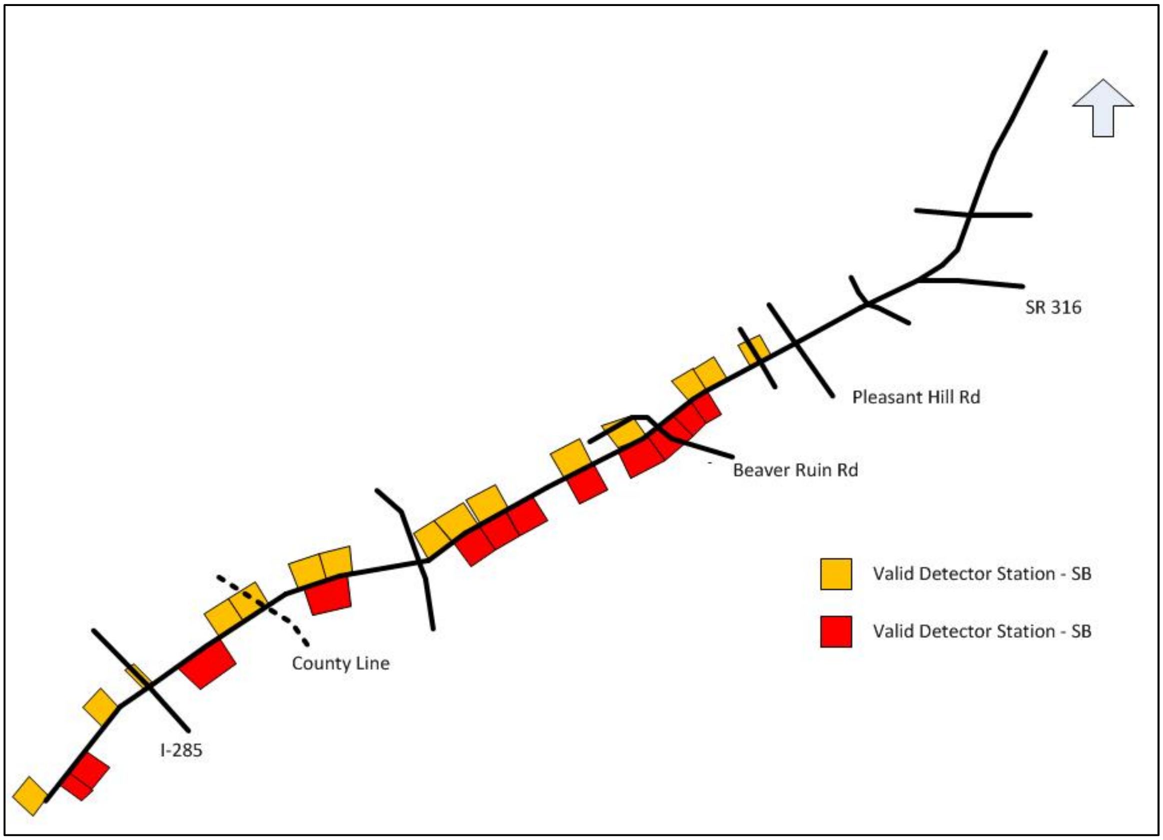
Facility	Direction	Lane Type	Number of Detector Station Used to Compute Travel Times			Distance Between Detector Stations (Miles)		
			Used	Maximum Potential	Percentage	Average	Maximum	Minimum
I-85	SB	General Purpose	18	33	55%	0.68	2.27	0.28
		Express	15	33	45%	0.77	2.61	0.31
	NB	General Purpose	18	33	55%	0.65	2.94	0.26
		Express	12	33	36%	1.31	3.20	0.28

Source: Texas A&M Transportation Institute.



Texas A&M Transportation Institute.

Figure A-1. General Purpose Lane Detector Stations Used in Congestion Analysis



Texas A&M Transportation Institute.

Figure A-2. Express Lane Detector Stations Used in Congestion Analysis

A before-and-after occupancy study was conducted by Georgia Institute of Technology (Georgia Tech), which included visual occupancy counts Monday through Wednesday at selected locations in the corridor at selected times of the year. Georgia Tech used an "eyes on target" method for collecting vehicle occupancy data. This method involved positioning observers in the landscaped gore areas of the overpasses. Here, observers were slightly elevated above the roadway. From this position, an observer monitored a vehicle passing in each lane and classified the vehicle based on the observed number of occupants (1 for single occupant, 2 for double occupant, 3 for three occupants, and 4+ for four or more occupants, including transit vehicles and vans. Vehicle occupancy levels were sampled at multiple locations in the evaluation corridor. Occupancy data were collected for two-hour intervals. These data were combined to obtain the average percentage of vehicles in each occupancy category. Occupancy data were collected quarterly beginning in the fall of 2010 through the summer of 2012 at the following locations inside the CRD corridor:

- Pleasant Hill Road
- Beaver Ruin Road
- Jimmy Carter Boulevard
- Old Peachtree Road
- Chamblee Tucker Road.

A.3 Travel Time and Travel Speeds

Travel time and its related quantities are widely understood and fundamentally useful in the definition and measurement of congestion. For this reason, travel time–based measures form the framework for quantifying the extent to which the CRD improvements influenced congestion on I-85. The travel times were computed by first converting the fixed-point average travel speeds to segment travel times and then summing the segment travel times along the corridor. Mean travel times were based on 11.75 miles northbound (NB) and 11.56 miles southbound (SB) where traffic sensor data were judged to be useable.

A.3.1 Travel Time

Changes in travel times on both the general purpose lanes and the Express Lanes were the primary measure of performance for the CRD national evaluation. Travel time is the average time consumed by vehicles traversing a fixed distance. Travel times are easily understood by practitioners and the public, and are applicable to both the user and facility perspectives of performance.

Table A-3 shows the pre- and post-deployment mean (or average) peak-period travel time for both the general purpose lanes and the Express Lanes. These travel times represent the total time for travelers to traverse through the corridors in either the general purpose lanes or the Express Lanes during the a.m. and p.m. peak periods in the peak direction of travel – southbound in the a.m. peak and northbound in the p.m. peak.

Table A-3. Pre- and Post-Deployment Mean Corridor Peak-Period Travel Times (in Minutes) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Peak Period (Direction of Flow)	Lane Type	Mean Corridor Travel Time (Minutes)[1]					
		Pre-Deployment	Post-Deployment	Change	Percent Change	t-value	Significant?[2]
A.M. Peak (Southbound) (6 a.m. to 10 a.m.)	General Purpose	16.1	16.9	0.8	5.10%	8.5	Yes
	Express	14.1	13.8	-0.3	-2.20%	-6.2	Yes
P.M. Peak (Northbound) (3:00 p.m. to 7 p.m.)	General Purpose	16.1	17.8	1.7	10.20%	21.3	Yes
	Express	14.3	13.8	-0.5	-3.80%	-12.1	Yes

[1] Based on NaviGAtor II data only. These travel times are for approximately 11.5 miles of I-85 covered by the NaviGAtor II system for April 2011-August 2011 and April 2012-August 2012.

[2] Statistically significant at the 95 percent confidence level.

Source: Texas A&M Transportation Institute based on data provided by Georgia Department of Transportation.

Figure A-3 provides a graphical representation of mean travel times for both the general purpose lanes and Express Lanes in the peak period direction during the a.m. and p.m. peak periods. The table and figure show that when averaged over the entire peak period, travel times in both the general purpose lanes and the Express Lanes changed little in the peak direction of travel because of the CRD deployment. During the a.m. peak, travel times in the general purpose lanes increased by less than a minute in the post-deployment period, while travel times in the Express Lanes remained essentially the same. In the p.m. peak, travel times in the general purpose lanes were slightly higher (about 2 minutes) in the post-deployment period compared to the pre-deployment. The average peak-period travel time for the Express Lanes reduced only slightly (by approximately ½ a minute) after introducing HOT operations to the Express Lanes.

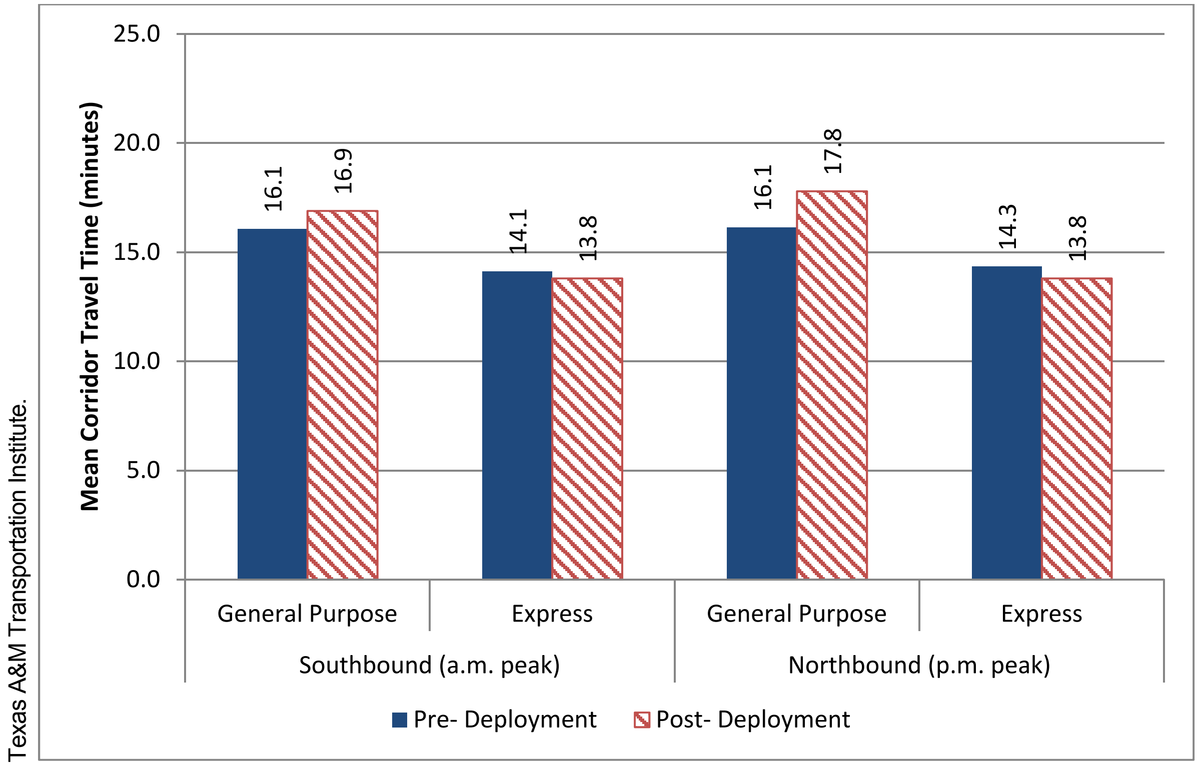


Figure A-3. Mean Corridor Peak Period Travel Times (in Minutes) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Table A-4 and Table A-5 present information on the changes in the pre- and post-deployment mean travel times for users of the general purpose lanes and Express Lanes in the a.m. and p.m. peak periods in half-hour increments. Figure A-4 through Figure A-7 graphically compare the pre- and post-deployment mean travel times the general purpose lanes for the peak direction of travel in each period.

Table A-4 shows that the mean travel time in the southbound general purpose lanes was slightly higher, by generally less than a minute, in the post-deployment period in all peak-period intervals in the a.m. peak. The greatest change between pre- and post-deployment mean travel times in the general purpose lanes occurred in the 7:00 a.m.-to-7:30 a.m. interval, when the mean travel time increased by 1.4 minutes. In all other time periods, the mean travel times in each interval in the a.m. peak increased by less than a minute. Increases in travel time imply a slight degradation in performance in the general purpose lanes in the a.m. peak; however, these changes were so slight that they were not likely to be noticeable to most travelers.

Table A-4. Pre- and Post-Deployment Mean Travel Times (Minutes): Southbound (A.M. Peak)

Time Interval		Mean Travel Time (Minutes)			
Beginning	End	Pre-Deployment	Post-Deployment	Change	Percent Change
General Purpose Lanes					
6:00 a.m.	6:30 a.m.	11.3	11.8	0.5	4.6%
6:30 a.m.	7:00 a.m.	13.6	14.6	0.9	6.9%
7:00 a.m.	7:30 a.m.	16.7	18.1	1.4	8.1%
7:30 a.m.	8:00 a.m.	19.6	20.5	0.9	4.8%
8:00 a.m.	8:30 a.m.	20.2	21.0	0.8	4.0%
8:30 a.m.	9:00 a.m.	19.1	19.8	0.7	3.5%
9:00 a.m.	9:30 a.m.	15.8	16.4	0.6	3.7%
9:30 a.m.	10:00 a.m.	13.6	14.0	0.4	2.6%
Express Lanes					
6:00 a.m.	6:30 a.m.	11.9	11.8	0.0	-0.2%
6:30 a.m.	7:00 a.m.	13.2	12.7	-0.5	-3.7%
7:00 a.m.	7:30 a.m.	14.7	14.0	-0.7	-4.8%
7:30 a.m.	8:00 a.m.	15.8	15.6	-0.2	-1.3%
8:00 a.m.	8:30 a.m.	16.2	16.6	0.4	2.2%
8:30 a.m.	9:00 a.m.	15.3	15.3	0.0	-0.2%
9:00 a.m.	9:30 a.m.	13.5	12.6	-0.9	-6.6%
9:30 a.m.	10:00 a.m.	12.7	11.8	-0.9	-6.9%

Source: Texas A&M Transportation Institute.

The mean travel times in the Express Lanes remained relatively constant for each interval within the a.m. peak period – decreasing less than a minute in most intervals, except in the heart of the a.m. peak, from 8:00 a.m. to 9:00 a.m. Between 8:00 a.m. and 8:30 a.m., the mean travel time in the Express Lanes increased slightly and remained unchanged during the 8:30 a.m.-to-9:00 a.m. interval. The greatest change in Express Lanes travel times were observed during the shoulder of the peaks – with travel time decreasing by almost a minute during the 9:00 a.m.-to-10:00 a.m. interval. These changes were again so slight that most motorists would not perceive much change when traveling in the Express Lanes.

Table A-5 also shows that there was only a slight improvement in travel times – less than 1½ minutes in the Express Lanes in the post-deployment period.

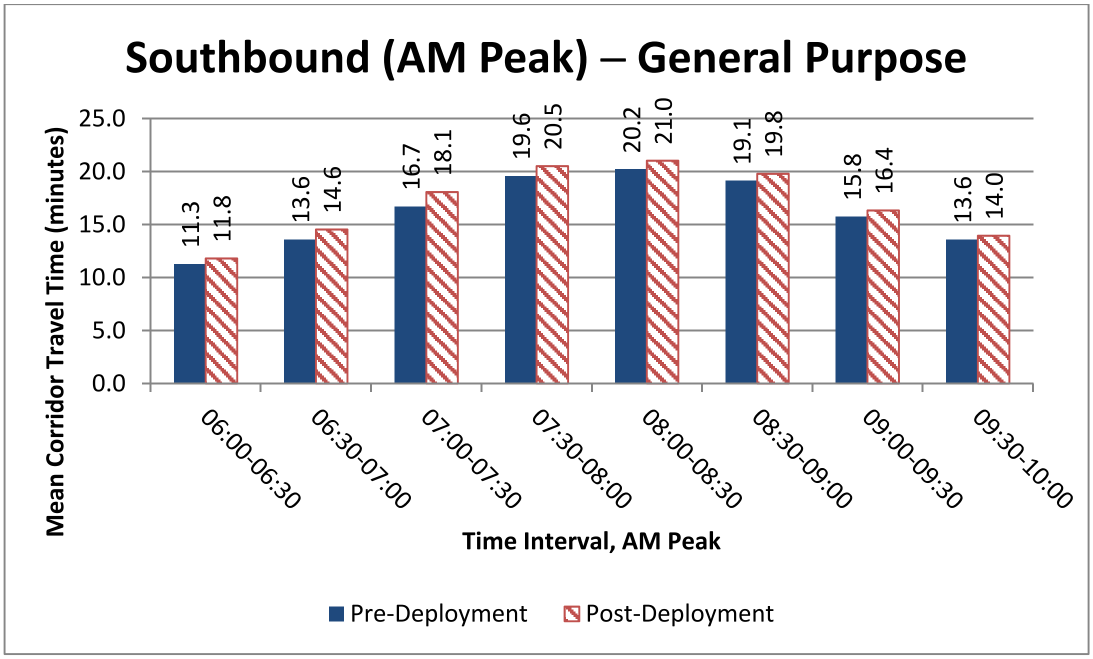
For the p.m. peak, the greatest impact of implementing the CRD improvements on general purpose lane travel times between the pre- and post-deployment evaluations occurred early during the peak periods. During the p.m. peak, travel times in the general purpose lanes increased by about 2 minutes from 3:00 p.m. to 4:30 p.m. and by between 1.3 and 1.7 minutes from 4:30 p.m. to 6:00 p.m. These results suggest that the general purpose lanes were slightly more congested during the post-deployment period compared to the pre-deployment period.

Table A-5. Pre- and Post-Deployment Mean Travel Times (Minutes): Northbound (P.M. Peak)

Time Interval		Mean Travel Time (Minutes)			
Beginning	End	Pre-Deployment	Post-Deployment	Change	Percent Change
General Purpose Lanes					
3:00 p.m.	3:30 p.m.	12.8	14.6	1.8	14.3%
3:30 p.m.	4:00 p.m.	14.3	16.7	2.4	16.7%
4:00 p.m.	4:30 p.m.	16.3	18.5	2.3	14.0%
4:30 p.m.	5:00 p.m.	18.0	19.7	1.7	9.6%
5:00 p.m.	5:30 p.m.	18.9	20.3	1.3	7.0%
5:30 p.m.	6:00 p.m.	18.1	19.6	1.5	8.5%
6:00 p.m.	6:30 p.m.	16.5	17.5	1.1	6.6%
6:30 p.m.	7:00 p.m.	14.5	15.4	0.9	6.2%
Express Lanes					
3:00 p.m.	3:30 p.m.	11.9	12.3	0.4	3.0%
3:30 p.m.	4:00 p.m.	13.3	13.1	-0.3	-1.9%
4:00 p.m.	4:30 p.m.	14.8	13.9	-1.0	-6.4%
4:30 p.m.	5:00 p.m.	16.0	14.7	-1.3	-8.3%
5:00 p.m.	5:30 p.m.	16.1	15.4	-0.8	-4.8%
5:30 p.m.	6:00 p.m.	15.6	15.1	-0.6	-3.7%
6:00 p.m.	6:30 p.m.	14.3	13.7	-0.6	-4.1%
6:30 p.m.	7:00 p.m.	12.8	12.6	-0.3	-2.0%

Source: Texas A&M Transportation Institute.

Table A-6 and Table A-7 show how the relative advantage of using the Express Lanes over the general purpose lanes during each interval during the a.m. and p.m. peak changed between the pre- and post-deployment periods. These tables indicate that with the exception of the interval from 6:00 a.m. to 6:30 a.m., travelers always received a benefit from using the Express Lanes both before and after the deployment of the CRD improvements. These tables highlight that the relative travel time advantage of using the Express Lanes increased in the post-deployment period by up to 2.1 minutes in the a.m. peak and up to 3.2 minutes in the p.m. peak during the post-deployment period. These results imply that, while the changes in actual travel times might not have been large, the travel time advantage of using the Express Lanes increased as a result of the CRD improvements in the corridor.



Texas A&M Transportation Institute.

Figure A-4. Comparison of Pre- and Post-Deployment Mean Travel Times (Minutes) in the Southbound General Purpose Lanes in the A.M. Peak

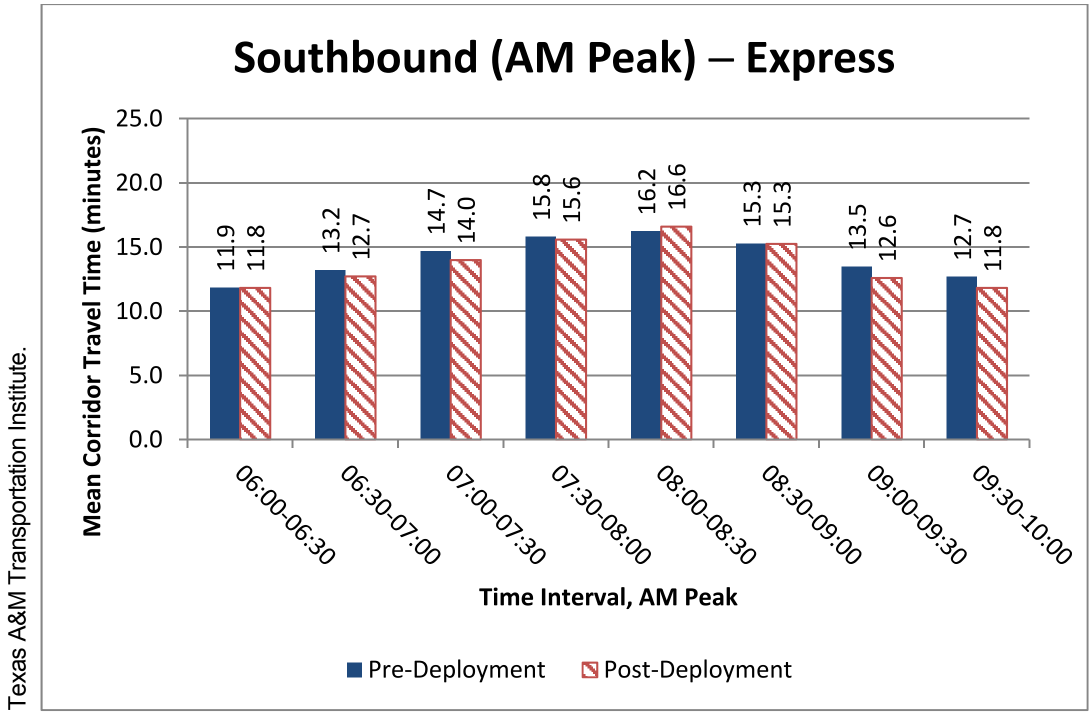


Figure A-5. Comparison of Pre- and Post-Deployment Mean Travel Times (Minutes) in the Southbound Express Lanes in the A.M. Peak

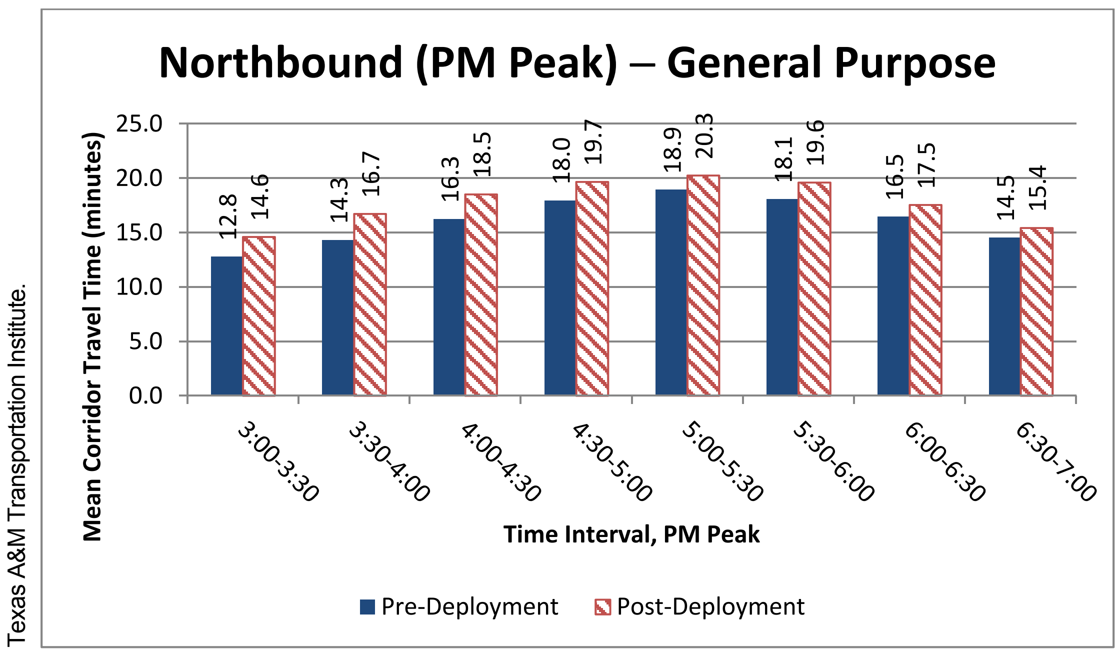
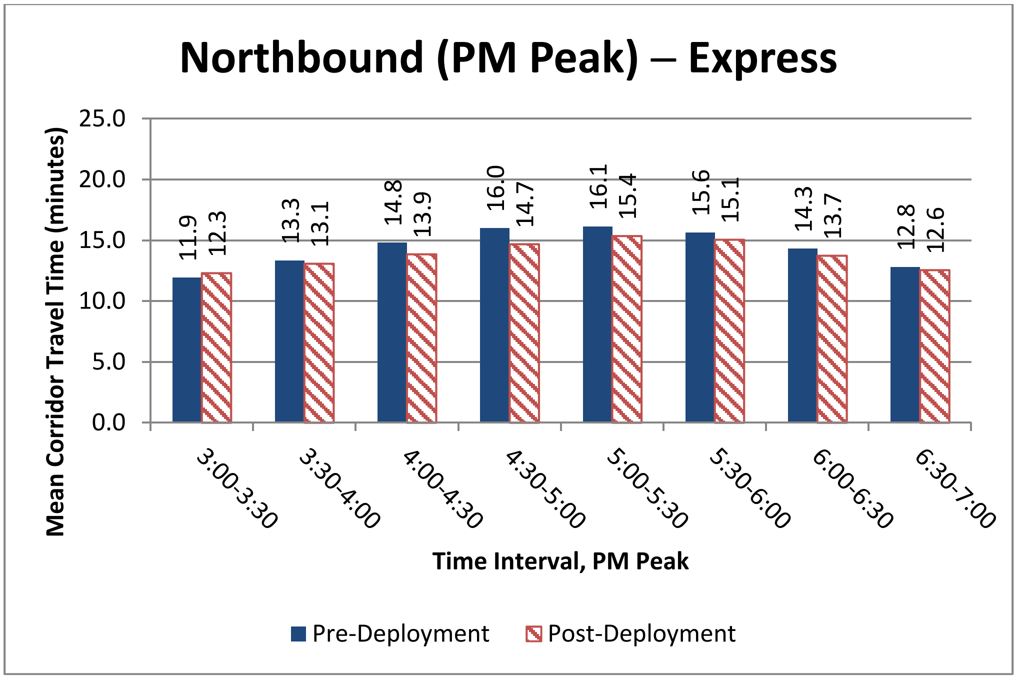


Figure A-6. Comparison of Pre- and Post-Deployment Mean Travel Times (Minutes) in the Northbound General Purpose Lanes in the P.M. Peak



Texas A&M Transportation Institute.

Figure A-7. Comparison of Pre- and Post-Deployment Mean Travel Times (Minutes) in the Northbound Express Lanes in the P.M. Peak

Table A-6. Change in Travel Time Advantage of Using the Express Lanes over the General Purpose Lanes in the A.M. Peak in the CRD Corridor

Time Interval		Relative Travel Time Advantage (minutes)		
Beginning	End	Pre-Deployment	Post-Deployment	Change
6:00 a.m.	6:30 a.m.	-0.5	0.0	0.5
6:30 a.m.	7:00 a.m.	0.4	1.8	1.4
7:00 a.m.	7:30 a.m.	2.0	4.1	2.1
7:30 a.m.	8:00 a.m.	3.8	5.0	1.2
8:00 a.m.	8:30 a.m.	4.0	4.4	0.4
8:30 a.m.	9:00 a.m.	3.9	4.6	0.7
9:00 a.m.	9:30 a.m.	2.3	3.8	1.5
9:30 a.m.	10:00 a.m.	0.9	2.1	1.2

Source: Texas A&M Transportation Institute.

Table A-7. Change in Travel Time Advantage of Using the Express Lanes over the General Purpose Lanes in the P.M. Peak in the CRD Corridor

Time Interval		Relative Travel Time Advantage (minutes)		
Beginning	End	Pre-Deployment	Post-Deployment	Change
3:00 p.m.	3:30 p.m.	0.8	2.3	1.5
3:30 p.m.	4:00 p.m.	1.0	3.7	2.7
4:00 p.m.	4:30 p.m.	1.4	4.7	3.2
4:30 p.m.	5:00 p.m.	2.0	5.0	3.0
5:00 p.m.	5:30 p.m.	2.8	4.9	2.1
5:30 p.m.	6:00 p.m.	2.4	4.5	2.1
6:00 p.m.	6:30 p.m.	2.1	3.8	1.7
6:30 p.m.	7:00 p.m.	1.7	2.9	1.2

Source: Texas A&M Transportation Institute.

Using a linear mixed-effect modeling technique, the national evaluation team conducted statistical analyses of these changes in travel times. The time of day and deployment were considered fixed effects while other factors such as monthly and day-of-week traffic patterns were treated as random effects. The models were calibrated separately by direction and by lane type. In this way, the factors that were known to potentially influence the traffic patterns were still appropriately accounted for in the models while the fixed-effect results indicated the magnitude and statistical significance of CRD deployment impacts.

Table A-8 and Table A-9 present the results of these analyses for the a.m. peak direction and the p.m. peak direction, respectively. All statistical comparisons were performed at a 95th percentile confidence level.

Table A-8. Results of Statistical Comparison of Pre- and Post-Deployment Mean Travel Times (Minutes): Southbound (A.M. Peak)

Time Interval		Model Estimated Mean Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Difference	Standard Error	t-value	Statistical Significant?[1]
General Purpose Lanes							
6:00 a.m.	6:30 a.m.	11.4	12.1	0.66	0.28	2.37	**Yes**
6:30 a.m.	7:00 a.m.	14.0	14.8	0.84	0.28	2.99	**Yes**
7:00 a.m.	7:30 a.m.	17.2	18.3	1.14	0.28	4.08	**Yes**
7:30 a.m.	8:00 a.m.	20.6	20.6	0.04	0.28	0.13	No
8:00 a.m.	8:30 a.m.	21.3	21.1	-0.13	0.28	-0.48	No
8:30 a.m.	9:00 a.m.	19.9	20.1	0.24	0.28	0.85	No
9:00 a.m.	9:30 a.m.	16.3	16.8	0.52	0.28	1.84	No
9:30 a.m.	10:00 a.m.	14.3	14.5	0.24	0.28	0.87	No
Express Lanes							
6:00 a.m.	6:30 a.m.	12.0	11.9	-0.05	0.22	-0.21	No
6:30 a.m.	7:00 a.m.	13.6	12.9	-0.73	0.20	-3.53	**Yes**
7:00 a.m.	7:30 a.m.	15.3	14.3	-0.93	0.20	-4.62	**Yes**
7:30 a.m.	8:00 a.m.	16.8	15.8	-0.99	0.20	-4.98	**Yes**
8:00 a.m.	8:30 a.m.	17.0	16.9	-0.11	0.20	-0.51	No
8:30 a.m.	9:00 a.m.	15.8	15.7	-0.04	0.20	-0.20	No
9:00 a.m.	9:30 a.m.	13.8	12.8	-0.96	0.20	-4.73	**Yes**
9:30 a.m.	10:00 a.m.	13.2	12.0	-1.24	0.20	-6.01	**Yes**

[1] Highlighted cells were determined to be statistically significant at a 95 percent confidence level.

Source: Texas A&M Transportation Institute.

Table A-9. Results of Statistical Comparison of Pre- and Post-Deployment Mean Travel Times (Minutes): Northbound (P.M. Peak)

Time Interval		Model Estimated Mean Travel Time (Minutes)					
Beginning	End	Pre-Deployment	Post-Deployment	Difference	Standard Deviation	t-value	Statistically Significant?[1]
General Purpose Lanes							
3:00 p.m.	3:30 p.m.	13.4	15.5	2.08	0.35	5.97	**Yes**
3:30 p.m.	4:00 p.m.	15.3	17.4	2.04	0.35	5.91	**Yes**
4:00 p.m.	4:30 p.m.	16.9	19.0	2.09	0.35	6.0	**Yes**
4:30 p.m.	5:00 p.m.	18.2	20.4	2.24	0.35	6.44	**Yes**
5:00 p.m.	5:30 p.m.	19.4	20.8	1.40	0.35	4.04	**Yes**
5:30 p.m.	6:00 p.m.	18.8	20.1	1.32	0.35	3.79	**Yes**
6:00 p.m.	6:30 p.m.	16.9	17.8	0.81	0.35	2.31	**Yes**
6:30 p.m.	7:00 p.m.	15.2	15.8	0.66	0.35	1.86	No
Express Lanes							
3:00 p.m.	3:30 p.m.	12.3	12.5	0.21	0.25	0.84	No
3:30 p.m.	4:00 p.m.	14.0	13.3	-0.62	0.25	-2.52	**Yes**
4:00 p.m.	4:30 p.m.	15.3	14.1	-1.21	0.25	-4.87	**Yes**
4:30 p.m.	5:00 p.m.	16.3	15.6	-0.67	0.25	-2.68	**Yes**
5:00 p.m.	5:30 p.m.	16.8	15.8	-0.95	0.25	-3.82	**Yes**
5:30 p.m.	6:00 p.m.	16.7	15.9	-0.85	0.25	-3.39	**Yes**
6:00 p.m.	6:30 p.m.	14.8	14.3	-0.52	0.25	-2.08	**Yes**
6:30 p.m.	7:00 p.m.	13.3	12.9	-0.39	0.25	-1.54	No

[1] Highlighted cells were determined to be statistically significant at a 95 percent confidence level.

Source: Texas A&M Transportation Institute.

Table A-8 shows the results of the comparison of model estimated mean travel times for the general purpose lanes and Express Lanes for the a.m. peak. This table shows that except for the very edge of the a.m. peak (from 6:00 a.m. to 7:30 a.m.), the estimated mean travel times in the general purpose lanes were not statistically different in the post-deployment period compared to the pre-deployment period. The table shows that from 6:00 a.m. to 7:30 a.m. the travel times in the general purpose lane in the southbound direction were determined to be statistically higher (by approximately a minute) during the post-deployment period compared to the pre-deployment period during this same time interval. Once past 7:30 a.m. for the remainder of the a.m. peak, the differences in the pre-and post-deployment travel times in the general purpose lane were not statistically different.

Table A-8 also shows the results of the model comparison of the travel times in the Express Lane in the southbound direction during the a.m. peak. The table shows that from 6:30 a.m. to 8:00 a.m. and again from 9:00 a.m. to 10:00 a.m., travel times in the Express lanes were statistically lower by approximately 1 minute in the post-deployment period compared to the pre-deployment period. At all other times (from 6:00 a.m. to 6:30 a.m. and again from 8:00 a.m. to 9:00 a.m.), no statistical difference existed in the travel times in the Express Lanes in the a.m. peak.

Table A-9 presents the results of the comparison of model estimated mean travel times for the general purpose lanes and Express Lanes for the p.m. peak period. This table shows that except for the very edge of the peak, the estimated mean travel times were all statistically higher in the post-deployment period compared to the pre-deployment period. For the general purpose lanes, travel times in the general purpose lanes were over 2 minutes higher early in the peak (i.e., before 5:00 p.m.), and less than 1.5 minutes higher later in the evening (i.e., after 5:00 p.m.). At the same time, the Express Lanes operated between 2 to 4 minutes faster consistently in the p.m. peak. Only early in the p.m. peak (between 3:00 p.m. and 3:30 p.m.) and late in the peak (from 6:30 p.m. to 7:00 p.m.) were travel times not statistically different in the post-evaluation period compared to the pre-evaluation period.

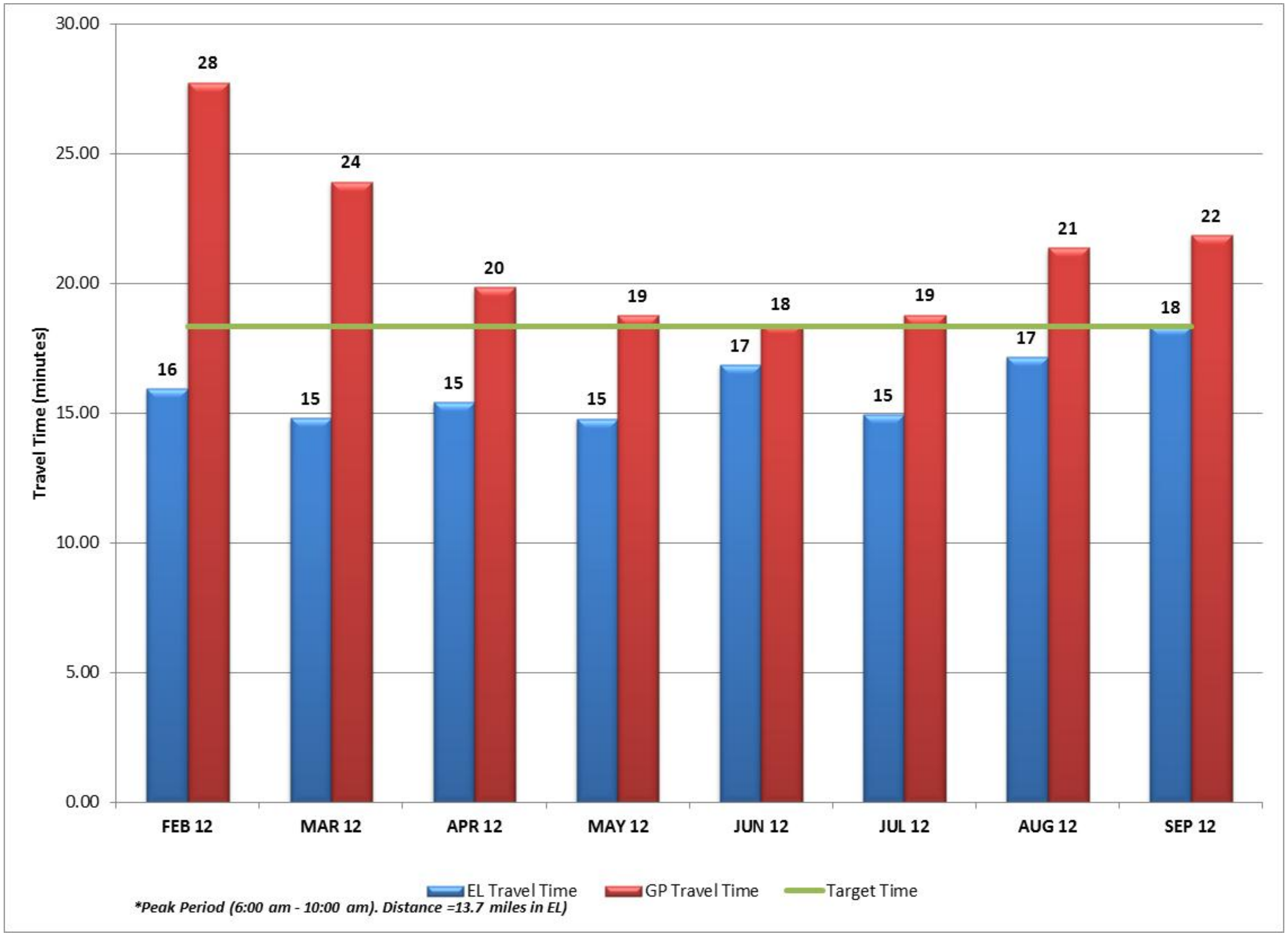
SRTA provided the national evaluation team with Figure A-8 and Figure A-9. The figures illustrate the average travel times for the Express Lanes and general purpose lanes for Tuesdays in the morning peak period from 6:00 a.m. to 10:00 a.m. and the afternoon peak period from 3:00 p.m. to 7:00 p.m. for eight months during the post-deployment period. The figures were based on data from the SRTA tolling automatic vehicle identification (AVI) system. SRTA selected Tuesdays for their analysis, as it shows the lowest travel time savings of all weekdays, especially in the morning peak period.

SRTA noted that in the morning southbound directions the calculations for travel time in the general purpose lanes were extrapolated from a data set covering a shorter distance (approximately 9.5 miles, from general purpose (GP) scan site 1 to GP scan site 4) to a longer distance (approximately 13.7 miles GP scan site 1 to GP scan site 6) assuming equal speed between these two segments to match the Express Lane (EL) data (approximately 13.7 miles from tolling gantries G-31 to G-02). The afternoon northbound data and calculations do not have these limitations as data were for a 12.06-mile length, from GP scan site 1/tolling gantry G-02 to GP scan site 6/tolling gantry G-27.

SRTA's travel time savings were slightly greater than the similar figures computed using the data from GDOT's NaviGAtor system. It should be noted that segments of I-85 used in the two analyses were slightly different in location and in length. The segment length used to compute travel times for the NaviGAtor data was about 11.5 miles, the distance covered by the NaviGAtor detection stations, whereas SRTA's data were for the full 15.5 mile corridor. The travel-time savings between the Express Lanes and the general purpose lanes computed from the NaviGAtor data during April 2012 and August 2012 range between 2.7 and 3.9 minutes in the morning peak (6:00 a.m. to 10:00 am.) and between 3.0 and 4.5 minutes in the afternoon peak (3:00 a.m. to 7:00 p.m.). Data from the SRTA AVI system showed travel time savings from 1 to 5 minutes in the morning peak and from 4 to 6 minutes in the afternoon peak for the same months. The greater travel time savings observed in the afternoon peak was consistent between both data sets.

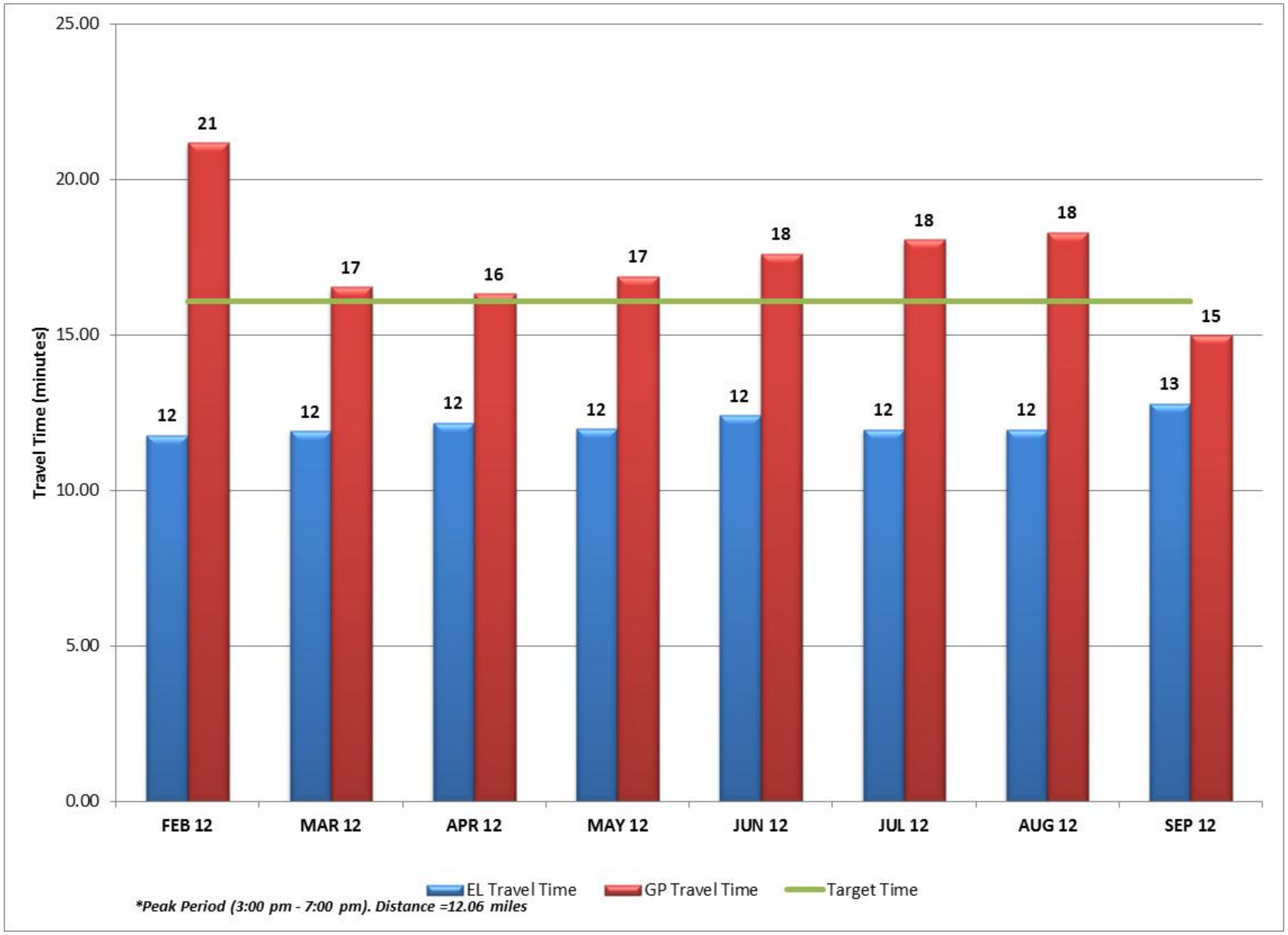
Further examination of the differences in travel time savings between the SRTA and GDOT data revealed that the differences in travel times on the Express Lanes appeared to be the major source of the differences in travel time savings between two data sources. The travel times from the GDOT data in the morning peak period were in the range of 17 to 18 minutes on the general purpose lanes and 13 to 15 minutes on the Express Lanes. The data from SRTA showed travel times from April to August in the range of 18 to 21 minutes on the general purpose lanes and 15 to 17 minutes on the Express Lanes. For the afternoon peak, the travel times from the GDOT data were between 17 to 19 minutes on the general purpose lanes and 13 to 15 minutes on the Express Lanes. The travel times from the SRTA data were approximately 16 to 18 minutes on the general purpose lanes and 12 minutes on the Express Lanes. The larger differences in Express Lane travel times could be attributed to the imputation of travel time using fewer valid detector stations on the Express Lanes than the general purpose lanes based on GDOT data. With less coverage from valid detector stations on the Express Lanes, the travel speeds produced from each station were used to extrapolate for longer segment distances which might obscure the spatial variation in congestion along the corridor.

State Roadway and Tollway Authority.



Target Time = travel time necessary to meet Federal HOV requirement of 45 mph over the detector to detector distance of approximately 13.5 miles.

Figure A-8. Tuesday A.M. Peak Period* Average Travel Times on I-85 Express Lanes versus General Purpose Lanes



State Roadway and Tollway Authority.

Target Time = travel time necessary to meet Federal HOV requirement of 45 mph over the detector to detector distance of approximately 13.5 miles.

Figure A-9. Tuesday P.M. Peak Period* Average Travel Times on I-85 Express Lanes versus General Purpose Lanes

A.3.2 Mean Travel Speed

The national evaluation team also compared the average travel speed in the corridor before and after deploying the CRD improvements in the I-85 corridor. The analysis compared the pre- and post-deployment mean travel speeds of both the general purpose and the Express Lanes for the peak direction of travel in the a.m. and p.m. peaks, as shown in Table A-10. Mean travel speeds were computed by averaging the average travel speeds from 30 minute interval during each peak period. Figure A-10 provides a graphical comparison of these mean travel speeds for type of lane in each period.

Table A-10. Pre- and Post-Deployment Mean Travel Speed (in mph) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Peak Period (Direction of Flow)	Lane Type	Mean Travel Speed (mph)[1]			
		Pre-Deployment	Post-Deployment	Change	Percent Change
A.M. Peak (Southbound)	General Purpose	46.1	43.9	-2.2	-4.7%
	Express	50.1	51.5	1.4	2.7%
P.M. Peak (Northbound)	General Purpose	45.1	41.0	-4.1	-9.0%
	Express	50.3	51.6	1.3	2.6%

[1] Based on NaviGAtor II data only.

Source: Texas A&M Transportation Institute.

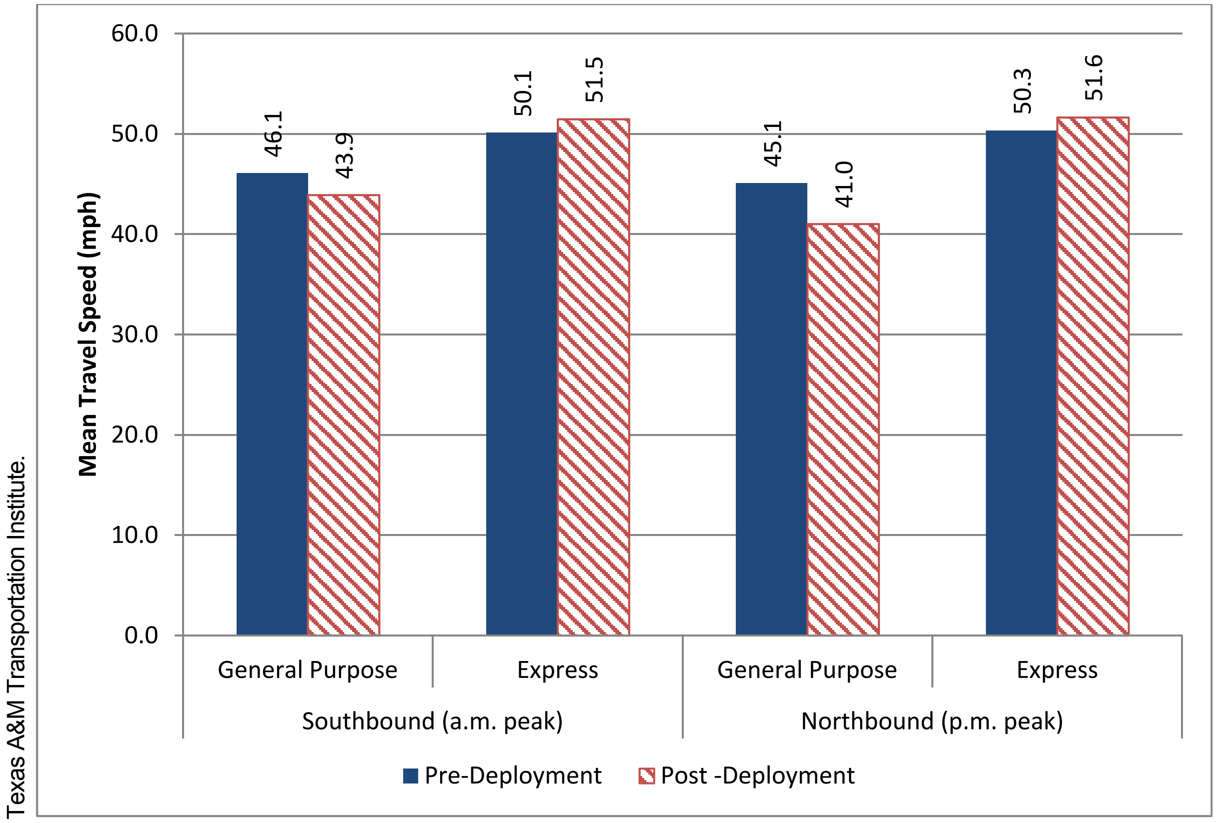


Figure A-10. Mean Travel Speed (in MPH) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

The table and figure show that when averaged over the entire peak period, average travel speeds in the general purpose lanes declined slightly in the peak direction of travel in both the a.m. and p.m. peaks. Mean peak period travel speed in the general purpose lanes dropped by 2 mph in the a.m. peak and by 4 mph in the p.m. peak. Mean travel speeds in the Express Lanes in both the a.m. and p.m. peaks increased by approximately 1 mph after the CRD improvements.

Table A-11 shows a comparison of the pre- and post-deployment corridor travel speeds for the a.m. peak direction of flow (southbound) while Table A-12 compares the pre- and post-deployment travel speeds for the p.m. peak direction of flow (northbound). The values in these tables were computed by averaging the travel speeds directly for each 30 minute interval, without controlling for day of week, or monthly variations. Figure A-11 through Figure A-14 presents the variation in mean travel speeds in the general purpose lanes and in the Express Lanes throughout the a.m. and p.m. peak periods

Table A-11. Pre- and Post-Deployment Mean Travel Sped (MPH): Southbound (A.M. Peak)

Time Interval		Mean Travel Speed (MPH)			
Beginning	End	Pre-Deployment	Post-Deployment	Change	Percent Change
General Purpose Lanes					
6:00 a.m.	6:30 a.m.	61.5	59.0	-2.5	-4.1%
6:30 a.m.	7:00 a.m.	51.5	48.3	-3.2	-6.2%
7:00 a.m.	7:30 a.m.	42.3	39.3	-3.1	-7.2%
7:30 a.m.	8:00 a.m.	36.9	34.7	-2.1	-5.8%
8:00 a.m.	8:30 a.m.	36.6	34.5	-2.1	-5.7%
8:30 a.m.	9:00 a.m.	38.7	37.3	-1.4	-3.7%
9:00 a.m.	9:30 a.m.	46.6	45.4	-1.2	-2.5%
9:30 a.m.	10:00 a.m.	53.2	51.9	-1.3	-2.4%
Express Lanes					
6:00 a.m.	6:30 a.m.	58.6	58.9	0.3	0.4%
6:30 a.m.	7:00 a.m.	52.7	54.8	2.1	4.0%
7:00 a.m.	7:30 a.m.	47.4	49.9	2.5	5.2%
7:30 a.m.	8:00 a.m.	44.3	45.2	0.9	2.1%
8:00 a.m.	8:30 a.m.	43.6	43.2	-0.4	-0.9%
8:30 a.m.	9:00 a.m.	46.3	47.4	1.1	2.3%
9:00 a.m.	9:30 a.m.	52.2	55.6	3.4	6.6%
9:30 a.m.	10:00 a.m.	55.4	59.0	3.6	6.5%

Source: Texas A&M Transportation Institute.

Table A-12. Pre- and Post-Deployment Mean Travel Speed (MPH): Northbound (P.M. Peak.)

Time Interval		Mean Travel Speed (MPH)			
Beginning	End	Pre-Deployment	Post- Deployment	Change	Percent Change
General Purpose Lanes					
3:00 p.m.	3:30 p.m.	55.6	49.4	-6.2	-11.1%
3:30 p.m.	4:00 p.m.	49.9	43.0	-6.9	-13.8%
4:00 p.m.	4:30 p.m.	43.9	38.9	-5.0	-11.4%
4:30 p.m.	5:00 p.m.	39.9	36.7	-3.2	-8.1%
5:00 p.m.	5:30 p.m.	38.1	35.6	-2.5	-6.5%
5:30 p.m.	6:00 p.m.	39.9	36.9	-3.0	-7.5%
6:00 p.m.	6:30 p.m.	44.1	41.5	-2.7	-6.1%
6:30 p.m.	7:00 p.m.	50.1	47.4	-2.7	-5.4%
Express Lanes					
3:00 p.m.	3:30 p.m.	59.4	57.6	-1.8	-3.0%
3:30 p.m.	4:00 p.m.	53.7	54.1	0.4	0.8%
4:00 p.m.	4:30 p.m.	48.2	51.1	2.9	5.9%
4:30 p.m.	5:00 p.m.	44.8	48.4	3.6	8.1%
5:00 p.m.	5:30 p.m.	44.6	46.4	1.8	3.9%
5:30 p.m.	6:00 p.m.	46.0	47.4	1.4	3.1%
6:00 p.m.	6:30 p.m.	50.3	51.8	1.5	3.0%
6:30 p.m.	7:00 p.m.	56.0	56.5	0.6	1.0%

Source: Texas A&M Transportation Institute.

Linear mixed effects models were used to quantify and evaluate the statistical significance of the effects of the CRD improvements on travel conditions on I-85. The models were calibrated for travel speeds by direction and lane type. The 30-minute time block indicator variables were treated as fixed effects in the models to capture their effects on travel speed and segregate the effects of CRD strategies. The month and interactions of day-of-week and time blocks were treated as random effects to recognize their influence on travel speed. Table A-13 and Table A-14 show the results of a mixed effect statistical analysis of travel speeds in the general purpose and Express Lanes in the peak direction of flow during the peak peaks. The shaded cells are the speed changes that were statistically significant at 95 percent confidence level.

Table A-13. Results of Statistical Comparison of Pre- and Post-Deployment Modeled Mean Travel Speeds (MPH): Southbound (A.M. Peak)

Time Interval		Modeled Mean Travel Speed (MPH)					
Beginning	End	Pre-Deployment	Post-Deployment	Difference	Std. Error	t-value	Statistically Significant?[1]
General Purpose Lanes							
6:00 a.m.	6:30 a.m.	61.1	58.4	-2.76	0.5184	-5.32	**Yes**
6:30 a.m.	7:00 a.m.	51.0	48.2	-2.80	0.5186	-5.40	**Yes**
7:00 a.m.	7:30 a.m.	42.2	39.5	-2.62	0.5195	-5.05	**Yes**
7:30 a.m.	8:00 a.m.	36.8	35.3	-1.54	0.5209	-2.96	**Yes**
8:00 a.m.	8:30 a.m.	36.4	35.2	-1.26	0.5188	-2.43	**Yes**
8:30 a.m.	9:00 a.m.	38.6	37.7	-0.93	0.5206	-1.79	No
9:00 a.m.	9:30 a.m.	46.0	45.2	-0.84	0.5226	-1.60	No
9:30 a.m.	10:00 a.m.	52.1	51.2	-0.92	0.5210	-1.76	No
Express Lanes							
6:00 a.m.	6:30 a.m.	58.2	58.6	0.40	0.4595	0.87	No
6:30 a.m.	7:00 a.m.	51.9	54.4	2.55	0.4253	6.00	**Yes**
7:00 a.m.	7:30 a.m.	46.7	49.5	2.81	0.4168	6.74	**Yes**
7:30 a.m.	8:00 a.m.	43.4	45.1	1.69	0.4106	4.13	**Yes**
8:00 a.m.	8:30 a.m.	43.0	43.2	0.15	0.4123	0.36	No
8:30 a.m.	9:00 a.m.	45.7	47.0	1.27	0.4133	3.06	**Yes**
9:00 a.m.	9:30 a.m.	51.5	55.2	3.66	0.4187	8.74	**Yes**
9:30 a.m.	10:00 a.m.	54.3	55.9	4.38	0.4252	10.29	**Yes**

[1] Cells in **bold** were determined to be statistically significant at a 95 percent confidence level.

Source: Texas A&M Transportation Institute.

Table A-14. Results of Statistical Comparison of Pre- and Post-Deployment Modeled Mean Travel Speeds (MPH): Northbound (P.M. Peak)

Time Interval		Modeled Mean Travel Speed (MPH)					
Beginning	End	Pre-Deployment	Post-Deployment	Difference	Std. Error	t-value	Statistically Significant?[1]
General Purpose Lanes							
3:00 p.m.	3:30 p.m.	54.7	48.7	-6.03	0.5303	-11.38	**Yes**
3:30 p.m.	4:00 p.m.	49.3	42.8	-6.60	0.5260	-12.54	**Yes**
4:00 p.m.	4:30 p.m.	44.0	38.8	-5.13	0.5316	-9.64	**Yes**
4:30 p.m.	5:00 p.m.	40.1	36.5	-3.66	0.5303	-6.89	**Yes**
5:00 p.m.	5:30 p.m.	38.2	35.4	-2.72	0.5290	-5.15	**Yes**
5:30 p.m.	6:00 p.m.	40.0	36.9	-3.05	0.5324	-5.74	**Yes**
6:00 p.m.	6:30 p.m.	44.1	41.6	-2.55	0.5335	-4.78	**Yes**
6:30 p.m.	7:00 p.m.	49.7	47.1	-2.66	0.5365	-4.95	**Yes**
Express Lanes							
3:00 p.m.	3:30 p.m.	58.5	57.0	-1.56	0.4140	-3.77	**Yes**
3:30 p.m.	4:00 p.m.	52.9	23.6	0.74	0.4119	1.80	No
4:00 p.m.	4:30 p.m.	47.9	50.7	2.72	0.4149	6.55	**Yes**
4:30 p.m.	5:00 p.m.	44.7	47.4	2.73	0.4187	6.51	**Yes**
5:00 p.m.	5:30 p.m.	44.2	45.8	1.53	0.4143	3.68	**Yes**
5:30 p.m.	6:00 p.m.	45.6	46.7	1.15	0.4167	2.77	**Yes**
6:00 p.m.	6:30 p.m.	49.8	51.1	1.26	0.4139	3.04	**Yes**
6:30 p.m.	7:00 p.m.	52.2	55.9	0.69	0.4205	1.63	No

[1] Cells in **bold** were determined to be statistically significant at a 95 percent confidence level.

Source: Texas A&M Transportation Institute.

Table A-13 and Table A-14 show more periods where the differences in mean travel speeds were statistically different than for mean travel times (see Table A-8 and Table A-9). This is because the variability in travel times derived from speeds tends to be greater than that of speeds particularly when the measured variances are high such as during the peak and shoulders of the peak periods. As a result, the detection power in travel time will generally be less during the period of high variability. During the periods of low variability, travel speeds and travel times will have similar power to detect the changes statistically.

Figure A-12 and Figure A-14 show that travel speeds in the Express Lanes in the a.m. and p.m. peak were consistently higher throughout the entire peak in the post-deployment period compared to the pre-deployment period. In almost every time interval during the a.m. peak (except two), travel speeds in the Express Lanes were 1-to-3 mph higher during the post-deployment evaluation. The only time intervals in the a.m. peak where the Express Lanes travel speeds were not statistically significant were from 6:00 a.m. to 6:30 a.m. and from 8:00 a.m. to 8:30 a.m. In the p.m. peak, travel speeds were approximately 2-to-4 mph faster in the heart of the peak (4:00 p.m. to 6:30 p.m.) in the post-deployment period compared to pre-deployment period. This suggests that introducing HOT operations did not negatively impact travel speeds in the Express Lanes on I-85 and, in fact, helped improve travel speeds slightly, compared to the pre-deployment condition.

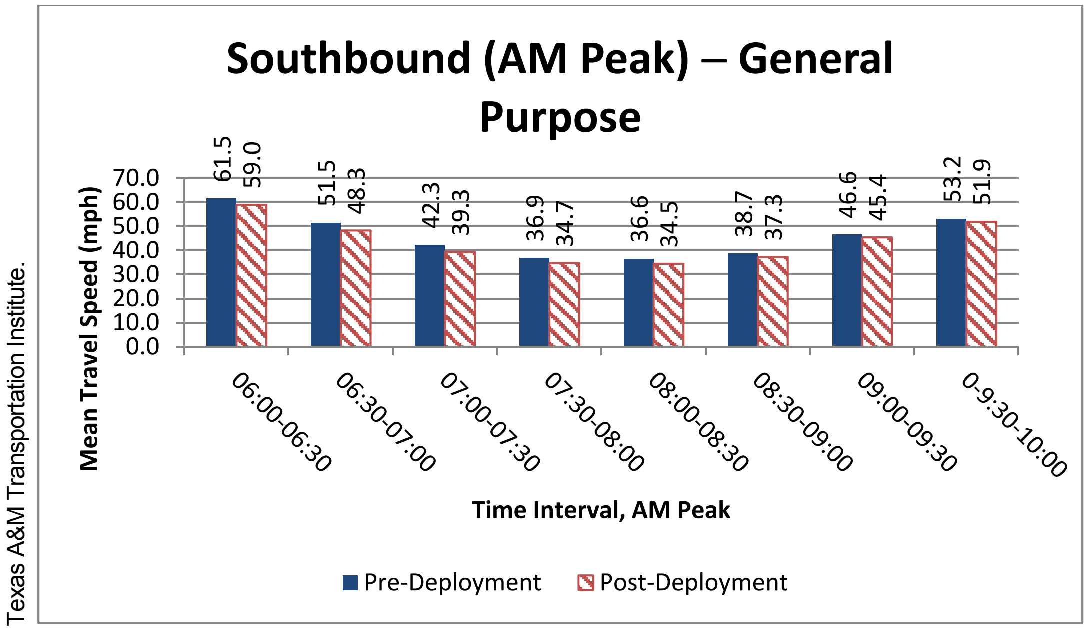


Figure A-11. Comparison of Pre- and Post-Deployment Mean Travel Speed (MPH) in the Southbound General Purpose Lanes in the A.M. Peak

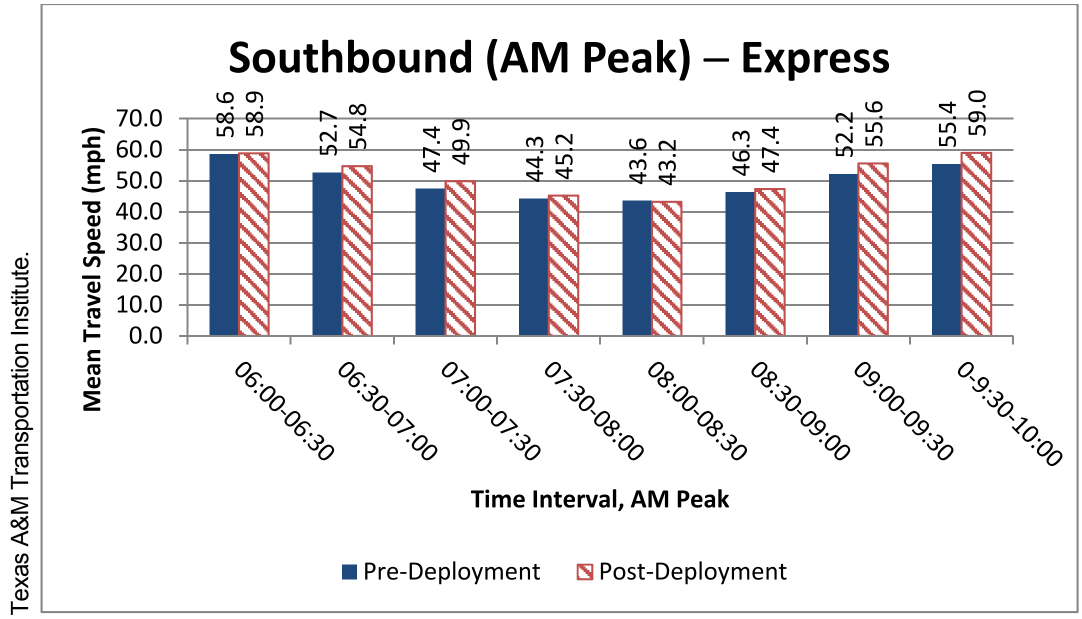


Figure A-12. Comparison of Pre- and Post-Deployment Mean Travel Speed (MPH) in the Southbound Express Lanes in the A.M. Peak

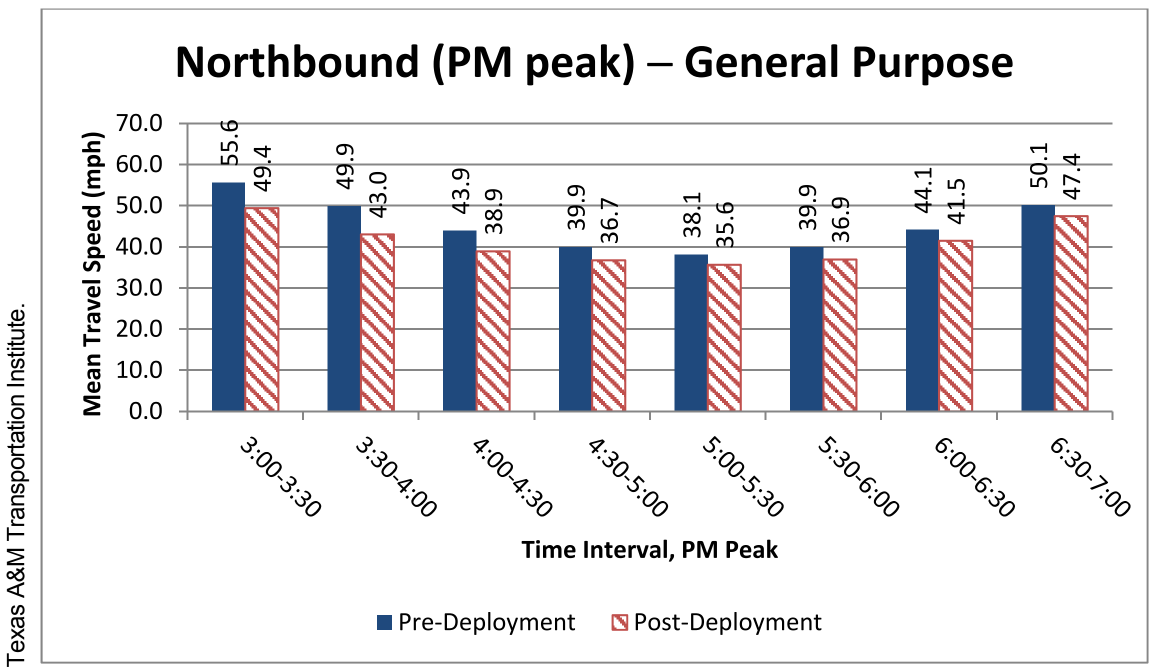


Figure A-13. Comparison of Pre- and Post-Deployment Mean Travel Speed (MPH) in the Northbound General Purpose Lanes in the P.M. Peak

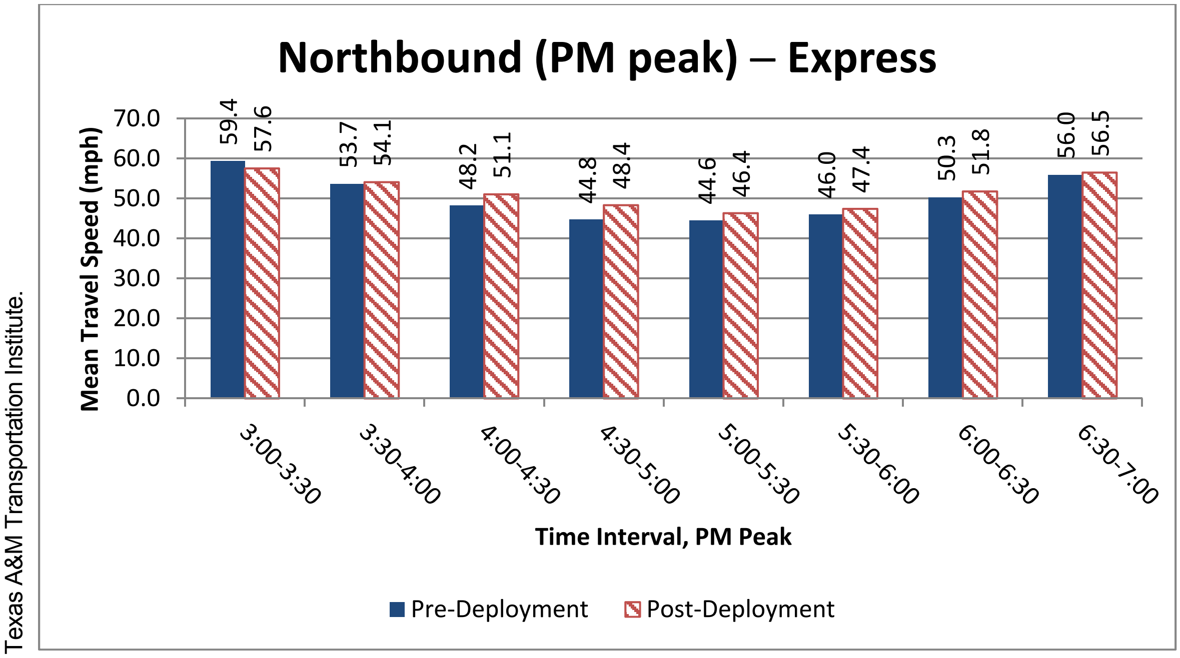


Figure A-14. Comparison of Pre- and Post-Deployment Mean Travel Speed (MPH) in the Northbound Express Lanes in the P.M. Peak

These tables and figures indicate that mean travel speeds in the general purpose lanes were consistently lower throughout both the a.m. and p.m. peak periods. During the a.m. peak, mean travel speeds in the southbound general purpose lanes in the first part of the peak, from 6:00 a.m. to 8:30 a.m., were observed to be 2 to 3 mph lower in the post-deployment period; however, after 8:30 a.m., reductions in speeds in the general purpose lane were not as great (around 1 mph). The reduction in travel speeds before 8:30 a.m. was determined to be statistically significant, while the speed reductions after 8:30 a.m. were not statistically different. While these speeds may be statistically significant, such small reductions in travels speeds may not be perceivable by motorists.

In the p.m. peak, mean travel speeds in the general purpose lanes were also consistently lower in the post-deployment period compared to the pre-deployment period. Table A-13 shows that before 4:30 p.m. travel speeds were between 5 and 7 mph lower in the post-deployment period compared to the pre-deployment mean travel speeds. After 4:30 p.m., travel speeds were around 3 mph lower in the post-deployment period compared to the pre-deployment period. These reductions in speeds were determined be statistically significant. This implies that in the p.m. peak, congestion in the general purpose lanes formed earlier during the peak in the post-deployment period compare to the pre-deployment period.

Figure A-15 and Figure A-16 illustrate the post-deployment average speeds in the Express Lanes and general purpose lanes provided by SRTA for the morning and afternoon peak periods. As noted previously, the figures represent travel on Tuesdays and were based on the SRTA tolling AVI data. The data indicated that speeds on the Express Lanes were above the target of 45 mph in both the morning and afternoon peak periods.

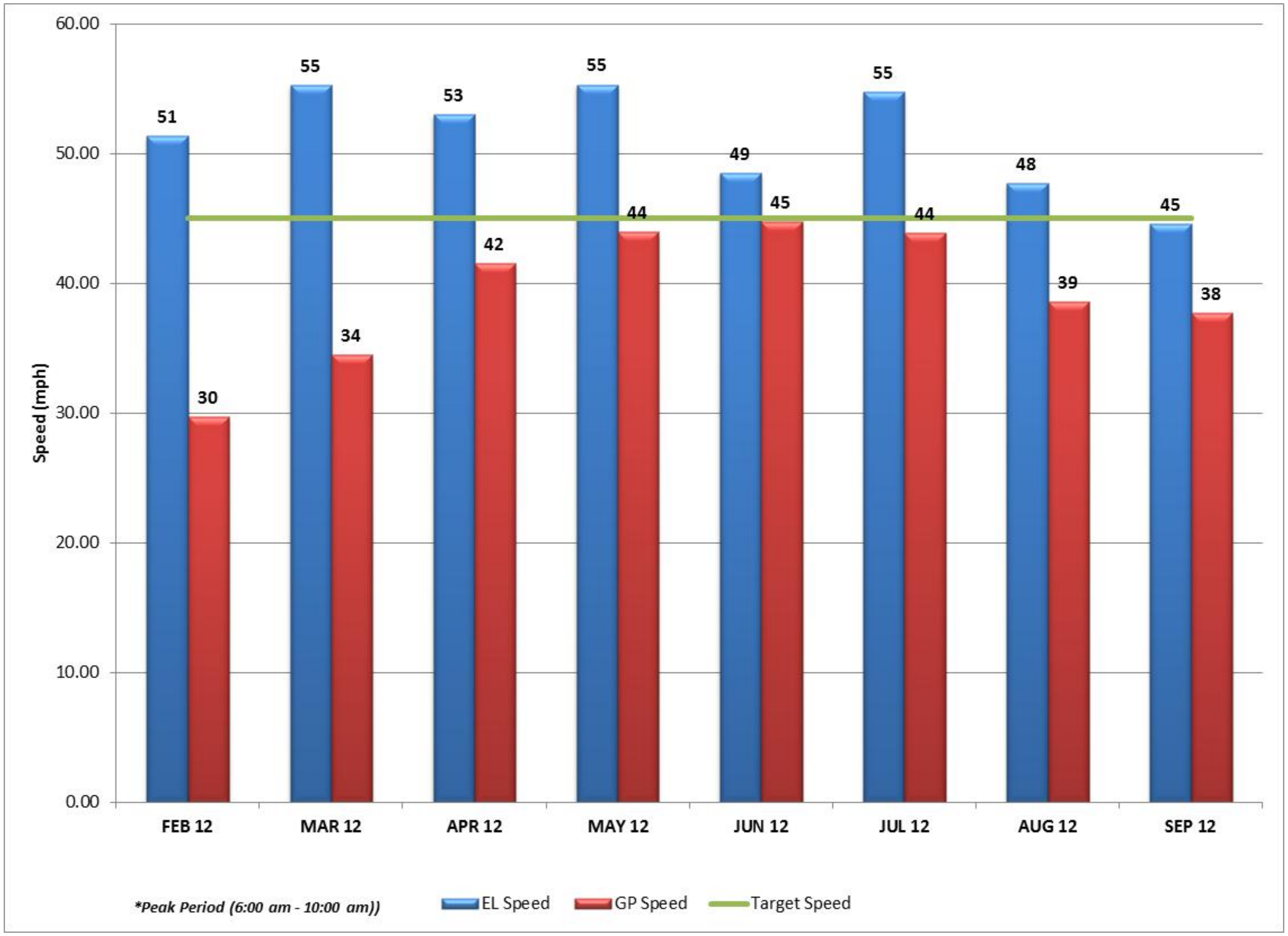
Table A-15 shows a comparison of the post-deployment average speed provided by SRTA and the average speed computed by the national evaluation team for both the Express Lanes and the general purpose lanes during each peak period. The table shows that these travel speeds were generally comparable, except for the general purpose lanes in the a.m. peak. Differences in travel speeds were most likely related to differences in data aggregation procedures, sample sizes, and data sources. It should be noted that speeds in the general purpose lanes in the a.m. peak were calculated by SRTA by extrapolating AVI data. AVI data for the southbound general purpose lanes were not available for the entire corridor until August 2012. Travel speed in the Express Lanes in the p.m. peak were calculated using AVI readers co-located between the general purpose lanes and the Express Lanes in the northbound direction.

Table A-15. Comparison of Average Travel Speed as Measured by SRTA and the National Evaluation Team

		Average Peak Period Travel Speeds (mph)	
Period	**Lane**	**SRTA**	**NaviGAtor Data**
A.M. Peak	General Purpose Lanes	39.5	43.9
	Express Lanes	51.4	51.5
P.M. Peak	General Purpose Lanes	41.8	41.0
	Express Lanes	59.6	51.6

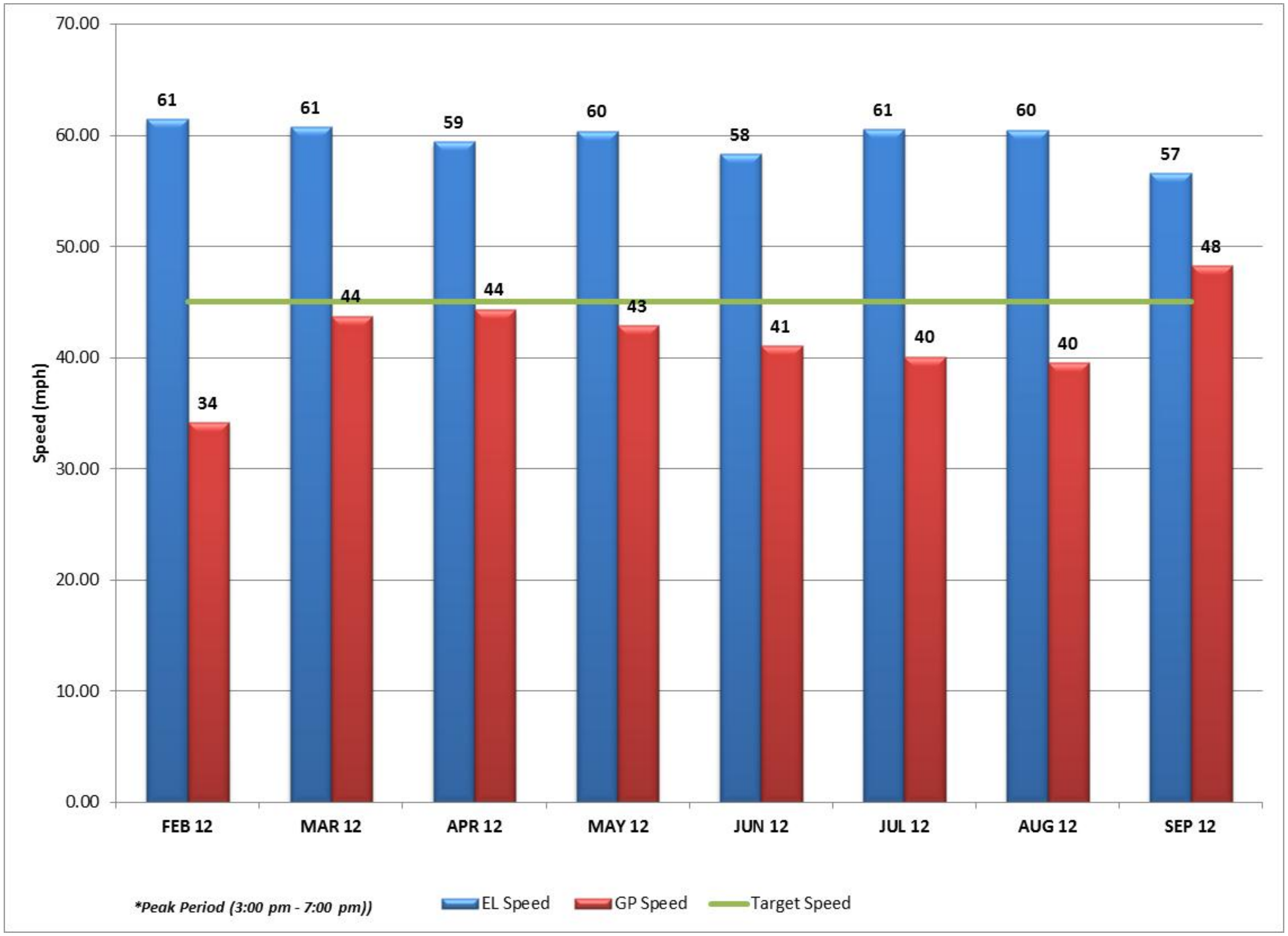
Source: Texas A&M Transportation Institute

State Roadway and Tollway Authority.



Target Speed = 45 mph for meeting Federal HOV requirement.

Figure A-15. Tuesday A.M. Peak Period * Average Speeds on I-85 Express Lanes versus General Purpose Lanes



State Roadway and Tollway Authority.

Target Speed = 45 mph for meeting Federal HOV requirement.

Figure A-16. Tuesday P.M. Peak Period * Average Speeds on I-85 Express Lanes versus General Purpose Lanes

A.3.3 Travel Time Index

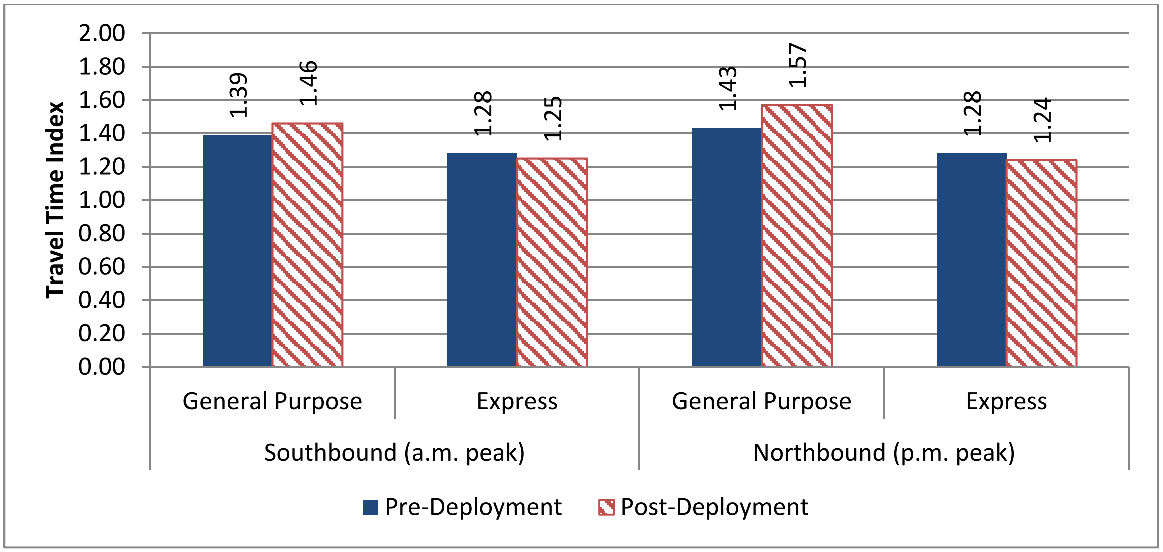
The travel time index (TTI) is another measure that is frequently used to assess the extent to which changes in a corridor impact travel time. The TTI is the ratio of the median travel time during peak periods to the free-flow travel time (i.e., the time it would take to traverse the same distance traveling at the speed limit). The TTI is used to assess how much more time a trip takes during the peak periods as opposed to the same trip if it occurred during non-peak travel periods. As an example, a TTI of 1.20 means that a trip during the peak period takes 20 percent longer than the same trip if it was made during free-flow periods.

Table A-16 shows the computed travel time indices for both pre- and post-deployment of the CRD improvements. Figure A-17 provides a graphical comparison of these indices. The indices shown in the table are for the peak direction of travel in both the a.m. and p.m. peak periods respectively.

Table A-16. Pre- and Post-Deployment Travel Time Index for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Peak Period (Direction of Flow)	Lane Type	Travel Time Index		
		Pre-Deployment	Post-Deployment	Change
A.M. Peak (Southbound)	General Purpose	1.39	1.46	0.07
	Express	1.28	1.25	-0.03
P.M. Peak (Northbound)	General Purpose	1.43	1.57	0.14
	Express	1.28	1.24	-0.04

Source: Texas A&M Transportation Institute.



Texas A&M Transportation Institute.

Figure A-17. Comparison of Pre- and Post-Deployment Travel Time Index for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Table A-16 and Figure A-17 show slight increases in travel time indices for the general purpose lanes in both the a.m. and p.m. peak. Table A-16 shows that a.m. and p.m. peak travel times in the general purpose lanes were taking 39 percent and 43 percent longer prior to the CRD deployment than the same trip during off-peak periods. In the post-deployment period, these trips were taking approximately 46 and 57 percent longer, a 7 and 14 percent increase. Express Lanes travel did not change substantially between the pre- and post-deployment periods. Table A-17 and Table A-18 show the travel time index in half-hour increments during the a.m. and p.m. peak periods, respectively.

Table A-17. Pre- and Post-Deployment Travel Time Indices for the Southbound Direction of Travel within the A.M. Peak

Time Interval		Travel Time Index			
Beginning	End	Pre-Deployment	Post-Deployment	Change	Percent Change
General Purpose Lanes					
6:00 a.m.	6:30 a.m.	1.05	1.09	0.04	3.8%
6:30 a.m.	7:00 a.m.	1.25	1.33	0.08	6.4%
7:00 a.m.	7:30 a.m.	1.52	1.64	0.12	7.9%
7:30 a.m.	8:00 a.m.	1.74	1.85	0.11	6.3%
8:00 a.m.	8:30 a.m.	1.76	1.86	0.10	5.7%
8:30 a.m.	9:00 a.m.	1.66	1.73	0.07	4.2%
9:00 a.m.	9:30 a.m.	1.38	1.41	0.03	2.2%
9:30 a.m.	10:00 a.m.	1.21	1.24	0.03	2.5%
Express Lanes					
6:00 a.m.	6:30 a.m.	1.10	1.09	-0.01	-0.9%
6:30 a.m.	7:00 a.m.	1.22	1.17	-0.05	-4.1%
7:00 a.m.	7:30 a.m.	1.35	1.29	-0.06	-4.4%
7:30 a.m.	8:00 a.m.	1.45	1.42	-0.03	-2.1%
8:00 a.m.	8:30 a.m.	1.47	1.49	0.02	1.4%
8:30 a.m.	9:00 a.m.	1.39	1.36	-0.03	-2.2%
9:00 a.m.	9:30 a.m.	1.23	1.16	-0.07	-5.7%
9:30 a.m.	10:00 a.m.	1.16	1.09	-0.07	-6.0%

Source: Texas A&M Transportation Institute.

Figure A-18 and Figure A-19 show how the travel time indices varied for both the general purpose lanes and the Express Lanes in the a.m. and p.m. peak respectively. These graphs indicate that there had been a shift in the travel time indices for the general purpose lanes in both the a.m. and p.m. peaks. The shift in travel time indices in the general purpose lanes was worse in the p.m. peak than it was in the a.m. peak. This shift was consistent throughout the entire peak, implying that travel in the general purpose lanes was getting longer throughout the peak and not just at the shoulders or a single interval within the peak.

Figure A-18 illustrates little change in the travel time indices of the Express Lanes during part of the a.m. peak occurred between the pre- and post-deployment periods. Pre-and post-deployment changes in travel time indices in the a.m. peak period track very similarly between 7:30 and 9:00 a.m. This implies that travelers using the Express Lanes in the a.m. peak were experiencing a similar trip as in the pre-deployment period.

Figure A-19 shows slight improvement in the travel time indices of the Express Lanes early on in the p.m. peak (from 3:30 p.m. to 5:00 p.m.) in the post-deployment period. During these times, travel in the Express Lanes tracked closer to free-flow travel times in the post-deployment period compared to the pre-deployment period.

Table A-18. Pre- and Post-Deployment Travel Time Indices for the Northbound Direction of Travel within the P.M. Peak

Time Interval		Travel Time Index			
Beginning	End	Pre-Deployment	Post-Deployment	Change	Percent Change
General Purpose Lanes					
3:00 p.m.	3:30 p.m.	1.16	1.30	0.14	12.1%
3:30 p.m.	4:00 p.m.	1.29	1.49	0.20	15.5%
4:00 p.m.	4:30 p.m.	1.46	1.65	0.19	13.0%
4:30 p.m.	5:00 p.m.	1.61	1.75	0.14	8.7%
5:00 p.m.	5:30 p.m.	1.69	1.80	0.11	6.5%
5:30 p.m.	6:00 p.m.	1.61	1.74	0.13	8.1%
6:00 p.m.	6:30 p.m.	1.46	1.55	0.09	6.2%
6:30 p.m.	7:00 p.m.	1.28	1.35	0.07	5.5%
Express Lanes					
3:00 p.m.	3:30 p.m.	1.08	1.12	0.04	3.7%
3:30 p.m.	4:00 p.m.	1.20	1.19	-0.01	-0.8%
4:00 p.m.	4:30 p.m.	1.33	1.26	-0.07	-5.3%
4:30 p.m.	5:00 p.m.	1.44	1.33	-0.11	-7.6%
5:00 p.m.	5:30 p.m.	1.44	1.39	-0.05	-3.5%
5:30 p.m.	6:00 p.m.	1.40	1.35	-0.05	-3.6%
6:00 p.m.	6:30 p.m.	1.28	1.24	-0.04	-3.1%
6:30 p.m.	7:00 p.m.	1.15	1.14	-0.01	-0.9%

Source: Texas A&M Transportation Institute.

Texas A&M Transportation Institute.

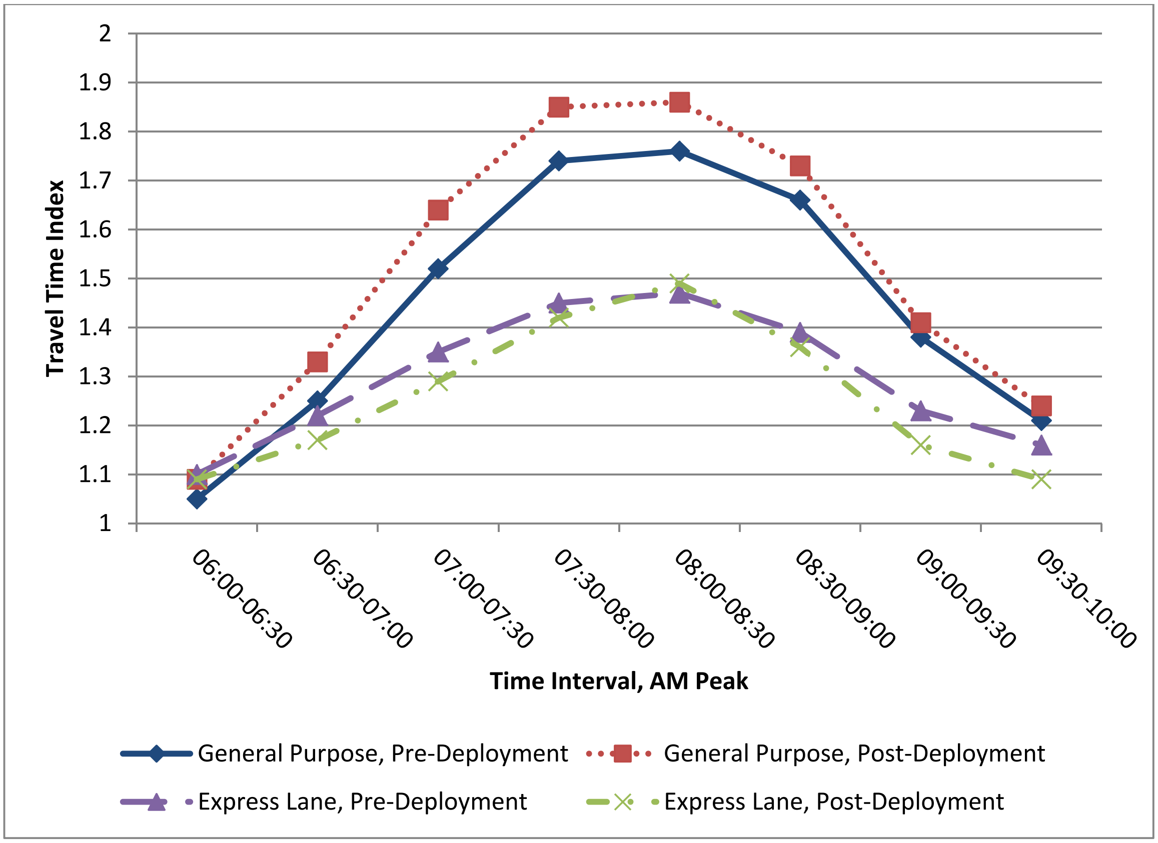


Figure A-18. Changes in the Pre- and Post-Deployment Travel Time Indices with the A.M. Peak for the Southbound Direction of Flow

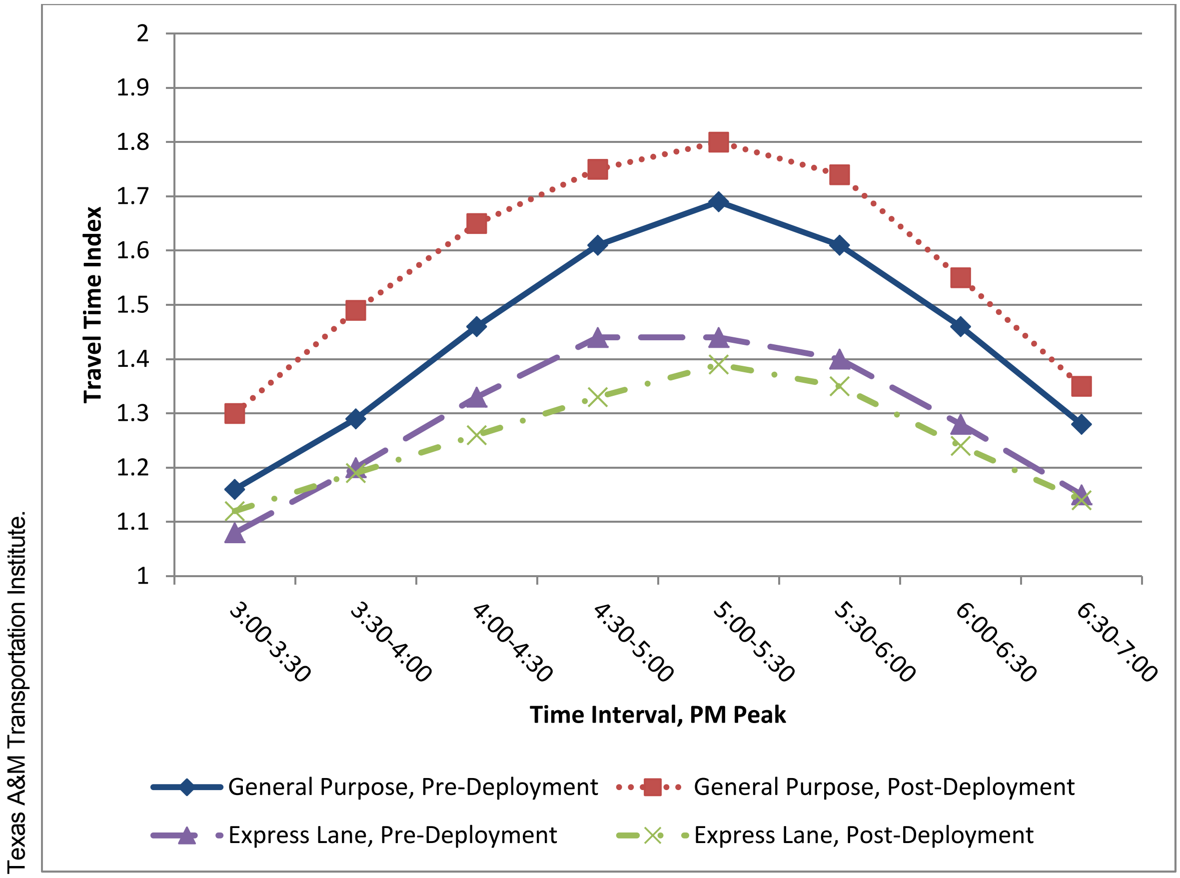


Figure A-19. Changes in the Pre- and Post-Deployment Travel Time Indices with the P.M. Peak

A.4 Travel Time Reliability

Travel-time reliability is a measure of the level of consistency in travel conditions over time. It is often used to assess how travel conditions and congestion vary over a substantial period of time. Travel-time reliability is often synonymous with travel-time predictability. Travelers often adjust their travel behaviors and expectations to accommodate expected levels of congestions. When unexpected congestion or changes in service are encountered, travelers are frustrated, and their satisfaction with the performance of the transportation system may decrease.

As part of the national evaluation, the national evaluation team examined how travel-time reliability was impacted by deploying the CRD improvements in the I-85 corridor. Specifically, the national evaluation team examined two measures of travel-time reliability: the 95th percentile travel time and the buffer index.

A.4.1 95th Percentile Travel Time

The national evaluation team examined the 95th percentile travel times on both the general purpose lanes and in the Express Lanes during both peak periods. The 95th percentile travel time is the time at which 95 percent of the travelers were measured traveling at or below. It is used often as a measure of travel-time reliability and represents the travel time on some of the heaviest traffic days.

Table A-19 presents the recorded 95th percentile travel time computed from the NaviGAtor data. Ninety-fifth percentile travel times were computed for both the general purpose lanes and the Express Lanes for the peak direction of travel for both the a.m. and p.m. peak periods. Figure A-20 provides a graphical representation of the computed 95th percentile travel times computed for the general purpose and Express Lanes for each peak direction of travel.

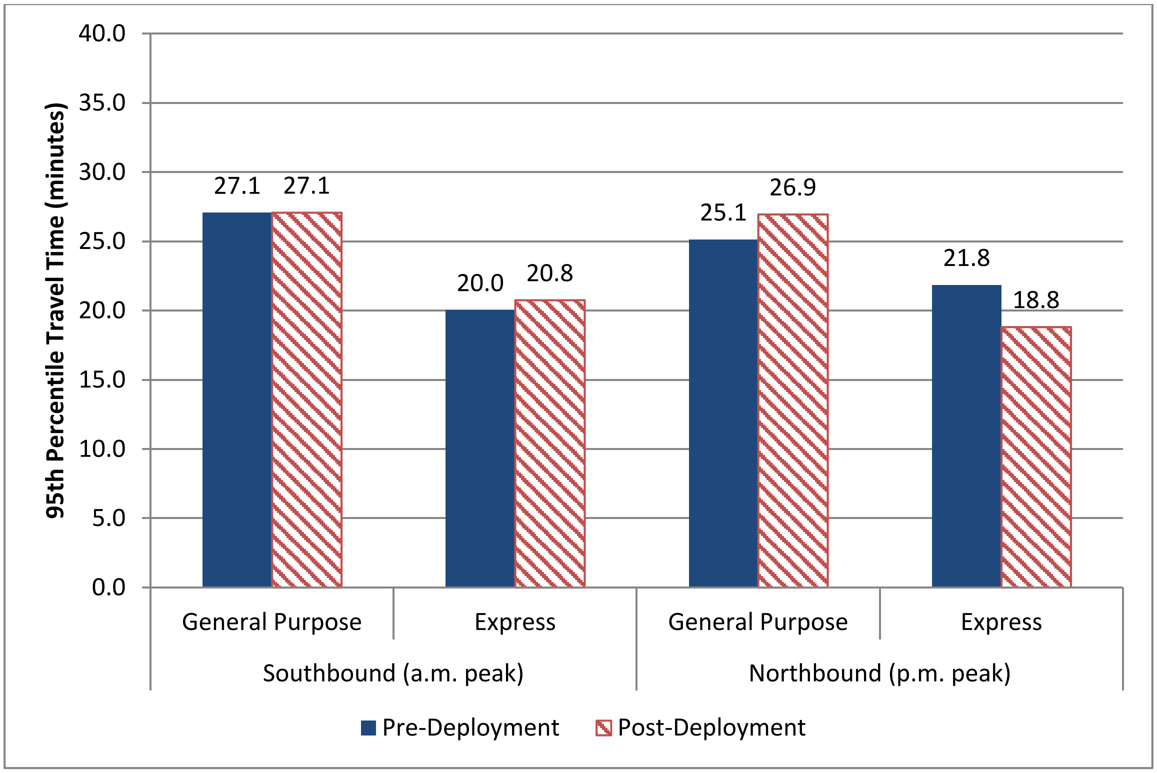
Table A-19 shows little to no change occurred in the peak period 95th percentile travel times for each lane type as a result of deploying the CRD improvements. In the a.m. peak, the peak period 95th percentile for the general purpose lanes remained unchanged, and increased by less than a minute in the Express Lanes in the post-deployment period. In the p.m. peak, the 95th percentile travel times in the general purpose lanes increased by less than two minutes in the post-deployment period, while the 95th percentile travel times in the Express Lanes actually declined by three minutes in the post-deployment period.

Table A-19. Pre- and Post-Deployment 95th Percentile Travel Time (in Minutes) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Peak Period (Direction of Flow)	Lane Type	95th Percentile Travel Time (Minutes)[1]			
		Pre-Deployment	Post-Deployment	Change	Percent Change
A.M. Peak (Southbound)	General Purpose	27.1	27.1	0.0	0.0%
	Express	20.0	20.8	0.8	3.6%
P.M. Peak (Northbound)	General Purpose	25.1	26.9	1.8	7.2%
	Express	21.8	18.8	-3.0	-13.9%

[1] Based on NaviGAtor II data only. NaviGAtor I data deemed to be unreliable for this evaluation purpose until data calibration process complete.

Source: Texas A&M Transportation Institute.



Texas A&M Transportation Institute.

Figure A-20. 95th Percentile Travel Times (in Minutes) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Table A-20 and Table A-21 show how the 95th percentile speed changed by intervals within the peak period between the pre- and post-deployment periods. Table A-20 shows the changes in the 95th percentile speeds for the both general purpose lanes and Express Lanes for the a.m. peak, while Table A-21 shows the changes for the p.m. peak. Figure A-21 through Figure A-24 provides graphical representations of these changes for each peak.

Table A-20. Pre- and Post-Deployment 95th Percentile Travel Times (Minutes): Southbound (A.M. Peak)

Time Interval		95th Percentile Travel Time (Minutes) [1]			
Beginning	End	Pre-Deployment	Post-Deployment	Change	Percent Change
General Purpose Lanes					
6:00 a.m.	6:30 a.m.	13.1	14.6	1.5	11.1%
6:30 a.m.	7:00 a.m.	18.0	19.5	1.4	8.0%
7:00 a.m.	7:30 a.m.	23.8	25.1	1.4	5.9%
7:30 a.m.	8:00 a.m.	33.6	28.4	-5.2	-15.4%
8:00 a.m.	8:30 a.m.	37.3	30.5	-6.8	-18.3%
8:30 a.m.	9:00 a.m.	29.0	29.2	0.1	0.5%
9:00 a.m.	9:30 a.m.	24.8	26.7	1.9	7.5%
9:30 a.m.	10:00 a.m.	23.7	22.8	-0.9	-3.8%
Express Lanes					
6:00 a.m.	6:30 a.m.	12.8	14.3	1.5	11.6%
6:30 a.m.	7:00 a.m.	15.1	15.1	0.0	0.1%
7:00 a.m.	7:30 a.m.	18.0	17.9	-0.1	-0.7%
7:30 a.m.	8:00 a.m.	23.3	20.9	-2.4	-10.1%
8:00 a.m.	8:30 a.m.	24.0	25.6	1.6	6.6%
8:30 a.m.	9:00 a.m.	21.7	24.9	3.2	14.7%
9:00 a.m.	9:30 a.m.	18.0	16.7	-1.3	-7.3%
9:30 a.m.	10:00 a.m.	18.9	14.2	-4.7	-25.1%

[1] Based on NaviGAtor II data only. NaviGAtor I data deemed to be unreliable for this evaluation purpose until data calibration process complete.

Source: Texas A&M Transportation Institute.

The tables and figures show that substantial changes in the 95th percentile travel times were observed in the post-deployment period. Table A-20 and Figure A-21 show that a substantial drop in the 95th percentile speeds was observed in the general purpose lanes in the heart of the a.m. peak (from 7:30 a.m. to 8:30 a.m.) after the deployment of the CRD improvements. During this time period, the 95th percentile travel time decreased by over five minutes in the post-deployment period. This drop suggests that during the heart of the peak, travel times became more stable (or consistent) in the post-deployment period. Leading up to the heart of the peak, the 95th percentile travel times in the general purpose lanes remained relatively unchanged – changing less than two minutes in all intervals except from 7:30 a.m. to 8:30 a.m.

Table A-21 and Figure A-23 present a different picture for the 95th percentile travel time for the general purpose lanes in the p.m. peak. This table and figure show that the 95th percentile travel time increased between two and six minutes during the heart of the peak (up to 6:00 p.m.) and then declined slightly after 6:00 p.m. This suggests that for the general purpose lanes, travel times in the general purpose lanes became less stable in the post-deployment period. One possible explanation for this is that as traffic demand shifted to the general purpose lanes, the effects of greater volume and incidents led to an increase in travel time variability. It should be noted, however, the p.m. peak demands were more elastic than a.m. demands; therefore, it is possible that travel patterns in the evening peak might take longer to reach equilibrium as people adjust to using the Express Lane.

Table A-21. Pre- and Post-Deployment 95th Percentile Travel Times (Minutes): Northbound (P.M. Peak)

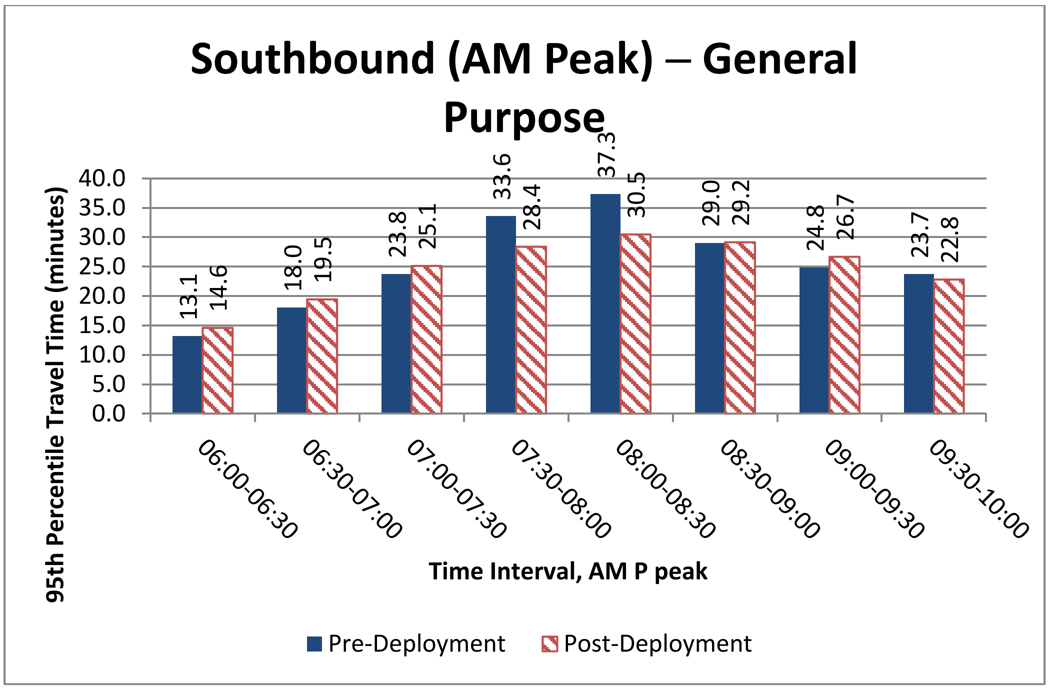
Time Interval		95th Percentile Travel Time (Minutes) [1]			
Beginning	End	Pre-Deployment	Post-Deployment	Change	Percent Change
General Purpose Lanes					
3:00 p.m.	3:30 p.m.	16.8	21.5	4.6	27.6%
3:30 p.m.	4:00 p.m.	20.4	23.4	3.0	14.7%
4:00 p.m.	4:30 p.m.	20.6	26.9	6.3	30.4%
4:30 p.m.	5:00 p.m.	25.8	31.7	5.9	23.0%
5:00 p.m.	5:30 p.m.	27.9	29.5	1.6	5.7%
5:30 p.m.	6:00 p.m.	26.0	28.8	2.8	10.7%
6:00 p.m.	6:30 p.m.	27.1	24.8	-2.3	-8.6%
6:30 p.m.	7:00 p.m.	24.9	24.6	-0.3	-1.2%
Express Lanes					
3:00 p.m.	3:30 p.m.	15.1	14.3	-0.8	-5.5%
3:30 p.m.	4:00 p.m.	19.0	15.3	-3.7	-19.4%
4:00 p.m.	4:30 p.m.	20.6	16.8	-3.8	-18.6%
4:30 p.m.	5:00 p.m.	22.5	20.6	-1.9	-8.6%
5:00 p.m.	5:30 p.m.	26.5	21.1	-5.4	-20.4%
5:30 p.m.	6:00 p.m.	23.2	21.4	-1.9	-8.0%
6:00 p.m.	6:30 p.m.	22.5	19.8	-2.8	-12.2%
6:30 p.m.	7:00 p.m.	19.4	15.4	-4.0	-20.8%

[1] Based on NaviGAtor II data only. NaviGAtor I data deemed to be unreliable for this evaluation purpose until data calibration process complete.

Source: Texas A&M Transportation Institute.

For those using the Express Lanes, only slight changes in the 95th percentile travel time were documented. The data show that for some portions of the a.m. peak (7:00 a.m. to 8:00 a.m. and 9:00 a.m. to 10:00 a.m.), the 95th percentile travel time decreased in the post-deployment period, and increased in another part of the a.m. peak (from 8:00 a.m. to 9:00 a.m.). While the increases were minimal (less than three minutes), they do suggest that at least in a portion of the a.m. peak, the introduction of tolling operations to the Express Lanes may have increased the variability in travel times slightly during a portion of the peak.

In the p.m. peak, the 95th percentile travel time declined in all intervals in the p.m. peak. The extent of this decrease ranged from just under a minute in the 3:00 p.m. to 3:30 p.m. interval to over five minutes in the 5:00 p.m. to 5:30 p.m. interval. This suggests that for the p.m. peak, the introduction of tolling operations in the Express Lanes might have helped improve the consistency of travel in the Express Lanes during the p.m. peak.



Texas A&M Transportation Institute.

Figure A-21. Comparison of Pre- and Post-Deployment 95th Percentile Travel Times (Minutes) in the Southbound General Purpose Lanes in the A.M. Peak

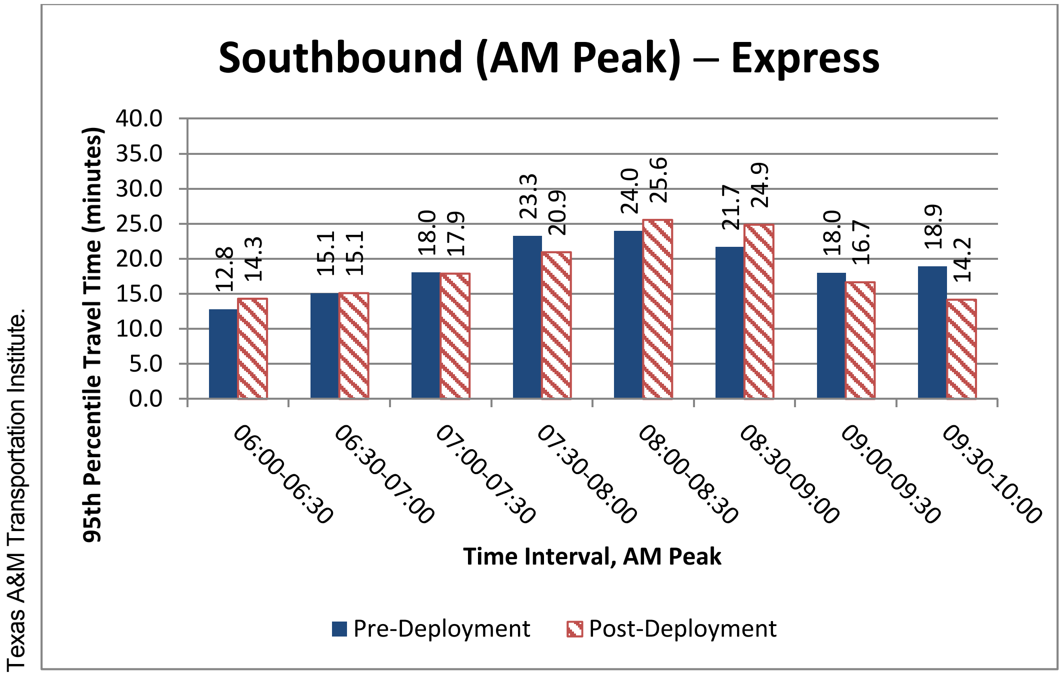


Figure A-22. Comparison of Pre- and Post-Deployment 95th Percentile Travel Times (Minutes) in the Southbound Express Lanes in the A.M. Peak

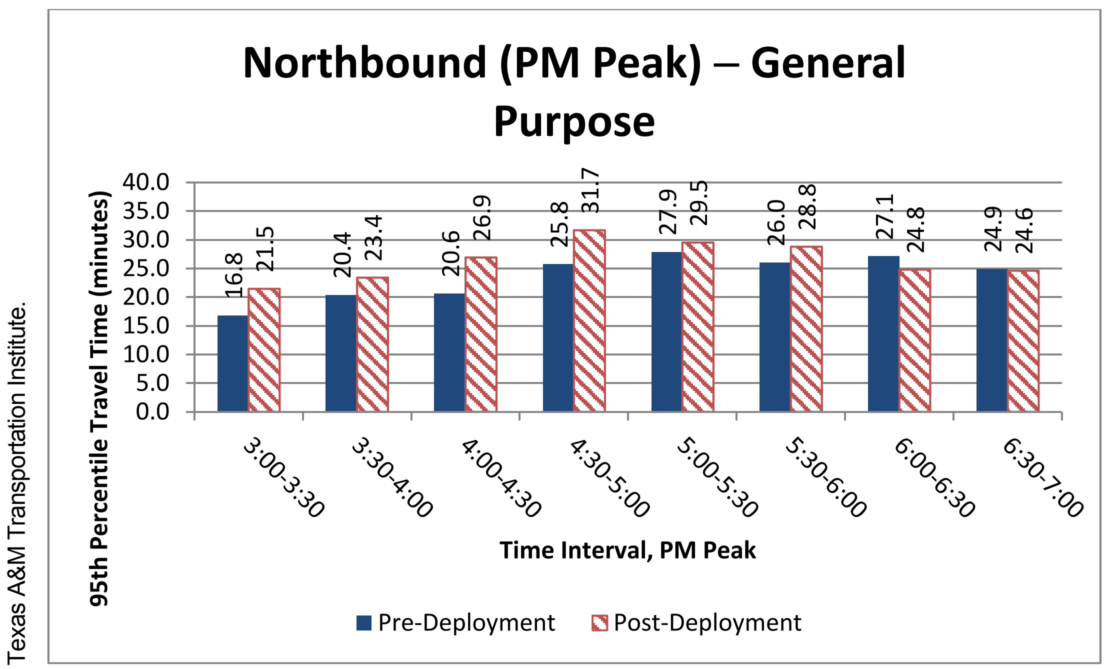


Figure A-23. Comparison of Pre- and Post-Deployment 95th Percentile Travel Times (Minutes) in the Northbound General Purpose Lanes for the P.M. Peak

Texas A&M Transportation Institute.

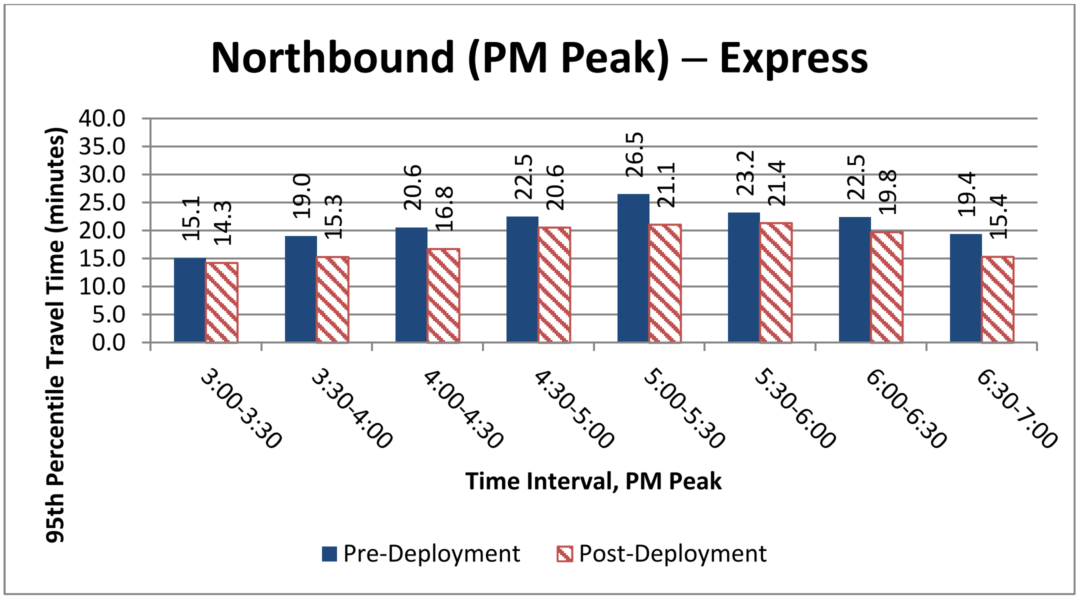


Figure A-24. Comparison of Pre- and Post-Deployment 95th Percentile Travel Times (Minutes) in the Northbound Express Lanes in the P.M. Peak

A.4.2 Buffer Index

Buffer time is the amount of *extra* time that travelers in a corridor need to allot to ensure that they arrive on time at their destination. Buffer index is computed as the difference between the 95th percentile travel time and the average travel time during a particular period of travel, expressed as a percentage of the normal travel time. For example, a buffer index of 40 percent in the a.m. peak means that to guarantee an on-time arrival during his or her morning commute, a traveler would have to allow an additional 40 percent more time for the trip than it would take on average. This would be equivalent to allocating an extra eight minutes in buffer time for a peak period trip that typically takes 20 minutes to complete. Smaller buffer indices imply that there is very little variability in the average trip time and that, on average, very little extra time needs to be allotted to the normal travel time to guarantee arrival on time. A high buffer index implies that travel times are highly variable and a traveler needs to allot more time to account for this variability to guarantee on time arrival.

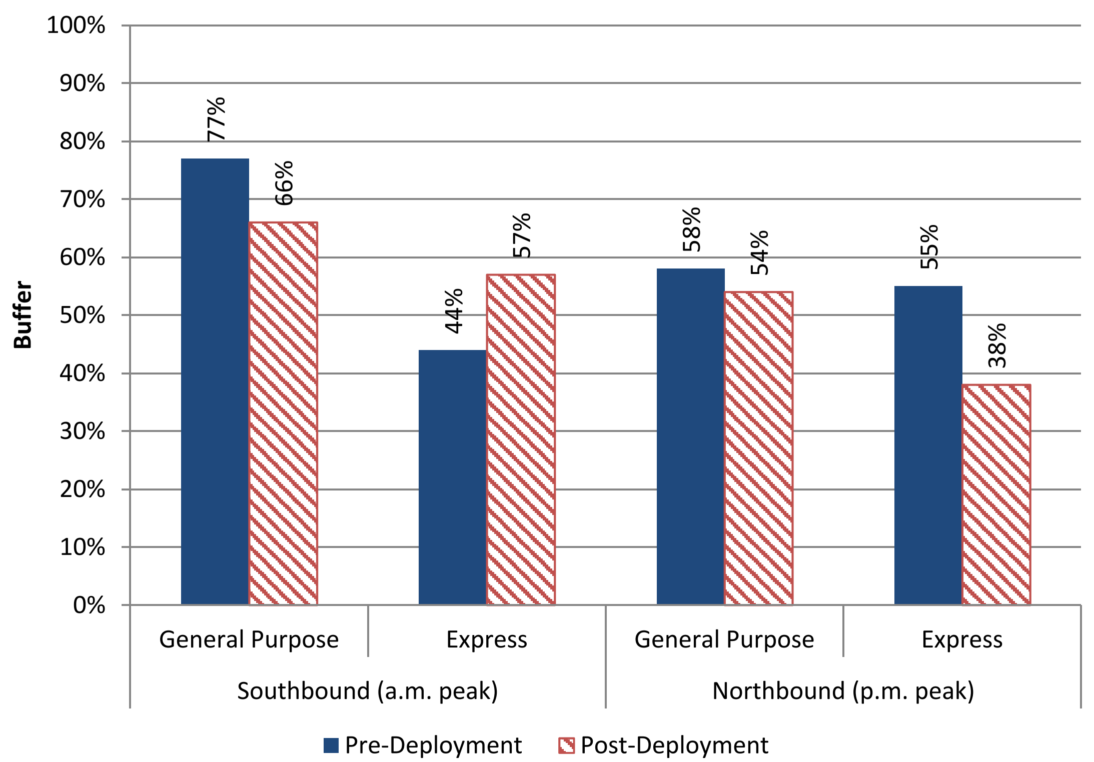
Table A-22 and Figure A-25 present changes in the buffer indices for travelers using the general purpose lanes and the Express Lanes in each peak period in the post-deployment period. The table and figure show the percentage of extra time that travelers had to allocate to their trip to guarantee travel through the corridor using the general purpose lanes declined in the both the a.m. and p.m. peaks, and declined in the p.m. peak for the Express Lanes travelers as well. Travelers using the Express Lanes in the a.m. peak, however, needed to allocate an additional 13 percent more buffer time to their travel to account for variations in travel time.

Table A-22. Peak Period Pre- and Post-Deployment Buffer Index for the I-85 General Purpose Lanes and Express Lanes – Peak Direction of Travel

Peak Period (Direction of Flow)	Lane Type	Buffer Index[1] Pre-Deployment	Post-Deployment	Change
A.M. Peak (Southbound)	General Purpose	77%	66%	-11%
	Express	44%	57%	13%
P.M. Peak (Northbound)	General Purpose	58%	54%	-4%
	Express	55%	38%	-17%

[1] Based on NaviGAtor II data only.

Source: Texas A&M Transportation Institute.



Texas A&M Transportation Institute.

Figure A-25. Comparison of Pre and Post-Deployment Buffer Indices for the General Purpose Lanes and Express Lanes for I-85

Table A-23 and Table A-24 show how buffer index in the general purpose lanes and Express Lanes changed throughout each peak period. Figure A-26 through Figure A-29 provides a graphical comparison of the change in buffer index for the general purpose lanes and Express Lanes in each peak. These figures show that the buffer indices reduced substantially (between 36 and 42 percent) in the general purpose lanes during the core of the a.m. peak period (from 7:30 a.m. to 8:30 a.m.) and also at the end of the a.m. peak period (from 9:30 a.m. to 10:00 a.m.). For the Express Lanes, the largest increases in buffer index in the morning occurred during the transition period from the heart of the peak to the shoulder of the peak (from 8:00 a.m. to 9:00 a.m.).

For the p.m. peak, substantial increases in the buffer index for the general purpose lanes occurred from 4:00 p.m. to 5:00 p.m. This suggests that travel times in the northbound peak direction of travel became less reliable in the p.m. peak period, compared to the pre-deployment period. On the other hand, Express Lanes buffer times were consistently lower in every interval of the p.m. peak in the post-deployment period compared to the pre-deployment interval.

Table A-23. Comparison of Pre-and Post-Deployment Buffer Indices for the A.M. Peak

Time Interval		Buffer Index		
Beginning	End	Pre-Deployment	Post-Deployment	Change
General Purpose Lanes				
6:00 a.m.	6:30 a.m.	18%	27%	9%
6:30 a.m.	7:00 a.m.	34%	36%	2%
7:00 a.m.	7:30 a.m.	44%	42%	-2%
7:30 a.m.	8:00 a.m.	76%	40%	-36%
8:00 a.m.	8:30 a.m.	85%	43%	-42%
8:30 a.m.	9:00 a.m.	48%	45%	-3%
9:00 a.m.	9:30 a.m.	60%	72%	12%
9:30 a.m.	10:00 a.m.	98%	79%	-19%
Express Lanes				
6:00 a.m.	6:30 a.m.	9%	23%	14%
6:30 a.m.	7:00 a.m.	14%	20%	6%
7:00 a.m.	7:30 a.m.	23%	30%	7%
7:30 a.m.	8:00 a.m.	50%	39%	-11%
8:00 a.m.	8:30 a.m.	50%	57%	7%
8:30 a.m.	9:00 a.m.	42%	74%	32%
9:00 a.m.	9:30 a.m.	35%	34%	-1%
9:30 a.m.	10:00 a.m.	60%	21%	-39%

Source: Texas A&M Transportation Institute.

Table A-24. Comparison of Pre-and Post-Deployment Buffer Indices for the P.M. Peak

Time Interval		Buffer Index		
Beginning	End	Pre-Deployment	Post-Deployment	Change
General Purpose Lanes				
3:00 p.m.	3:30 p.m.	37%	52%	15%
3:30 p.m.	4:00 p.m.	45%	42%	-3%
4:00 p.m.	4:30 p.m.	28%	49%	21%
4:30 p.m.	5:00 p.m.	48%	66%	18%
5:00 p.m.	5:30 p.m.	52%	50%	-2%
5:30 p.m.	6:00 p.m.	47%	52%	5%
6:00 p.m.	6:30 p.m.	70%	43%	-27%
6:30 p.m.	7:00 p.m.	81%	65%	-16%
Express Lanes				
3:00 p.m.	3:30 p.m.	31%	18%	-13%
3:30 p.m.	4:00 p.m.	48%	17%	-31%
4:00 p.m.	4:30 p.m.	41%	22%	-19%
4:30 p.m.	5:00 p.m.	46%	44%	-2%
5:00 p.m.	5:30 p.m.	73%	41%	-32%
5:30 p.m.	6:00 p.m.	55%	47%	-8%
6:00 p.m.	6:30 p.m.	61%	46%	-15%
6:30 p.m.	7:00 p.m.	58%	23%	-35%

Source: Texas A&M Transportation Institute.

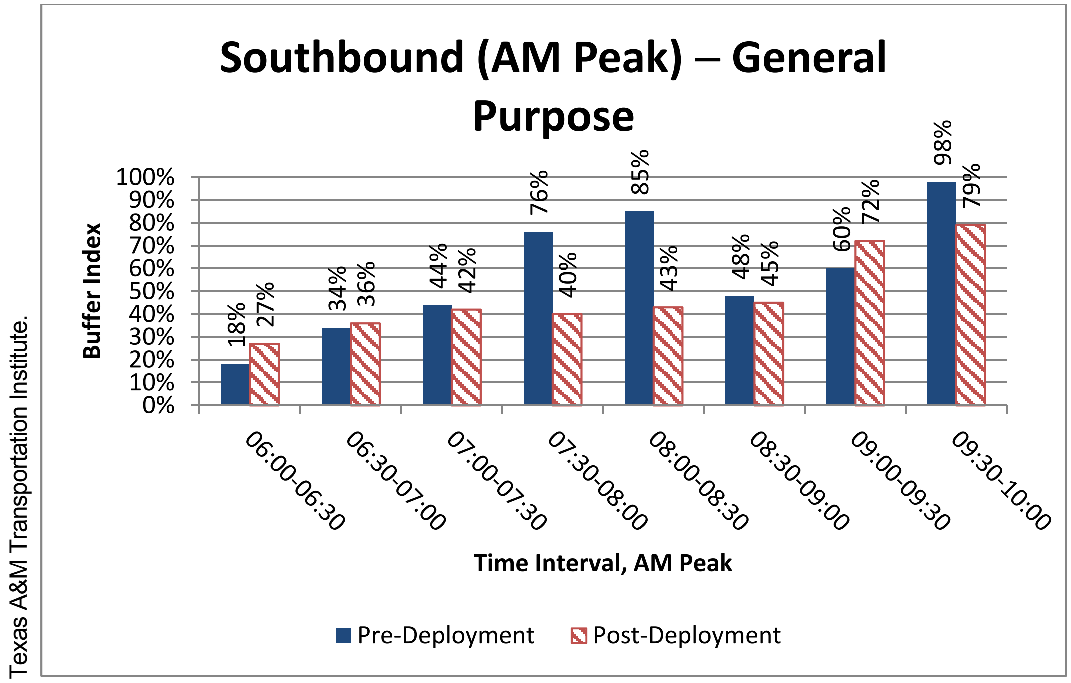


Figure A-26. Comparison of Pre- and Post-Deployment Buffer Index in the Southbound General Purpose Lanes in the A.M. Peak

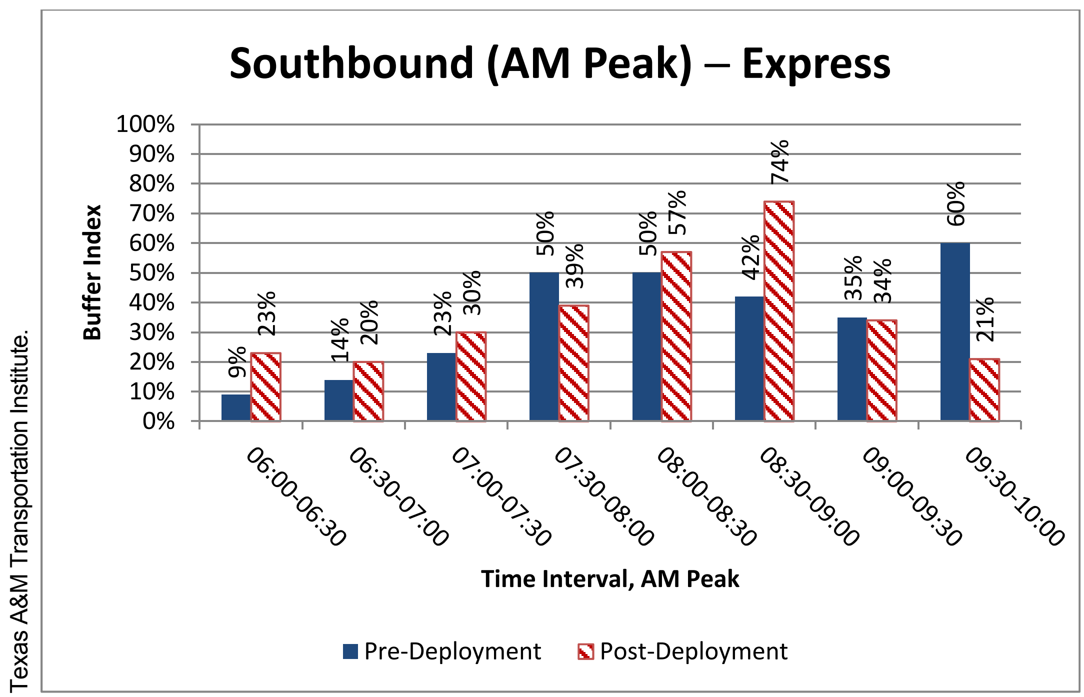


Figure A-27. Comparison of Pre- and Post-Deployment Buffer Index in the Southbound Express Lanes in the A.M. Peak

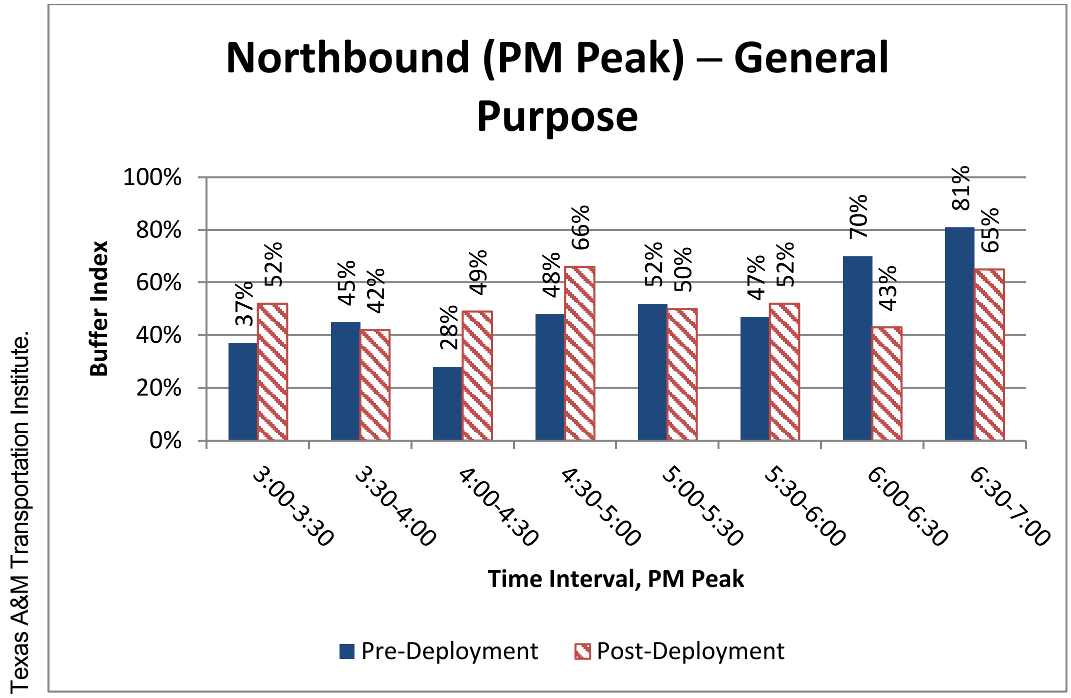


Figure A-28. Comparison of Pre- and Post-Deployment Buffer Index in the Northbound General Purpose Lanes in the P.M. Peak

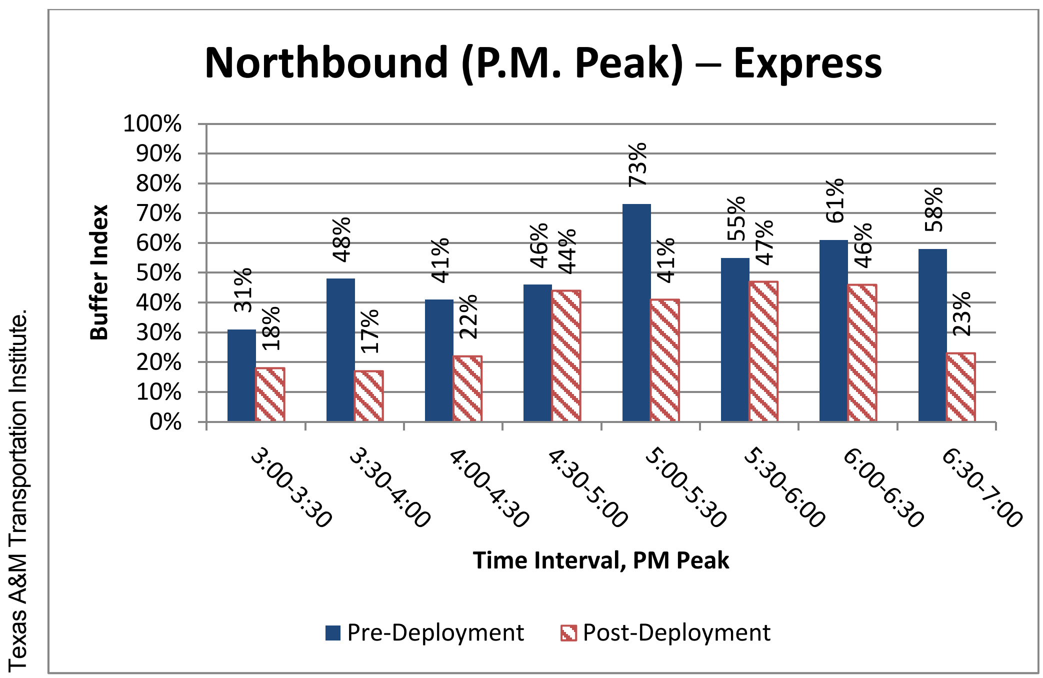


Figure A-29. Comparison of Pre- and Post-Deployment Buffer Index in the Northbound Express Lanes in the P.M. Peak

A.5 Vehicle Occupancy Levels

Under contract to GDOT, the Georgia Institute of Technology collected data on the number of occupants of vehicles traveling in both the general purpose lanes and in the Express Lanes at key locations in the corridor. Table A-25 and Table A-26 show average number of vehicle occupants at various points in the corridor. Table A-27 presents the percentage of non-transit vehicles by occupancy levels for the pre- and post-deployment periods. These tables indicate that a substantial change occurred in the number of occupants per non-transit vehicle between the pre- and post-deployment evaluation intervals – particularly in the number of occupants per vehicle in the Express Lanes. The number of occupants for vehicles traveling in the Express Lanes dropped from approximately 2 persons per vehicle to 1.22 in the a.m. peak and to 1.26 in the p.m. peak. This change could be directly attributed to converting from a HOV to HOT operation allowing single-occupant vehicles in the Express Lanes. The tables also show that there was a slight increase in the occupancy level of vehicles traveling in the general purpose lanes – from approximately 1.06 to 1.11 in the a.m. peak and from approximately 1.10 to 1.15 in the p.m. peak. These differences are illustrated in Figure A-30 and Figure A-31 for the a.m. and p.m. peak periods respectively.

Table A-25. Average Number of Occupants per Vehicle (Non-Transit): Southbound (A.M. Peak)

		Average Number of Occupants per Vehicle (Non-Transit)			
Location	**Lane Type**	**Pre-Deployment**	**Post-Deployment**	**Change**	**Percent Change**
Jimmy Carter	General Purpose	1.06	1.12	0.06	5.8%
	Express Lanes	2.00	1.23	-0.76	-38.3%
Center Way	General Purpose	NA	NA	NA	NA
	Express Lanes	NA	NA	NA	NA
Beaver Ruin	General Purpose	1.06	1.12	0.06	5.4%
	Express Lanes	2.02	1.18	-0.84	-41.5%
Pleasant Hill	General Purpose	1.04	1.11	0.07	6.3%
	Express Lanes	1.94	1.19	-0.74	-38.4%
Old Peachtree Road	General Purpose	1.07	1.09	0.02	2.0%
	Express Lanes	1.98	1.27	-0.72	-36.1%
Average	**General Purpose**	**1.06**	**1.11**	**0.05**	**5.0%**
	Express Lanes	**1.99**	**1.22**	**-0.77**	**-38.7%**

Note: Data not available for Center Way.

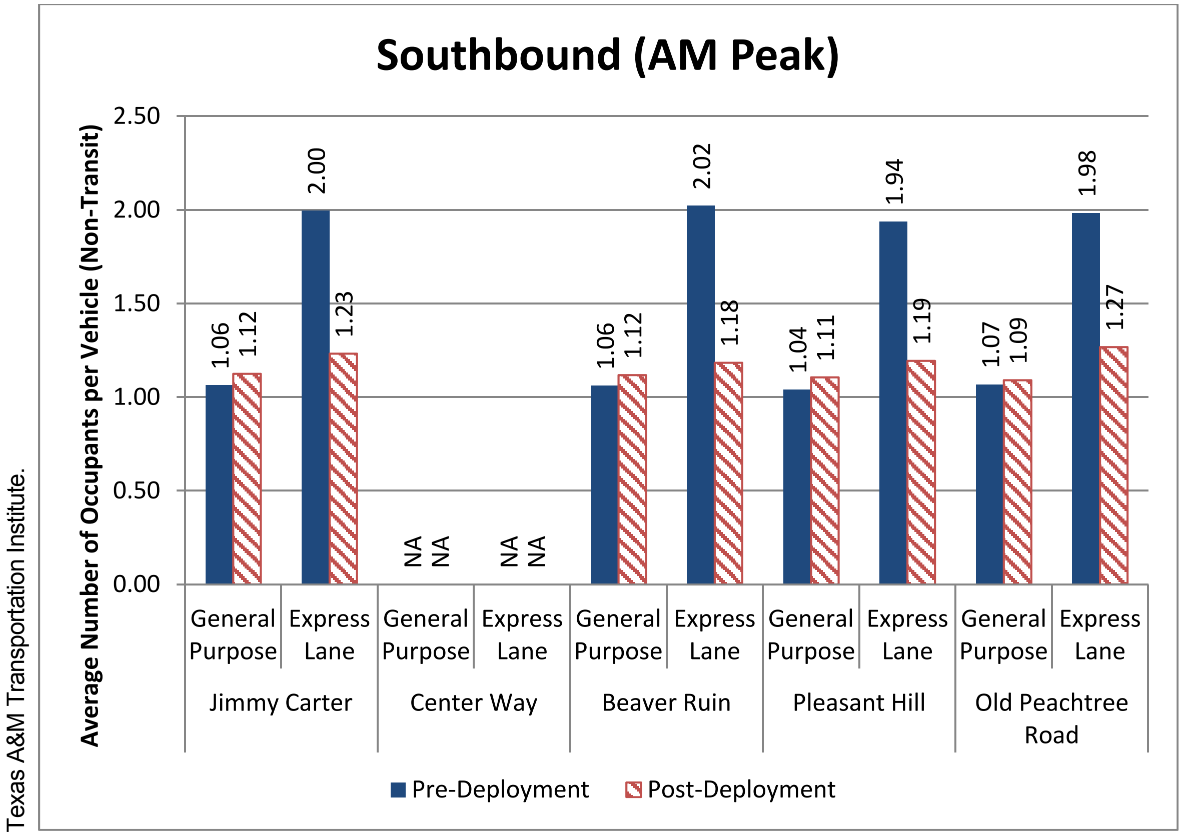
Source: Georgia Institute of Technology.

Table A-26. Average Number of Occupants per Vehicle (Non-Transit): Northbound (P.M. Peak)

Location	Lane Type	Average Number of Occupants per Vehicle (Non-Transit) Pre-Deployment	Post-Deployment	Change	Percent Change
Jimmy Carter	General Purpose	1.08	1.13	0.06	5.2%
	Express Lanes	2.03	1.24	-0.78	-38.7%
Center Way	General Purpose	1.12	1.16	0.04	3.5%
	Express Lanes	2.06	1.32	-0.74	-36.1%
Beaver Ruin	General Purpose	1.10	1.16	0.06	5.6%
	Express Lanes	2.05	1.21	-0.84	-40.8%
Pleasant Hill	General Purpose	1.08	1.15	0.08	7.3%
	Express Lanes	2.02	1.24	-0.78	-38.8%
Old Peachtree Road	General Purpose	1.10	1.14	0.04	4.0%
	Express Lanes	1.99	1.28	-0.71	-35.7%
Average	**General Purpose**	**1.10**	**1.15**	**0.05**	**4.7%**
	Express Lanes	**2.03**	**1.26**	**-0.77**	**-38.0%**

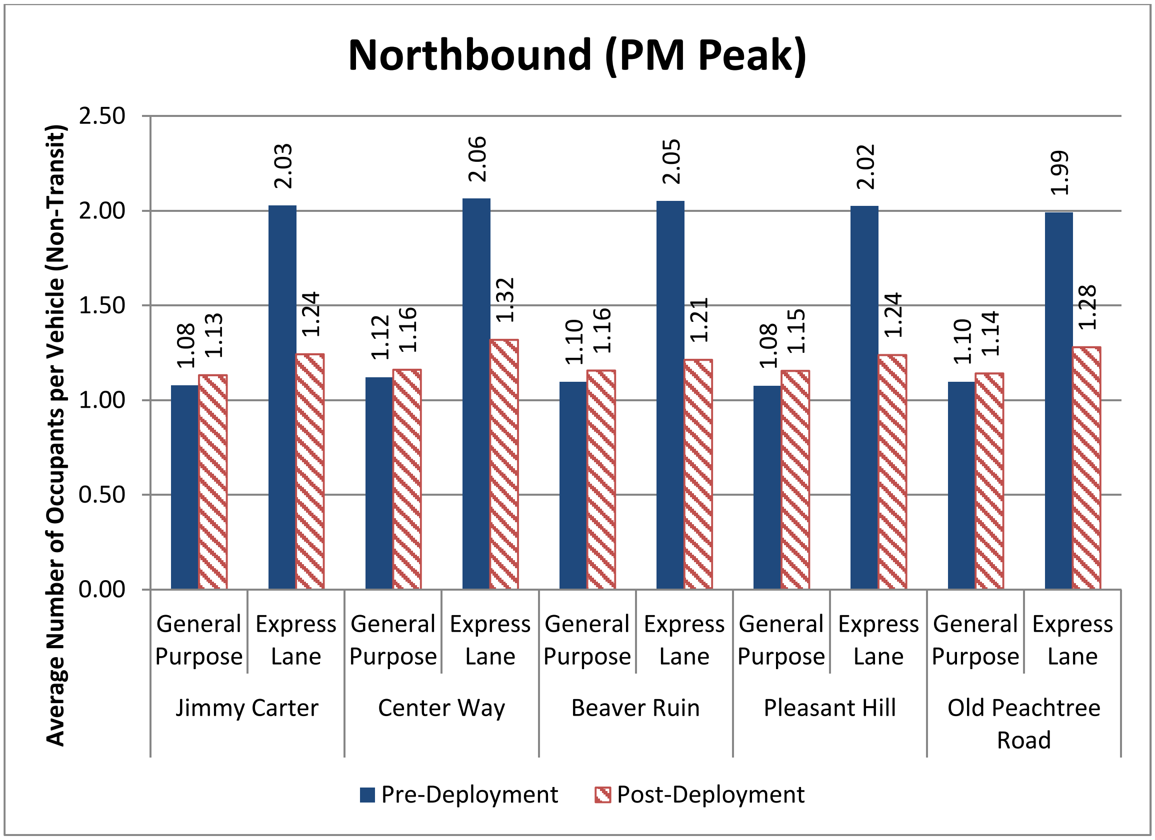
Source: Georgia Institute of Technology.

As shown in Table A-27, the proportion of vehicles in the Express Lane by the number of occupants (i.e., one, two, three and four or more) changed. The percentages for the general purpose lanes were averaged across all five lanes. In the Express Lane, the percentage of all vehicles that were SOV increased from 7.4 percent (morning peak period) and 8.0 percent (afternoon peak period) before the Express Lanes were implemented to 85.3 percent and 83.4 percent of all vehicles, respectively. In contrast, HOV2s in the Express Lane decreased from 87.1 percent (morning peak period) and 83.7 percent (afternoon peak period) to 12.1 percent and 13.5 percent, respectively. The percent of carpools with three of more people in the Express Lane also decreased from 5.5 to 2.6 percent in the morning peak period and 8.2 to 3.2 percent in the afternoon peak period during the first year that the Express Lanes were in operation. One possible explanation for this drop might be hesitancy of some individuals to open Peach Pass accounts, even though it would enable them to use the Express Lane for free. However, higher-occupant non-transit vehicles were never more than 10 percent of the total volume in either the HOV or Express Lanes.



Note: Data not available for Center Way.

Figure A-30. Comparison of Pre- and Post- Deployment Average Number of Occupants per Vehicle (Non-Transit) in the General Purpose and Express Lanes: A.M. Peak



Texas A&M Transportation Institute.

Figure A-31. Comparison of Pre- and Post- Deployment Average Number of Occupants per Vehicle (Non-Transit) in the General Purpose and Express Lanes: P.M. Peak

With single-occupant vehicles permitted to use the Express Lanes for the first time by paying a toll, the dramatic before/after change in the Express Lanes was to be expected. After the opening of the Express Lanes, HOV2s had to register for a transponder and pay a toll to use the Express Lanes – at the same rate as single-occupant vehicles. The higher proportion of HOV2s in the general purpose lane suggests that many existing two-person carpools did not use the Express Lanes because they either did not want to pay a toll or did not add an individual to increase their occupancy to become eligible for toll-exempt status and instead moved to the general purpose lanes.

Appendix D – TDM Analysis contains further discussion on the impact of the CRD on carpools.

Table A-27. Percent of Non-Transit Vehicles by Occupancy Level, Pre- and Post-Deployment[1]

Lane Type	Time Period	Percent of Vehicles by Occupancy			
		1	2	3	4+
Southbound Morning Peak Period (7:00 – 9:00 a.m.)					
HOV/Express Lane	Before	7.4	87.1	3.1	2.4
	After	85.3	12.1	0.9	1.7
General Purpose	Before	95.1	4.6	0.2	0.1
	After	89.2	10.2	0.4	0.2
Northbound Afternoon Peak Period (4:30 – 6:30 p.m.)					
HOV/Express Lane	Before	8.0	83.7	5.2	3.1
	After	83.4	13.5	1.0	2.2
General Purpose	Before	92.7	6.6	0.4	0.2
	After	86.5	12.4	0.7	0.4

Source: Texas A&M Transportation Institute, 2013 based on data provided by the Georgia Institute of Technology.

A.6 Vehicle and Person Throughput

Changes in vehicular and person throughput were examined to assess the extent to which congestion was reduced by deploying the CRD improvements in the I-85 corridor. According to the NCHRP's *Guide to Effective Freeway Performance Measurement*,[2] throughput is a fundamental measure of freeway performance. Throughput is a measure of the number of users "served" by the transportation system. The congestion analysis focused on how deploying the CRD projects changed the throughput in the I-85 corridor. Using throughput as a measure of effectiveness in evaluating the impacts of the CRD deployments allowed the evaluation team to determine if more vehicles and/or persons were "served" because of the deployment, even though travel times or travel-time reliability had not changed.

Two types of throughput were used in this assessment: vehicle throughput and person throughput. Vehicle throughput (VT) was determined by measuring the number of vehicle using both the general purpose lanes and the Express Lanes in the I-85 corridor. Person throughput (PT) is the total number of persons "served" by different transportation modes utilizing the corridor. Each of these is discussed in the following sections.

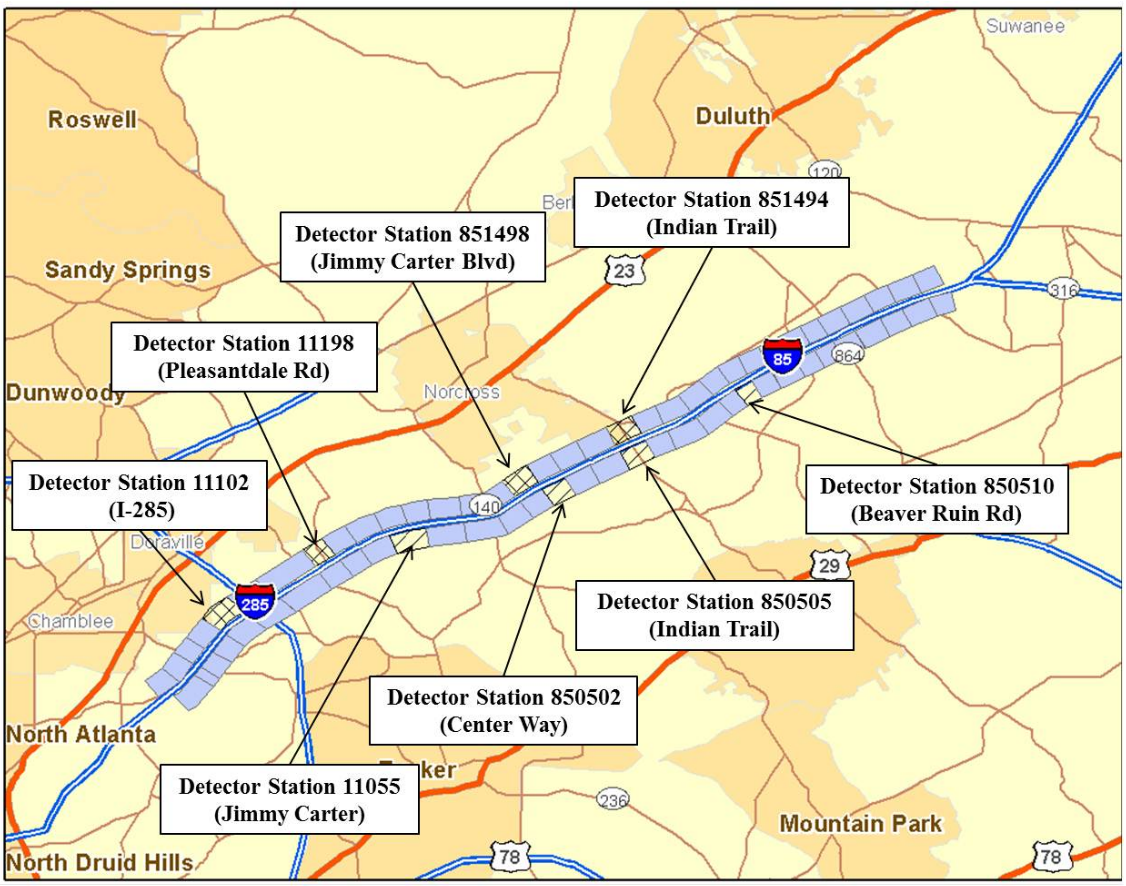
[1] Only data collected from the three observation locations between I-285 and GA 316 were used in the analysis. A large majority of the VMT within the CRD corridor was within the section between I-285 and GA 316.

[2] Cambridge Systematics, et al. August 2006. *Guide to Effective Freeway Performance Measurement: Final Report and Guidebook,* NCHRP Project 3-68.

A.6.1 Vehicle Throughput

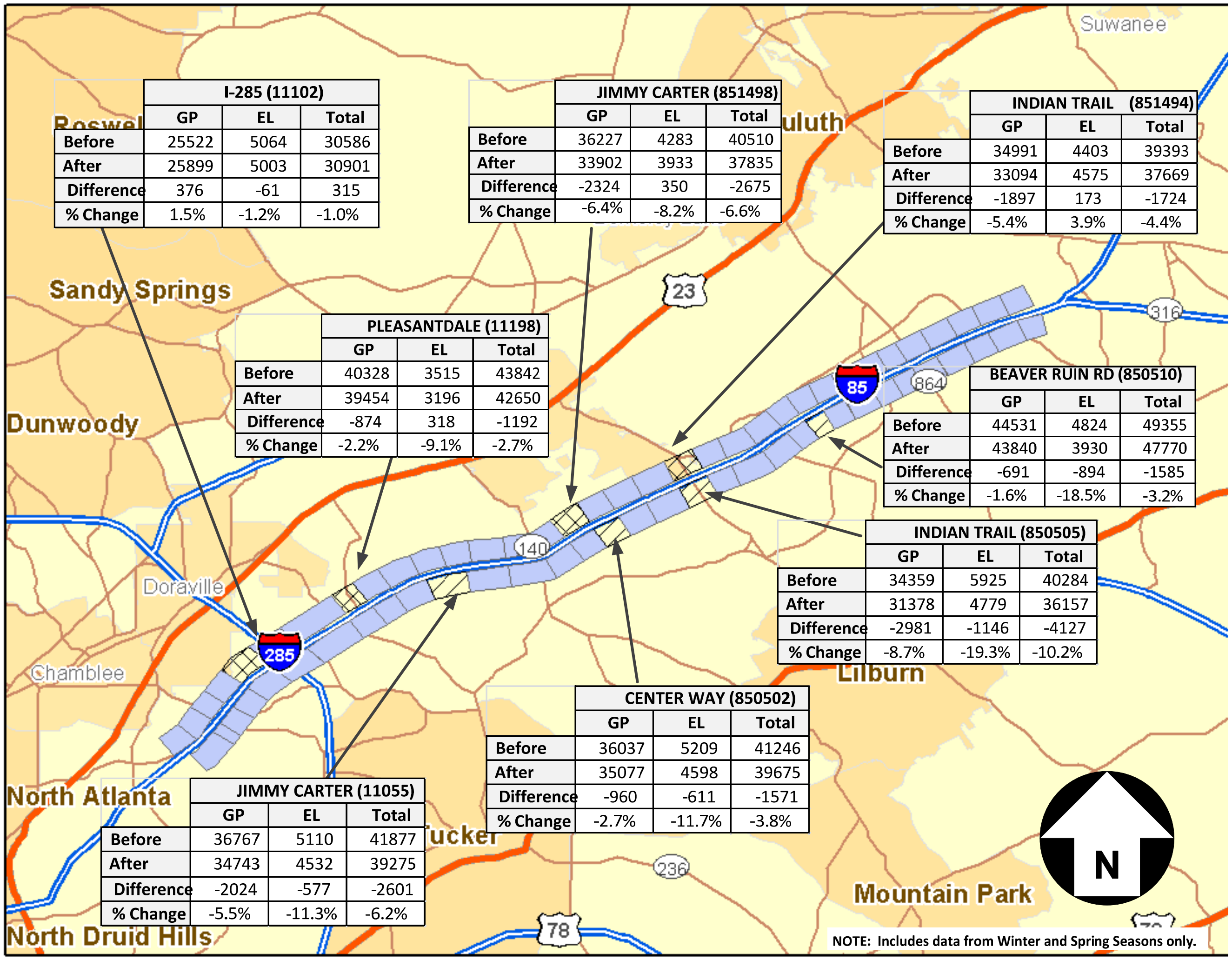
Figure A-32 shows the locations where vehicle throughput was analyzed. These stations were selected because they provided the best availability of data passing the evaluation team's data quality checks on both the general purpose lanes and the Express Lanes.

Figure A-33 provides the average peak period throughput in the peak direction of travel for the evaluation corridor. Figure A-34 provides an indication of the average peak period vehicle throughput for the a.m. peak direction of flow (southbound) while Figure A-35 shows the average peak period throughput for the p.m. peak direction of flow (northbound). These figures show that while average peak period throughput on the general purpose lanes remained relatively constant in both the a.m. and p.m. peak periods, average throughput on the Express Lanes dropped after conversion to HOT operations. In the a.m. peak, the percent reduction in vehicle throughput in the Express Lanes ranged from 1 percent to 9 percent after the conversion, while in the p.m. peak, vehicle throughput on the Express Lanes was reduced between 11 percent and 19 percent.



Texas A&M Transportation Institute.

Figure A-32. Locations Selected for Analyzing Average Peak Period Throughput (Based on Data Availability)



I-285 (11102)	GP	EL	Total
Before	25522	5064	30586
After	25899	5003	30901
Difference	376	-61	315
% Change	1.5%	-1.2%	-1.0%

JIMMY CARTER (851498)	GP	EL	Total
Before	36227	4283	40510
After	33902	3933	37835
Difference	-2324	350	-2675
% Change	-6.4%	-8.2%	-6.6%

INDIAN TRAIL (851494)	GP	EL	Total
Before	34991	4403	39393
After	33094	4575	37669
Difference	-1897	173	-1724
% Change	-5.4%	3.9%	-4.4%

PLEASANTDALE (11198)	GP	EL	Total
Before	40328	3515	43842
After	39454	3196	42650
Difference	-874	318	-1192
% Change	-2.2%	-9.1%	-2.7%

BEAVER RUIN RD (850510)	GP	EL	Total
Before	44531	4824	49355
After	43840	3930	47770
Difference	-691	-894	-1585
% Change	-1.6%	-18.5%	-3.2%

INDIAN TRAIL (850505)	GP	EL	Total
Before	34359	5925	40284
After	31378	4779	36157
Difference	-2981	-1146	-4127
% Change	-8.7%	-19.3%	-10.2%

CENTER WAY (850502)	GP	EL	Total
Before	36037	5209	41246
After	35077	4598	39675
Difference	-960	-611	-1571
% Change	-2.7%	-11.7%	-3.8%

JIMMY CARTER (11055)	GP	EL	Total
Before	36767	5110	41877
After	34743	4532	39275
Difference	-2024	-577	-2601
% Change	-5.5%	-11.3%	-6.2%

Texas A&M Transportation Institute.

Figure A-33. Comparison of Pre- and Post-Deployment Peak Period Vehicle Throughput in the Peak Direction of Flow at Selected Screenlines in the I-85 CRD Corridor

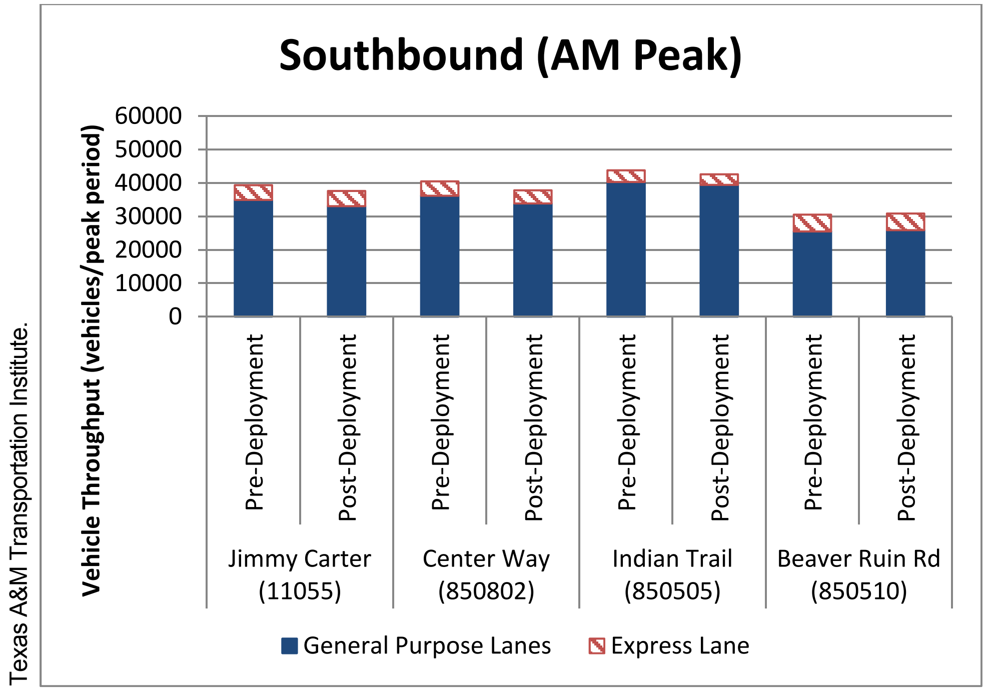


Figure A-34. Change in Vehicle Throughput at Select Points in the I-85 Corridor in the A.M. Peak

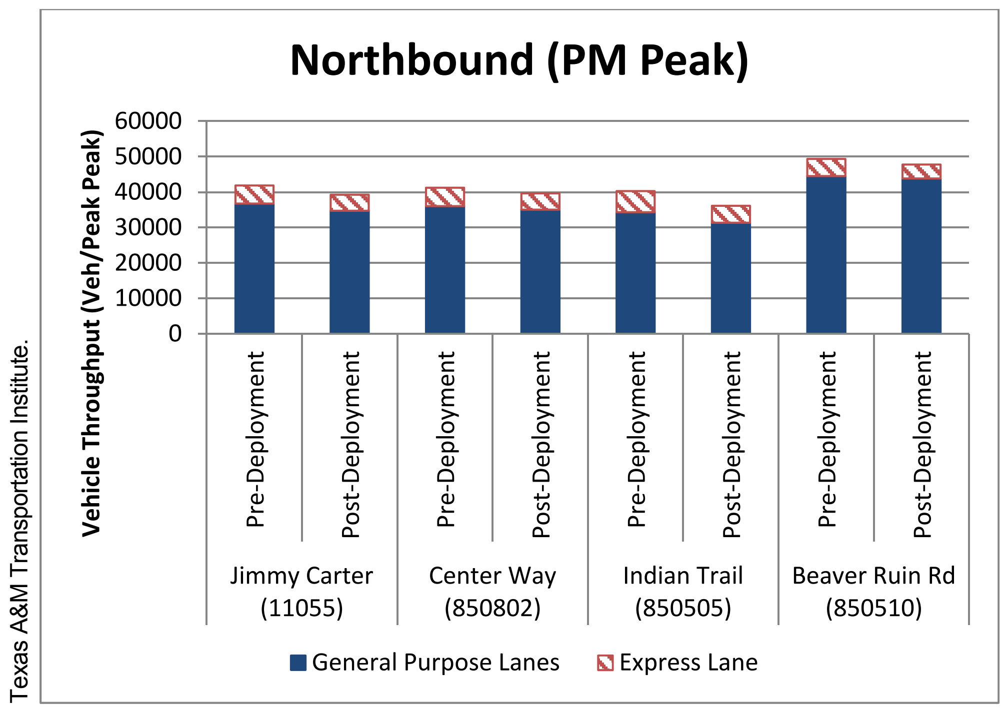


Figure A-35. Change in Vehicle Throughput at Select Points in the I-85 Corridor in the P.M. Peak

Table A-28 presents the pre- and post-deployment average vehicle throughput for both general purpose lanes and the Express Lanes in each peak direction of travel. The table indicates that the average vehicle throughput declined in both the a.m. and p.m. peak periods in all lanes, around 3 to 4 percent except for a substantial drop of 13.8 percent in northbound Express Lane during the p.m. peak. The overall findings were consistent with the patterns shown in Figure A-34 and Figure A-35, which generally show slight dips in the total vehicle throughput measured at each detection site. Given that there was a decline in vehicle throughput in all lanes, factors other than tolling in the Express Lane may explain some of the drop. For example, as discussed in Appendix M – Exogenous Factors, unemployment during the post-deployment period remained high as did gasoline prices, both of which may have reduced the amount of travel in the corridor compared to the pre-deployment period.

Table A-28. Pre-and Post-Deployment of Average Total Peak Period Vehicle Throughput

Peak Period	Lane Type	Average Vehicle Throughput			
		Pre-Deployment	Post-Deployment	Change	Percent Change
Southbound (A.M. Peak)	General Purpose	34,007	32,856	-1,151	-3.4%
	Express Lanes	4,283	4,168	-115	-2.7%
	Total	**38,289**	**37,024**	**-1,265**	**-3.3%**
Northbound (P.M. Peak)	General Purpose	37,527	35,946	-1,581	-4.2%
	Express Lanes	5,146	4,436	-710	-13.8%
	Total	**42,673**	**40,381**	**-2,291**	**-5.4%**

Source: Texas A&M Transportation Institute.

To investigate the effects of CRD strategies on traffic flow, linear mixed effects models were used in this analysis. Five months of pre- and post-deployment data were used in the model calibration as in the case of travel speed models. Four stations were selected in each direction of travel to represent volume conditions along I-85. Throughput (vehicles/unit time) was used as a response variable because it is an aggregate measure of how many vehicles can move through a cross section. The months, day-of-week, and station groups were treated as random factors because their effects on throughputs are not of primary interest by themselves, and not all stations were included in the model calibration. The time block and CRD strategies were treated as fixed effects as their effects on observed throughputs are the primary objective of this analysis. The best fitted model was determined based on overall goodness-of-fit statistics (Akaike Information Criterion), t-value of model coefficients, and logical interpretation of the sign of model coefficients. The log-likelihood ratio test was used to determine the most parsimonious model among competing candidate model structures. The fixed-effect variables are considered statistically significant at the 95 percent confidence level if the t-value is less than -1.96 or greater than 1.96.

For each group of data sets, the throughput models were calibrated for the following conditions:

- General purpose lanes and Express Lanes for the southbound in the a.m. peak; and
- General purpose lanes and Express Lanes for the northbound in the p.m. peak.

Table A-29 and Table A-30 summarize the effects of the CRD improvements on throughputs (measured as the number of vehicles per 30-minute interval) for the a.m. and p.m. peak periods respectively. The shaded cells indicate the changes that were statistically significant at a 95 percent confidence level. These tables clearly show that on average, vehicle throughput in the general purpose lanes fell significantly in the post-deployment period. The results of the statistical analyses also show that the increase in vehicle throughput on the Express Lanes in the middle of the a.m. peak in the post-deployment period was not statistically significant (except from 7:30 to 8:00 a.m.). The tables also show that average throughput in the Express Lanes in the p.m. peak fell significantly in the post-deployment period, compared to the pre-deployment period.

Table A-29. Results of Mixed Effect Modeling of Average Vehicle Throughput by 30-Minute Intervals in the A.M. Peak

		Average Throughput (vehicles per 30-min interval)					
Beginning	**End**	**Pre-Deployment**	**Post-Deployment**	**Change**	**Standard Error**	**t-statistic**	**Statistically Significant?[1]**
General Purpose Lanes							
6:00 a.m.	6:30 a.m.	3,953	4,036	84	17.4	4.8	**Yes**
6:30 a.m.	7:00 a.m.	4,813	4,759	-54	17.4	-3.1	**Yes**
7:00 a.m.	7:30 a.m.	4,804	4,638	-166	17.5	-9.5	**Yes**
7:30 a.m.	8:00 a.m.	4,519	4,251	-268	17.5	-15.3	**Yes**
8:00 a.m.	8:30 a.m.	4,182	3,853	-329	17.5	-18.9	**Yes**
8:30 a.m.	9:00 a.m.	3,960	3,685	-275	17.5	-15.7	**Yes**
9:00 a.m.	9:30 p.m.	3,886	3,774	-111	17.6	-6.3	**Yes**
9:30 p.m.	10:00 a.m.	3,890	3,860	-31	17.6	-1.7	No
Express Lanes							
6:00 a.m.	6:30 a.m.	350	328	-22	4.2	-5.2	**Yes**
6:30 a.m.	7:00 a.m.	563	551	-12	4.1	-3.0	**Yes**
7:00 a.m.	7:30 a.m.	649	651	2	3.9	0.4	No
7:30 a.m.	8:00 a.m.	640	668	28	3.8	7.3	**Yes**
8:00 a.m.	8:30 a.m.	615	618	3	3.8	0.7	No
8:30 a.m.	9:00 a.m.	556	561	5	3.8	1.3	No
9:00 a.m.	9:30 p.m.	485	449	-36	3.9	-9.2	**Yes**
9:30 p.m.	10:00 a.m.	425	343	-82	4.0	-20.7	**Yes**

[1] Cells in **bold** are statistically significant at a 95 percent confidence level.

Source: Texas A&M Transportation Institute.

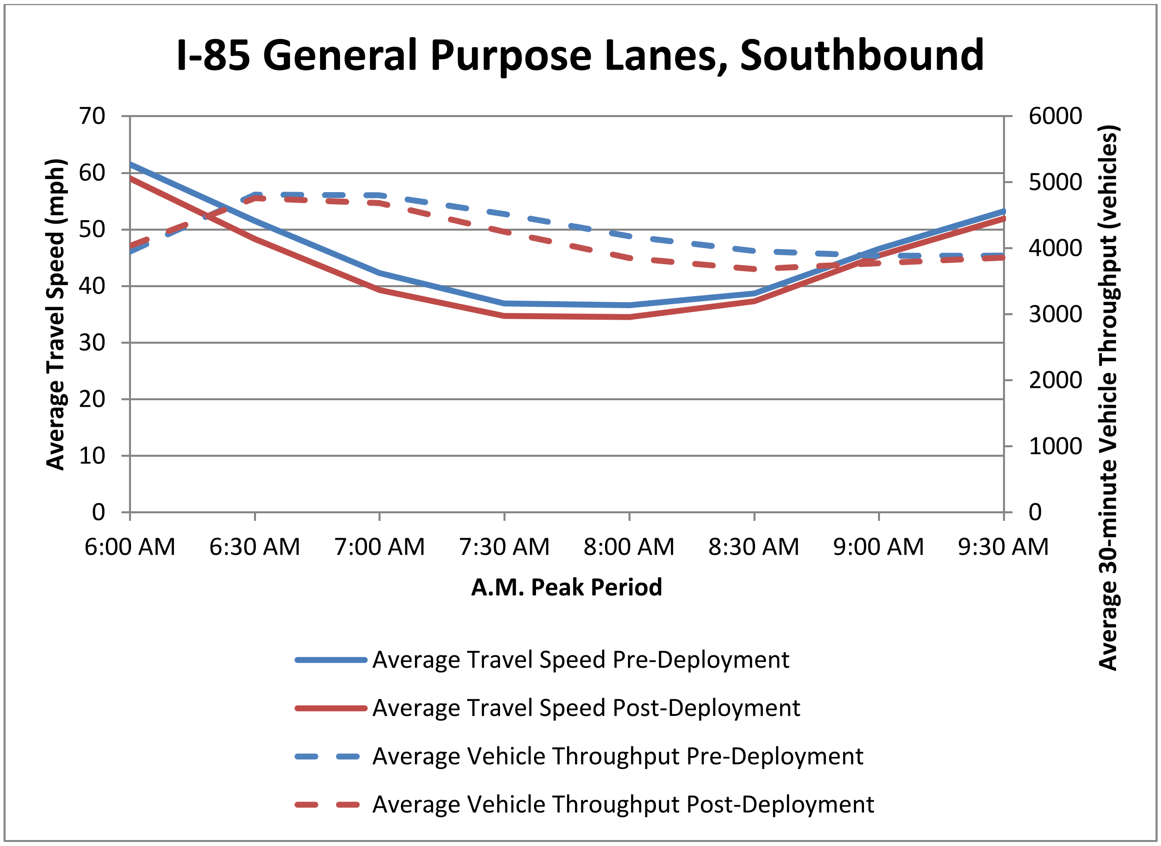
Table A-30. Results of Mixed Effect Modeling of Average Vehicle Throughput by 30-Minute Intervals in the P.M. Peak

		Average Throughput (vehicles per 30-min interval)					
Beginning	End	Pre-Deployment	Post-Deployment	Change	Standard Error	t-statistic	Statistically Significant?[1]
General Purpose Lanes							
3:00 p.m.	3:30 p.m.	4,758	4,547	-211	17.5	-12.1	**Yes**
3:30 p.m.	4:00 p.m.	4,814	4,542	-272	17.5	-15.6	**Yes**
4:00 p.m.	4:30 p.m.	4,843	4,523	-320	17.5	-18.3	**Yes**
4:30 p.m.	5:00 p.m.	4,761	4,473	-288	17.6	-16.4	**Yes**
5:00 p.m.	5:30 p.m.	4,707	4,477	-230	17.5	-13.2	**Yes**
5:30 p.m.	6:00 p.m.	4,602	4,453	-149	17.5	-8.5	**Yes**
6:00 p.m.	6:30 p.m.	4,597	4,474	-123	17.5	-7.06	**Yes**
6:30 p.m.	7:00 p.m.	4,444	4,457	13	17.5	0.748	No
Express Lanes							
3:00 p.m.	3:30 p.m.	528	366	-162	4.0	-40.1	**Yes**
3:30 p.m.	4:00 p.m.	669	490	-179	4.0	-45.3	**Yes**
4:00 p.m.	4:30 p.m.	709	585	-125	3.9	-32.1	**Yes**
4:30 p.m.	5:00 p.m.	714	662	-51	3.8	-13.3	**Yes**
5:00 p.m.	5:30 p.m.	706	681	-25	3.8	-6.67	**Yes**
5:30 p.m.	6:00 p.m.	670	654	-16	3.8	-4.29	**Yes**
6:00 p.m.	6:30 p.m.	618	554	-65	3.9	-16.6	**Yes**
6:30 p.m.	7:00 p.m.	531	444	-86	4.0	-21.8	**Yes**

[1] Cells in **bold** are statistically significant at a 95 percent confidence level.

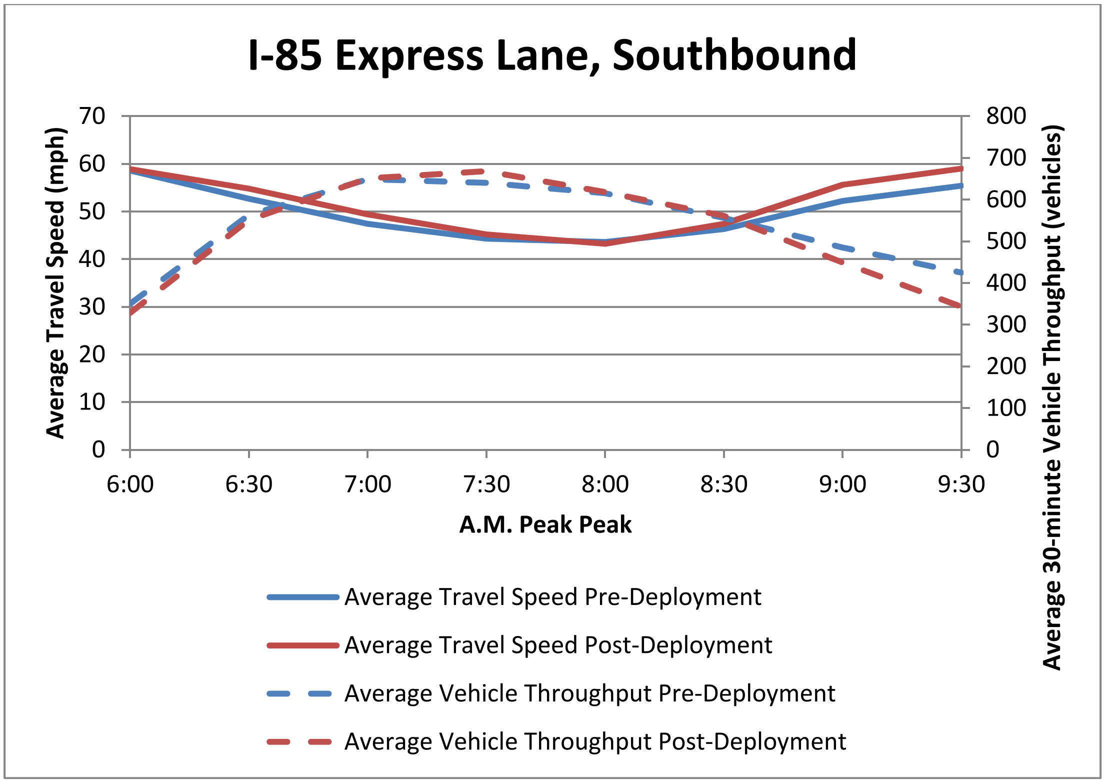
Source: Texas A&M Transportation Institute.

Figure A-36 through Figure A-39 compare average travel speed with average vehicle throughput for general purpose lanes and Express Lanes for the a.m. and p.m. peak respectively. Figure A-36 shows that during the a.m. peak both average travel speeds and average vehicle throughput was generally lower throughout the entire a.m. peak period after the HOT operations began. Figure A-37 shows that in the Express Lanes during the a.m. peak period, average travel speeds and average vehicle throughput did not substantially change in the post-deployment period compared to the pre-deployment period. This suggests that conditions in the general purpose lanes during the a.m. peak generally worsened after HOT operations began in the Express Lanes. Part of the decline could be attributed to a shift of demand from the Express Lane to the general purpose lanes. Figure A-37 also shows that operations in the Express Lanes during the a.m. peak were generally not impacted by the conversion to HOT operations. Both vehicle speeds and vehicle throughput were similar in the post-deployment period compared to the pre-deployment period.



Texas A&M Transportation Institute.

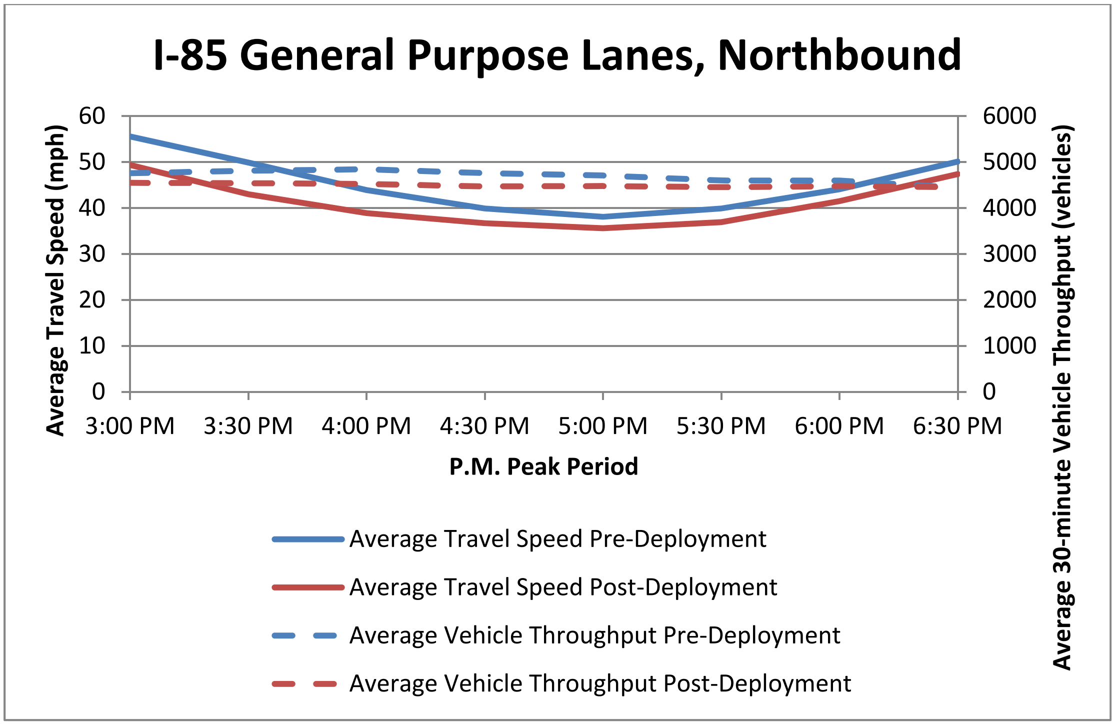
Figure A-36. Comparison of Average Travel Speed and Average Vehicle Throughput for the General Purpose Lanes, A.M. Peak Period



Texas A&M Transportation Institute.

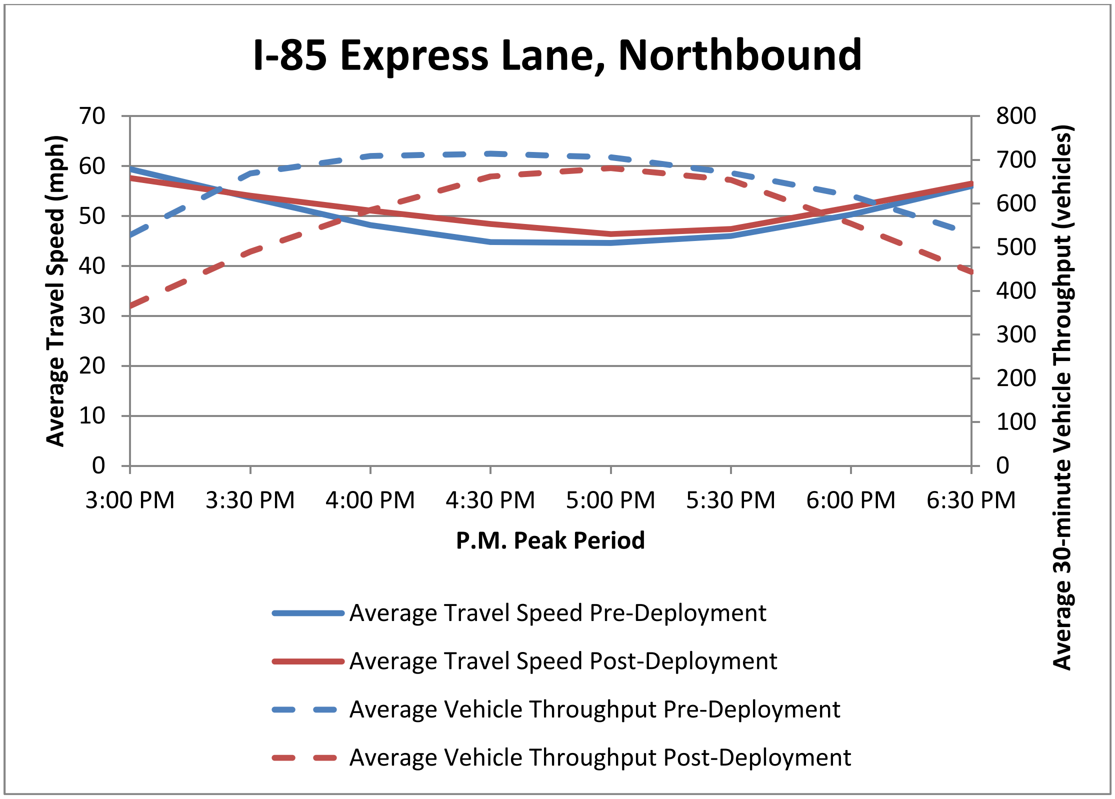
Figure A-37. Comparison of Average Travel Speed and Average Vehicle Throughput for the Express Lane, A.M. Peak Period

Figure A-38 shows that in the p.m. peak both average travel speed and vehicle throughput in the general purpose lanes were lower throughout the entire duration of the p.m. peak in the post-deployment period compared to the pre-deployment period. Conversely, average travel speeds improved slightly while average vehicle throughput declined slightly in the Express Lane in the post-deployment period, particularly in the shoulder of the peaks (from 3:00 to 4:30 and from 5:30 to 7:00) during the post-deployment period (as shown in Figure A-39). This suggests that HOT operations were more successful at attracting demand from the general purpose lanes during the a.m. peak compared to the p.m. peak. This is because generally travel demands are less elastic in the a.m. peak compared to the p.m. peak. Travelers generally require a more stable, predictable trip in the a.m. peak compared to the p.m. peak and, therefore, may have been more likely to utilize the Express Lanes in the a.m. peak with the expectation it would provide a faster trip.



Texas A&M Transportation Institute.

Figure A-38. Comparison of Average Travel Speed and Average Vehicle Throughput for the General Purpose Lanes, P.M. Peak Period



Texas A&M Transportation Institute.

Figure A-39. Comparison of Average Travel Speed and Average Vehicle Throughput for the Express Lane, P.M. Peak Period

Table A-31 provides an estimate of the number of vehicles in each vehicle occupancy category in both the Express Lanes and the general purpose lanes in each peak period. These estimates were derived by multiplying the modeled average corridor throughputs by the percentage of vehicles in each vehicle category. This table provides a sense of the net gains and losses in the number of vehicles in each vehicle-occupancy category after the HOV-to-HOT conversion. Table A-31 shows a substantial replacement of two-person vehicles by one-person vehicles in the Express Lane for both peak periods in the post-deployment period. The table also shows a substantial increase in the number of two-person vehicles using the general purpose lanes during both the peak periods in the post-deployment period. This suggests that some two-person vehicles were not willing to pay to use the Express Lanes in the post-deployment period. Furthermore, Table A-31 shows that the number of three-person and vehicles with four or more occupants dropped substantially in the Express Lanes, while increasing in the general purpose lanes. This also suggests that there were a number of three- and four-person carpools now electing to use the general purpose lanes over the Express Lanes even though they could still ride for free during the post-deployment period. This could be a short-term effect of the requirements to have a transponder and register as an HOV3+ carpool. As travelers become more familiar with the requirements and operation of the Express lanes, and as HOT operations become more widespread in the Atlanta region, higher occupancy vehicles might return to the Express Lanes.

Table A-31. Estimated Number of Vehicles by Occupancy Level[3]

Lane Type	Time Period	Estimated Vehicle Throughput by Occupancy				
		1	2	3	4+	Total
Southbound Morning Peak Period (6:00– 10:00 a.m.)						
HOV/Express Lane	Before	317	3,730	133	103	4,283
	After	3,555	504	38	71	4,168
General Purpose	Before	32,341	1,564	68	34	34,007
	After	29,308	3,351	131	66	32,856
Total	Before	32,658	5,294	201	137	38,290
	After	32,863	3,855	169	137	37,024
Northbound Afternoon Peak Period (3:00 – 7:00 p.m.)						
HOV/Express Lane	Before	412	4307	268	160	5,146
	After	3,698	598	43	97	4,436
General Purpose	Before	34,825	2,477	150	75	37,597
	After	31,093	4,457	252	144	35,946
Total	Before	35,237	6,784	418	235	42,673
	After	34,792	5,056	296	241	40,386

Source: Texas A&M Transportation Institute 2013.

A.6.2 Person Throughput

Person throughput (PT) is similar in concept to vehicle throughput; however, the emphasis is on the number of people served as opposed to the number of vehicles served. PT is defined as the number of persons, including vehicle occupants, pedestrians, and bicyclists, traversing a roadway section in one direction per unit time. PT is estimated by multiplying vehicle throughput for different vehicle classes by the average number of occupants per vehicles in each vehicle class. PT changes were estimated by summing the following:

- PT changes attributed to CRD transit improvements; and
- PT changes due to converting the I-85 HOV lane to Express Lane operations.

Table A-32 shows how the national evaluation team computed the person throughput changes due to converting the I-85 Express Lanes from HOV operations. Person throughput was estimated by multiplying vehicle throughput for the general purpose lanes and the Express Lanes by the number of occupants per vehicles in each occupancy category. The total person throughput for the peak period was then computed by summing the person throughput from the general purpose lanes with the estimated person throughput from the Express Lanes. The total peak period person throughput for

[3] Only data collected from the three observation locations between I-285 and GA 316 were used in the analysis. A large majority of the VMT within the CRD corridor was within the section between I-285 and GA 316.

the non-transit improvements was computed for both peak directions of flow for the pre- or post-deployment evaluation periods.

Table A-33 shows that as a result of the CRD transit improvements made in the corridor, average ridership in both the peak periods increased in the post-deployment period. These numbers were added to the total peak period person throughput resulting from allowing HOT operation in the Express Lanes. The result, provided in Table A-34, represents the grand total estimated person throughput in the corridor. Total peak period person throughput was estimated for both the pre- and post-deployment evaluation periods.

Table A-32. Estimated Non-Transit Peak Period Person Throughput

Lane Type	Time Period	Estimated Person Throughput (Non-Transit) by Person per Vehicle				
		1	2	3	4+	Total
Southbound Morning Peak Period (6:00 – 10:00 a.m.)						
HOV/Express Lane	Before	317	7,460	398	411	8,587
	After	3,555	1,009	113	283	4,960
General Purpose	Before	32,340	3,129	204	136	35,809
	After	29,307	6,703	394	263	36,667
Total	Before	32,657	10,589	602	547	44,395
	After	32,863	7,711	507	546	41,627
Northbound Afternoon Peak Period (3:00 – 7:00 p.m.)						
HOV/Express Lane	Before	412	8,614	803	638	10,466
	After	3,699	1,198	133	390	5,420
General Purpose	Before	34,825	4,954	450	300	40,529
	After	31,093	8,915	755	575	41,338
Total	Before	35,237	13,568	1,253	938	50,996
	After	34,792	10,112	888	965	46,758

Source: Texas A&M Transportation Institute.

Table A-33. Pre- and Post-Deployment Average Peak Period Transit Ridership Occurring in the CRD Corridor

Location	Unit	Average Peak Period Transit Ridership (persons)	
		Pre-Deployment	Post-Deployment
Southbound (A.M. Peak)	Average Peak Period Riders	1,385	1,464
	Number of Buses	50	58
Northbound (P.M. Peak)	Average Peak Period Riders	1,374	1,451
	Number of Buses	61	67

Source: Texas A&M Transportation Institute.

Table A-34. Computation of Pre-and Post-Deployment Total Peak Period Person Throughput

Peak Period	Person Throughput (Non-Transit)	Average Peak Period Transit Ridership	Total Peak Period Person Throughput
Pre Deployment			
Southbound (A.M. Peak)	44,395	1,385	45,780
Northbound (P.M. Peak)	50,996	1,374	52,370
Post-Deployment			
Southbound (A.M. Peak)	41,627	1,464	43,091
Northbound (P.M. Peak)	46,758	1,451	48,209

Source: Texas A&M Transportation Institute.

Table A-35 shows the changes in person throughput in the corridor after implementing HOT operations in the Express Lanes as well the transit improvements in the corridor. In the a.m. peak, total person throughput declined by approximately 6 percent in the post-deployment period. In the p.m. peak the decline was about 8 percent. Given that person throughput in the general purpose lanes did not decline and transit ridership in the Express Lanes increased, the overall decline in person throughput in the both the a.m. and p.m. peak periods can be attributed to the major drop in average vehicle occupancy in the Express Lanes after tolling began.

Table A-35. Comparison of Total Peak Period Person Throughput Pre- and Post-Deployment of CRD Improvements

Peak Period	Total Peak Period Person Throughput (persons)			
	Pre-Deployment	Post-Deployment	Change	Percent Change
Southbound (A.M. Peak)	45,780	43,091	-2,689	-5.8%
Northbound (P.M. Peak)	52,370	48,209	-4,151	-7.9%

Source: Texas A&M Transportation Institute.

A.7 Vehicle Miles Traveled

The national evaluation team also examined VMT as part of the congestion analysis. VMT is the product of the number of vehicles traveling over the length of the facility (i.e., VT) multiplied by the length of the facility.

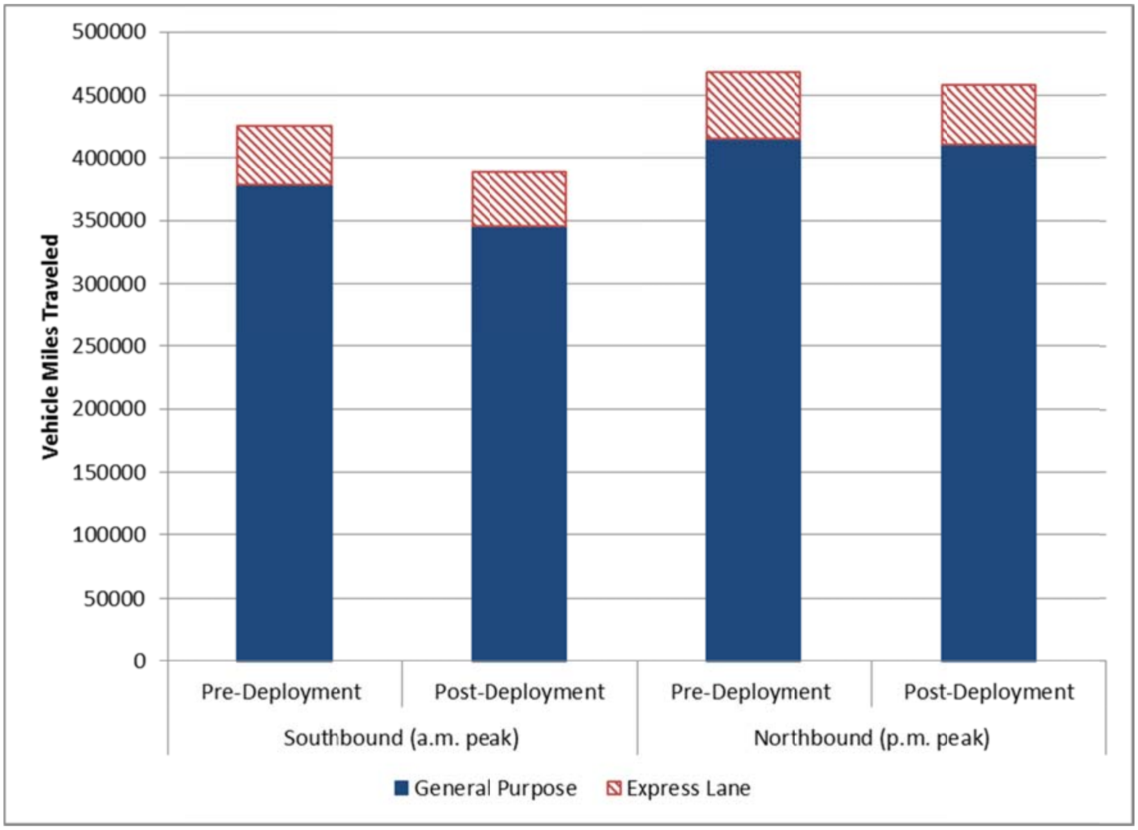
Table A-36 and Figure A-40 show the change in VMT in the corridor as a result of the CRD deployment. Overall, VMT in both the general purpose lanes and the Express Lanes declined in the post-deployment period in both the a.m. and p.m. peaks. In the a.m. peak, VMT was reduced by 8.6 percent, while in the p.m. peak VMT was reduced by 2.1 percent. The majority of this change can be attributed to reductions in VMT in the general purpose lanes in the a.m. peak period.

Table A-36. Pre-and Post-Deployment of VMT in the General Purpose and Express Lanes within the CRD Corridor

Peak Period	Lane Type	Vehicle Miles Traveled in the CRD Corridor[1]			
		Pre-Deployment	Post-Deployment	Change	Percent Change
Southbound (A.M. Peak)	General Purpose	379,018.2	345,241.9	-33,776.3	-8.9%
	Express Lanes	46,225.6	43,470.4	-2,755.2	-6.0%
	Total	**425,243.8**	**388,712.3**	**-36,531.5**	**-8.6%**
Northbound (P.M. Peak)	General Purpose	415,061.8	410,430.5	-4,631.3	-1.1%
	Express Lanes	52,434.1	47,377.5	-5,056.6	-9.6%
	Total	**467,495.9**	**457808**	**-9,687.9**	**-2.1%**

[1] Based on NaviGAtor II data for approximately 11.5 miles of I-85 covered by the NaviGAtor II system

Source: Texas A&M Transportation Institute.



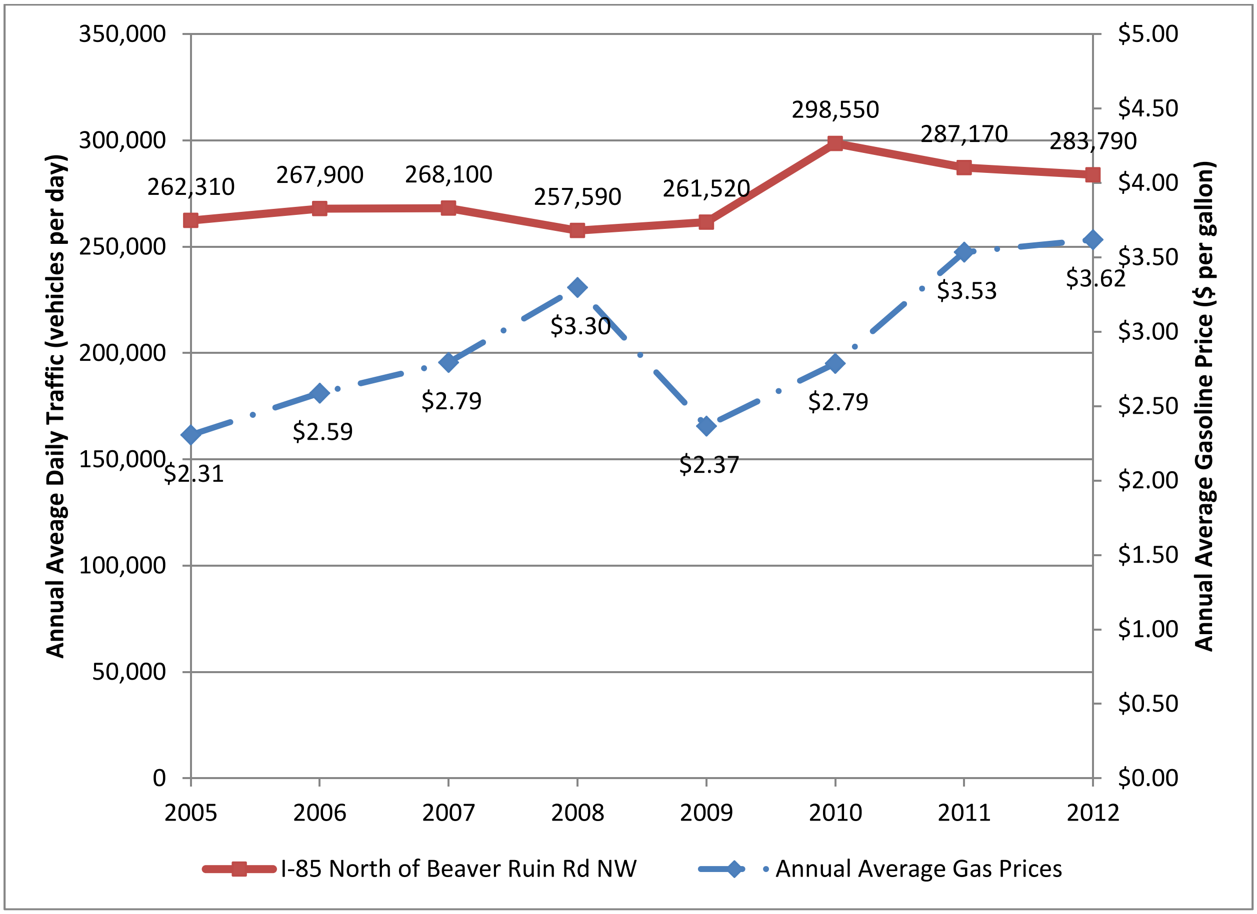
Texas A&M Transportation Institute.

Figure A-40. Comparison of Pre- and Post-Deployment VMT in the I-85 Corridor

A.8 Comparison of AADT and Gasoline Prices and Unemployment

In order to assess how exogenous factors might impact the results of the evaluation, a comparison of trends in gasoline prices and unemployment rates and annual average daily traffic (AADT) volumes was performed for both the study corridor as well as the control sites identified by the local partners. The expectation was that both gasoline prices and unemployment had an inverse relationship to travel demand – as both gasoline prices rise and unemployment rates rise, travel demand (as measured by AADT) would decline. Similarly, declines in either gasoline prices or unemployment would cause noticeable increases in AADT volumes.

Figure A-41 shows a comparison of the AADT on I-85 near Beaver Ruin Rd. and annual average gasoline prices from 2005 to 2012. The figure shows that between 2005 and 2008, gasoline prices in the Atlanta area increased by approximately $1 per gallon over the three year period. However, between 2008 and 2009, annual average gasoline dropped by approximately $1.00 per gallon, only to continue to rise to approximately $0.60 per year until 2011 and then leveling off between 2011 and 2012. Over the same time period, AADT in the corridor remained relatively constant until 2009, before experiencing a dramatic increase in 2010 and then declining again in 2011 and 2012. This is opposite to the expectation.



Texas A&M Transportation Institute.

Figure A-41. AADT on I-85 in the Study Corridor and Annual Average Gasoline Prices from 2005 to 2012

Figure A-42 compares the relative change in both AADT and gasoline prices referenced to 2005 for not only I-85 but also for the other control corridors in the study area. The figure shows that since 2005, the tendency for annual average gasoline prices in the Atlanta area had been to increase while the tendency of the AADTs at all control sites, except for I-85 and GA 400 both of which are on the northeast side of the Atlanta region, had been to decline. (Construction on I-85 was completed in 2009, and most likely accounts for the sharp upswing to 2010.) For both I-85 and GA 400, AADT values had remained relatively constant and even increased in comparison to annual average gasoline prices in the region.

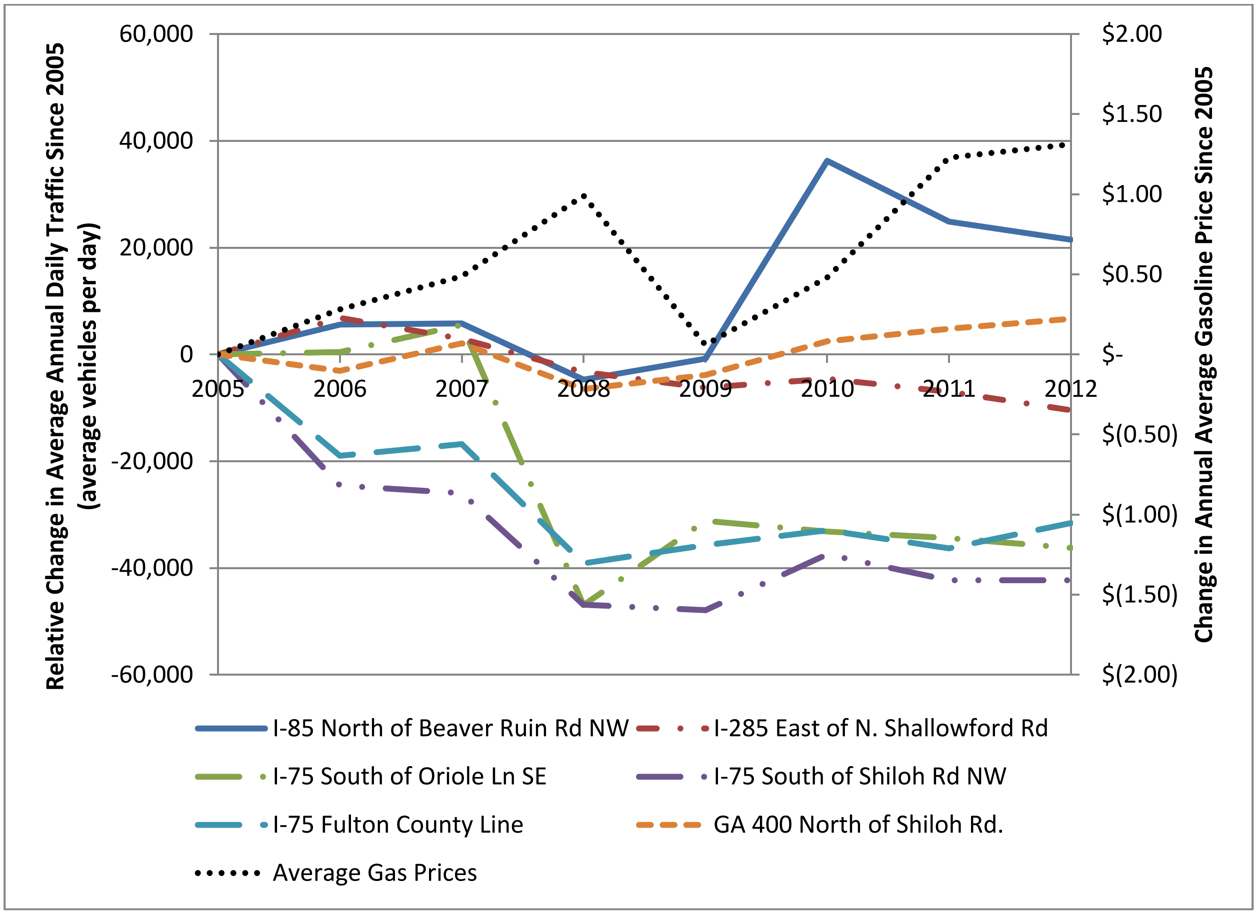
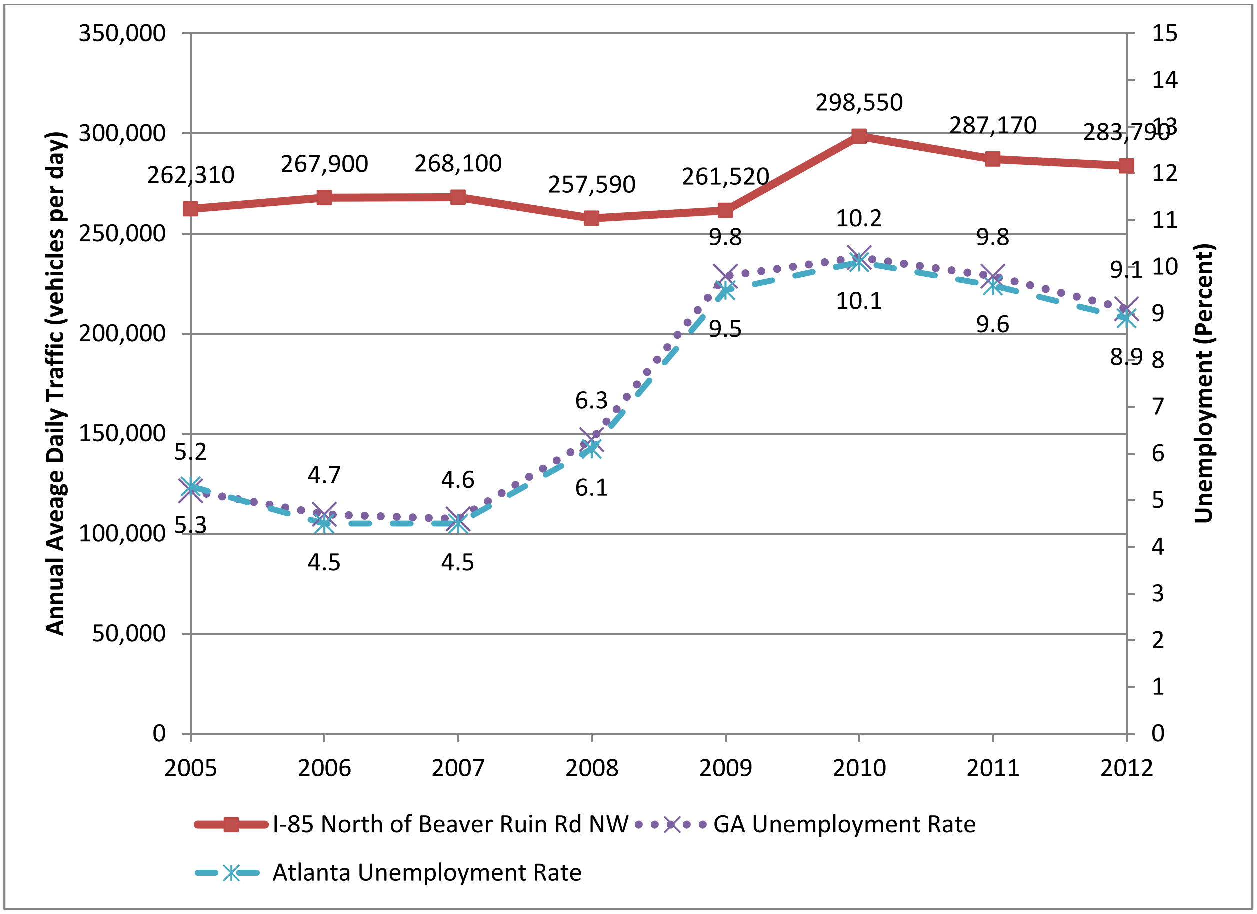


Figure A-42. Relative Change in AADT from Selected Sites and Annual Average Gasoline Prices Since 2005

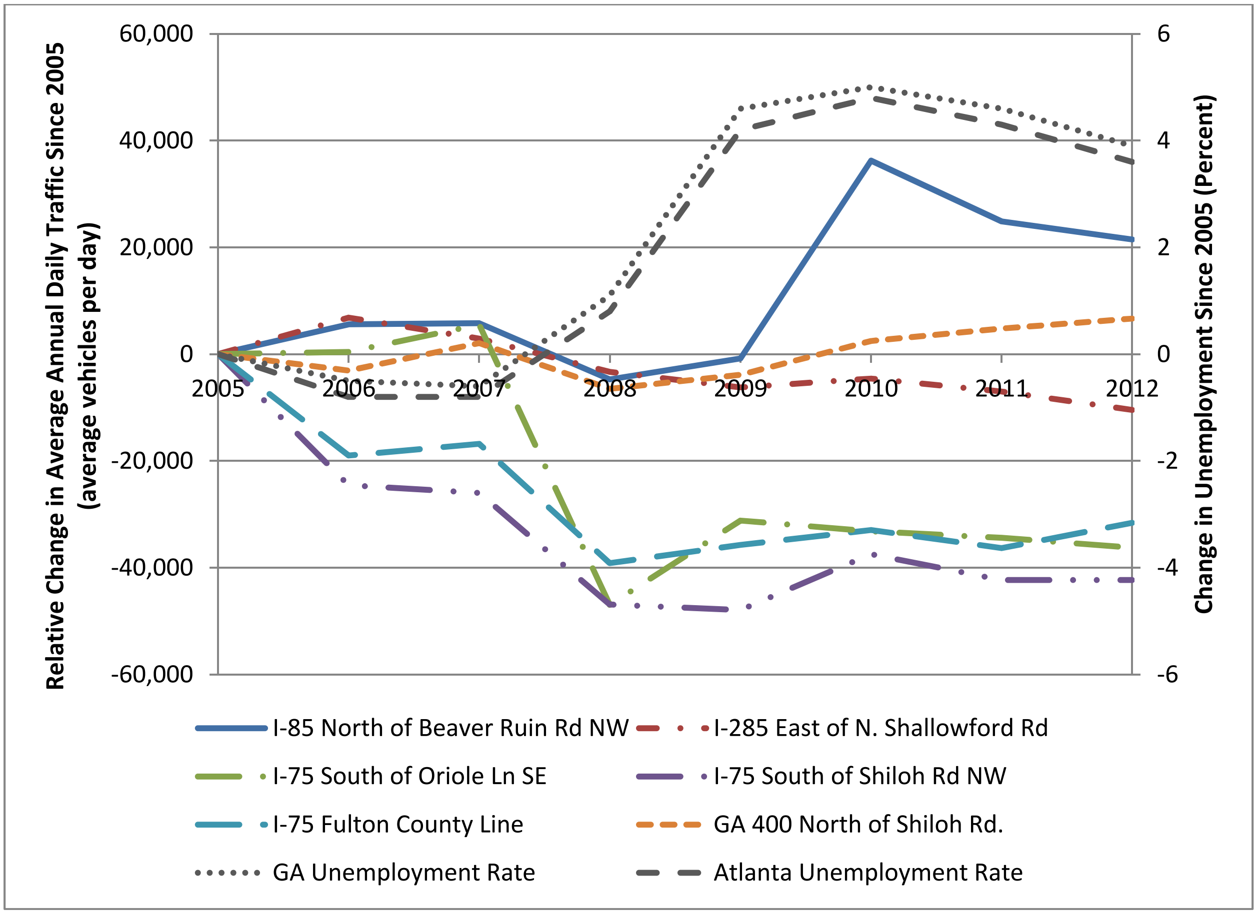
Figure A-43 shows a comparison of AADTs on I-85 in the study corridor and unemployment rates for both the Atlanta area and the state of Georgia. The figure shows that between 2005 and 2007, unemployment remained relatively constant, hovering at less than 5 percent. During this time, traffic volumes on I-85 remained relatively constant. Beginning in 2007, unemployment in the area and in the state began increasing as a result of the economic downturn. Unemployment peaked in the state and in the Atlanta region in 2010 at around 10 percent, before starting to decline throughout the duration of the study period. These changes in unemployment, however, did not seem to have a dramatic impact on travel demand in the corridor. As noted previously, AADT volumes remained relatively constant from 2005 to 2009, before increasing dramatically in 2010 and then leveling off between 2011 and 2012.



Texas A&M Transportation Institute.

Figure A-43. AADT on I-85 in the Study Corridor and State and Local Unemployment Rates from 2005 to 2012

Figure A-44 shows the relative change in AADTs from selected control sites and the changes in the unemployment rates since 2005. The figure shows that travel demand on I-85 responded differently to the economic downturn compared to other sites, especially I-75. Travel demand on roadways such as I-75 and to a lesser extent I-285 tended to drop as the unemployment rate in the region and state increased. On I-85, however, travel demand in the corridor lagged behind changes in employment. As the unemployment rate increased, travel on I-85 also increased. This suggests that traffic demand on I-85 was not impacted in the same way as the traffic from other parts of the region by the economic downturn. Other factors not captured in the analysis are likely to have contributed to the changes in AADT values experienced in the I-85 corridor.



Texas A&M Transportation Institute.

Figure A-44. Relative Change in AADT from Selected Sites and Changes in State and Local Unemployment since 2005

A.9 Perceptions of Congestion on I-85

Information on the perception of users of I-85 on the impacts of CRD projects was available from a household panel travel survey sponsored by Volpe and from focus groups of different I-85 user groups sponsored by GDOT. The household travel survey methodology is presented first, followed by the results related to congestion on the I-85 Express Lanes and general purpose lanes. The focus group results related to congestion are also summarized. Appendix C -- Transit Analysis contains information on details of the on-board transit ridership survey and Appendix J -- Business Impacts contains information detailing how the business focus groups were performed.

A.9.1 Atlanta Household Travel Survey Methodology

To assist in evaluating the impact of converting the existing HOV lanes on I-85 to the HOT Express Lanes, Volpe sponsored a panel household travel survey.[4] The same households were surveyed before and after the I-85 HOV-to-HOT conversion to assess changes in travel behavior and perceptions toward the project. The survey consisted of a demographic questionnaire, a travel diary, and follow-up questions on current travel patterns and attitudes. The travel diary covered a 48-hour period in which respondents recorded the details of all trips, including origin, destination, time, travel mode, and purpose. There were specific follow-up questions related to trip satisfaction for trips using I-85.

The pre-deployment – wave 1 – surveys were conducted in April and May, 2011, as the Express Lanes were anticipated to open in the summer of 2011. The actual opening of the I-85 Express Lanes occurred in October 2011. The post-deployment – or wave 2 – surveys were conducted in April and May 2012, seven months after the opening of the Express Lanes. This schedule provided travelers with several months to adjust to the Express Lanes, the new tolling system, and the new 3+ carpool requirement for toll-free use. Conducting the surveys at the same time of year also minimized the potential for seasonal variation.

The survey was conducted by the Resource Systems Group (RSG) under contract to Volpe. Participants were recruited from three different I-85 user groups – drivers, transit riders, and vanpoolers. Drivers on I-85 were identified through the use of license plate capture photography on sections of I-85 and Buford Highway. The license plate numbers were matched to addresses, and potential participants were sent a postcard with a website to register. Transit riders were intercepted by survey staff on board buses, at corridor park-and-ride lots, and at corridor transit stations. Transit riders were asked a series of questions to ensure they traveled in the I-85 corridor and were given postcards with a website to register for the survey. Members of GRTA-organized vanpools received an e-mail solicitation requesting their participation.

Overall, 1,655 households with 3,126 individuals, participated in both waves of the survey.
For wave 1, 37,888 total survey invitations were distributed, with 2,412 households responding, accounting for a response rate of 6.4 percent. A total of 1,655 households continued participating in wave 2, accounting for a retention rate of 69 percent and an overall response rate of 4.5 percent.

Table A-37 provides a summary of the demographics of the respondents participating in the Atlanta Household Travel Survey sponsored by Volpe.

[4] Volpe National Transportation Systems Center. June 13, 2013. "Atlanta CRD Traveler Behavior Survey: Key Findings," Draft.

Table A-37. Demographics of Atlanta Household Travel Survey

Participant Characteristics	Percentage
Gender	
Male	55%
Female	45%
Race	
White	45%
Black	13%
Asian	8%
Hispanic	6%
Age	
18 to 24 years	3%
25 to 54 years	73%
55 to 65 years	19%
>65 years	5%
Household Income	
<$50K	13%
$50K to $90K	38%
$100K to $150K	23%
>$150K	13%
Household Composition	
Adult Only	60%
With Children	40%
Vehicles per Household	
0 vehicles	0%
1 vehicle	20%
2 vehicles	52%
3+ vehicles	26%
Education	
Less than a Bachelor's Degree	35%
Bachelor's Degree or higher	65%
Employment	
Full-time	72%
Part-time	6%
Self-employed	5%
Student	4%
Homemaker	6%
Retired	4%
Unemployed	3%
Commutes per week	
5 days per week	62%
4 days per week	11%
3 days per week	8%

Source: Volpe National Transportation Systems Center

In comparing participants in wave 1 and wave 2 to assess the impact of possible panel attrition, notable differences included a small increase in the proportion of 35-to-45 year olds and a drop-off in the number of respondents in the youngest age groups. There was also a slight decline in the share of respondents with lower levels of education. Further, there was a slight decline in the proportion of two adult households with children.

A.9.2 Atlanta Household Travel Survey Congestion-Related Questions

From the trip diaries completed by the survey respondents, the overall number of trips declined by 15 percent across the two waves of surveys. The total number of reported trips in the I-85 corridor declined by 18 percent, and the number of reported trips outside the corridor declined by 12 percent. The share of trips in the corridor experienced a small, but statistically significant 2 percent decline across the two waves, with 47 percent of all wave 1 trips occurring in the I-85 corridor, compared to 45 percent of all wave 2 trips.

As shown in Table A-38, the overall number of reported trips declined by 15 percent. There was a significant decline of 12 percent in the number of driving trips reported on I-85 and a 33 percent decline in the number of driving trips reported on other roads in the corridor. There was a significant increase of 30 percent in the number of trips reporting use of any transit.

Table A-38. Change in the Use of the Corridor (Based on Trip Diaries)

	Wave 1/ (Share of Total Trips)	Wave 2/ (Share of Total Trips)	% Change in Trip Count
All Trips	19,397 (100%)	16,521 (100%)	-15%
Corridor Trips	9,035 (47%)	7,449 (45%)	-18%
Drive on I-85	6,338 (33%)	5,553 (34%)	-12%
General Purpose Lanes	5,924 (31%)	4,733 (29%)	-20%
HOV/Express Lanes[5] (excludes transit)	414 (2%)	820 (5%)	+98%
Any Transit on I-85	165 (1%)	207 (1%)	+30%
Other roads in Corridor	2,532 (13%)	1,689 (10%)	-33%

Source: Volpe, used with permission.

[5] This table is based on person-trips, so two individual traveling together from the same household are counted as separate trips. If the analysis is confined to vehicle-trips (e.g. individuals from the same household traveling together are counted as one trip), there was a 126 percent increase in the share of Express Lane relative to HOV lane trips. Not surprisingly, removing “duplicate” household members had a larger impact on HOV lane trips (which drop from 414 to 350) compared to Express Lane trips (which drop from 820 to 791). When duplicates were removed, the share of total trips remained unchanged, at 2 percent for HOV lanes trips and 5 percent for Express Lane trips.

With regard to the Express Lanes, the trip diaries showed nearly a doubling – a 98 percent increase – in the number of trips reported in the Express Lanes from wave 1 (HOV operation) to wave 2 (Express Lanes). The share of trips on the HOV lanes versus the Express Lanes increased from 2 percent of all reported trips in wave 1 to 5 percent of all reported trips in wave 2. At the same time, the share of trips in the general purpose lanes experienced a slight, but statistically significant decline of 2 percent.

A close examination of reported trips in the Express Lanes indicated that 82 percent were toll-paying single-occupancy vehicles, 4 percent were two-person carpools paying a toll, 9 percent were 3+ toll-exempt carpools, and 5 percent were toll-exempt AFVs or motorcycles. There appeared to be some inconsistencies in two-person carpools, with some respondents indicating they did not pay a toll as a two-person carpool.

A paired comparison of self-reported use of the HOV lanes in wave 1 and the Express Lanes in wave 2 provided further insight into possible changes in travel behavior due to the implementation of tolling. A total of 54 percent of respondents reported no trips on either the HOV lanes or the Express Lanes. A total of 22 percent reported using the Express Lanes more than they did the HOV lanes, including 18 percent who were new weekly users. A total of 21 percent of respondents reported using the Express Lanes less than they did the HOV lanes, including 17 percent who stopped making regular trips between the two waves. A total of 77 percent of the respondents reported fewer trips on the Express Lanes citing not wanting to pay a toll as the major factor. Further, 16 percent indicated they no longer used the lanes because their two-person carpool had to pay a toll.

An examination of changes in reported travel times for morning commute trips found no change in mean travel for individuals making the same commute trips in wave 1 and wave 2. The mean travel time for all morning commute trips for these individuals was 40.43 minutes in wave 1 and 40.54 minutes in wave 2. The mean travel time for commute trips during the 7:00 a.m.-to-9:00 a.m. peak period was 39.67 minutes in wave 1 and 39.77 minutes in wave 2.

Overall, the survey results identified an increase in the mean occupancy for all I-85 driving trips, excluding transit and vanpools, from 1.13 to 1.17. In the HOV lanes/Express Lanes there was a dramatic decrease in vehicle occupancy levels from a mean of 2.2 in wave 1 (HOV lanes) to 1.18 in wave 2 (Express Lanes). There was an increase in vehicle occupancy levels in the general purpose lanes from 1.07 in wave 1 to 1.18 in wave 2. Before tolling was initiated, 4 percent of all trips reported in the general purpose lanes had two or more people. After tolling was implemented, 12 percent of all reported trips in the general purpose lanes had two or more people. These occupancy patterns were consistent with those reported in Section A.5 using data from the Georgia Tech occupancy field study.

Respondents were asked when they made the decision to use the Express Lanes. A total of 42 percent indicated they generally decided to use the Express Lanes during their trip, compared to 18 percent who reported making the decision before they began their trip, 19 percent who reported they sometimes decided before and sometimes during their trip, and 21 percent who reported only using the Express Lanes when they could travel for free.

Reasons for using the Express Lanes based on a provided list included: 71 percent, regular lanes were very congested; 66 percent, wanted to save time; 43 percent, wanted to have more reliable trip; and 15 percent, Express Lanes were safer.

The survey included questions associated with trip satisfaction due to the pricing on I-85. Travelers who either drove alone or rode the bus were asked to rate their level of satisfaction on a seven-point scale with different aspects of their trips, including travel speed, driving time, and predictability of their driving time. Information on questions related to transit, tolling, safety, and other topics is presented in the other appropriate appendices. The analysis of driving trip satisfaction focused on travel during the morning peak period from 7:00 a.m. to 9:00 a.m. since pricing was supposed to provide the greatest benefits during congested time periods.

On all three measures – travel speed, driving time, and driving time predictability – dissatisfaction tended to outweigh satisfaction in both wave 1 and wave 2 or both before and after implementation of the Express Lanes. As shown in Table A-39 approximately 60 percent of trips in the general purpose lanes were rated as unsatisfactory for travel time and travel speed in both wave 1 and wave 2. There was no statistically significant difference in the distribution of ratings across the two waves for the two measures. There was a statistically significance difference in the distribution of ratings for driving time predictability, however, with the largest change occurring the in the somewhat dissatisfied category, which increased from 12 percent in wave 1 to 16 percent in wave 2.

Table A-39. Satisfaction with A.M. Peak Hour General Purpose Lane Trips (Wave 1, N=985 Trips; Wave 2, N=723 Trips)

	Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Very Satisfied
Travel Time							
Wave 1	20%	22%	18%	10%	10%	15%	4%
Wave 2	19%	22%	19%	9%	11%	17%	5%
Travel Speed							
Wave 1	20%	23%	16%	9%	11%	16%	5%
Wave 2	19%	21%	17%	11%	11%	17%	5%
Predictability*							
Wave 1	21%	16%	12%	18%	12%	17%	4%
Wave 2	19%	16%	16%	15%	10%	19%	5%

* On predictability, there is a significant difference in the distribution of wave 1 vs. wave 2 responses (chi-square=23.58, significant at <.01 level)

Source: Volpe, used with permission.

Table A-40 reveals a significant difference across waves for the Express Lanes on all three measures, with trips in wave 2 receiving more positive ratings. The percentage of trips rated as satisfactory for travel time increased from 32 percent in wave 1 to 43 percent in wave 2. The somewhat satisfied rating increased by 10 percent from wave 1 to wave 2 and the very satisfied rating increased by 3 percent. The somewhat satisfied category for the travel speed measure increased from 11 percent in wave 1 to 20 percent in wave 2 and from 6 percent to 12 percent for the trip-time reliability measure.

Table A-40. Satisfaction with A.M. Peak Hour HOV/Express Lane Trips (Wave 1: N=93 Trips; Wave 2, N=169 Trips)

	Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Very Satisfied	
Travel Time								
Wave 1	12%	18%	27%	11%	8%	21%	3%	Chi-sq=40.1
Wave 2	13%	15%	20%	9%	18%	19%	6%	sig <..0001
Travel Speed								
Wave 1	12%	15%	29%	9%	11%	20%	4%	Chi-sq=34.2;
Wave 2	15%	16%	15%	10%	20%	18%	5%	sig <.0001
Predictability								
Wave 1	14%	10%	20%	27%	6%	21%	3%	Chi-sq=23.1;
Wave 2	13%	9%	23%	19%	12%	18%	6%	sig .0008

Source: Volpe, used with permission.

Transit riders on I-85 were more satisfied on all three measures than drivers for both waves. Large majorities reported being satisfied, with a quarter being very satisfied. These findings are consistent with the on-board transit survey results reported in Appendix C – Transit Analysis.

Respondents were also presented with statements about their travel experience since the Express Lanes opened on I-85 to which they could agree or disagree on a seven-point scale (or say they don't know). Figure A-45 shows that a majority of 54 percent disagreed that their travel on I-85 had been improved by the Express Lanes and only 16 percent were in agreement. However, although not shown here, it should be noted that 54 percent of respondents who used the Express Lane at least once a week were significantly more likely to agree that the Express lanes have improved their travel on I-85 compared to only 6 percent among other I-85 users.

In addition to no noticeable improvement on I-85 itself for the majority of wave 2 respondents, 50 percent also felt that congestion was worse on other routes in the I-85 corridor. Only 13 percent disagreed that congestion had become worse on those other routes.

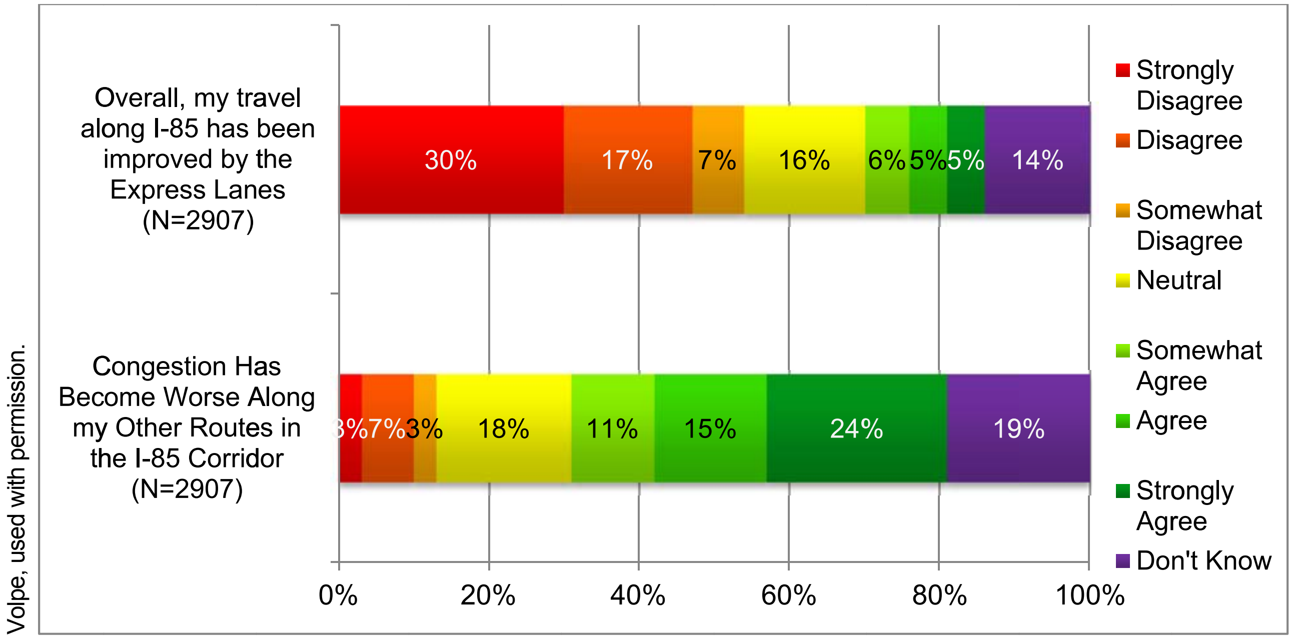


Figure A-45. Attitudes toward Tolling (Wave 2, N=2907 Respondents)

A.9.3 Congestion Perceptions of Other I-85 User Groups

Noble Insight, Inc., under contract to SRTA, conducted focus groups with specific user groups as part of the national evaluation. The purpose of the focus groups was to obtain reactions to the Express Lanes from bus and HERO operators and from business owners in the CRD area. The composition and number of participants in each of the five focus groups were:

- GRTA Bus Operators – 5 participants;
- Gwinnett Bus Operators – 5 participants;
- HERO Operators – 6 participants;
- CRD Area Small Business Owners with Commercial Trucks – 8 participants; and
- CRD Area Small/Larger Business Owners – 9 participants.

The focus groups were conducted in August and September 2012. The bus and HERO operators had all been driving on or patrolling the I-85 HOV lanes prior to the implementation of the Express Lanes. The focus group script included questions on the participant's perceptions of changes in congestion, motorist's behavior, traffic and safety, crashes and incidents, and Express Lane signing. The focus groups with business representatives also included questions on use of the Express Lanes, impacts on businesses, and impacts on customers.

The general reaction from participants in the five focus groups was mixed related to the impact of the Express Lanes on traffic congestion on I-85. Participants in all five focus groups indicated that congestion levels were better in the Express Lanes and worse in the general purpose lanes during the post-deployment period. HERO and bus operators noted that travel in the Express Lanes was less congested, but that travel in the general purpose lanes was more congested. They also noted that congestion continued to be worse in the Spaghetti Junction, from Highway 316 to Jimmy Carter, and around Highway 985. The difficulty with merging into and out of the Express Lanes due to traffic congestion in the general purpose lanes was also noted. HERO operators did indicate an improvement in response time because of the Express Lanes, however.

Representatives from small businesses with commercial trucks and small business owners in the CID area also indicated that traffic congestion had not improved with the implementation of the Express Lanes. They echoed similar concerns that congestion was worse in the general purpose lanes and slightly better in the Express Lanes. Some participants noted they had initially been hopeful that the Express Lanes would help relieve congestion in the corridor, but that these expectations had not been met and that traffic congestion in the corridor was worse.

A.10 Findings of Congestion Impacts

The following provides a summary of the interpretation of the congestion analysis results and the effect of the implemented CRD improvements on congestion in the corridor. Table A-41 summarizes the impacts of the CRD improvements on congestion across the five hypotheses in the national evaluation.

A.10.1 Travel Times/Travel Speeds

- For the general purpose lanes, mean peak period travel times remained the same or increased in the post-deployment period in both the a.m. and p.m. peaks. For the a.m. peak, these increases were statistically significant early in the peak period (from 6:00 a.m. to 7:30 a.m.). After 7:30 a.m., changes in mean travel times were not statistically significant. In the p.m. peak, travel times in the general purpose lanes increased significantly during every interval, except from between 6:30 to 7:00 p.m.
- For the Express Lanes, mean peak period travel times were slightly lower in the post-deployment period in both the a.m. and p.m. peak. While these reductions were statistically different during most intervals in each peak, the magnitude of the reductions (generally less than a minute and at best 1.25 minutes) in travel times may not have been noticeable to most users of the Express Lanes.
- The relative travel time advantage of using the Express Lanes increased in the post-deployment period (up to 2.1 minutes in the a.m. peak and up to 3.2 minutes in the p.m. peak). This implies that, while the changes in actual travel times may not have been large, the travel time advantage of using the Express Lanes improved as a result of the CRD projects. This change in p.m. peak travel times was attributed to travel times increasing in the general purpose lanes during the p.m. peak.
- Similar observations were made regarding mean travel speeds. Mean speeds in general purpose lanes were lower during each peak. Travel speeds in the general purpose lanes were generally between 1 and 3 mph slower during each interval in the a.m. peak and between 2 and 6 mph slower in the p.m. peak.
- Mean travel speeds in the Express Lanes increased in the post-deployment period; however, these increases were minimal, generally less than 2 mph in the both peaks.

A.10.2 Travel Times Variability

- The CRD improvements did not appear to have an impact on the travel time variability in general purpose lanes in either the a.m. or p.m. peak periods. The 95th percentile travel time for the general purpose lanes basically remained unchanged in both peaks in the post-deployment period, except for the heart of the a.m. peak where the 95th percentile travel time was reduced from 7:30 a.m. to 8:30 a.m.
- Travel time variability in the Express Lanes seemed to improve for only the p.m. peak. For the Express Lanes, the 95th percentile travel times generally remained the same or increased slightly in the a.m. peak. During the p.m. peak, however, the 95th percentile travel time in the Express Lanes reduced in every interval. Changes in buffer time (the amount of extra time that drivers needed to allocate to a peak period trip) were most substantial in the p.m. peak.

A.10.3 Throughput

- Total peak period vehicle throughput in the general purpose lanes and the Express Lanes were lower in both the a.m. and p.m. peaks in the post-deployment period. Total peak period vehicle throughput was reduced by 3 percent in the a.m. peak and 5 percent in the p.m. peak. Total vehicle throughput in both the general purpose lanes and in the Express Lanes was statistically lower in almost every interval during the a.m. and p.m. peaks. In addition to the impact of tolling, economic factors such as continued high unemployment and gasoline prices could explain the drop.
- The CRD improvements had a significant impact on the occupant levels of vehicles in the Express Lanes. The average number of occupants per vehicle in the Express Lanes declined from approximately two occupants per vehicle to approximately 1.25 in the post-deployment period. This change was consistent across both peak periods. The average number of occupants per vehicle in the general purpose lanes increased from 1.06 to 1.11 in the a.m. peak and from around 1.10 to 1.15 in the p.m. peak, owing substantially to the increase in 2-person carpools shifting from the Express Lanes to the general purpose lanes.
- Including the effects of the transit improvements, total peak period person throughput was still impacted. In the a.m. peak, total peak period person throughput declined by 6 percent and by 9 percent in the p.m. peak.
- VMT in both the general purpose lanes and in the Express Lanes decreased in both the a.m. and p.m. peak periods in the post-deployment period. VMT in the Express Lanes decreased 6 and 10 percent in the a.m. peak and p.m. peak, respectively. VMT in the general purpose lanes decreased by almost 9 percent in the a.m. peak. VMT remained relatively unchanged in the general purpose lanes in the p.m. peak.

A.10.4 Extent of Congestion

- Because of issues associated with available of good, consistent sensor data throughout the corridor, the national evaluation team was unable to perform an analysis of how CRD improvement had on the spatial and temporal distribution of congestion within the corridor.

A.10.5 Users' Perceptions

- The results from the Volpe household travel survey and the focus groups of HERO operators, GRTA and Gwinnett operators, and representatives from businesses in the corridor indicated a perception that congestion levels on I-85 had not improved with the implementation of the Express Lanes and other CRD projects. Approximately 60 percent of the survey respondents rated trips in the general purpose lanes as unsatisfactory for travel time and travel speed in both wave 1 and wave 2. Respondents reported increased satisfaction with travel in the Express Lanes, however, with satisfaction for travel time increasing from 32 percent in wave 1 to 43 percent in wave 2. Participants in the focus groups suggested that the Express Lanes were less congested, but the general purpose lanes were more congested in the post-deployment period.
- Travelers who used the Express Lanes in wave 2 expressed greater satisfaction with their use of the lanes compared to those using the HOV lanes in wave 1. Those who used the Express Lane at least once per week were also more inclined to perceive improvements in their travel on I-85 in the post-deployment period.

Table A-41. Summary of Congestion Impacts Across CRD Hypotheses

Hypotheses	Result	Evidence
• Converting the I-85 HOV lanes to HOT operations will improve travel time and average travel speeds on both the general purpose and high occupancy lanes on I-85.	Somewhat Supported	For the general purpose lanes, mean peak period travel times remained the same or increased in the post-deployment period in both the a.m. and p.m. For the Express Lanes, mean peak period travel times were slightly lower in the post-deployment period in both the a.m. and p.m. peak. Mean speeds in general purpose lanes were lower during each peak. Mean travel speeds in the Express Lanes increased in the post-deployment period; however, these increases were minimal, generally less than 2 mph in the both peaks.
• Converting the I-85 HOV lanes to HOT operations will improve travel-time reliability and reduce variability on both the general purpose and high occupancy lanes on I-85.	Not Supported	The CRD improvements did not appear to have an impact on the travel-time variability in general purpose lanes in either the a.m. or p.m. peak periods. Travel-time variability in the Express Lanes seemed to be improved for only the p.m. peak.
• Deploying the CRD improvements will result in more vehicles and persons being served on I-85.	Somewhat Supported	Total peak period vehicle throughput in the general purpose lanes and the Express Lanes was lower in both the a.m. and p.m. peaks in the post-deployment period. The average number of occupants per vehicle in the Express Lanes declined from approximately two occupants per vehicle to approximately 1.25 in the post-deployment period. The average number of occupants per vehicle in the general purpose lanes increased from 1.06 to 1.11 in the a.m. peak and from 1.10 to 1.15 in the p.m. peak. Even after the effects of the transit improvements were included, total peak period person throughput was still impacted, with a 6 percent decline in the a.m. and 9 percent decline in the p.m.
• Implementing the CRD improvements in the I-85 corridor will reduce the spatial and temporal extent of congestion.	NA	Issues associated with available sensor data prevented an analysis of the spatial and temporal distribution of congestion within the corridor. Travel-time variability in the Express Lanes seemed to be improved for only the p.m. peak.
• As a result of the CRD improvements, the perception of travelers is that congestion has been reduced in the I-85 corridor.	Supported Somewhat – Mixed Results	The results from the household travel survey and the focus groups of HERO operators, bus operators, and business representatives indicated a general perception that congestion had not been reduced in the I-85 corridor. Traffic congestion in the general purpose lanes got worse, while congestion levels in the Express Lanes had improved slightly. Users of the Express Lanes were more positive in their assessment than users in general.

Source: Texas A&M Transportation Institute.

Appendix B. Tolling Analysis

This appendix contains the tolling analysis for the Atlanta CRD project. The tolling analysis focused on the effect of the I-85 high-occupancy toll (HOT) lanes, called the I-85 Express Lanes, on travel behavior, vehicular throughput, and traffic congestion on I-85 in DeKalb and Gwinnett counties in Georgia.

Table B-1 presents the hypotheses/questions for the tolling analysis, which were identified in the Atlanta CRD Evaluation Plan and the Atlanta CRD Tolling Test Plan.[1] The first was a hypothesis that tolling would increase vehicular throughput in Express Lanes and improve travel reliability. The second was a question that sought to identify changes in usage occurring as a result of increasing the vehicle-occupancy requirement on the Express Lanes from HOV2+ to HOV3+. The third was a related question that examined how much travelers utilized the I-85 Express Lanes. The last hypothesis stated that variable pricing would regulate access so as to improve the operation of the Express Lanes.

Table B-1. Tolling Hypothesis/Questions

Hypothesis/Questions
• Tolling will increase vehicular throughput on the I-85 Express Lanes and improve travel reliability.
• What changes in usage will occur as a result of the conversion of the HOV2+ lanes to HOV3+ lanes?
• How much will travelers utilize the I-85 Express Lanes system?
• Variable pricing on the I-85 Express Lanes will regulate vehicular access so as to improve the operation of the lanes.

Source: Battelle

The appendix is divided into eight sections. The data sources used in the analysis are described next in Section B.1. Information on the types and number of Peach Pass accounts and transponders is presented in Section B.2. Section B.3 discusses use of the I-85 Express Lanes by different user groups, toll rates, and traffic flow. Section B.4 summarizes the toll revenues collected on the I-85 Express Lanes. Information on enforcing the Express Lanes toll, vehicle occupancy, and operating requirements is presented in Section B.5. The results from a value of time analysis are described in Section B.6. Information from surveys, interviews, and focus groups on the tolling aspects of the CRD is summarized in Section B.7. Section B.8 presents a summary of the tolling analysis relating to the hypotheses and questions.

[1] Zimmerman, Carol et al. April 6, 2011. "Atlanta Congestion Reduction Demonstration: National Evaluation Plan," Publication Number FHWA-JPO-11-003; and Goodin, Ginger. August 2, 2011. "Atlanta Congestion Reduction Demonstration: National Evaluation: Tolling Data Test Plan," Publication Number FHWA-JPO-11-097.

B.1 Data Sources

The tolling analysis relied on a number of different data sources. First, information on Peach Pass account options, transponders, and other topics related to the Express Lanes was obtained from the State Road and Tollway Authority (SRTA) Peach Pass and I-85 Express Lanes websites. Second, SRTA provided data to the national evaluation team on accounts by type, revenues, violations receiving notices, and citations by month. SRTA also provided a data set with individual Peach Pass transactions for the 12-month period from October, 2011 through September, 2012. Further, SRTA, provided data from the automatic vehicle identification (AVI) sensors located along the Express Lanes and the general purpose lanes. The Georgia Institute of Technology (Georgia Tech) provided data from vehicle-occupancy counts conducted for the Georgia Department of Transportation (GDOT). Data from the GDOT NaviGAtor system used in Appendix A – Congestion Analysis were also examined. Responses from the tolling-related questions in the Atlanta household travel survey sponsored by the Volpe National Transportation Systems Center were reviewed and analyzed. The summary of GDOT-sponsored focus groups with HERO operators, Georgia Regional Transportation Authority (GRTA) operators, Gwinnett bus operators, and business representatives in the I-85 corridor was reviewed.

The tolling transaction dataset provided by SRTA included the following information for each toll transaction from October 1, 2011 to September 30, 2012.

- The beginning and end time of a trip;
- The segment of the highway where the trip was recorded;
- The account type associated with the transponder;
- The current toll status;
- The direction of travel;
- Whether a violation was posted to an account;
- The toll price posted to accounts;
- The ZIP code associated with the registration address for the accounts; and
- Make and model of the vehicle (given as typed by individual users when registering for a toll account).

Not all of the variables were recorded for each of the nearly 4 million transactions processed during the post-deployment period, however. Common values that were missing from some transactions included the ZIP code, the account type, and the vehicle make and model. Approximately 404,000 transactions did not have an associated ZIP code, 320,000 transactions did not indicate an account type, and 529,000 transactions did not have a vehicle make and model. The reason for the partial loss of these data elements may be explained by adjustments in processing toll data during the first four months of operation. In addition, the vehicle make and model was hard to decipher due to the multiple spellings and misspellings of common vehicles.

The number of toll transactions in the monthly summaries and the total transaction dataset did not match exactly. Toll leakage or non-payment of tolls due to faulty transponders, vehicles without Peach Passes, and other factors were addressed at different points in processing for the two data sets. Both data sources reflected the same trends, however, and the slight differences should not influence the analysis presented in this appendix.

B.2 Peach Pass Accounts and Transponders

This section highlights the types of Peach Pass accounts available for users of the I-85 Express Lanes and the number of Peach Passes and transponders issued during the pre- and post-deployment periods.

B.2.1 Types of Peach Pass Accounts

All users of the I-85 Express Lanes must have an active Peach Pass account and a valid transponder. Individuals can open a Peach Pass account online, by telephone, and in person at one of three customer service centers. There is no charge to open an account or to obtain a transponder, but an initial payment of $20 and a valid, active credit card or debit card is required to replenish the account

Before SRTA introduced the Peach Pass in June 2011, there were 169,255 active accounts and 293,356 active transponders associated with the Cruise Card system, which was the precursor to the Peach Pass. Existing Cruise Card accounts were automatically converted to Peach Pass accounts in June 2011. The term Peach Pass was used in this analysis to include both Peach Passes and Cruise Cards and transponders.

The following six types of Peach Pass accounts are available for different user groups.

- **Personal Toll Account.** This account is available for personal vehicles. No more than 10 vehicles can be associated with an individual personal toll account. Each vehicle associated with the account must have a transponder registered in primary mode: either non-toll or toll. To change to the alternate toll mode, the vehicle owner must pre-register the toll mode change before using the Express Lanes. The account requires a prepayment of $20. Sufficient funds must be maintained in the account to cover tolls and other charges.
- **Commercial Toll Account.** This account is for companies or businesses with corporate, leased, or rented vehicles. There are no limitations on the number of Peach Passes that can be linked to a commercial toll account. Each vehicle associated with the account must have a transponder registered in primary mode: either non-toll or toll. To change to the alternate toll mode, the vehicle owner must pre-register the toll mode change before using the Express Lanes. The account requires a prepayment of $20. Sufficient funds must be maintained in the account to cover tolls and other charges.
- **Toll Exempt Account.** This account is for vehicles that will always qualify for non-toll status based on meeting the vehicle occupancy (3+) or alternative-fuel vehicles (AFV) requirements. Failure to properly use the toll facility will result in a toll violation. Peach Passes associated with a toll exempt account cannot be used for payment on toll facilities, such as GA 400, where all lanes and all vehicles are tolled. Changing status between toll and non-toll modes is not permitted with this type of account type.
- **Non-Revenue Account.** This account is for non-emergency transit vehicles and other vehicles that always qualify for non-toll exempt status.
- **Emergency Non-Revenue Account.** This account is only for emergency vehicles. The major different between an emergency non-revenue account and a non-revenue account is that emergency non-revenue account vehicles are not subject to double white line violations.

- **Post-Paid Account.** This account is a special corporate account that allows a company to be invoiced on a monthly basis for the use of the Express Lanes. Auto-pay is also allowed. A company name and a tax identification number are required to establish a post-paid account. Each vehicle associated with the account must have a valid transponder registered in primary mode, either non-toll or toll.

B.2.2 Number of New Accounts and Peach Passes

Table B-2 presents the total number of new accounts opened and Peach Passes issued from June 2011 through September 2012. A total of 69,143 new accounts were opened and 197,044 new Peach Pass were issued over the 6-month period. Personal toll accounts represented 95 percent of the new total accounts compared to 3 percent of commercial toll accounts, total Peach Passes. In addition, Toll exempt accounts represented approximately 1.5 percent of the new accounts and post-paid accounts, non-revenue accounts, and emergency accounts combined to account for the remaining 0.5 percent of new accounts.

Table B-2. New Accounts Opened and Peach Passes Issued by Month

Month	New Accounts Opened	New Peach Passes Issued
June 2011	235	14,704
July 2011	4,054	8,521
August 2011	4,786	33,978
September 2011	7,769	19,182
October 2011	13,349	23,013
November 2011	5,209	13,866
December 2011	3,463	9,253
January 2012	4,071	9,643
February 2012	3,583	8,252
Mar 2012	3,699	9,105
April 2012	3,242	8,296
May 2012	3,407	8,879
June 2012	3,415	8,341
July 2012	3,118	7,068
August 2012	3,154	8,180
September 2012	2,589	6,763
Total	69,143	197,044

Source: Texas A&M Transportation Institute, based on SRTA data.

B.3 Use of the I-85 Express Lanes and Toll Rates

Use of the I-85 Express Lanes is examined in this section. Section B.3.1 presents information on use of the Express Lanes by toll and non-tolled vehicles. Section B.3.2 summarizes frequency of use information for different Express Lanes user groups. Section B.3.3 discusses flow rates on different segments of the Express Lanes. Section B.3.4 presents information on the Express Lanes toll rates. Section B.3.5 explores changes in carpooling and vehicle-occupancy levels on the Express Lanes and the general purpose lanes before and after implementation of the tolling.

As noted previously, the number of transactions included in the monthly summaries and the total transactions dataset did not match perfectly. There were very slight differences in the total number of transactions based on when toll leakage was accounted for in the transaction processing. The small differences should not influence the analysis presented in this section, which focused on general-use trends. Information on the actual rates paid by users of the Express Lanes is also summarized.

B.3.1 Toll and Non-Tolled Use of the I-85 Express Lanes

Table B-3 presents the monthly trips or transactions, the percent of non-tolled trips, the average number of weekday trips, and the daily fare (i.e., toll) average for October 2011 through September 2012 from the SRTA monthly summary. Monthly use grew over the first six months of operation from 159,799 trips in October 2011 to 413,516 in March 2012. Average weekday trips increased from 7,273 in October 2011 to a high of 17,585 in May 2012. Average weekday trips in June 2012 through September 2012 were in the range of 16,000 to 17,000. As noted in the table footnotes, these use levels seem to reflect seasonal trends, which included winter holidays in December, spring break in April, and summer vacation in June, July, and August. The daily fare average ranged from $1.03 in June 2012 to $1.47 in September 2012.

The percent of non-tolled trips shown in Table B-3 included 3+ carpools, motorcycles, AFVs, transit buses, and enforcement and emergency vehicles. To assess usage of the Express Lanes by 3+ carpools, the national evaluation team reviewed the transactions database for the make and model information for vehicles in the non-tolled categories. Conventional passenger vehicles were identified, along with those that were clearly motorcycles, AFVs, buses, and emergency vehicles. The conventional passenger vehicles were assumed to be declared 3+ carpools, accounting for approximately 29,300 HOV3+ vehicles per month, which equated to approximately 976 HOV3+ on a daily basis (assuming 30 days in a month).

Figure B-1 shows the monthly transactions for tolled and HOV3+ vehicles. The monthly transactions representing HOV3+ carpoolers remained relatively constant throughout the one-year post-deployment period, although their portion of total transactions fell. HOV3+ users represented approximately 14 percent of transactions in October 2011 when tolling began. The proportion of HOV 3+ vehicles to total transactions decreased to 7 percent in September 2012, reflecting the increase in tolled transactions. The lowest number of tolled transactions occurred in October 2011 and the highest occurred in August 2012.

Table B-3. I-85 Express Lanes Monthly Travel Data, October 2011 through September 2012

I-85 Express Lanes: Trips and Fare				
Monthly Summary	**Monthly Trips**	**Percent of Trips Non-Tolled[1]**	**Weekday Trips Average[2]**	**Daily Fare Average[3]**
October 2011	159,799	23%	7,273	$1.19
November 2011	221,552	21%	10,353	$1.09
December 2011[3]	209,561	21%	9,385	$1.16
January 2012	254,075	20%	11,623	$1.26
February 2012	349,270	16%	14,630	$1.18
March 2012	413,516	15%	16,817	$1.19
April 2012[3]	385,426	15%	16,334	$1.08
May 2012	439,021	14%	17,585	$1.14
June 2012[3]	387,676	14%	16,447	$1.03
July 2012[3]	380,698	14%	15,968	$1.09
August 2012[4]	429,964	14%	16,619	$1.35
September 2012	387,935	14%	17,182	$1.47

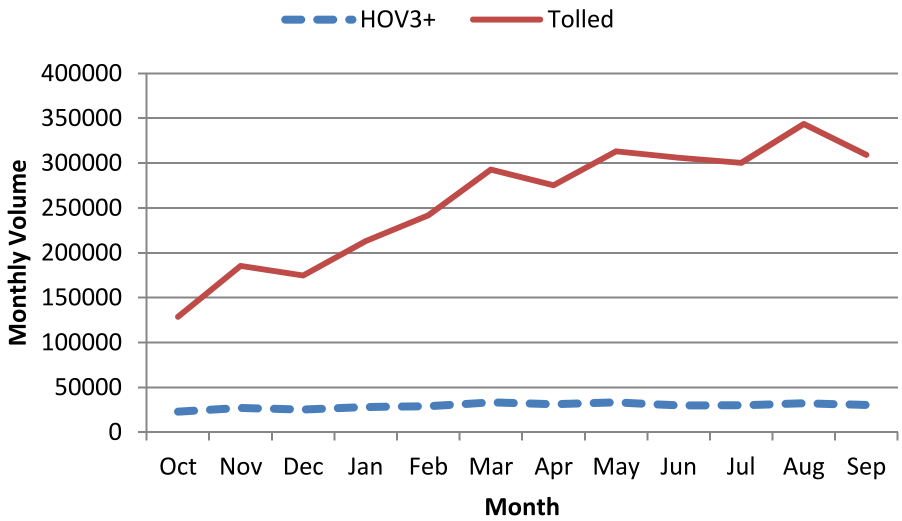
[1] Non-tolled trips included 3+ carpools, motorcycles, AFVs, transit buses, and enforcement and emergency vehicles.

[2] Averages did not include weekends and state holidays.

[3] Data reflected a reduction in overall traffic during winter holidays (December), spring break (April) and school vacation (June-July) periods.

[4] Trip count for 8/30/12 included an excusal of about 1,600 NB Express Lanes Vehicles due to an accident.

Source: State Road and Tollway Authority, October 31, 2012, Monthly Summary.



Texas A&M Transportation Institute, based on SRTA data.

Figure B-1. Monthly Transactions of Tolled and HOV3+ Vehicles

Other common non-tolled vehicles, besides those used for transit services, emergency responders, and enforcement, were motorcycles and AFVs. Motorcycles represented approximately 34,400 transactions in the Express Lanes during the year after tolling was implemented, or roughly 0.8 percent of total transactions. Motorcycles represented 841 transactions in December, 2011 and 5,444 transactions in May, 2012. Approximately 1,600 motorcycles were observed to have traveled in the Express Lanes at least once during the year, with a monthly median trip frequency of two trips per motorcycle.

Trip activity from AFVs was fairly insignificant on the Express Lanes. AFVs included the Chevy Volt, Nissan Leaf, Honda Civic GX, and the Tesla Roadster. Only 43 AFVs were recorded to have taken at least one trip on the Express Lanes. A total of 1,024 trips were recorded by AFVs on the Express Lanes during the year, representing 0.02 percent of the total transactions.

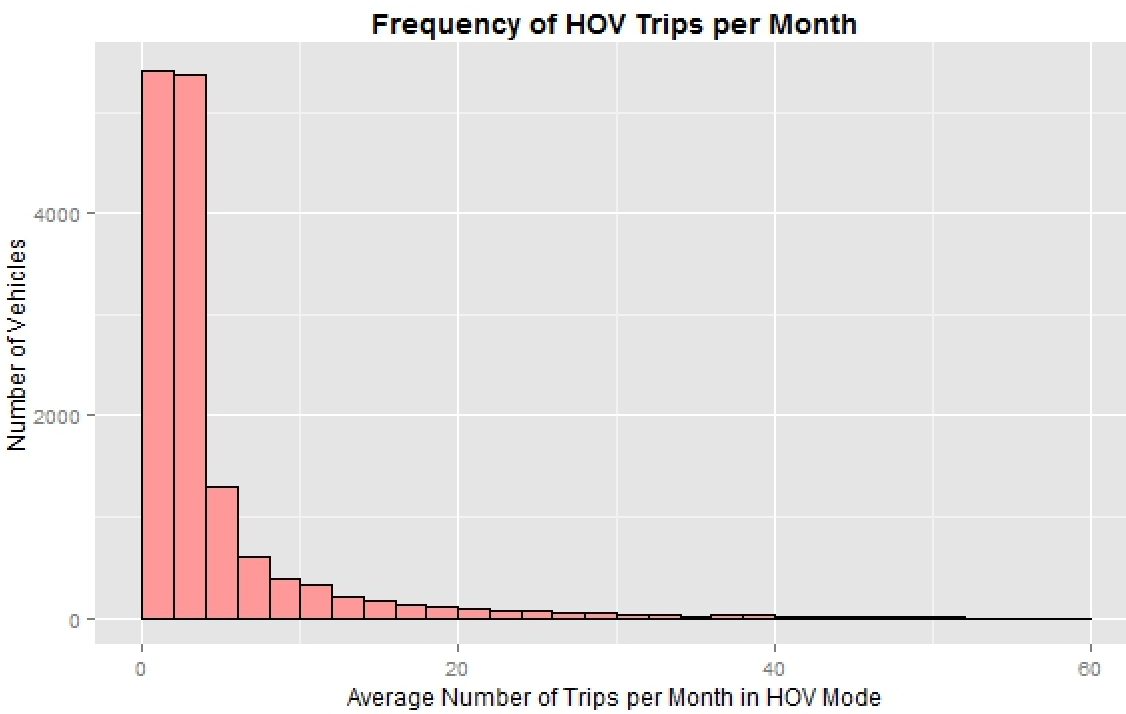
B.3.2 Frequency of Use

As illustrated in Figure B-2, the majority of HOV3+ vehicles traveled intermittently on the Express Lanes. Almost 500 HOV3+ vehicles used the lane on a regular basis, however. Vehicles designated as HOV3+ took a median of two trips per month in the HOV mode. Of the 14,477 vehicles that used the Express Lanes at least once as an HOV3+:

- 473 vehicles, or 3.2 percent of all HOV3+s, took an average of 20 or more trips per month;
- 1,379 vehicles, or 9.5 percent of all HOV3+s, took an average of 10 or more trips per month; and
- 2,679 vehicles, or 18.5 percent of all HOV3+s, took an average of 5 or more trips per month.

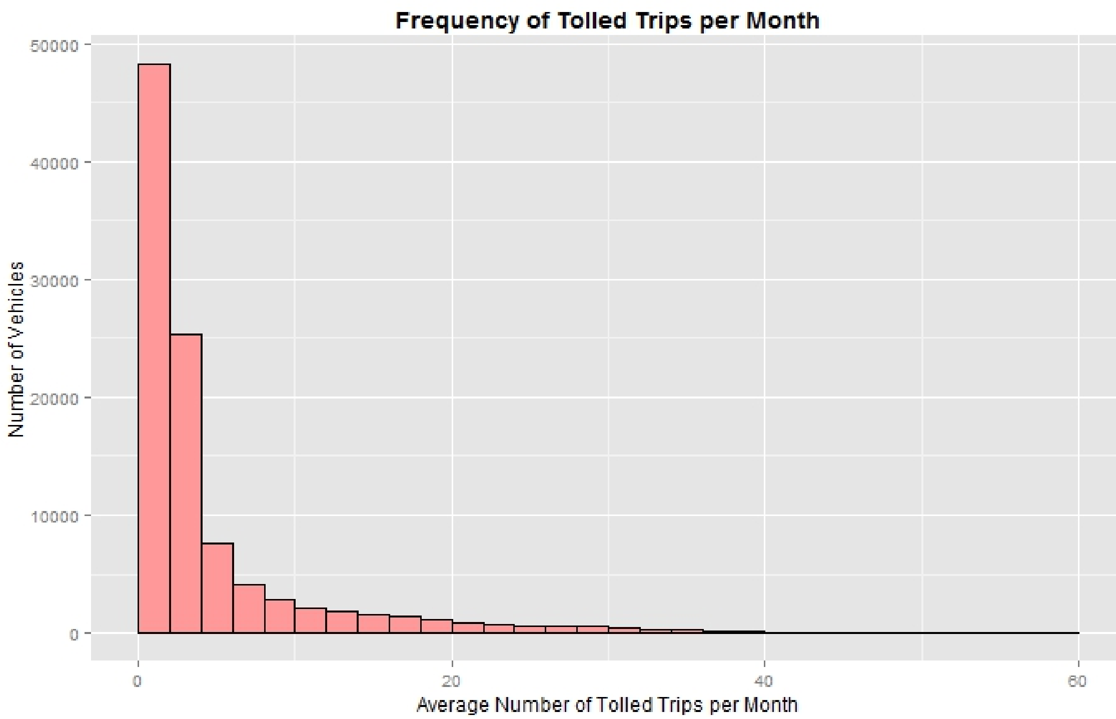
The trip pattern for tolled vehicles was similar to that of HOV3+ users. Figure B-3 illustrates the monthly transaction distribution of tolled trips during the year after tolling began. Vehicles taking tolled trips had a median of two trips per month in toll mode. Of the 100,790 passenger vehicles that used the Express Lanes at least once in toll mode:

- 4,597 vehicles, or 4.6 percent of all vehicles, took an average of 20 or more trips per month;
- 12,439 vehicles, or 12.3 percent of all vehicles, took an average of 10 or more trips per month; and
- 21,884 vehicles, or 21.7 percent of all vehicles, took an average of 5 or more trips per month.



Texas A&M Transportation Institute, based on SRTA data.

Figure B-2. Monthly HOV3+ Transactions per User



Texas A&M Transportation Institute, based on SRTA data.

Figure B-3. Monthly Tolled Transactions per User

The vast majority of Express Lane users traveled in only one toll status. Throughout the one-year post-deployment tolling period, 6,599 passenger vehicles and vanpools were observed to have traveled only in the Express Lanes as an HOV3+ and not to have taken any tolled trips. In contrast, 92,912 passenger vehicles only took tolled trips on the Express Lanes, while 7,878 vehicles had alternated between taking tolled and HOV3+ trips on the corridor. Vehicles with alternated toll statuses had the following additional characteristics:

- 4,136, or 53 percent of vehicles with alternated toll statuses, vehicles took more toll trips than HOV3+ trips;
- 1,595 vehicles, or 20 percent of vehicles with alternated toll statuses, took, on a monthly average, the same number of toll trips as HOV3+ trips; and
- 2,147 vehicles, or 27 percent of vehicles with alternated toll statuses, took more HOV3+ trips than toll trips.

B.3.3 Flow Rates by Express Lane Segments

The vehicle flow rate by Express Lane segment was examined to assess if use levels varied along the corridor. Figure B-4 illustrates the average flow rate by toll segment during the morning peak period from 6:00 a.m. to 10:00 a.m. on weekdays from February 2012 to September 2012 in the southbound direction of travel. The time period beginning in February was selected to accommodate the initial ramp up period. The toll segment with the highest flow rate was the Indian Trail segment, extending from approximately milemarker 102 to milemarker 100. The highest average flow rate occurred from 7:10 a.m. to 7:15 a.m. with a rate of 27.8 vehicles per minute. The peak hour was found to occur from 6:55 a.m. to 7:55 a.m. with an average flow rate of 1,600 vehicles per hour.

Texas A&M Transportation Institute, based on SRTA data.

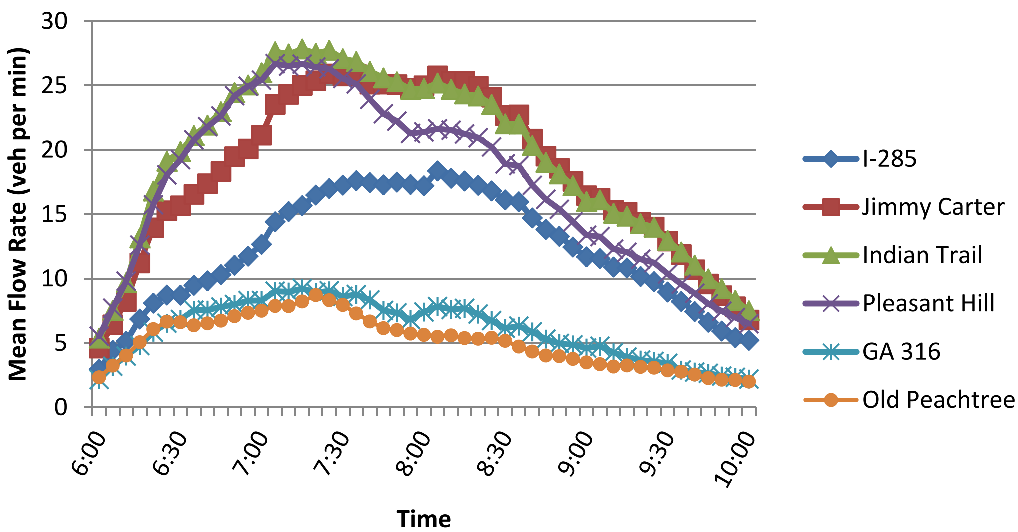


Figure B-4. Average Vehicle Flow Rate by Toll Segment, A.M. Peak Period in the Southbound Direction, February to September 2012

Figure B-5 shows the average flow rate by toll segment of the Express Lanes during the afternoon peak period from 3:00 p.m. to 7:00 p.m. on weekdays from June to September 2012 in the northbound direction. The June period was selected for the afternoon analysis to reflect when the toll rates appeared to have been stabilized. The toll segment with the highest flow rate during the afternoon peak period was the northbound Jimmy Carter segment, extending from roughly milemarker 97 to milemarker 100. The highest average flow rate occurred from 5:15 p.m. to 5:20 p.m. with a rate of 27.3 vehicles per minute. The peak hour was found to occur from 4:25 p.m. to 5:25 p.m. with an average flow rate of 1,580 vehicles per hour. When the flow rates were compared to a 2007 study by Georgia Tech, the effective capacity of the Express Lanes was comparable to the high range of the previous HOV operations.

Texas A&M Transportation Institute, based on SRTA data.

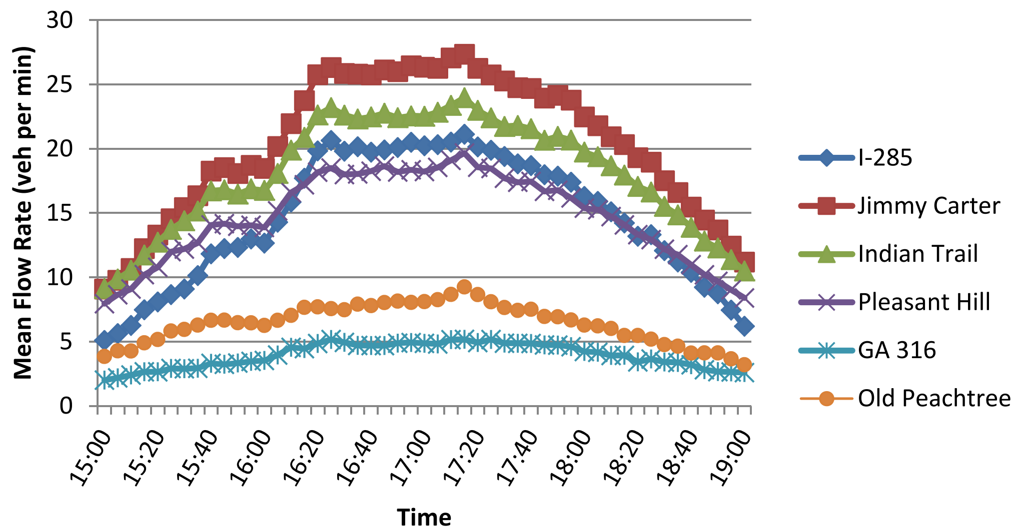


Figure B-5. Average Vehicle Flow Rate by Toll Segment, P.M. Peak Period in the Northbound Direction, June to September 2012

B.3.4 I-85 Express Lanes Toll Rates

The I-85 Express Lanes use dynamic pricing. The SRTA Board of Directors set the policy, including the toll rate per mile. The toll rate for use of the I-85 Express Lanes ranged from $0.01 to $0.90 per mile. The toll rates are continually adjusted based on algorithms that consider traffic volumes in the Express Lanes to maintain free-flow traffic conditions. As use of the lanes increases, the toll rate also increases to ensure that Express Lane users experience free-flow traffic conditions and reliable trip times. The toll rates are posted on dynamic message signs prior to entry points to the Express Lanes, allowing drivers to decide if they want to pay the toll and use the Express Lanes or travel in the general purpose lanes toll-free.

Table B-3 presented the average daily fare or toll by month. The actual toll paid by a driver may be much different, however, especially during the morning and afternoon peak periods. During the initial weeks of operation, the Governor, acting as Chair of the SRTA Board of Directors, requested that the SRTA staff examine ways to increase use of the Express Lanes. Adjustments were made to the algorithms that set the toll price in response to this request. Further, to encourage use during off-peak hours, the SRTA Board of Directors changed the toll policy on January 20, 2012 to lower the minimum toll rate to $0.01 per mile of travel or $0.16 for an entire corridor trip.

The transaction dataset was examined to identify the actual tolls paid by travelers during different times of the day. Figure B-6 shows the highest toll rate observed during the morning and evening peak periods for weekdays from October 2011 to September 2012. The highest toll rate occurred on September 11, 2012 during the morning peak period in the southbound direction, with a maximum toll of $5.95 for travel on the entire 16-mile corridor, which equates to $0.38 per mile. The figure illustrates the lower maximum tolls, which relates to lower use levels, during the initial period of operation. The maximum tolls in the afternoon peak period tended to be lower than the morning peak, reflecting lower levels of congestion and faster travel speeds.

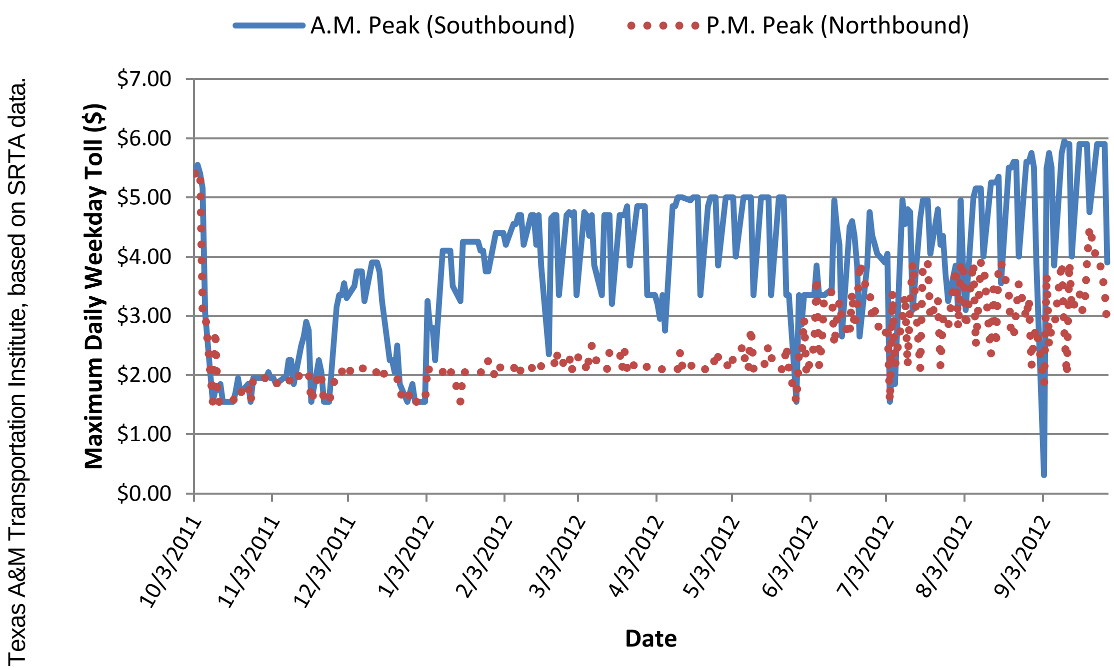


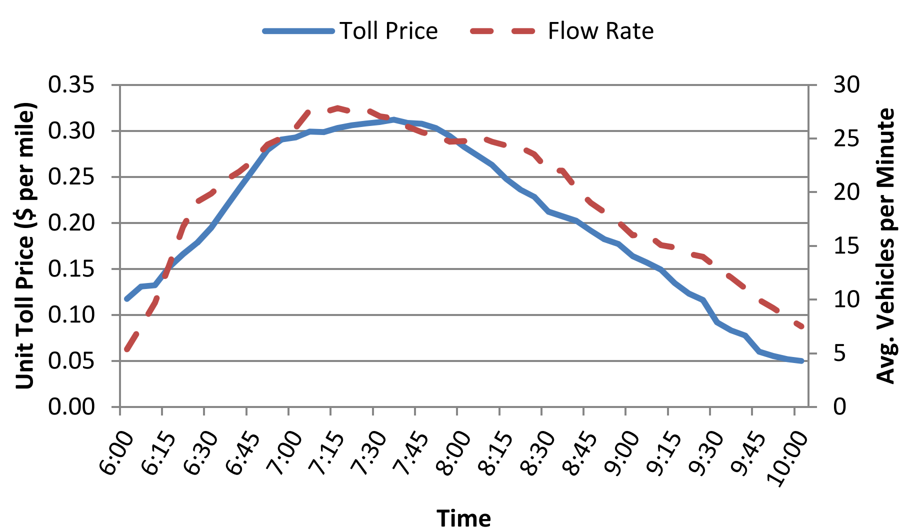
Figure B-6. Maximum Weekday Toll Rates by Peak Period

As illustrated in Figure B-6, after the first week of operation, the maximum toll rate in the morning peak period gradually increased reaching almost $5.00 in February 2012 and held at that level until August 7, 2012, when it began to increase. The maximum toll rate reached a high of $5.95 in September 2012. Toll rates were generally lower on Fridays than the other weekdays. The average maximum toll on Fridays was $3.59, compared to the Monday-Thursday average maximum of $4.63. Demand was generally lower on Friday, reflecting four-day work weeks, telecommuting options, and furloughs.

The maximum daily toll rate during the afternoon peak period in the northbound direction remained at or below $2.50 for an entire corridor trip after the first two weeks of operation until May 10, 2012; the daily maximum toll price increased to $3.90 on June 22, 2012. The only day when the maximum toll price was greater than $3.90 for an entire corridor trip was on September 21, 2012, when the price was $4.50. From June to September 2012, Wednesday had the lowest average daily maximum toll rate of $2.77 for an entire corridor trip in the northbound direction; Thursdays had the highest with an average of $3.35 per trip.

The relationship between toll price and flow rate is examined in Figure B-7 for the morning peak direction and Figure B-8 for the afternoon peak direction. The Indian Trail segment was selected for the morning peak direction because that segment had the highest mean flow rate of all of the tolling segments. The Jimmy Carter segment was selected for the afternoon peak direction because it had the highest mean flow rate during that time period. The morning period peak toll rate occurred between 7:20 a.m. to 7:25 a.m. with an average of $0.31 per mile. The mean morning peak hour toll rate was observed to be from 7:00 a.m. to 8:00 a.m., approximately 5 minutes later from when the peak hour flow rate occurred. The afternoon period peak toll rate occurred between 5:45 p.m. to 5:50 p.m. with an average of $0.15 per mile. The mean afternoon peak hour toll rate was observed to be from 5:05 p.m. to 6:05 p.m., about 40 minutes later than when the peak hour flow rate occurred.

As illustrated by Figure B-7 and Figure B-8, the relationship between toll price and flow rate appeared to be fairly close during the morning peak period, but was not as close during the afternoon peak period. The trends in these figures are similar to those illustrated in Figure B-4 and Figure B-5, which compared vehicle flow rates by toll segments. An inference could be made that demand for the Express Lane during the morning peak period was higher and more consistent than demand for travel in the Express Lane during the afternoon peak period. According to SRTA, demand in the morning peak period was more intense and performed at capacity for a longer period of time than in the afternoon peak period. As a result, morning prices had to increase more quickly, reaching a higher peak and remaining higher for longer on average compared to the afternoon peak period price. Although lower overall, the afternoon price was high enough to prevent long queue formations and did not require as frequent adjustments or as large increases as for the morning peak.



Texas A&M Transportation Institute, based on SRTA data.

Figure B-7. Average Toll Price and Flow Rate at Jimmy Carter, A.M. Peak Period from June to September 2012

Texas A&M Transportation Institute, based on SRTA data.

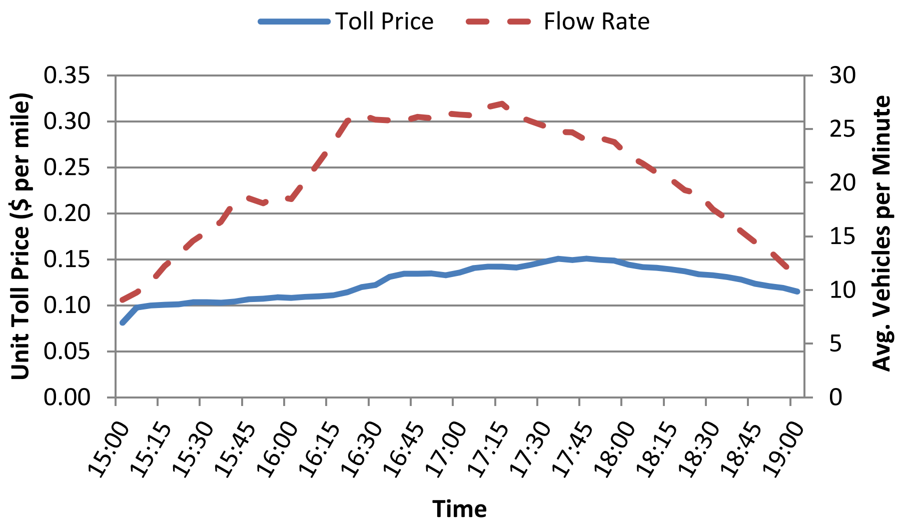


Figure B-8. Average Toll Price and Flow Rate at Jimmy Carter, P.M. Peak Period from June to September 2012

The relationship between speed and median toll price is illustrated in Figure B-9 for the morning peak period and in Figure B-10 and for the afternoon peak period. Speed data were collected from the tolling system and calculated by taking the difference in travel time between two different points, or toll gantries, on the Express Lane. Therefore, speeds differed from data collected by GDOT's traffic sensors because the tolling system speeds were representative of averaged trip segment speeds, not single spot location values of the GDOT sensors. Speeds for the morning period were taken from trips that only traveled the Indian Trail segment, and afternoon speeds only represented travel on the Jimmy Carter segment. Speeds were shown on the figures as median speeds and the 10^{th} percentile speeds for each analysis period. The 10^{th} percentile speeds showed the amount of time that speeds were greater than the indicated value. In other words, speeds were greater than the 10^{th} percentile for 90 percent of the time – similar to the speed measure from the federal regulation 23 U.S.C. § 166 that stipulates that an HOV lane has to operate at 45 mph or higher at least 90 percent of the time – in this case for each four-hour peak period.

Speeds were calculated by considering only trips that were completely taken within the Indian Trail segment (for the a.m. peak period) or the Jimmy Carter segment (for the p.m. peak period). Trips with travel outside those segments were not included in the analysis. The gantries that were within each segment were used to estimate average trip speeds, based on the speeds reported for each trip by SRTA's tolling contractor. Speeds were also averaged and aggregated into 5-minute intervals. The Indian Trail segment had 17,013 southbound trips (recorded from February – September 2012) that were used to calculate average speeds, flow rates, and toll amounts. The Jimmy Carter segment had 19,344 northbound trips (recorded from June – September 2012) that were used to calculate average speeds, flow rates, and toll amounts.

During the a.m. peak period on the southbound Indian Trail segment, the 10^{th} percentile speed reached a minimum of 24.0 mph from 8:25 a.m. to 8:30 a.m. The median speed during the a.m. period was the slowest from 8:25 a.m. to 8:30 a.m., with a speed of 35.5 mph. The 10^{th} percentile speed started to decrease below 45 mph from 7:20 a.m. to 7:25 a.m., slightly after the mean peak flow rate occurred 10 minutes earlier. The median toll rate changed only slightly between $0.30 and $0.33

per mile of travel from 6:50 a.m. to 8:00 a.m., even when the 10th percentile and median speeds dropped during that same time period. According to SRTA, a lower toll rate was used in the early part of the morning peak in order to increase volumes in the Express Lanes to reduce the impact on the general purpose lanes, while maintaining requirements of 23 U.S.C § 166.

During the afternoon peak period on the northbound Jimmy Carter segment, the 10th percentile speed reached a minimum of 39.0 mph from 5:25 p.m. to 5:30 p.m. and the median speed had a minimum of 50.8 mph from 5:35 p.m. to 5:40 p.m. The median toll rate had peaked at $0.15 per mile from 5:30 p.m. to 5:35 p.m., approximately the same time as lowest speeds. Unlike the morning peak period, speeds were only slightly degraded throughout the p.m. peak period.

Texas A&M Transportation Institute, based on SRTA data.

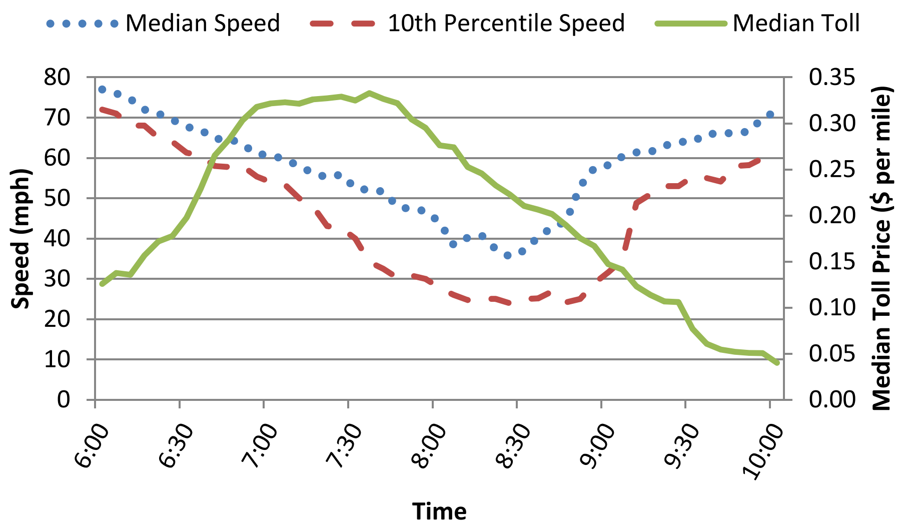
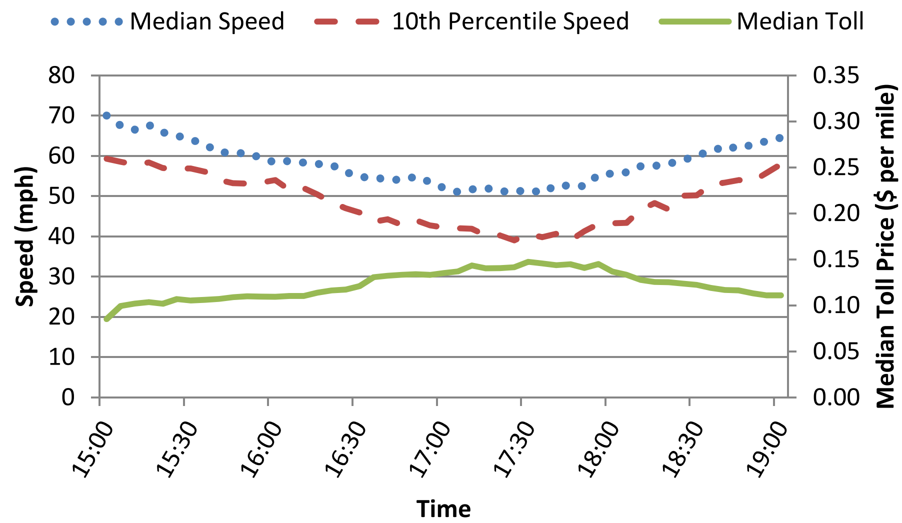


Figure B-9. Comparison of Speed and Toll Price at Indian Trail, A.M. Peak Period from February to September 2012



Texas A&M Transportation Institute, based on SRTA data.

Figure B-10. Comparison of Speed and Toll Price at Jimmy Carter, P.M. Peak Period from June to September 2012

B.3.5 Changes in Carpools and Vehicle Occupancy Levels

Data from a number of different sources were examined to assess the impact of the Express Lanes on vehicle-occupancy levels on the CRD corridor. As highlighted in this section, data from all sources showed a decline in vehicle-occupancy levels in the Express Lanes and an increase in vehicle-occupancy levels in the general purpose lanes. This change reflected an increase in the vehicle-occupancy requirement from HOV2+ to HOV3+ for non-tolled travel in the Express Lanes. It appeared that many existing 2+ carpools did not add a third person to be eligible to use the Express Lanes for free, but rather were using the general purpose lanes or making other travel changes. Information from the different sources on changes in vehicle-occupancy levels are highlighted in this section. More detailed information on changes in vehicle-occupancy levels were discussed in Appendix A – Congestion Analysis.

A before-and-after occupancy study was conducted by Georgia Tech, which included visual occupancy counts Monday through Wednesday at selected locations in the corridor at selected times of the year. The study indicated that average non-transit vehicle occupancy during both peak periods in both directions declined from an average of 1.99 persons per vehicle in the HOV lane prior to tolling to 1.22 persons per vehicle in the Express Lane after tolling during the morning peak period. The study further found that average non-transit vehicle occupancy in the general purpose lanes increased slightly before and after the CRD implementation, from 1.06 persons per vehicle to 1.11 persons during the morning peak. For the afternoon peak period, the occupancy dropped from 2.03 in the HOV lane to 1.26 in the Express Lane and increased from 1.10 to 1.15 in the general purpose lanes.

In addition to average vehicle occupancy, the study provided the percentage of vehicles with one, two, three, and four or more occupants. As discussed in Appendix A – Congestion Analysis, the percentages for the general purpose lanes were averaged across all five lanes. Based on the vehicle volumes in the Express Lanes, the number of weekday two-person carpool trips during the morning and afternoon peak periods (6:00 a.m. to 10:00 a.m. and 3:00 p.m. to 7:00 p.m.) in the peak direction of travel declined from 8,037 in the pre-deployment period to 1,102 in the post-deployment period.

HOV3+ vehicles in the Express Lanes dropped from 664 in the pre-deployment period to 249 in the post-deployment period for the combined morning and afternoon peak periods in the peak direction of travel. In contrast, the analysis reported in Section B.3.1 estimated 976 HOV3+ per day based on 7 days a week, 24 hours a day in both directions of travel. Thus, while the decline to 249 HOV3+ trips in the peak periods estimated from the occupancy data was substantial, the total number of HOV3+ using the Express Lanes could have been closer to the 976 trips based on toll transactions for the entire day.

The results from Volpe's household travel survey provided further confirmation of the shift of carpools from the Express Lanes to the general purpose lanes. Based on trip diaries, the survey found that the mean occupancy for all reported I-85 driving trips (excluding transit and vanpools) increased from 1.13 to 1.17 from the pre- to post-deployment periods. The mean vehicle occupancy in the Express Lanes decreased from 2.22 with the HOV operation to 1.18 with the Express Lanes. The mean vehicle-occupancy level in the general purpose lanes increased from 1.07 to 1.18, however. Prior to tolling, 4 percent of trips in the general purpose lanes had two or more people, but after tolling this figure increased to 12 percent.

Data collected from a SRTA-sponsored survey of carpoolers discussed in Appendix D – TDM Analysis during the post-deployment period provided additional evidence of a decline in carpool formation following the beginning of tolling. The survey results indicated only 6.0 percent of the sample of prior HOV lane users reported adding a third person to their carpool to comply with the increased occupancy requirement. However, 29.4 percent of the same sample switched to driving alone. A small portion had either joined a vanpool (2.2 percent) or switched to transit (4.0 percent).

Another potential source of additional carpooling in the Express Lanes might have been from casual carpools, or slugging, that formed at park-and-ride lots. However, no dramatic increases in slugging were evident in the post-deployment period. Data on casual carpooling were collected from July 2011 to September 2012 and are discussed further in Appendix D – TDM Analysis. The incidents of slugging ranged from 2 to 30 events per month at a total of eight park-and-ride lots dispersed throughout the corridor.

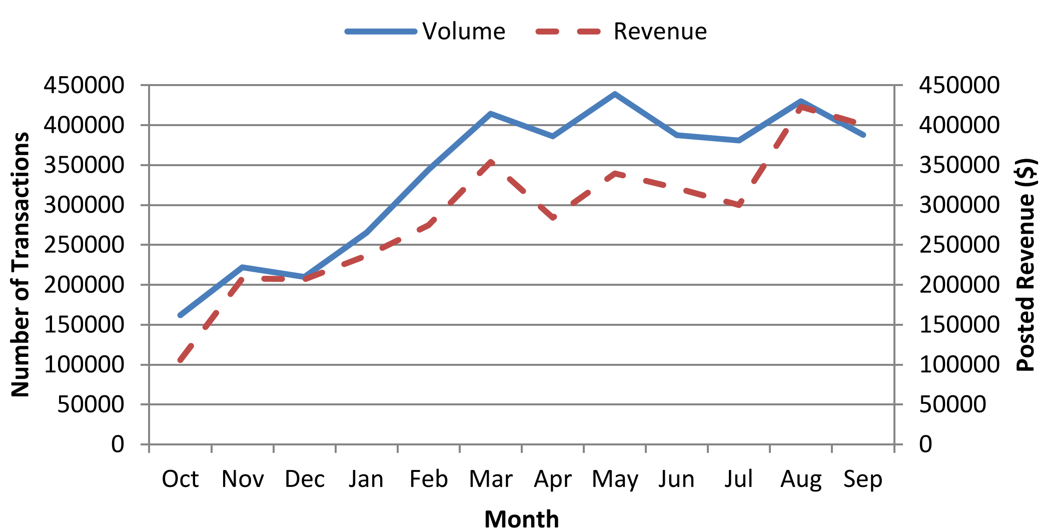
B.4 I-85 Express Lanes Toll Revenues

The toll revenues are used to support the operation and maintenance of the I-85 Express Lanes and were another measure for gauging the acceptance of tolling by the traveling public. Table B-4 presents the posted toll revenues on the I-85 Express Lanes for October 2011 through September 2012. Total posted revenues for the Express Lanes grew from $105,807 in October 2011 to $400,760 in August 2012. The posted levels for the 12-month period were approximately $3.5 million. The month with the highest posted revenue occurred in August 2012 with $422,932. An increase in the monthly number of transactions was associated with the growth in revenue. The month with the lowest volume occurred during October 2011 with 162,034 transactions and May 2012 had the highest with 439,100 transactions. Figure B-11 shows the relationship between the number of transactions and the total posted revenue. The total posted revenue was defined as the amount that was originally charged to toll accounts before any potential refunds or violations were processed. Transactions were inclusive of all tolled and non-tolled trips.

Table B-4. I-85 Express Lanes Toll Revenues by Month

Month	Posted Toll Revenues
2011	
October	$105,807
November	$208,169
December	$206,962
2012	
January	$236,613
February	$274,746
March	$353,884
April	$284,213
May	$339,496
June	$321,090
July	$299,955
August	$422,932
September	$400,760

Source: SRTA



Texas A&M Transportation Institute, based on SRTA data.

Figure B-11. I-85 Express Lanes Transactions and Posted Revenue

B.5 Enforcement of Express Lanes Tolling, Vehicle Occupancy, and Operations

Enforcement of the I-85 Express Lanes involves monitoring a number of different elements. Four types of violations and their associated enforcement response are described below.

- Using the Express Lanes without a registered Peach Pass transponder. A $25 administrative fee per violation is issued to the vehicle owner, along with the toll charge. If not paid, the vehicle owner is subject to a civil penalty of an additional $70 per violation.
- Adjusting an account from toll mode to carpool toll-exempt status, indicating there will be three people in the vehicle, and traveling in the Express Lanes with less than three people. In addition to a violation notice from SRTA, drivers may be pulled over by law enforcement officers and issued a citation.
- Faulty or non-working transponders that do not read correctly. A toll violation may be sent to the vehicle owner. Customers are requested to contact the Peach Pass Customer Service and replace the faulty transponder.
- Entering or exiting the Express Lanes by improperly crossing the double-white line. Violators are detected by the gantry-controlled access (GCA) system and a $25 violation fee is automatically issued to the vehicle owner. The driver may receive an additional citation if they are pulled over by a law enforcement official.

SRTA issues the violation notices, which are generated automatically when a Peach Pass is not read or a vehicle crosses the double white line. In addition, SRTA contracts with Georgia Department of Public Safety (DPS) to provide on-site enforcement of the vehicle occupancy requirement and the restriction on crossing the double white line. While DPS can issue citations for any violations while patrolling the Express Lanes, the contract with SRTA is only for those two restrictions.

Table B-5 presents the number and type of the citations issued by the DPS by month for the period from December 2011 through September 2012. The number of citations issued for not meeting the 3+ vehicle-occupancy requirement when using a toll-exempt account ranged from a low of 24 in December 2011 to a high of 79 in August 2012. Occupancy citations ranged from a low of 9 percent of the total citations in May 2012 to a high of 31 percent in August 2012.

Table B-6 presents the number of violation notices issued by SRTA from November 2011 through September 2012. Violation notices were generated when an account has at least three violations. The noticed violations may be on GA 400, the I-85 Express Lanes, or a combination of both. Only warning letter violations were sent during the first three months. SRTA placed a hold on issuing violation notices in March and April and again in July due to technical difficulties. When the holds were lifted, the backlog of accumulated notices caused spikes in the number of violation notices sent in May and August.

Table B-5. Express Lanes Citations Issued by the Department of Public Safety

	Type of Citation						Total
	Occupancy		Double White Lines		Other		
	Number	Percent	Number	Percent	Number	Percent	
December 2011	24	16%	7	5%	117	79%	148
January 2012	25	17%	8	5%	118	78%	151
February 2012	39	12%	19	6%	276	83%	334
March 2012	80	23%	27	8%	244	70%	351
April 2012	36	15%	2	1%	207	84%	245
May 2012	21	9%	24	10%	187	81%	232
June 2012	63	21%	13	4%	229	75%	305
July 2012	65	17%	83	24%	204	58%	352
August 2012	79	31%	21	8%	158	61%	258
September 2012	42	23%	6	3%	134	74%	182

Source: State Road and Tollway Authority.

Table B-6. Number of Violation Notices Issued by SRTA

Month	Number of Violation Notices[1]
November 2011	597[2]
December 2011	160[2]
January 2012	550[2]
February 2012	4,772
Mar 2012	3,100
April 2012	2,950
May 2012	12,680[3]
June 2012	3,552
July 2012	672
August 2012	18,223[3]
September 2012	3,380
Total	**50,636**

[1] SRTA generated a violation notice when an account has at least three violations. The violations might be on GA 400, the I-85 Express Lanes, or both.

[2] Only warning letter notices were sent in November 2011, December 2011, January 2012.

[3] SRTA placed a hold on issuing notices in the March/April time frame and again in July. When the holds were lifted, the backlog of accumulated notices causes spikes in the number of violation notices sent in May and August.

Source: State Road and Tollway Authority.

B.6 Value of Time Analysis

Better understanding the value that travelers place on saving time by using the Express Lanes assisted in determining the effectiveness of tolling as a demand management strategy. An analysis of the willingness-to-pay (WTP) for travel time savings on the I-85 Express Lanes was conducted using AVI data provided by SRTA to represent non-tolled trip activity in the general purpose lanes. The toll transaction data were used for tolled activity and toll and toll-exempt transponder status in the Express Lanes. The analysis covered the period from February 25 to August 24, 2012 based on the availability of the AVI data. The time frame was limited due to the AVI sensors being inactive during the first few months of tolling and issues about data quality.

There are 73 AVI readers in the northbound direction and 65 AVI readers in the southbound direction. The AVI readers provided accurate location and time data for over 207,000 unique transponder identification numbers. Using the unique transponder identification numbers from the AVI records, the travel times and distances for all trips of transponder equipped vehicles were obtained along the general purpose lanes. Toll transaction data provided similar information on tolled Express Lane trips, along with specific data on the trip beginning point, the ending point, and the toll amount. The two data sets included over 5.6 million total trips spanning the six-month period, with approximately

3.5 million trips in the general purpose lanes and 2.1 million trips in the Express Lanes. The trips were approximately evenly split between the northbound and southbound directions.

The amount of time saved by an Express Lane user was calculated by matching their trips in the Express Lanes with trips they made in the general purpose lanes occurring at the same time of day at the same location, but on different days. For corresponding trips, the difference in travel time between the lane types was used as the amount of time saved. Unfortunately, not all Express Lane trips had a matching trip in the general purpose lanes. Trips that could not be paired were set aside from the analysis, using a 10-minute window for designating trips that occurred at the same time. Applying the window resulted in the exclusion of 40 percent of the Express Lane trips in the initial data set. The approximately 1.3 million remaining Express Lane trips were matched to the general purpose lane trips that occurred at the same place and time.

The WTP was calculated for all of the matched Express Lane and general purpose lane trips. Trips that were found to have either a negative or unrealistically high WTP were excluded from the further analysis. Specifically, WTP values that were $0 per hour, less than $0 per hour (negative values), and those greater than $400 per hour were excluded from further analysis. Negative WTP values were indicative of instances when travel time on the Express Lane was longer than corresponding travel from the general purpose lanes. Approximately 5 percent of the almost 1.3 million trips in the Express Lanes had longer travel times than the corresponding trip on a different day on the general purpose lanes. The resulting data set, after applying the screen for outlier WTP values, contained approximately 1.15 million Express Lanes trips, accounting for 89.5 percent of the initial data set.

The WTP analysis considered travel that occurred in both the northbound and southbound directions during all time periods, and also during specific a.m. and p.m. peak periods in the peak direction of flow. Peak travel during the morning peak period was comprised of trips in the southbound direction from 6:00 a.m. to 10:00 a.m., which accounted for 386,209 trips. The afternoon peak travel consisted of northbound trips from 3:00 p.m. to 7:00 p.m., accounting for 414,841 trips.

The distribution of WTP values for travelers who used the Express Lanes are shown in Figure B-12 through Figure B-15 and are summarized in Table B-7. The solid line in each of the four WTP figures represents the cumulative distribution frequency. The long tail of the distribution toward the right of the figures was a result of travelers paying a toll for a very small amount of travel time savings. For example, a $0.50 toll for a five-second travel time savings equates to a $360 per hour WTP value. The WTP graphs had an arbitrary cutoff at $400 per hour. However, a much lower cutoff point would result in only a small percentage of trips being removed, such as using a cutoff at $100 per hour. Due to the long tailed distribution, the median WTP was believed to better reflect what most Express Lanes travelers were willing to pay. The median WTP value was $19.45 per hour for all Express Lane trips on the CRD corridor. The median a.m. peak period WTP value was $33.17 per hour for southbound trips, representing the highest WTP for all the time periods.

Texas A&M Transportation Institute, based on SRTA data.

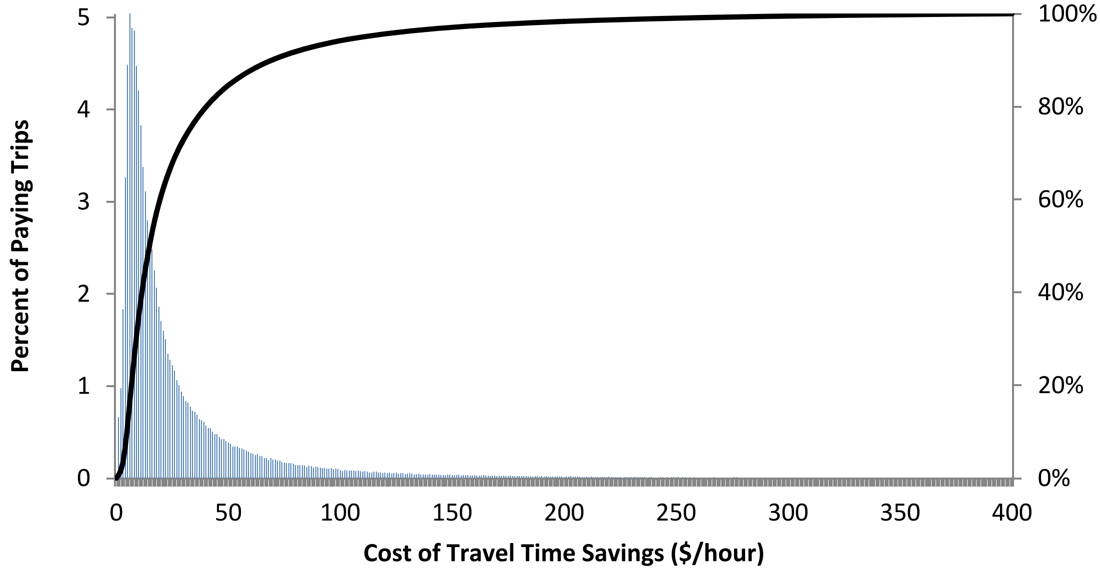


Figure B-12. Cost of Travel Time Savings for All Northbound Trips

Texas A&M Transportation Institute, based on SRTA data.

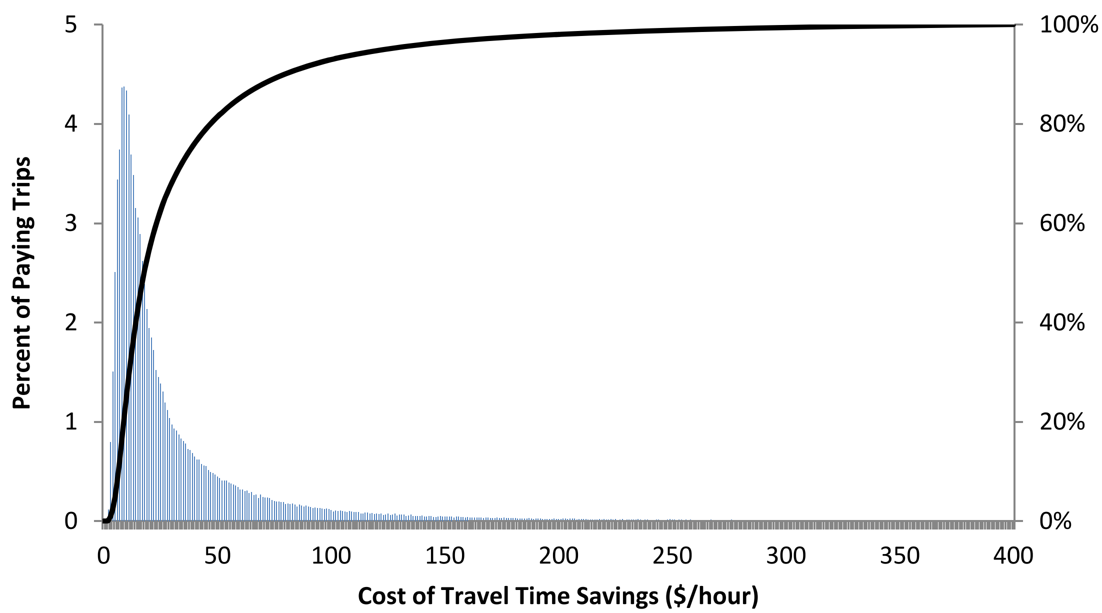


Figure B-13. Cost of Travel Time Savings for P.M. Peak Northbound Trips

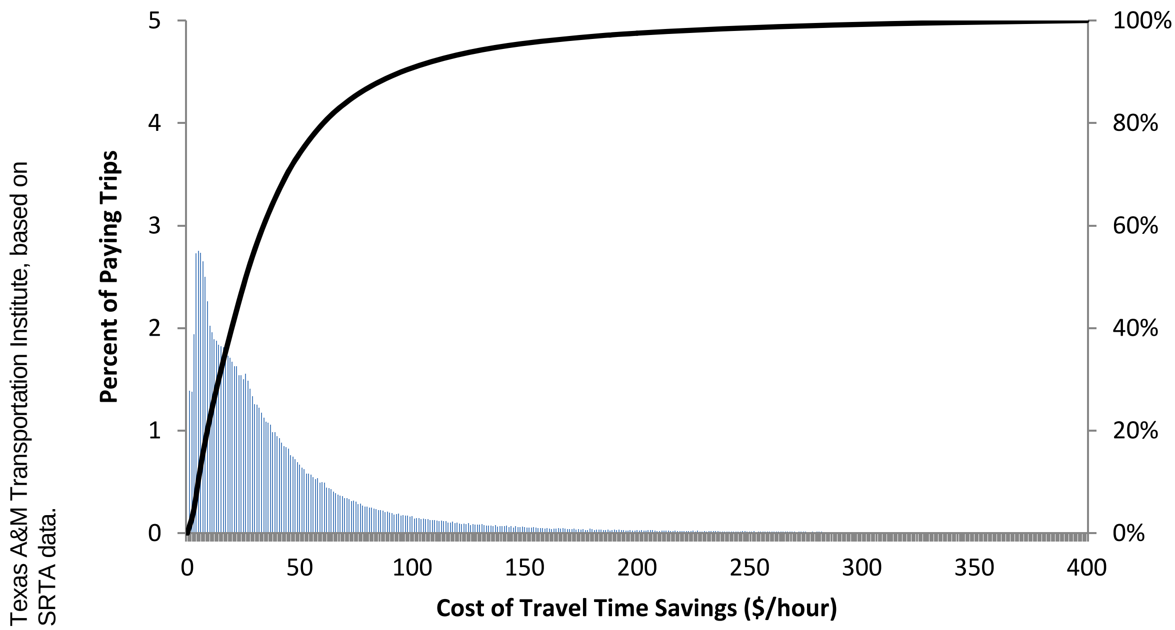


Figure B-14. Cost of Travel Time Savings for All Southbound Trips

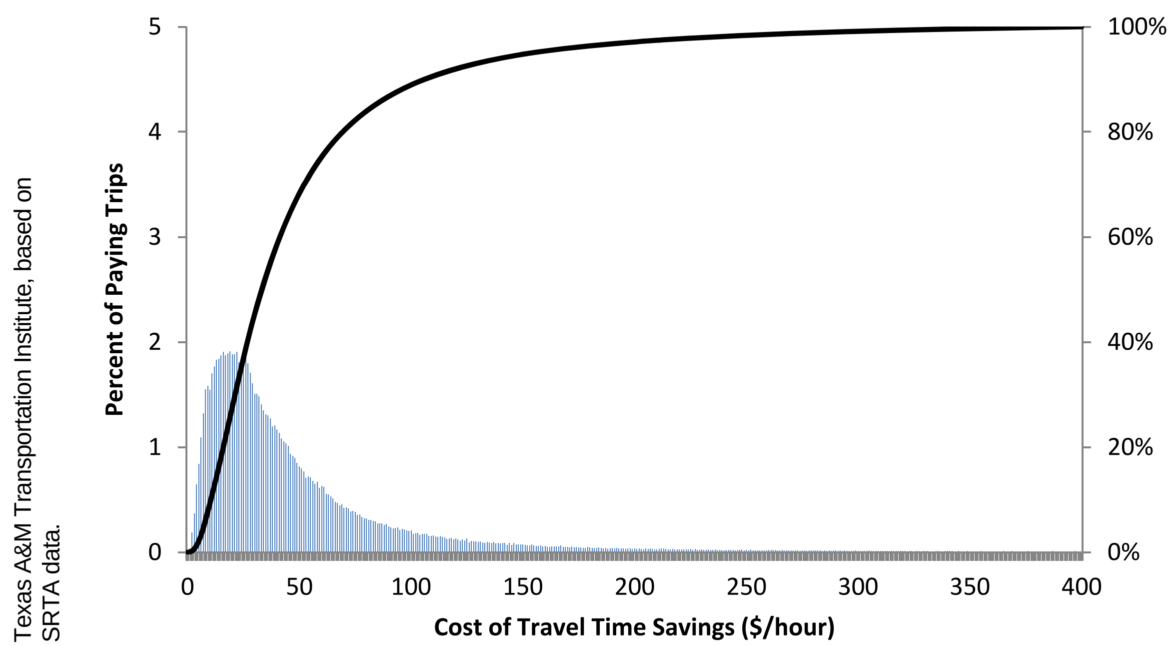


Figure B-15. Cost of Travel Time Savings for A.M. Peak Southbound Trips

Table B-7. Willingness-to-Pay ($/hour)

Direction	Statistical Measure	Time of Day	
		All Day	Peak
Northbound	Mean	30.19	34.75
	Median	14.83	17.76
Southbound	Mean	42.29	49.95
	Median	26.11	33.17
Both	Mean	36.07	NA
	Median	19.45	NA

Source: Texas A&M Transportation Institute, based on SRTA data.

A closer assessment of the WTP was made by examining how frequently users took the I-85 Express Lanes over the general purpose lanes. This analysis was conducted to investigate if frequent Express Lane toll-payers used the Express Lanes regardless of congestion in the general purpose lanes and if infrequent Express Lanes users paid a toll only when they observed unusual congestion on the general purpose lanes.

The frequency of Express Lane usage was grouped according to the percent of total trips taken in the Express Lanes. No users were counted if they did not make any Express Lanes trips during the six-month period. The specific categories were defined as: rare (0.01 percent to 15.00 percent) of all trips taken in the Express Lanes, occasional (15.01 percent to 30.00 percent), irregular (30.01 percent to 50.00 percent), and frequent (50.01 percent to 100.00 percent). The number of trips and transponders by group is presented in Table B-8. Approximately half of the users from the sample, defined as the number of active transponders, took the Express Lanes less than 30 percent of the time.

An important finding from the value of time analysis was that Express Lane usage, as a proportion of total trips on the corridor, was not a major factor influencing willingness to participate. Travelers often appeared to value each trip differently, irrespectively of traffic conditions. Findings from the Volpe – sponsored household panel travel survey indicated similar characteristics. A comparison of Express Lanes and general purpose lane use against workplace schedule flexibility found that workers with no flexibility were less likely to take the Express Lanes than those with moderate or total flexibility. Users with less schedule flexibility were also found to come from low income households. The mean toll paid by households with incomes lower than $50,000 was $0.53 compared to households with income greater than $150,000 paying a mean toll of $1.20. The mean toll rate for higher income households was also in the middle of the mean daily fare range of $1.03-to-$1.47 (averaged and aggregated by month). That relationship suggests greater use of the Express Lanes by higher income individuals.

A major caveat needed to be considered when comparing the value of time analysis to the Volpe-sponsored surveys. Users who did not have transponders or never traveled in the Express Lanes from February – August 2012 were not taken into account in the value of time analysis. Another caveat was that the Volpe-sponsored survey focused only on household behaviors and attitudes; it did not consider the impact of business and commercial trip demand. In contrast, the value of time analysis incorporated Express Lane travel across all users including business travelers.

Table B-8. Frequencies of Express Lane Use by Trips and Transponders for WTP Analysis

Group by % of Trips Taken in Express Lane	Northbound		Southbound	
	Number of Trips	Number of Transponders	Number of Trips	Number of Transponders
Rare *0.01 – 15.00%*	41,254	14,622	33,561	12,332
Occasional *15.01 – 30.00%*	69,912	12,622	52,690	10,035
Irregular *30.01 – 50.00%*	112,400	14,797	90,174	12,285
Frequent *50.01 – 100.00%*	325,974	12,533	332,124	21,784
Total	**549,540**	**54,574**	**509, 549**	**56,436**

Source: Texas A&M Transportation Institute, based on SRTA data.

The travel-time savings were examined for each of the groups and the results are displayed graphically in Figure B-16 through Figure B-21. As illustrated, frequent users tended to save a little more travel time and paid slightly higher tolls on average. The difference between the three other groups (rare, occasional, and irregular) was very minor. When dividing the toll paid by the travel time saved, all four groups had nearly identical WTP values for travel-time savings on the Express Lanes. Figure B-16 and Figure B-17 show the WTP based on the frequency of use that was defined by the four groups.

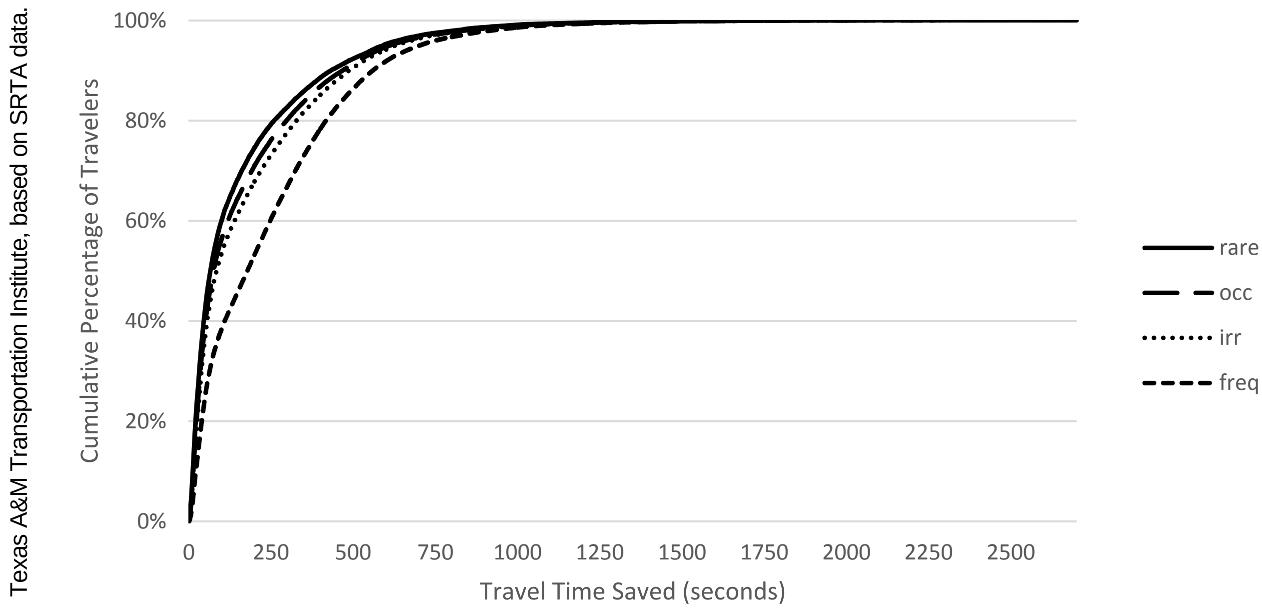


Figure B-16. Travel-Time Savings by Frequency of Use (Northbound Direction)

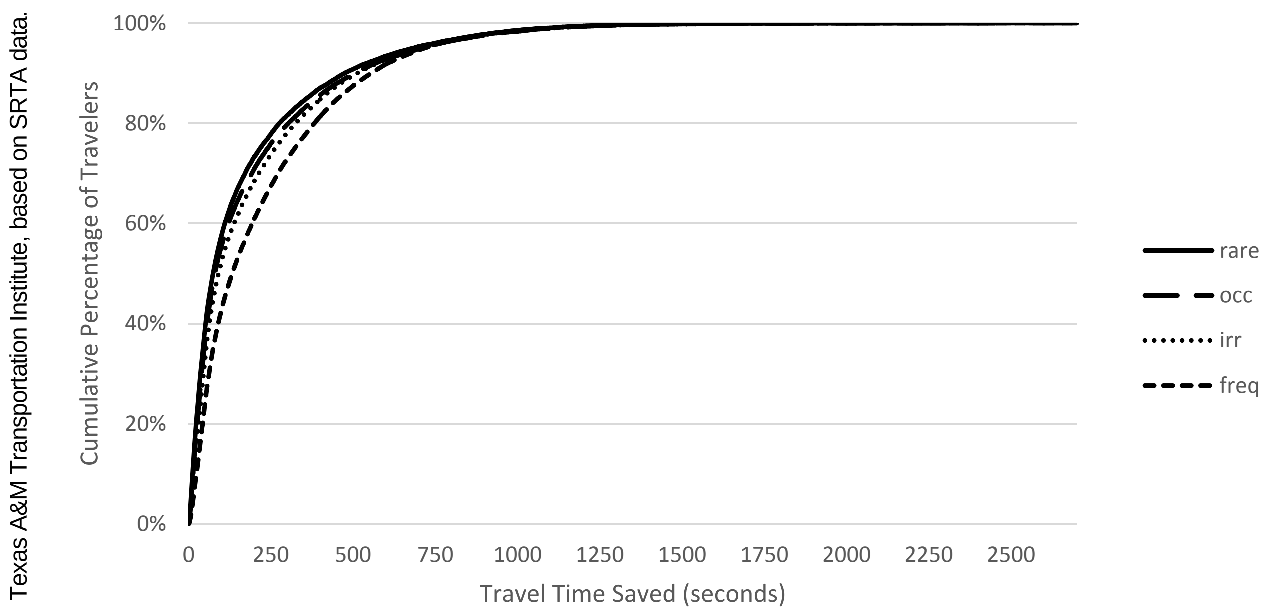


Figure B-17. Travel-Time Savings by Frequency of Use (Southbound Direction)

Texas A&M Transportation Institute, based on SRTA data.

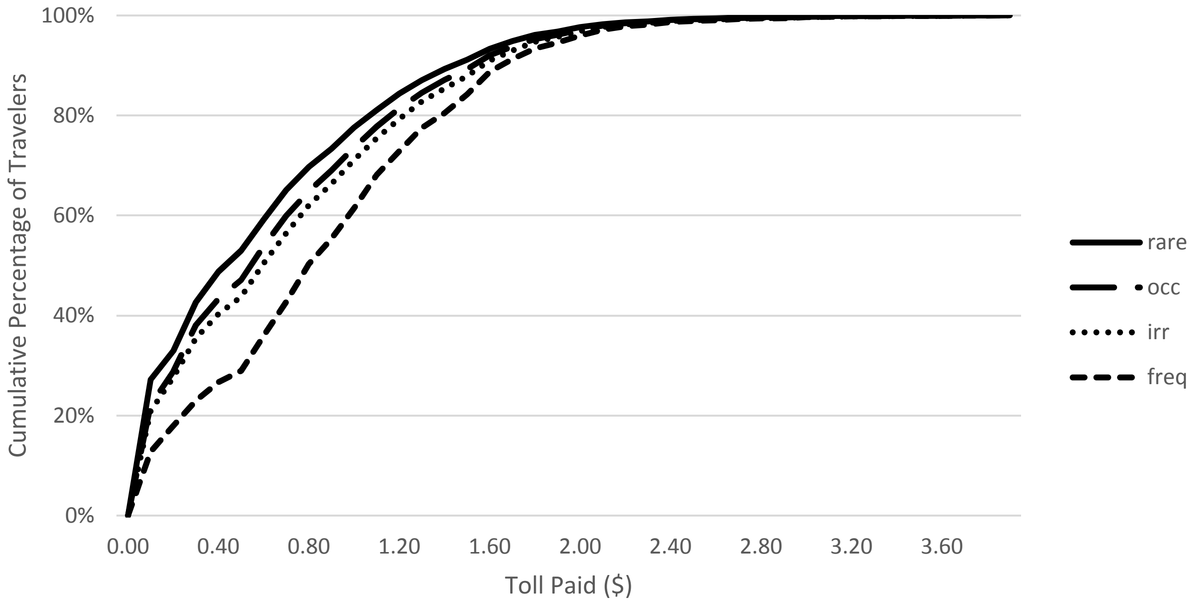


Figure B-18. Toll Paid by Frequency of Use (Northbound Direction)

Texas A&M Transportation Institute, based on SRTA data.

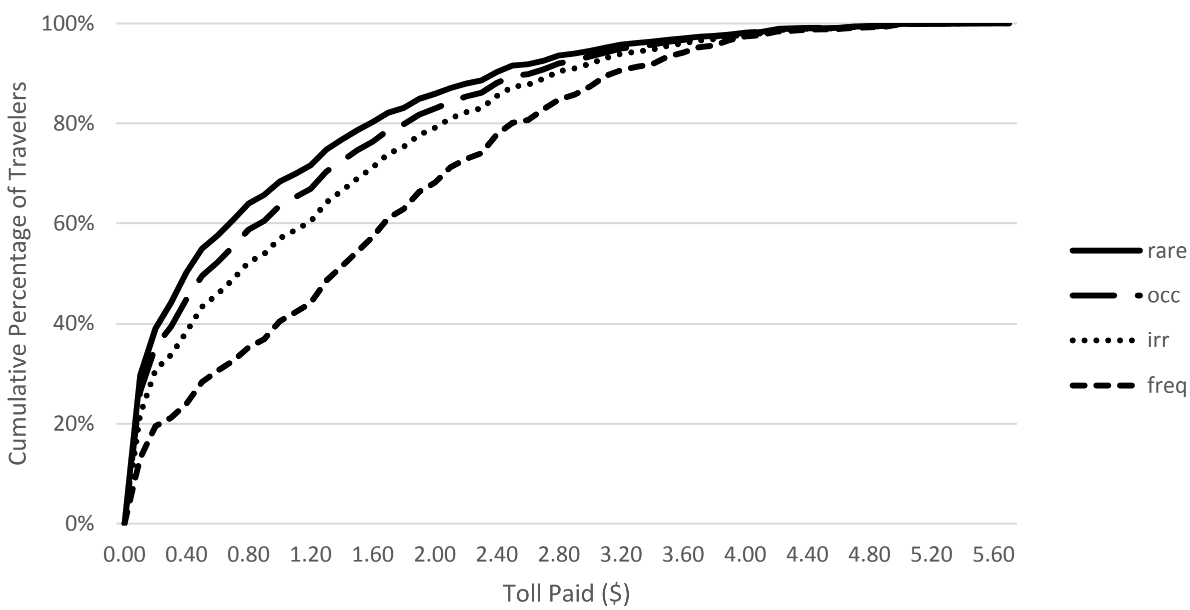


Figure B-19. Toll Paid by Frequency of Use (Southbound Direction)

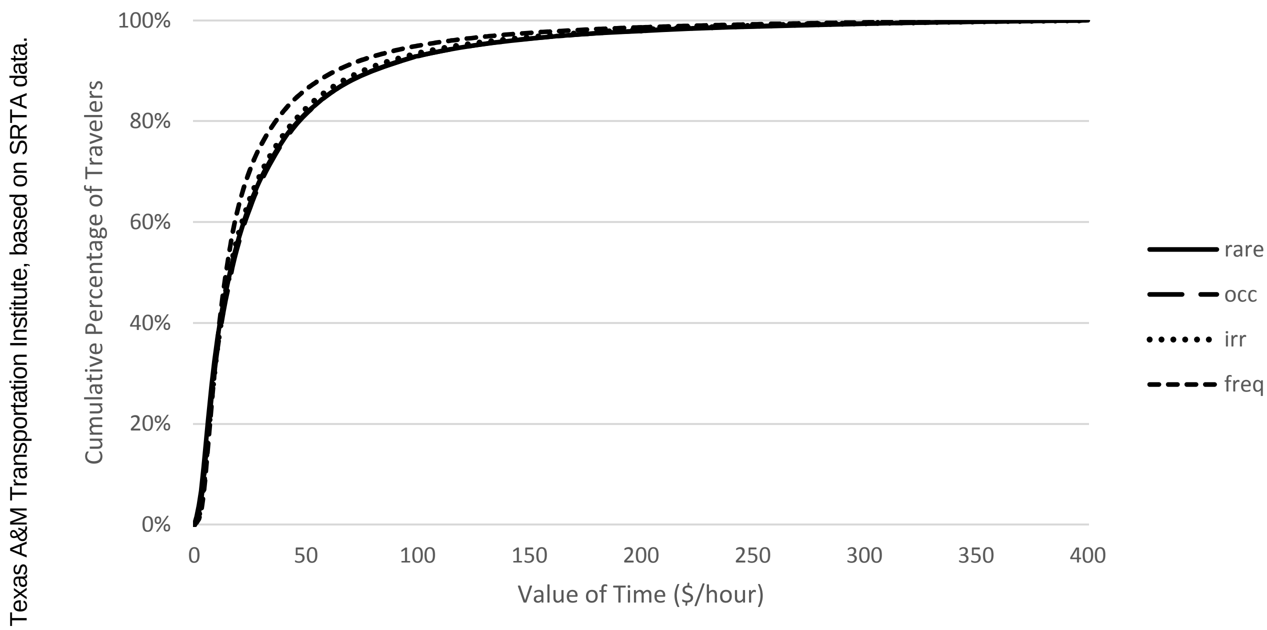


Figure B-20. Willingness-to-Pay by Frequency of Use (Northbound Direction)

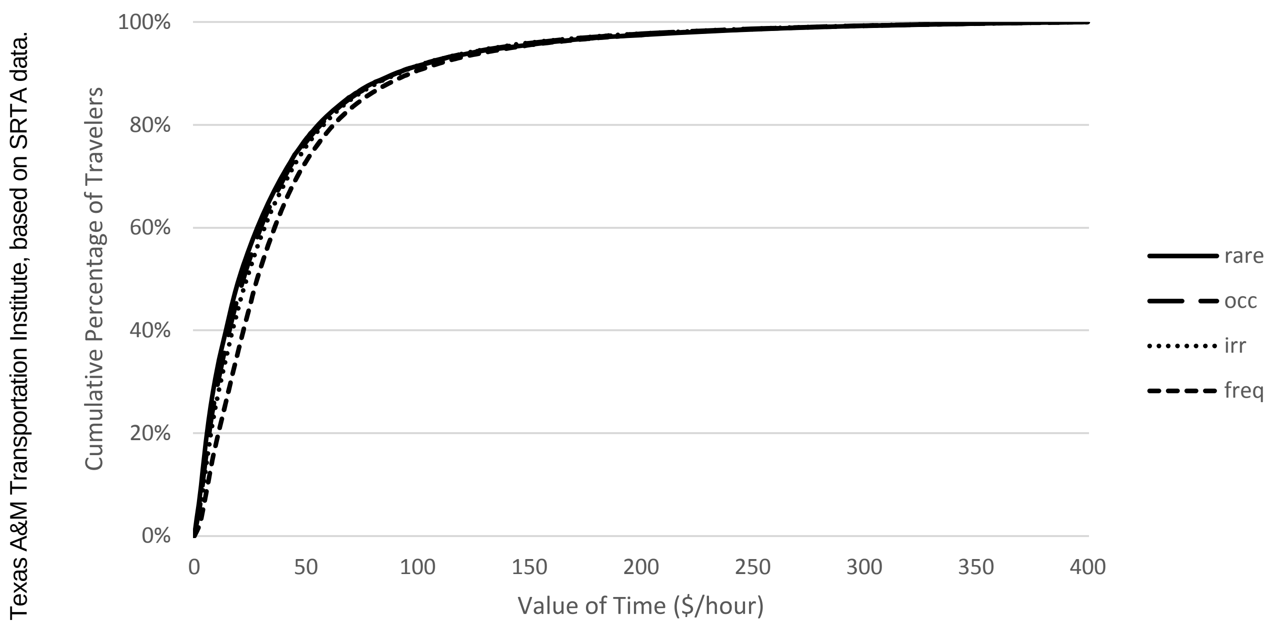


Figure B-21. Willingness-to-Pay by Frequency of Use (Southbound Direction)

The median WTP value from the analysis for all-day travel in both directions was $19.45 per hour. The highest median WTP value at $33.17 per hour occurred in the a.m. peak period in the southbound direction. Demand for travel in the northbound direction during the p.m. peak period was lower, with a median WTP value of $17.76 per hour. Additionally, the WTP varied little by frequency of use, as measured by the percentage of trips taken in the Express Lanes versus the general purpose lanes.

This WTP analysis was limited by the fact it was not based on stated preference information about each of the travelers. The tolls paid for each transaction gave an indication of the value that travelers would at least pay to access the Express Lanes. Individuals who had a higher demand, and would potentially pay more for travel, could not be discerned from the data. Drivers who had equipped transponders and drove in the general purpose lanes may have had a lower value of time, but that value of time may have been at least greater than $0 per hour. To summarize, the values from this analysis indicated at least the minimum WTP values, but the possible value of time may be higher.

The WTP analysis was also limited by basing the WTP values on activity from Express Lane users who took particular Express Lanes trips that could be matched to their general purpose lane travel. To expand the analysis to assess the value of time for all roadway users would have been a considerable effort that was outside the scope of the national evaluation.

An additional consideration that may have had an impact on the value of time analysis could be the influence of congestion on the Express Lanes. As discussed next in Section B.7, travel speeds were degraded during the a.m. peak period and speeds were slightly degraded during the p.m. peak period. In essence, the highest WTP values were indicative of some users paying a toll to travel in a lane that had a small improvement in performance over the general purpose lanes, while a majority of users experienced more significant travel time savings for a similar or lower toll. The WTP values from the analysis were not representative of congestion-free trips.

B.7 Perceptions of Tolling on I-85

Information on the perception of users of I-85 related to the tolling aspects of the CRD projects was available from a household panel travel survey sponsored by Volpe and focus groups of different I-85 user groups sponsored by GDOT. The household travel survey results related to tolling on the I-85 Express Lanes are presented in this section, followed by a summary of the focus group results.

B.7.1 Atlanta Household Travel Survey

To assist in evaluating the impact of converting the existing HOV lanes on I-85 to the Express Lanes, Volpe sponsored a household panel travel survey. The same households were surveyed before (wave 1) and after (wave 2) the I-85 HOV-to-HOT conversion to assess changes in travel behavior and perceptions toward the CRD projects. The survey consisted of a demographic questionnaire, a travel diary, and follow-up questions on current travel patterns and attitudes. The travel diary covered a 48-hour period in which respondents recorded the details of all trips, including origin, destination, time, travel mode, and purpose. Further details about the survey methodology were contained in Appendix A – Congestion Analysis.

The survey included questions on Peach Pass accounts, the number of transponders purchased, and use of the Express Lanes. Questions associated with trip satisfaction due to the pricing on I-85 were also included. Travelers who either drove alone or rode the bus were asked to rate their level of satisfaction with different aspects of their trips, including travel speed, driving time, and predictability of their driving time.

A seven-point response scale was used with each question – very satisfied (7), satisfied (6), somewhat satisfied (5), neutral (4), somewhat dissatisfied (3), dissatisfied (2), and very dissatisfied (1). The categories of very satisfied, satisfied, and somewhat satisfied were grouped into satisfactory trips, and very dissatisfied, dissatisfied, and somewhat dissatisfied were grouped into unsatisfactory trips.

Responses to the questions on Peach Passes, transponders, and use of the Express Lanes are summarized below.

- Overall, 34 percent of the households in the sample reported having one or more Peach Passes, with 17 percent having one transponder, 14 percent with two transponders, and 3 percent with 3 or more transponders. The remaining 66 percent of households did not have a Peach Pass.
- A total of 52 percent of households with Peach Passes reported obtaining them after the Express Lanes were implemented, while 46 percent purchased their transponders prior to tolling, and 2 percent could not recall when they obtained their transponder.
- Peach Pass ownership differed significantly by household income. Only 20 percent of the households in the lowest income category of less than $50,000 annual household income reported Peach Pass ownership, compared to 34 percent of households earning between $75,000 and $99,999, and 48 percent of households earning $150,000 and above.
- Respondents were asked a series of questions related to the Peach Pass and the Express Lanes, using the seven point scale noted previously. Overall, 70 percent of the respondents were satisfied with their experience of opening and setting up their Peach Pass account and 72 percent were satisfied with managing their account. In response to the question on changing their toll mode transponder status from tolled when driving alone to non-tolled when driving in a 3+ carpool, 43 percent indicated "not applicable." These responses indicated that many travelers did not change their toll status, as confirmed by the toll transaction analysis in Section B.3.2.
- Respondents without Peach Pass accounts were asked to select from a pre-selected list the reasons why they had not purchased a pass. The three factors receiving the most responses were "tolls are too expensive," 42 percent; "don't use toll roads often enough," 40 percent; and "against tolling in general," 39 percent.
- A total of 90 percent of the employed respondents indicated they did not receive reimbursement for tolls as part of their employee benefit package, 9 percent did not know, and 1 percent reported receiving partial or total toll reimbursement.
- The results from the travel diaries found that the mean occupancy for all reported I-85 driving trips (excluding transit and vanpools) increased from 1.13 to 1.17 from the pre- to post-deployment periods. The mean vehicle occupancy in the Express Lanes decreased from 2.22 with the HOV operation to 1.18 with the Express Lanes. The mean vehicle-occupancy level in the general purpose lanes increased from 1.07

to 1.18, however. Prior to tolling, 4 percent of trips in the general purpose lanes had two or more people, but after tolling this figure increased to 12 percent.

Survey respondents reported a 15 percent decline in the overall number of trips reported in the two-day travel diaries. The total number of reported trips in the I-85 corridor declined by 18 percent, and the number of reported trips outside the corridor declined by 12 percent. The share of trips in the corridor experienced a small, but statistically significant 2 percent decline across the two waves, with 47 percent of all wave 1 trips occurring in the I-85 corridor, compared to 45 percent of all wave 2 trips.

As shown in Table B-9, the overall number of reported trips declined by 20 percent. There was a significant decline of 12 percent in the number of driving trips reported on I-85 and a 33 percent decline in the number of driving trips reported on other roads in the corridor. There was a significant increase of 30 percent in the number of trips reporting use of any transit.

Table B-9. Change in the Use of the Corridor (Based on Trip Diaries)

	Wave 1/ (Share of Total Trips)	Wave 2/ (Share of Total Trips)	% Change in Trip Count
All Trips	19,397 (100%)	16,521 (100%)	-15%
Corridor Trips	9,035 (47%)	7,449 (45%)	-18%
Drive on I-85	6,338 (33%)	5,553 (34%)	-12%
General Purpose Lanes	5,924 (31%)	4,733 (29%)	-20%
HOV/Express Lanes[2] (excludes transit)	414 (2%)	820 (5%)	+98%
Any Transit on I-85	165 (1%)	207 (1%)	+30%
Other Roads in Corridor	2,532 (13%)	1,689 (10%)	-33%

Source: Volpe, used with permission.

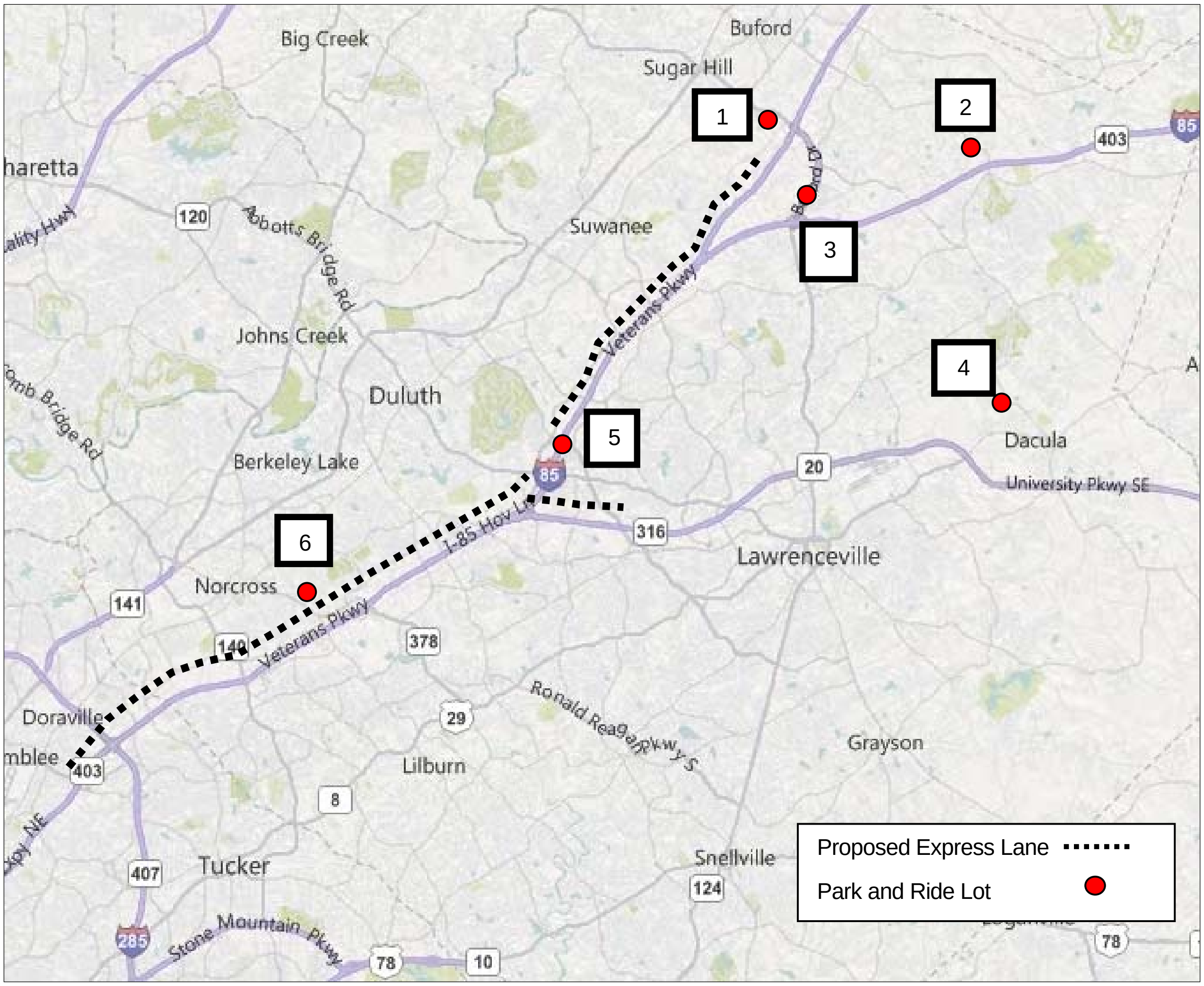
With regard to the Express Lanes, the trip diaries showed nearly a doubling – a 98 percent increase – in the number of trips reported in the Express Lanes from wave 1 (HOV operation) to wave 2 (Express Lanes). The share of trips on the HOV lanes verses the Express Lanes increased from 2 percent of all reported trips in wave 1 to 5 percent of all reported trips in wave 2. At the same time, the share of trips in the general purpose lanes experienced a slight, but statistically significant decline of 2 percent.

[2] This table is based on person-trips, so two individual traveling together from the same household were counted as separate trips. If the analysis is confined to vehicle trips (e.g., individuals from the same household traveling together are counted as one trip), there was a 126 percent increase in the share of Express Lane relative to HOV lane trips. Not surprisingly, removing "duplicate" household members has a larger impact on HOV lane trips (which drop from 414 to 350) compared to Express Lane trips (which drop from 820 to 791). When duplicates are removed, the share of total trips remained unchanged, at 2 percent for HOV lanes trips and 5 percent for Express Lane trips.

Appendix C. Transit Analysis

The CRD provided funding for 36 buses to be used on five new routes of the Xpress Buses on I-85. However, only three of the five routes were in service by the end of the evaluation in September 2012. All three routes began at staggered intervals prior to tolling. The Route 411 (Mall of Georgia to Midtown) began service in August 2010. The Route 416 (Dacula to Downtown) began in July 2011, and the Route 413 (Hamilton Mill to Downtown) began in August 2011. During the evaluation period 20 of the 36 CRD-funded buses had been purchased. Twelve of the purchased buses were assigned to the three new routes on I-85. The remaining eight were assigned to other routes.

The CRD also included funding for park-and-ride lot enhancements. These enhancements included three new lots—Mall of Georgia, Hamilton Mill, and Hebron Baptist Dacula—and one expanded lot at I-985/GA 20. The Mall of Georgia lot was the first to open in August of 2010 with 750 leased spaces. Next to open was a 400-space leased lot at the Hebron Baptist Church in Dacula in June 2011. In July 2011 the I-985/GA 20 lot was expanded to add 400 spaces to the 347 that already existed. Finally, the Hamilton Mill lot opened in August 2011 with 918 spaces. That amounted to 2,468 additional park-and-ride lot spaces in the I-85 corridor, which was a 117 percent increase. In addition to the CRD-funded park-and-ride lots, the evaluation included analysis of two other lots not funded by the CRD but located on I-85. They were the Discover Mills and Indian Trail Park-and-Ride Lots. Figure C-1 shows the locations of the park-and-ride lots and the routes that they serve.



Georgia Regional Transportation Authority

ID No.	Park-and-Ride Lot	Routes Served		Route Start Date
1	I-985/GA 20	101	(Buford to Downtown)	Current
2	Hamilton Mill	413	(Hamilton Mill to Downtown)	Aug-11
3	Mall of Georgia	411	(Mall of Georgia to Midtown)	Aug-10
4	Hebron Baptist	416	Dacula to Downtown)	Jul-11
		103	(Discover Mills to Downtown)	Current
5	Discover Mills	410	(Discover Mills to Lindberg)	Current
		412	(Discover Mills to Midtown)	Current
6	Indian Trail	102	(Indian Trail to Downtown)	Current

Figure C-1. Park and Ride Lot Locations and Routes Served

Table C-1 presents the hypotheses for the Atlanta CRD transit analysis. The first hypothesis related to the increased travel speeds of buses, the travel-time savings, and the improved trip-time reliability provided by the I-85 Express Lanes. The second and third hypotheses related to increasing transit ridership, influencing a mode shift to transit, and reducing congestion on I-85. The last hypothesis related to the relative contribution of each of the transit strategies to mode shift and congestion reduction.

Table C-1. Transit Hypotheses/Question

Hypotheses/Questions
• The Atlanta CRD projects will enhance transit performance in the I-85 corridor.
• The Atlanta CRD projects will increase ridership and facilitate a mode shift to transit within the I-85 corridor.
• Increased ridership/mode shift to transit will contribute to congestion mitigation within the I-85 corridor.
• What was the relative contribution of each Atlanta CRD project element to increased ridership and/or mode shift to transit within the I-85 corridor?

Source: Center for Urban Transportation Research

The remainder of this appendix is divided into six sections. The data sources used in the analysis are presented in Section C.1. Information on bus travel times and bus on-time performance is presented in Section C.2. Park-and-ride lot usage data are provided in Section C.3. Changes in transit ridership are discussed in Section C.4. The results from the August 2011 and May 2012 on-board rider surveys are presented in Section 0. In Section C.6 the appendix concludes with a summary of the impacts from the transit CRD projects relative to the hypotheses and question.

C.1 Data Sources

A variety of data from the Georgia Regional Transportation Authority (GRTA) and its contracted bus operators was used to analyze the Atlanta CRD transit projects. These included bus travel times, ridership, revenue miles and hours, park-and-ride lots counts, on-board surveys of riders, and the Volpe household travel survey.

Ridership data were analyzed two ways. The first method involved using three analysis periods. The first analysis period was April to June 2010. This was the baseline period prior to tolling and any CRD-funded bus service. The second analysis period was April to June 2011. This was an intermediate time period after one of the CRD-funded routes began operating but still before tolling. The third analysis period was April to June 2012. This was after tolling and after the other two CRD-funded routes began. An average daily ridership figure was calculated for each period. From that information, the percentage change between analysis periods was calculated. This was the same method that was used in the evaluation of the Miami and Minnesota UPAs and is being used in the evaluation of the Seattle UPA and Los Angeles CRD as well. The main advantage of this method is that it controls for seasonal variation in the weather. The second method used was to look at the overall trend in ridership from the beginning the evaluation in August 2009 to the end of the evaluation in September 2012. This helped illustrate what was occurring over the entire evaluation period.

Bus travel time and on-time performance data were analyzed the same way as ridership. However, this data were only available from September 2010 to June 2012. It had to be collected manually by the bus drivers each month because the Xpress buses were not equipped with automated vehicle location (AVL) systems.

Occupancy counts at the park-and-ride lots were conducted by GRTA's contracted operators four times during the evaluation (Oct. 2010, Apr. 2011, Oct. 2011, and Apr. 2012). Two on-board surveys were conducted of I-85 Xpress riders, the first in August 2011 prior to tolling and the second in May 2012 after tolling. The Volpe National Transportation Systems Center conducted a before/after panel survey of I-85 travelers, including transit riders. More information on the survey methodology can be found in Section 0.

C.2 Bus Travel Time and On-Time Performance Data

A goal of the I-85 Express Lanes was reducing bus travel times and improving on-time performance. Bus travel time data were collected manually each month from September 2010 to September 2012. Data were collected for five days on the second full week of each month. Each bus driver was given a travel time report card on which to record departure and arrival times. Since the intent was to focus on travel times inside the I-85 Express Lanes, the travel time report cards were limited to arrival/departure times from the park-and-ride lots and the first stop off of the interstate. On-time performance was calculated by comparing actual arrival times to scheduled arrival times. The standard was five minutes meaning if a bus arrived within five minutes of the scheduled arrival time it was considered on-time. Table C-2 shows the sample sizes, with the sampled trips representing the number of cards that were collected each month. The total trips represent the total number of bus trips there were made each month for the a.m. and p.m. peak periods (assuming four weeks in a month). Table C-3 shows the change in on-time performance for the I-85 Xpress buses before and after tolling.

Table C-2. Monthly Sample Sizes for Xpress Bus Travel Time Data Collection

Route	Sampled Trips (AM)	Total Trips (AM)	Sampled Trips (PM)	Total Trips (PM)
101	45	180	65	260
102	20	80	25	100
103	70	280	85	340
410	25	100	25	100
411	30	120	30	120
412	40	160	50	200
413	30	120	25	100
416	30	120	30	120
Total	**290**	**1,160**	**335**	**1,340**

Source: Center for Urban Transportation Research

Table C-3. Peak Period On-Time Performance Before and After Tolling

Route	A.M. Peak Period		P.M. Peak Period	
	Apr-Jun 2011	Apr-Jun 2012	Apr-Jun 2011	Apr-Jun 2012
101	93.2%	99.2%	84.7%	93.7%
102	100.0%	100.0%	80.9%	65.8%
103	92.9%	93.4%	95.6%	98.2%
410	67.8%	49.8%	93.2%	98.4%
411	94.3%	81.3%	97.1%	34.9%
412	99.1%	96.6%	97.7%	97.2%
413		98.3%		88.4%
416		97.1%		95.2%
Overall	**91.2%**	**89.9%**	**91.5%**	**84.0%**

Source: Center for Urban Transportation Research

It must be noted that the analysis of on-time performance was complicated by the fact that several changes were made to the schedules and route alignments during the evaluation. The scheduled travel times were reduced on some of the routes, and in March 2012 the route alignment in downtown Atlanta was changed. Xpress buses were moved off of Peachtree Street to Peachtree Center Avenue and Courtland Street. This realignment was not part of the Atlanta CRD. GRTA realigned the routes at the request of the City of Atlanta to remove conflicts with the Atlanta Streetcar Project and to implement the city's vision for Peachtree Street. In addition to the realignment, there was some reduction in the number of downtown bus stops and some changes to the schedule times. As a result of these schedule and alignment changes, some of the routes exhibited seemingly contradictory trends in on-time performance and travel times.

For example, on-time performance for the Route 410 (Discover Mills to MARTA Lindbergh Station) dropped from 67.8 percent to 49.8 percent in the a.m. peak period even though the actual travel times remained roughly the same. No bad weather was reported by the drivers for the April to June 2012 time period. They did report heavy traffic, but this was also reported by bus drivers on other routes that had higher on-time performance. The Route 410 underwent a schedule change in July 2011. Specifically, the scheduled travel time from Discover Mills to Lindbergh MARTA station for the 6:30 a.m. trip was cut by 10 minutes (from 30 to 20). When looking at the data for April to June 2012, 14 of the 34 late runs (41 percent) came from the 6:30 a.m. trips.

Another example was the Route 411 (Mall of Georgia to Midtown Atlanta). Its on-time performance in the a.m. peak period dropped from 94.3 percent to 81.3 percent. However, its travel time improved by 10.1 percent or 4 minutes 44 seconds. In the p.m. peak period, on-time performance dropped by an even wider margin from 97.1 percent to 34.9 percent even though average travel times were only about a minute and a half longer. In February 2012, the Route 411 underwent a schedule change. Specifically, the scheduled travel time from Mall of Georgia to Civic Center MARTA in the a.m. was reduced by 5 minutes. In the p.m., the scheduled travel time from the Arts Center MARTA station to the Mall of Georgia in the p.m. was cut in half from 1 hour to 35 minutes. Prior to February 2012, the bus would leave the MARTA Art Center and travel to Discover Mills where it would stop before continuing on to Hamilton Mills. The bus would then leave Hamilton Mills and travel back to Discover Mills. After February 2012, the first stop at Discover Mills was eliminated. Had the afternoon buses been operating on the old schedule, the on-time performance for April to June 2012 would have been around 98 percent instead of the low 34.9 percent.

On-time performance for the Route 102 (Indian Trail Park and Ride to Downtown) dropped from 80.9 percent to 65.8 percent in the p.m. peak period even though the travel times improved by 4.3 percent or about 1 minute 15 seconds. It is unlikely that the downtown realignment was the cause, since the other downtown Xpress routes (101, 103, 412, 413, and 416) had higher on-time performance. A more probable cause was a schedule change that occurred in March 2012 at the same time as the realignment. Specifically, the scheduled travel time from the Civic Center MARTA station to the Indian Trail park-and-ride lot was cut by 4 minutes. This could have made an otherwise on-time bus be classified as late.

In light of all the schedule changes that occurred, the evaluation team recommended using the actual bus travel times in Table C-4 and Table C-5 as a better indicator of travel performance on I-85. Travel times were independent of the schedule. Furthermore, the road segments used for the calculations were limited to the highway portion of the route. Overall, travel times had improved by 2.4 percent in the a.m. peak period and 5.0 percent in the p.m. peak period.

Table C-4. Xpress Bus Travel Times A.M. Peak Period

Route	Apr-Jun 2011	Apr-Jun 2012	% Change	p Value
101	00:47:09	00:42:21	-10.2%	0.000*
102	00:23:52	00:24:08	1.1%	0.748
103	00:36:27	00:37:39	3.3%	0.091
410	00:35:05	00:35:17	0.6%	0.829
411	00:46:48	00:41:50	-10.6%	0.000*
412	00:40:01	00:40:28	1.2%	0.620
413		00:43:58	n/a	
416		0:44:30	n/a	
Overall Percent Change			**-2.4%**	

* Statistically significant at the 95 percent confidence level.

Source: Center for Urban Transportation Research

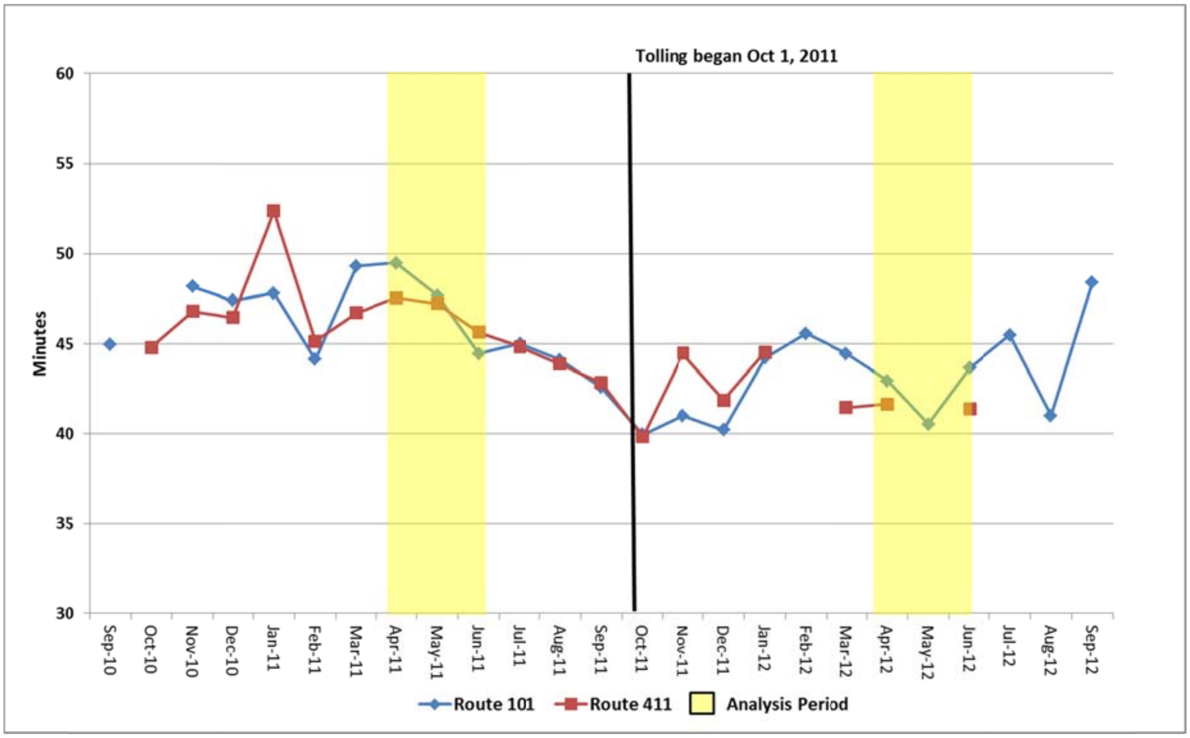
Table C-5. Xpress Bus Travel Times P.M. Peak Period

Route	Apr-Jun 2011	Apr-Jun 2012	% Change	p Value
101	00:51:33	00:48:00	-6.9%	0.001*
102	00:31:36	00:30:15	-4.3%	0.217
103	00:46:05	00:41:51	-9.2%	0.000*
410	00:44:07	00:38:36	-12.5%	0.000*
411	00:44:22	00:46:02	3.8%	0.285
412	00:42:29	00:42:05	-0.9%	0.782
413		00:54:41	n/a	
416		00:57:22	n/a	
Overall Percent Change			**-5.0%**	

* Statistically significant at the 95 percent confidence level.

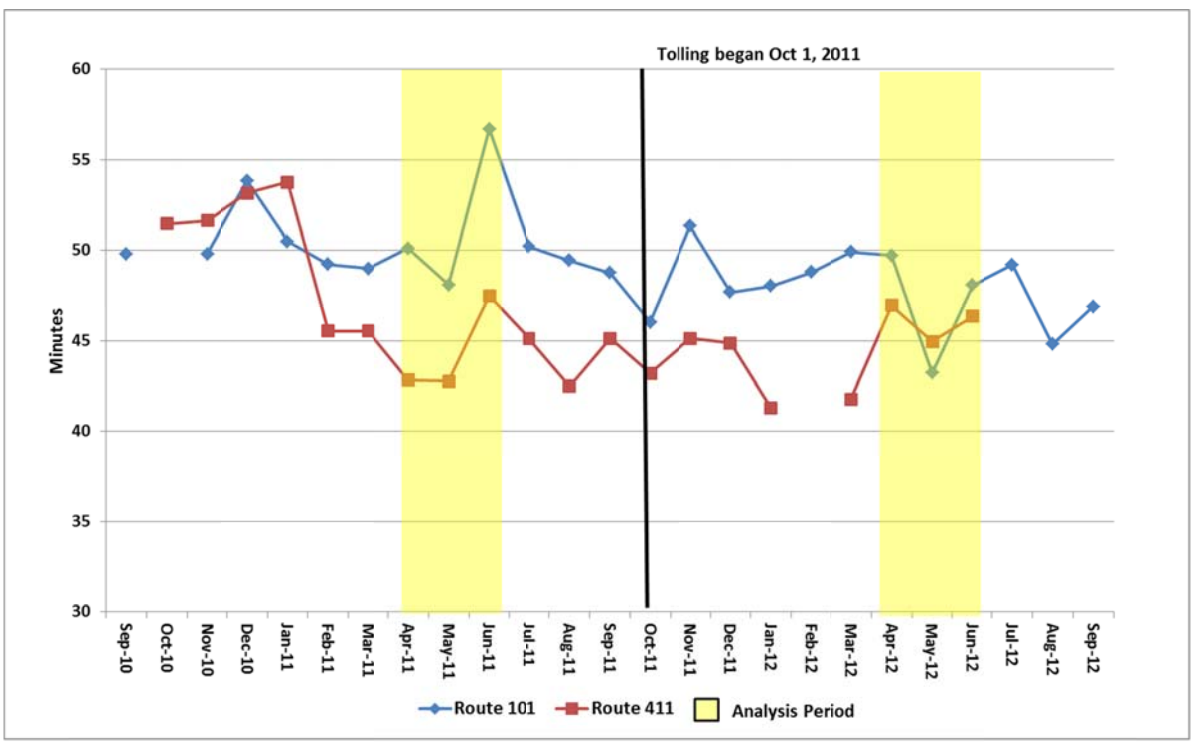
Source: Center for Urban Transportation Research

An independent sample *t*-test was performed to see if the changes in travel times were statistically significant. The results are indicated by the p values in Table C-4 and Table C-5. The results show that in five of the seven instances where there was a decrease in travel time, the change was statistically significant. In all five instances where there was an increase in travel time, the change was minimal (less than 2 minutes) and not statistically significant. Of particular note are Route 101 and Route 411. Unlike some of the other Xpress routes, these two routes traveled the full 15.5 mile length of the I-85 Express Lanes. Figure C-2 and Figure C-3 show the overall trends in their travel time. Figure C-2 shows that for the a.m. period the downward trend began well before the start of tolling. Therefore, the tolls cannot be considered the primary cause of the reduction. It is possible that the economic recession contributed to fewer vehicles on the road, which in turn would have led to shorter travel times. The congestion analysis in Appendix A reported a decrease in vehicle throughput in both the Express Lanes and the I-85 corridor as a whole after tolling. However, it did not pinpoint when the decrease first began.



Center for Urban Transportation Research

Figure C-2. Route 101 and 411 A.M. Peak Travel Times



Center for Urban Transportation Research

Figure C-3. Route 101 and 411 P.M. Peak Travel Times

C.3 Park-and-Ride Lot Use

The Atlanta CRD included funding for four park-and-ride lots (three new lots and one expansion). Four occupancy counts were conducted over the course of the evaluation to measure changes in utilization. These counts were conducted in October 2010, April 2011, October 2011, and April 2012. What stood out in the analysis was that utilization increased at the lots serviced by the three new CRD-funded routes while utilization decreased at the lots served by the non-CRD-funded routes. The only exception was the Indian Trail Park-and-Ride lot. The results are shown in Table C-6.

Table C-6. Park-and-Ride Lot Utilization

Lot	CRD-funded Lot	Served by CRD-funded Route	Oct 2010	Apr 2011	Oct 2011	Apr 2012
Mall of Georgia (Opened Aug-10)	Yes	Yes	n/a[1]	112	280	312
Hebron Baptist Church (Opened Jun-11)	Yes	Yes				215
I-985/GA 20 (Expanded Jul-11)	Yes	No	302	292	219	269
Hamilton Mill (Opened Jul-11)	Yes	Yes			286	316
Discover Mills GCT (Expanded 2010)	No	No	469	278	609	269
Discover Mills GRTA	No	No	257	493	347	458
Indian Trail	No	No	194	196	268	215

[1] The October 2010 park-and-ride lot count data for the Mall of Georgia lot were lost in the mail, and there were no additional copies of the data.

Source: Center for Urban Transportation Research

The Mall of Georgia lot was a new lot that opened in August 2010. It was served by the Route 411, a CRD-funded route that travels from the Mall of Georgia to Midtown. Utilization at this lot increased 178.6 percent from April 2011 to April 2012. Ridership grew steadily on the Route 411 since it began service in August 2010.

The Hebron Baptist Church lot was a new leased lot that opened in June 2011. It was served by the Route 416, a CRD-funded route that travels from Dacula to downtown Atlanta. Only one count was performed for this lot in April 2012. Roughly half of the 400 leased spaces were occupied. Like the Route 411, ridership on the Route 416 grew steadily since it began service in July 2011.

The I-985 lot was an existing lot that was expanded in July 2011 from 347 to 747 spaces. It was served by the Route 101, a non-CRD-funded route that traveled from Buford to downtown Atlanta. The number of occupied spaces dropped 7.9 percent from 292 to 262 between April 2011 and April 2012. Coincidentally, ridership on the Route 101 had been declining steadily since April 2011.

The Hamilton Mill lot was a new lot that opened in August 2011. This lot was served by the Route 413, a CRD-funded route that traveled from Hamilton Mill to downtown Atlanta. Utilization at this lot increased 10.5 percent from October 2011 to April 2012. This was not a completely accurate comparison because the counts were done at different seasons. However, ridership grew steadily on the Route 413 since it began service in August 2011.

The usage pattern of the GCT lot at Discover Mills showed a dip in April compared to October in both the pre- and post-deployment periods. According to GCT, many students park at that lot and April is the traditional period of spring break, which might account for the drop usage. However, that explanation does not concur with ridership on Route 103 serving that lot, which did not decline in April, as might be expected.

C.4 Transit Ridership Data

As shown in Table C-7, average daily ridership increased by 21 percent in the a.m. peak period and 17 percent in the p.m. peak period.

Table C-7. Average Daily Riders I-85 Xpress Bus

Service	Apr-Jun 2010	Apr-Jun 2011	Apr-Jun 2012	% Change 10 to 12
A.M. Peak	1,210	1,366	1,459	21%
P.M. Peak	1,239	1,364	1,454	17%

Source: Center for Urban Transportation Research

Figure C-4 shows the monthly trend in average daily ridership on the I-85 Xpress bus service from August 2009 to September 2012. The shaded sections represent the April-to-June analysis periods that were used in the calculations.

A closer analysis showed that the three CRD-funded routes were the cause of the sustained ridership on I-85. Figure C-5 is similar to Figure C-4 except that it excludes the ridership from the three CRD-funded routes. Figure C-5 illustrates that it was the three CRD-funded routes that kept ridership in the corridor above the baseline. Had it not been for these new routes, there would have been a decline in transit ridership.

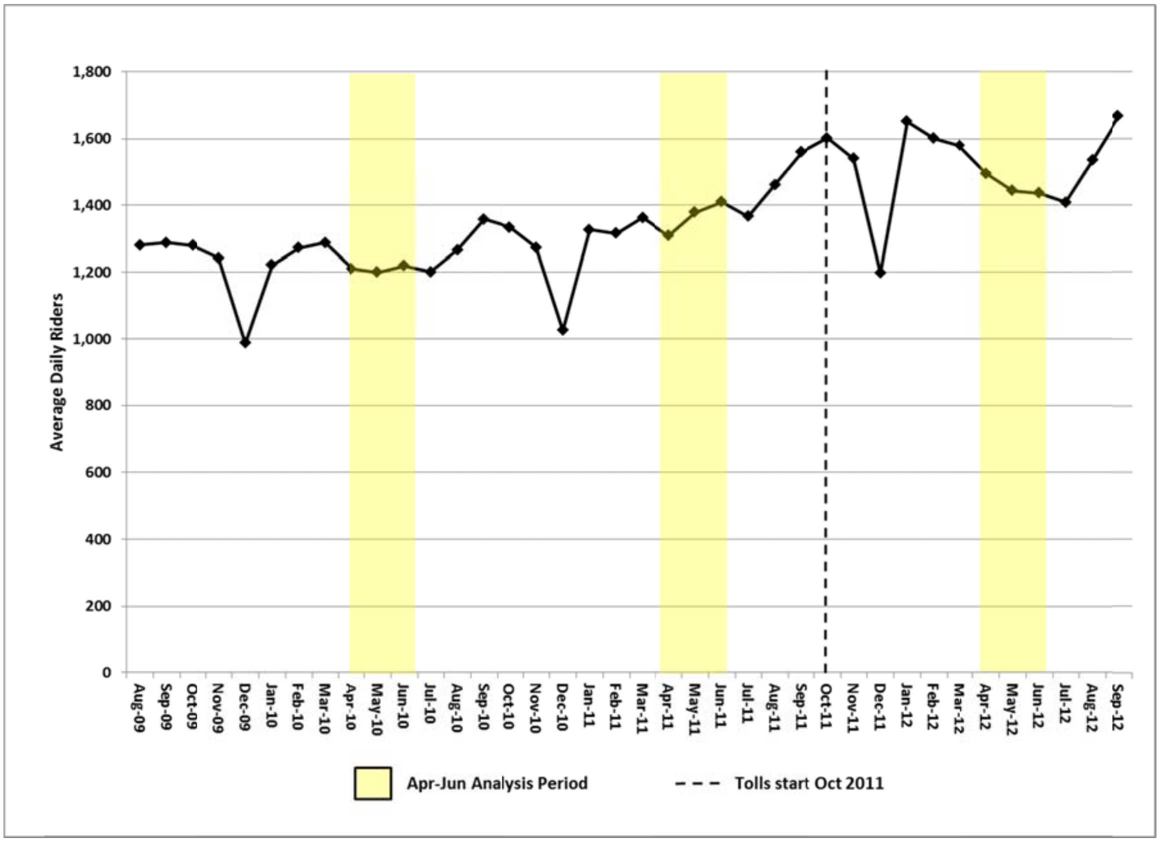


Figure C-4. I-85 Xpress Bus Average Daily Riders (a.m. peak)

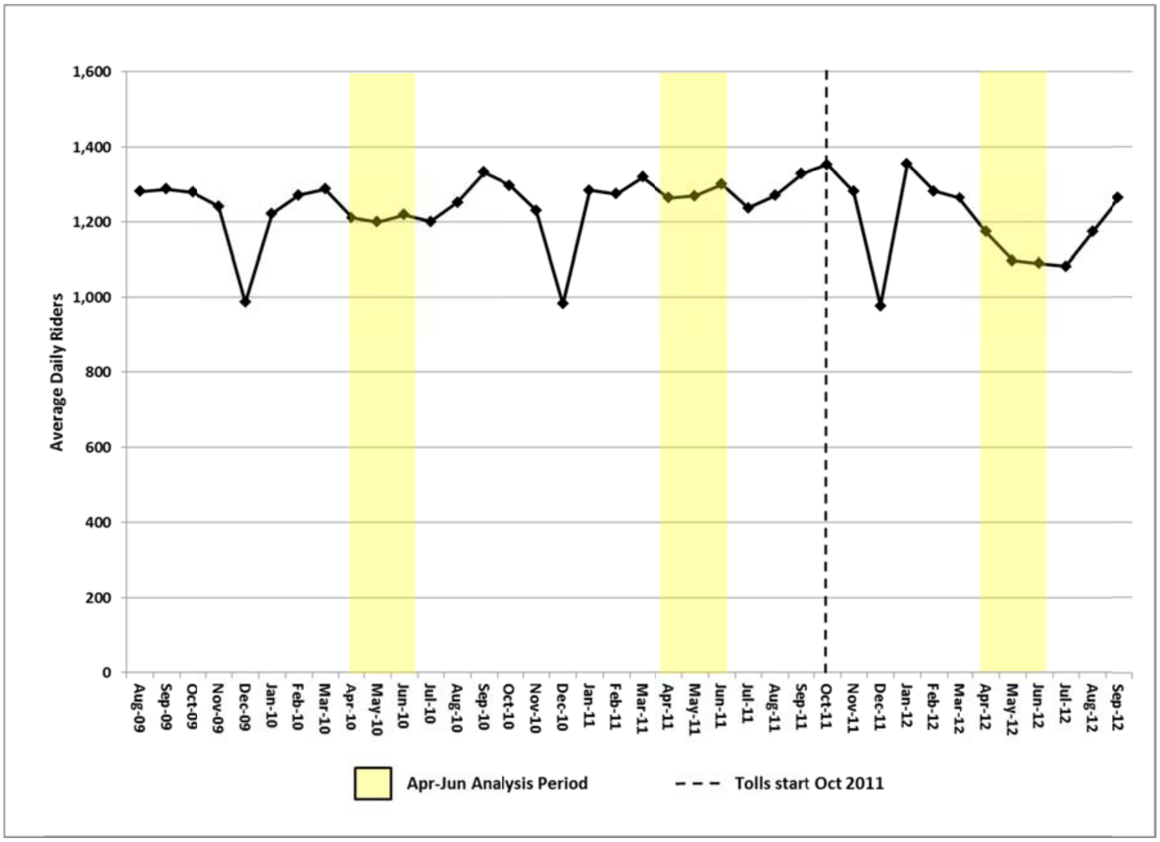


Figure C-5. I-85 Xpress Bus Average Daily Riders (excluding CRD routes)

Did riders switch from the pre-existing routes to the new CRD-funded routes? In theory, some riders will switch to new routes if the new routes are more convenient (for example if the new route originates closer to home). A detailed analysis revealed that this does not appear to have occurred. A Pearson's correlation test was performed to see whether there was a statistical correlation between the ridership patterns of CRD and non-CRD routes serving common destinations. In a Pearson's correlation, the r value can range from -1 to +1. An r value of -1 represents a perfect negative linear relationship. An r value of +1 represents a perfect positive linear relationship. An r value of 0 represents no linear relationship. If the new CRD-funded routes captured riders who previously rode the non-CRD-funded routes, a significant negative correlation would be expected.

The Routes 411 and 412 both provide service to Midtown. The Route 411 was a CRD-funded route, and the Route 412 was a non-CRD route. The Route 411 originated further east than the Route 412. Riders who used to take the Route 412 could have potentially switched to the Route 411 because it was closer to their home. However, the Pearson's correlation test revealed that the correlation in ridership between these two routes was very weak. The r value equaled -0.175, and the results were not statistically significant.

A similar correlation test was performed between the Routes 103, 413 and 416, all of which provided service to downtown. The Routes 413 and 416 were CRD-funded routes both of which were located further east than the non-CRD Route 103. The Pearson's correlation test revealed a weak correlation between the Route 103 and the 413 (r value equaled -0.220) and between the Route 103 and 413 (r value equaled -0.243). In both cases, the results were not statistically significant.

To see if there were factors besides the CRD improvements influencing the changes in ridership, the evaluation included an analysis of average bus revenue hours, the average price per gallon of gasoline, and the average unemployment rate. Average bus revenue hours are defined here as the average number of hours Xpress buses were in revenue service each month. It excluded non-revenue service hours (i.e., hours spent to/from the garage). One would expect to see a positive correlation between ridership and revenue hours and between ridership and gasoline prices. One would expect to see a negative correlation between ridership and the unemployment rate.

As shown in Table C-8, the results were not completely as expected. Both ridership and revenue hours increased between 2010 and 2011, but between 2011 and 2012 ridership fell even as revenue hours continued to increase. Gasoline prices rose by about a dollar per gallon between 2010 and 2011 and fell by about ten cents between 2011 and 2012. The average unemployment rate remained high at close to 10 percent between 2010 and 2011 but then fell by a percentage point between 2011 and 2012. Figure C-6 and Figure C-7 show the overall trend in gasoline prices and unemployment rates compared to Xpress bus monthly boardings from August 2009 and September 2012.

Table C-8. Exogenous Factors, Xpress Bus Riders and Revenue Hours

Measure	Apr-Jun 2010	Apr-Jun 2011	Apr-Jun 2012
Avg. Daily Riders	2,878	3,386	3,172
Avg. Daily Revenue Hours	148	169	208
Avg. Price per Gallon of Gas	$2.81	$3.78	$3.67
Avg. Unemployment Rate	9.9%	9.7%	8.8%

Sources: Monthly boardings and revenue hours were provided by GRTA.
Average price per gallon of gasoline data were from the U.S. Energy Information Administration.
Average unemployment rate data were from the Georgia Department of Labor.

Center for Urban Transportation Research

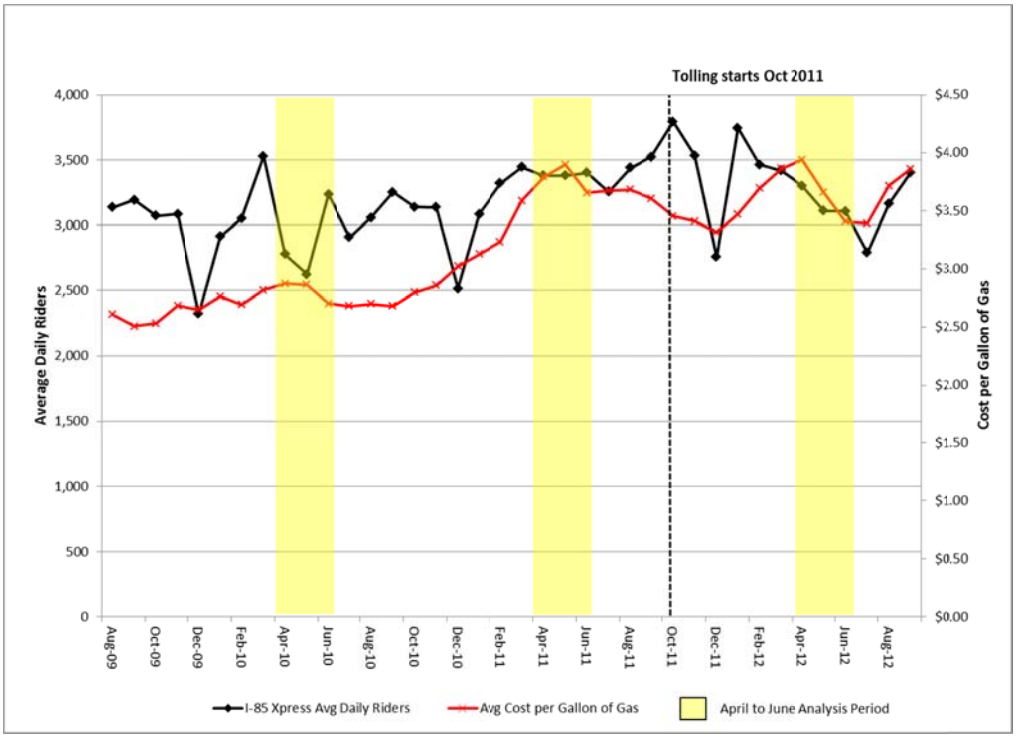


Figure C-6. I-85 Xpress Bus Monthly Boardings vs. Average Cost of Gasoline

Center for Urban Transportation Research

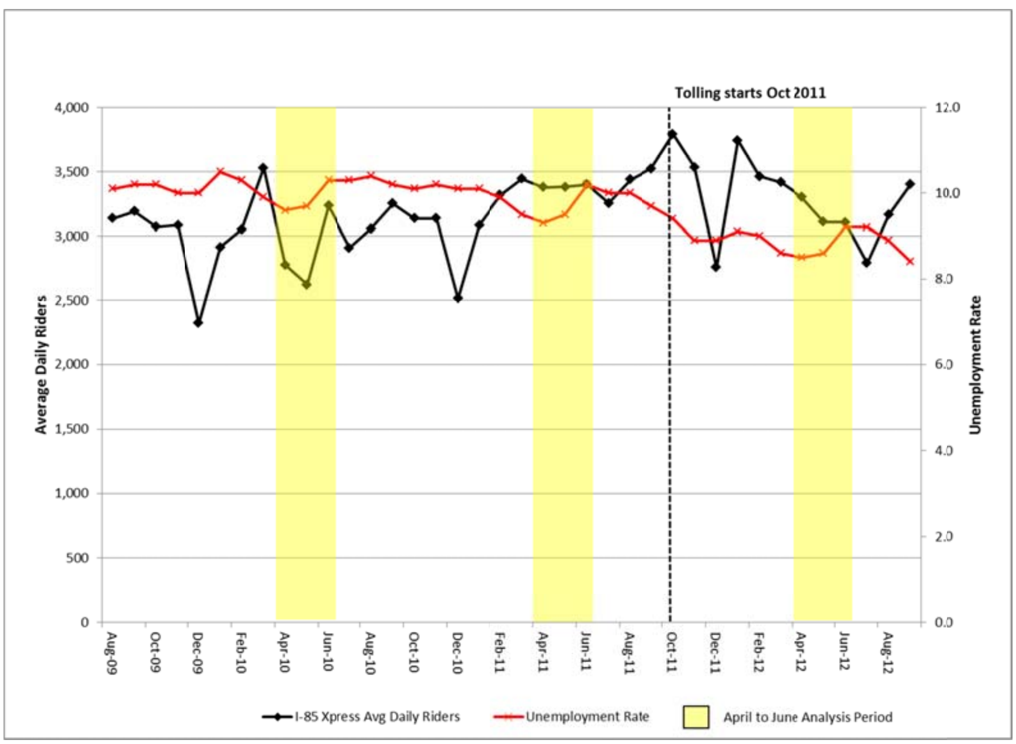


Figure C-7. I-85 Xpress Bus Monthly Boardings vs. Unemployment Rate

A Pearson's correlation test was performed to see if there was a statistical correlation between the average daily riders, average daily revenue hours, average cost per gallon of gasoline, and the average unemployment rate. The results are shown in Table C-9. There was a moderate correlation between average daily riders and average revenue hours. There was also a moderate correlation between average daily riders and the average cost per gallon of gasoline. In both cases, the correlation was statistically significant at the 99 percent confidence level. The results showed a weak correlation between the unemployment rate and average daily ridership. However the results were not statistically significant. These results were included to show that there could be a variety of external factors that influenced riders to take Xpress bus besides the Express Lanes.

Table C-9. Pearson's Correlation Test

		Average Daily Revenue Hours	Average Cost per Gallon	Average Unemployment Rate
Average Daily Riders	Pearson Correlation	.519*	.499*	-.284
	Sig. (2-tailed)	.001	.001	.083
	N	38	38	38

* Correlation is significant at the 99 percent confidence level.

Source: Center for Urban Transportation Research

From the data shown above, two things could be said with certainty about ridership levels in the I-85 corridor. The first was that ridership increased prior to tolling. The second was that the three new CRD-funded routes were what kept ridership above the baseline.

The third hypothesis for the transit analysis was that increased transit ridership would contribute to congestion mitigation within the I-85 corridor. One of the ways to measure congestion mitigation is person throughput, the number of people traversing a corridor over a specified time across all modes. If more people take transit, that will result in greater person throughput. Table C-10 shows person throughput before and after tolling. It divides the data into non-transit and transit components. The former represents person throughput in vehicles other than transit (e.g., carpools and single-occupant vehicles). Transit's share of total person throughput was small (less than 4 percent) both before and after tolling. However, its percentage share did increase slightly after tolling. It increased from 3.0 to 3.4 percent in the a.m. peak southbound and from 2.6 to 3.0 percent in the p.m. peak northbound. In that sense, transit did contribute slightly to congestion mitigation. However, it needs to be pointed out that total person throughput declined by 6 percent in the a.m. peak period and by 9 percent in the p.m. peak period, which may have been due to continuing weak economic conditions in the post-deployment period.

Table C-10. Peak Period Person Throughput

Peak Period	Person Throughput (Non-Transit)		Person Throughput (Transit)		Total Person Throughput	
	Pre Deployment					
Southbound (a.m. peak)	44,395	97.0%	1,385	3.0%	45,780	100.0%
Northbound (p.m. peak)	50,996	97.4%	1,374	2.6%	52,370	100.0%
	Post-Deployment					
Southbound (a.m. peak)	41,627	96.6%	1,464	3.4%	43,091	100.0%
Northbound (p.m. peak)	46,758	97.0%	1,451	3.0%	48,209	100.0%

Note: Figures shown are average daily figures. The months used for the pre-deployment calculation were April to August 2011. The months used for post-deployment were April to August 2012.

Source: Center for Urban Transportation Research

C.5 I-85 Xpress On-Board Transit Ridership Survey

The Atlanta CRD evaluation included two passenger on-board surveys of I-85 Xpress riders. The first was conducted in August 2011 just prior to the start of tolling on I-85. The second was conducted in May 2012, seven months after tolling. For both surveys, the responses were weighted based on the ridership of each route.

The August 2011 surveys were collected over three days from August 29 to 31. The overall response rate was 63.5 percent, as shown in Table C-11. Average daily ridership in August for all of the I-85 Xpress routes was 3,438 (not shown in table). The margin of error of survey responses was ± 2.1 percent at the 95 percent confidence level.

Table C-11. August 2011 Survey Response Summary

Route	Surveys Collected	Passenger Counts	Return Rate
101	262	373	70.2%
102	123	201	61.2%
103	510	912	55.9%
410	74	103	71.8%
411	93	118	78.8%
412	209	314	66.6%
413	18	37	48.6%
416	60	65	92.3%
TOTAL	**1,349**	**2,123**	**63.5%**

Source: GRTA

The May 2012 surveys were collected over two days from May 2 to 3. The overall response rate was 55.5 percent, as shown in Table C-12. Average daily ridership in May for all the I-85 Xpress bus routes was 3,108 (not shown). The margin of error for survey responses was ± 2.9 percent at the 95 percent confidence level.

Table C-12. May 2012 Survey Response Summary

Route	Surveys Collected	Passenger Counts	Return Rate
101	139	239	58.2%
102	66	111	59.5%
103	199	471	42.3%
410	44	86	51.2%
411	109	172	63.4%
412	124	239	51.9%
413	87	96	90.6%
416	62	82	75.6%
TOTAL	**830**	**1,496**	**55.5%**

Source: GRTA

Socio-Economic Characteristics of I-85 Xpress Riders

Table C-13 highlights the socio-economic characteristics of I-85 Xpress riders. For the most part, there was not much of a change in characteristics of the two surveys. I-85 Xpress riders tend to be middle-age, white, affluent, and have access to at least one vehicle. There were some shifts in demographics between the two surveys. From 2011 to 2012, the percentage of riders who identified as Caucasian/White rose 4.1 percentage points while the percentage that identified as Asian dropped by 5.1 percentage points. In the 2011 survey, riders were evenly split between males and females, but in the 2012 survey, the percentage of female riders rose to 56.1 percent. Finally, in the 2011 survey riders in the 18-24 age bracket represented 11.0 percent of all riders. In the 2012 survey, the percentage of 18-24 year olds dropped to 2.5 percent.

Table C-13. Socio-Economic Characteristics of I-85 Xpress Riders

Category		2011 Survey	2012 Survey
Age	Under 18	0.2%	0.1%
	18-24	11.0%	2.6%
	25-34	12.9%	12.8%
	35-44	27.4%	28.0%
	45-54	30.4%	34.1%
	55-64	16.4%	21.1%
	65-74	1.5%	1.2%
	75-84	0.1%	0.0%
	85 or older	0.0%	0.0%
Ethnicity	African American/Black	30.7%	30.6%
	American Indian	0.6%	0.8%
	Asian	12.6%	8.1%
	Caucasian/White	51.7%	55.8%
	Other	4.4%	4.8%
Hispanic/Latino	Yes	7.7%	6.4%
	No	92.3%	93.6%
Gender	Male	49.4%	43.4%
	Female	50.6%	56.6%
Annual Household Income	Less than $10,000	1.5%	1.1%
	$10,000 to $24,999	3.1%	1.1%
	$25,000 to $34,999	3.2%	4.4%
	$35,000 to $49,999	8.1%	9.8%
	$50,000 to $74,999	18.8%	19.3%
	$75,000 to $99,999	17.5%	21.2%
	$100,000 to $149,999	23.1%	28.2%
	$150,000 to $199,999	7.9%	9.8%
	$200,000 to $249,999	1.8%	3.2%
	$250,000 or more	0.6%	1.9%
	I'd rather not say	14.4%	n/a
Number of automobiles in household	0	0.8%	0.7%
	1	19.4%	17.4%
	2	49.9%	52.7%
	3 or more	29.9%	29.2%
Automobile available	Yes	91.8%	96.0%
	No	8.2%	4.0%

Source: August 2011 and May 2012 GRTA Xpress Surveys

Trip Purposes

GRTA's Xpress bus service, whether on I-85 or other roadways, was primarily a peak period, peak direction service. Not surprisingly, the vast majority of riders were commuters going to and from home and work. This was confirmed in Table C-14 and Table C-15 showing their morning origins and destinations. Not only were most of the riders commuters, they were people who chose to take transit instead of their car to work. For example, riders were asked how they would make their trip if the Xpress bus service was not available. As shown in Table C-16, 65.3 percent said they would drive alone were it not for Xpress bus and 17.7 percent said they would drive to the nearest MARTA station. Only 9.5 percent said they would carpool. (Due to survey length, this question was not asked in the 2012 post-tolling survey.)

Table C-14. Trip Origins of I-85 Xpress Bus Riders

Trip Origin	Freq.	%
Home	802	98.2%
Workplace	4	0.5%
Hospital	1	0.1%
Bank	1	0.1%
College	0	0.0%
Another Home	1	0.1%
School	3	0.4%
Other	5	0.6%
Total	**817**	**100.0%**

Source: May 2012 GRTA Xpress Survey (post-toll)

Table C-15. Trip Destinations of I-85 Xpress Bus Riders

Trip Origin	Freq.	
Home	12	1.5%
Workplace	748	94.7%
Store	1	0.1%
Hospital	1	0.1%
Bank	6	0.8%
Hotel	1	0.1%
College	10	1.3%
Restaurant	1	0.1%
School	4	0.5%
Other	6	0.8%
Total	**790**	**100.0%**

Source: May 2012 GRTA Xpress Survey (post-toll)

Table C-16. How Riders Would Make Trip Without I-85 Xpress Bus

Response	Freq.	%
Carpool	127	9.5%
Drive to a MARTA Station	236	17.7%
Vanpool	31	2.3%
Drive alone for the entire trip	871	65.3%
Take a Taxi	7	0.5%
Would not make the trip	27	2.0%
Other	35	2.6%
Total	**1,334**	**100.0%**

Source: August 2011 GRTA Xpress Survey (pre-toll)

Toll Related Questions

The August 2011 survey, conducted just prior to the start of tolls, asked bus riders how they felt about the plans to convert the HOV lane into a HOT lane. As shown in Table C-17, the majority (59.9 percent) disapproved of the plans and only 9.4 percent approved.

Table C-17. Rider Opinions about I-85 HOV Conversion before Tolling

Response	Freq.	%
Unaware of plans	117	8.8%
Approve	124	9.4%
Disapprove	793	59.9%
Undecided	290	21.9%
Total	**1,324**	**100.0%**

Source: August 2011 GRTA Xpress Survey (pre-toll)

This question was cross-tabulated against the various socio-economic variables in Table C-13 to see if there were any discernible patterns of disapproval, but no such patterns emerged. The disapproval was fairly uniform across all socio-economic variables.

The negative attitudes about tolls appeared again in the May 2012 post-tolling survey where bus riders were asked to indicate their level of agreement or disagreement with several statements regarding the I-85 tolls. The statements and the results are shown in Table C-18. The majority either disagreed or strongly disagreed with the statements that tolling I-85 had improved their travel and tolling I-85 had been good for the Atlanta region. Furthermore, a majority agreed or strongly agreed that the tolls were unfair to people on limited incomes. As was done with the 2011 survey, cross-tabulations were performed on the various socio-economic groups. No patterns emerged in the cross-tabulations.

Table C-18. Rider Opinions about I-85 HOV Conversion after Tolling

Statement	Strongly Agree/ Agree		Neutral		Strongly Disagree/ Disagree	
	Freq.	%	Freq.	%	Freq.	%
Tolling I-85 has improved my travel	148	18.2%	242	29.7%	425	52.1%
Tolling I-85 has been good for the Atlanta region	106	13.1%	189	23.3%	515	63.6%
Tolling I-85 is unfair to people on limited incomes	440	54.5%	205	25.4%	163	20.2%

Source: May 2012 GRTA Xpress Survey (post-toll)

According to staff from GRTA, several factors could be contributing to the public's negative attitudes about tolls. These factors included: the HOT concept being widely disliked by the public even prior to implementation; the perception that the lane conversion amounted to taking an existing free lane; raising the HOV occupancy requirement from two- to three-person carpools; adding a toll and not having access at one of the points with the heaviest demand; no barrier separation and a perceived weak enforcement of HOT lanes.

The May 2012 survey asked riders whether they were influenced to take transit because of the tolls. In the survey, it was found that 82.9 percent of the riders had already been riding the bus before tolls began (table not shown). It was not surprising then that only 19.6 percent of all riders reported being influenced by the tolls, as shown in Table C-19. However when the question of influence was cross-tabulated against whether a rider began taking the bus before or after tolling began, there were significant differences. While only 13.5 percent of riders from the "before" group said they were influenced to take transit because of the tolls, 48.9 percent of riders from the "after" group said they were influenced. A Fisher's Exact test was performed to test for a correlation, and the results were statistically significant at the 95 percent confidence level (2 Sig p value = 0.000).

Table C-19. Did the HOV Conversion Influence Your Decision to Ride a Bus?

Type of Rider	Yes		No	
	Freq.	%	Freq.	%
All riders	162	19.6%	663	80.4%
Pre-toll riders	92	13.5%	590	86.5%
Post-toll riders	69	48.9%	72	51.1%

Source: May 2012 GRTA Xpress Survey (post-toll)

Travel Time Perceptions

Riders were asked how their travel times now compare to before tolls. As shown in Table C-20, nearly half (49.1 percent) reported slower travel times. These findings were unexpected since the actual bus travel times have decreased, as was reported in Section C.2.

Table C-20. Rider Perceptions of Travel Times after Tolling

Response	Freq.	%
30 minutes slower or more	43	6.9%
15 to 29 minutes slower	45	7.2%
5 to 14 minutes slower	99	15.8%
1 to 4 minutes slower	120	19.2%
1 to 4 minutes faster	16	2.6%
5 to 14 minutes faster	59	9.4%
15 to 29 minutes faster	168	26.9%
30 minutes faster or more	75	12.0%
Total	**625**	**100.0%**

Source: May 2012 GRTA Xpress Bus Survey (post-toll)

Rider Opinions about Xpress Bus

Riders were very enthusiastic about the Xpress bus service. For example, riders were asked how they would describe the Xpress bus service to others, and over 90 percent said they either liked it or loved it, as shown in Table C-21. (Due to survey length, the riders were asked opinions of Xpress Bus in the 2011 pre-tolling survey only.)

Table C-21. How Riders Describe I-85 Xpress Bus Service

Response	Freq.	%
I will never ride it again	0	0.0%
I don't like it	2	0.2%
It is OK	123	9.3%
I like it	585	44.2%
I love it	614	46.4%
Total	**1,324**	**100.0%**

Source: August 2011 GRTA Xpress Survey (pre-toll)

Riders were asked to rate their level of satisfaction with 13 aspects of the bus service as well as their overall level of satisfaction. The ratings were scaled from 1 to 5 with 1 being poor and 5 being excellent. The mean scores are shown in Table C-22. Overall satisfaction was rated 4.1 (very good). Eight of the thirteen service aspects were rated over 4.0 as well, including travel time and buses arriving on time.

Table C-22. Service Aspect Ratings

Service Aspect	Freq.	Mean	Std. Dev.
Travel Time	978	4.3	0.8
Buses Arriving on Time	1,325	4.3	0.8
Driver Courtesy	1,323	4.3	0.8
Cost of Service	1,313	3.2	1.1
Directness of the Route	1,321	4.3	0.8
Availability of Schedule Info	1,327	3.9	1.0
Comfort	1,330	4.1	0.8
Ride Quality	1,329	4.2	0.8
Safe Operation	1,329	4.3	0.7
Safety and Security at Park and Ride Lots	1,327	3.9	1.0
Cleanliness	1,328	4.3	0.8
XpressGA.com website	1,218	3.7	0.9
Customer Service	1,288	3.7	1.0
Overall Satisfaction	**1,320**	**4.1**	**0.7**

Scale: 1 = Poor ; 2 = Fair; 3 = Good; 4 = Very Good; 5 = Excellent

Source: August 2011 GRTA Xpress Survey (pre-toll)

Volpe Household Travel Survey

The on-board survey findings on attitudes about the bus service and the Express Lanes mirror those found in the Volpe household travel survey. That panel survey was done in two waves before and after tolling (April 2011 and April 2012). Participants kept a two-day travel diary as well as surveys measuring satisfaction and attitudes. Details on the methodology were presented in Appendix A – Congestion Analysis.

Table C-23 shows the results for waves one and two. In both waves of the surveys, large majorities of transit riders reported being satisfied (combined very satisfied, satisfied, or somewhat satisfied), with a quarter or more being “very satisfied.” However, on all the repeated measures there was a statistically significant decline in positive ratings. Regarding the reliability of the service, for example, there was a 16 percent decline in the proportion of respondents indicating they were “very satisfied” with this aspect of their trip, though there was no change in the percent dissatisfied (5 percent in wave 1 vs. 5 percent in wave 2). This suggested that respondents were still satisfied, just not quite as strongly. For travel time, there was a slight decline in the share of transit trips rated as satisfactory (84 percent in wave 1 vs. 81 percent in wave 2), and a 7 percent increase in the share of trips rated as unsatisfactory on this dimension. With respect to wait time at a stop, the largest differences across the two waves included a decline in the percent of trips that received a rating of either “very satisfied” (-5 percent) or “satisfied” (-5 percent). Despite these declines in satisfaction, it is worth emphasizing that large majorities of respondents were very satisfied with their experience on transit. In addition, it is important to note that in April 2012, when the wave 2 survey was administered, there were some adjustments to the transit service that resulted in a temporary increase in customer complaints.

Table C-23. Satisfaction with Bus Transit Trips

	Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Very Satisfied
Travel Time							
Wave 1	1%	3%	5%	7%	15%	42%	27%
Wave 2	2%	7%	6%	3%	15%	43%	23%
Wait Time at Stop							
Wave 1	2%	1%	3%	7%	10%	47%	30%
Wave 2	2%	2%	7%	8%	14%	42%	25%
Reliability							
Wave 1	2%	*%	3%	3%	8%	39%	45%
Wave 2	1%	1%	3%	5%	10%	51%	29%
Availability of Seats							
Wave 1	1%	1%	4%	2%	11%	45%	36%
Wave 2	1%	1%	5%	4%	8%	52%	30%
Parking Availability at Park-N-Ride							
Wave 2	*	*	1%	6%	1%	37%	55%

Wave 1, N = 154 trips; Wave 2, N = 152 trips

Source: Volpe

C.6 Summary Transit Impacts

Table C-24 presents a summary of the transit impacts for each of the hypothesis in the transit analysis. The analysis of the data presented a mixed picture indicating that the CRD transit enhancements had a generally positive impact on travel in the I-85 corridor but some improvements were partially offset by other factors.

Table C-24. Summary of Transit Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• The Atlanta CRD projects will enhance transit performance in the I-85 corridor.	Mostly supported	Overall bus travel times in the I-85 Express Lanes were 2.4 percent shorter in the a.m. peak period and 5.0 percent shorter in the p.m. peak period. However, the a.m. bus travel times began to shorten even before tolling.
• The Atlanta CRD projects will increase ridership and facilitate a mode shift to transit within the I-85 corridor.	Somewhat supported	Transit ridership in the I-85 Express Lanes increased by 21 percent in the a.m. peak period and 17 percent in the p.m. peak period. Much of the growth came from the new CRD-funded routes. Ridership on many of the pre-existing routes fell. Statistical tests on ridership patterns suggest that the new CRD-funded routes were tapping new riders, whereas the existing routes had already reached their maximum potential. Utilization increased at all the park-and-ride lots serviced by the CRD-funded routes.
• Increased ridership/mode shift to transit will contribute to congestion mitigation within the I-85 corridor.	Somewhat supported	The percentage of total person throughput due to transit was small (less than 4 percent). However, its percentage share did increase during post-deployment.
• What was the relative contribution of each Atlanta CRD project element to increased ridership and/or mode shift to transit within the I-85 corridor?	Transit ridership on CRD-funded routes increased by 10.2 percent but fell on non-CRD routes.	Almost 49 percent of the new riders who began taking the bus after the start of tolls said the tolls influenced them to take transit. The main reason why post-deployment ridership was higher than the baseline was because of the 3 CRD-funded routes. Had it not been for these new routes, ridership in the corridor would have been lower than the baseline.

Source: Center for Urban Transportation Research

Appendix D. TDM Analysis

The Transportation Demand Management (TDM) element of the Atlanta CRD focused on maintaining and expanding the use of carpools and vanpools in the I-85 corridor and on the Express Lanes. The TDM program's main objective were to promote and incentivize the use of high occupancy modes to travel in the Express Lanes and in the I-85 corridor and to minimize the impact of the CRD project on existing carpools. As presented in Table D-1, the hypotheses and question focus on reducing trips and vehicle miles of travel (VMT) by helping to form 3+ person carpools as a result of the TDM outreach activities. The impact of the CRD project on existing 2-person carpools was also examined, given the increase in the vehicle occupancy requirement to 3+ in order to use the Express Lanes for free. The TDM analysis investigated whether the Atlanta CRD TDM initiatives and promotion of commute alternatives removed trips and decreased VMT from I-85, as well as whether Clean Air Campaign (CAC) incentives supported formation of 3+ person carpools and vanpools on I-85.

Table D-1. Telecommuting Hypotheses/Questions

Hypotheses/Questions
• Promotion of commute alternatives removes trips and vehicle miles traveled (VMT) from I-85
• CAC incentives support formation of 3+ carpools and vanpools on I-85
• What was the relative contribution of the Atlanta CRD TDM initiatives on reducing I-85 vehicle trips/VMT?

Source: Battelle

The appendix is divided into six sections. Section D.1 describes the TDM program that was part of the CRD. The sources of data used in the analysis are described in Section D.2. Section D.3 presents the CAC incentive programs and Section D.4 presents an analysis of their effectiveness in the achieving the CRD objectives. Section D.5 analyzes the impact of the CRD on carpooling in the corridor. A summary of all the TDM analysis relating to the hypotheses and question is presented in Section D.6.

D.1   TDM Program

The TDM element of the Atlanta CRD was funded by the State Road and Tollway Authority (SRTA) and the Georgia DOT (GDOT), with no federal resources. The CAC, a TDM contractor to GDOT, managed the TDM component. The CAC is a regional TDM service provider. To support the CRD projects, particularly the Express Lanes, the CAC undertook public outreach to increase the number of 3-person carpools using the I-85 corridor, who could continue to use the Express Lanes for free. Their efforts focused on converting existing 2-person to 3-person carpools and on creating 3-person carpools from single-occupant vehicle (SOV) drivers. CAC used existing carpooler databases to identify and contact 2-person carpoolers, but did not market to new Peach Pass customers. In conjunction with SRTA, CAC identified SOV commuters who travel in the I-85 Express Lanes and encouraged carpool formation. SOV drivers were also targeted through outreach to employers in the I-85 corridor and to employers outside the corridor who may have employees who use the I-85 corridor.

The primary focus of CAC's efforts to support higher occupancy modes in the corridor included the addition of a full-time staff person to contact all 2-person carpoolers in the CAC registrant database (who have registered for various incentive programs) and encourage the addition of another rider to create a 3-person carpool that could continue to use the Express Lanes for free. (2-person carpools had to pay the toll after implementation of the Express Lanes.) Targeted outreach conducted by CAC to existing carpoolers from July 2011 to February 2012 discussed the Express Lanes project and encouraged carpoolers to maintain their shared rides and increase the occupancy of their carpool, with outreach activity peaking in August and September 2011, prior to the opening of the Express Lanes. Staff also made special presentations to employer groups within the I-85 corridor.

D.2 Data Sources

Four types of data for the TDM analysis were used: TDM program data, survey data, vehicle occupancy data, and casual carpooling data.

TDM Program Data. A primary source of data for the TDM analysis was provided by CAC and its Employer Services unit. CAC, as a contractor to GDOT, provided most of the data for the data items enumerated in Table D-2, tabulated by month and summarized for four six-month periods corresponding to the pre-deployment period (October 2010 – September 2011) and the post-deployment period after the opening of the I-85 Express Lanes (October 2011 – September 2012).

Data related to employer outreach were provided in summary format since these activities largely occurred during one period just prior to deployment. Data on vanpools and vanpoolers were collected by CAC from regional vanpool vendors. Program impacts, in the form of vehicle trip and VMT reduction, was provided by CAC as derived from "trip tracking" software that participating commuters use to qualify for incentives and prize drawings. Rideshare matchlist information was provided to CAC by the Atlanta Regional Commission (ARC), that operates the ridematching system for the region.

Table D-2. TDM Elements and Sources

Data Element	Source
Employer Outreach Contacts	CAC
Employees Receiving Information	CAC
Marketing Materials Distributed	CAC
New Carpool Rewards Recipients (3+ carpools)	CAC
New Cash for Commuters Recipients (mode shift incentive)	CAC
New Commuter Prizes Recipients (drawing for all alternative mode users)	CAC
New Vanpools and Vanpoolers	CAC from Vanpool Providers
New Ridematching Registrants	CAC from ARC
Vehicle Trip and VMT Reduction from TDM program	CAC

Source: ESTC

Carpooler Survey Data. Two key surveys informed the evaluation of the TDM program, particularly with respect to the impact of the CRD project on existing carpooling (using the I-85 HOV lane). First, the Volpe household travel survey provided information on the behavior and changes in behavior of carpools using the I-85 corridor. Details about the survey are in Appendix A – Congestion Analysis.

Second, a survey of existing carpools, within the CAC database of those eligible for existing incentives) was conducted for SRTA during the pre- and post-deployment periods.[1] Using the CAC registrant database, in March 2011 an invitation to participate in the pre-deployment survey was e-mailed to 2,572 carpoolers with valid e-mail addresses. 439 respondents completed the on-line survey. Using the same methodology as the pre-deployment survey but with questions adapted for the presence of the Express Lanes, the post-deployment survey was conducted in April 2012. Among the 2,760 valid e-mail addresses 346 completed the on-line survey. 168 respondents participated in both the 2011 and 2012 surveys.

Vehicle Occupancy Data. Georgia Tech performed a field observation study of vehicle occupancy before and after the start of tolling, and details are presented in Appendix A – Congestion Analysis. These data were also used to estimate person throughout. The vehicle occupancy data were used in the TDM analysis to corroborate carpool impact findings based on the other data presented in the TDM analysis.

Casual Carpooling Data. Data were collected at park-and-ride lots in the corridor to assess whether casual carpooling was generated by the tolling and increase in the occupancy requirement for toll-free use of the Express Lanes. Drivers of Xpress buses serving the park-and-ride lots in the I-85 corridor were asked to report occurrences of casual carpooling as part of GRTA's evaluation support activity.

D.3 CAC Incentive Programs

The CAC offers incentives to commuters who are willing to switch to a higher occupancy commute mode and to those who maintain this alternative mode usage. A special incentive is provided for carpools with 3 or more occupants and this incentive pre-dates and is independent of the CRD project. However, the CAC did not offer additional incentive beyond their current incentive program for commuters in the I-85 corridor, other than develop a targeted outreach brochure and one-and-one contact with each registered 2-person carpool in the corridor. The nature and amount of incentives were not changed for the I-85 corridor. The incentives include:

Carpool Rewards (CR). Carpoolers who commute in 3-person or 4-or-more-people arrangements are eligible for an *extra* incentive for $40-$60 gas cards. This "carpool rewards" incentive complements the Express Lanes project quite well, as it encourages registered 3+ carpools that travel for free in the Express Lanes.

Cash for Commuters (CFC). Registered commuters receive $3 per day for each day using a non-drive alone mode, up to $100 over 90 days. Only those commuters previously driving alone qualify and the recipient's employer must verify their eligibility.

Commuter Prize (CP). The Commute Prize program offers a monthly drawing of $25 gift cards for any eligible commuter using an alternative mode.

[1] Based on unpublished reports in 2011 and 2012 prepared by Noble Insight, Inc. under contract to SRTA.

D.4 Effectiveness of CAC Activities in I-85 Corridor

The nine data elements in Table D-2 were used to assess the effectiveness of CAC in influencing the use of non-SOV modes in the I-85 corridor. For most of the data items (items 4-9 in Table D-2), a before-and-after assessment was made of commuters' response to CAC incentives and activities. It should be noted that the "after" or "post-deployment" reported numbers were somewhat affected by an increase in the CAC database. Periodically, normal for all ridesharing programs, CAC purges its database, focuses marketing efforts and updates its numbers. In April 2012, the number of program registrants likely to be using the I-85 corridor rose from 3,086 (the baseline number of CAC registrants from October 2010 to March 2012) to 4,149. This served to boost the numbers in the second half of the post-deployment period as more commuters were eligible to receive incentives.

For the employer and employee outreach element, conducted through employers in the I-85 corridor, a clear before and after assessment was not possible, because these activities served to educate commuters about the Express Lanes, alternatives to driving alone, and promote the incentives offered by CAC for higher occupancy modes. These activities were not necessarily above and beyond the normal employer outreach conducted by CAC. Rather, they represented a conscious focus on the I-85 corridor of regular outreach activities in the month leading up to the initiation of tolls. Overall, however, TDM outreach, and dissemination of information on options for alternative modes in general, was not widespread, compared to SRTA's extensive outreach emphasizing how to obtain and use a transponder rather than carpooling options to use the lane for free.

<u>Employer and Employee Outreach.</u> CAC focused some of their outreach efforts, among some 1,500 client worksites, to employers who were expected to be impacted by the Express Lanes project. A special brochure was handed out to employee transportation coordinators that explained the Peach Pass program and how CAC could help commuters use the lanes for free. The additional staff person, hired to contact all carpoolers, made several presentations to employer groups, one before implementation and three after. The I-85 brochure was distributed to employer representatives one-on-one and at CAC functions, such as at their annual PACE Award event. Some 250 brochures were distributed prior to the start of tolling and over 350 through the end of the one-year post-deployment period.

In terms of direct commuter outreach, CAC contacted every registered carpooler in a 2-person carpool to encourage the addition of another rider in order to use the Express Lanes for free (and be eligible for the Carpool Rewards program). Between July 2011 and February 2012, attempts were made to contact a total of 3,205 carpoolers, with some 1,261 carpoolers successfully reached. Follow-up also occurred to assess whether the initial information was successful in forming 3-person carpools. Thus, of the 1,261 people reached (who had registered with CAC), over 700 noted that they had not formed a 3-person carpool in response to the Express Lanes project and 18 registered carpools were able to add a third carpooler, thus being able to utilize the Express Lanes for free. Most of the remaining respondents were no longer carpooling in the I-85 corridor.

Carpool Rewards. 3- and 4-person carpools were eligible for an *extra* incentive (above the Commuter Prize program) of a $40-$60 gas card. This Carpool Rewards incentive complemented the Express Lanes project in that it encouraged registered 3+ carpools that traveled for free in the Express Lanes. During the pre-deployment period in 2011, a total of 60 three-person carpools received $40 gas cards, between 3 and 12 carpools per month. A total of 48 carpools with four or more people--between 2 and 11 carpools per month--received the $60 gas card. June 2011 was the month with the greatest activity in Carpool Rewards. During the post-deployment period, 55 carpools received the $40 reward and 34 4-person carpools received $60. Pre- and post-deployment Carpool Rewards numbers are summarized in Figure D-1. Three-quarters of these post-deployment reward recipients came in the second half of the year, after new registrants were added to the database as described above.

ESTC based on CAC data

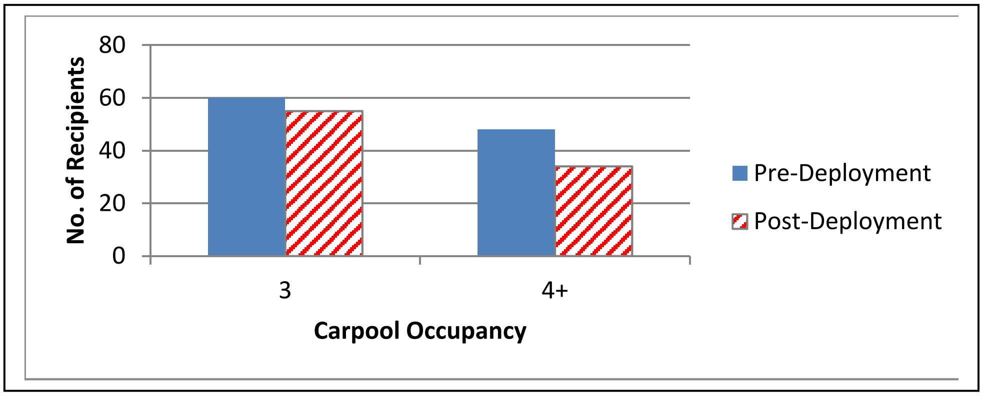


Figure D-1. Carpool Rewards Recipients

Cash for Commuters. During the pre-deployment period (October 2010 – September 2011), CAC realized 158 new Cash for Commuters recipients who commute in the I-85 corridor, of which 92 (58 percent) were new carpoolers, 45 (29 percent) switched to bus or train, 8 (5 percent) chose to telework, and 3 (2 percent) joined a vanpool. These commuters received $3 per day for each day using a non-drive alone mode, up to $100 over 90 days. During the pre-deployment period, the two months with the greatest activity in carpool formation were May and June 2011, presumably when media reports on the opening of the Express Lanes and Peach Pass registration was very active. In the post-deployment period (October 2011 – September 2012) 148 new Cash for Commuters recipients were registered, with some 55 percent of these switching to carpooling. The second most prevalent switch was to bus/train (20 percent). Only two new vanpoolers were registered and 19 teleworkers (13 percent). Cash for Commuters numbers are summarized in Figure D-2. As with the other incentive programs, the vast majority (89 percent) of new Cash for Commuter recipients were added to the database in the second half of the post-deployment period after the database was expanded from 3,086 to 4,149.

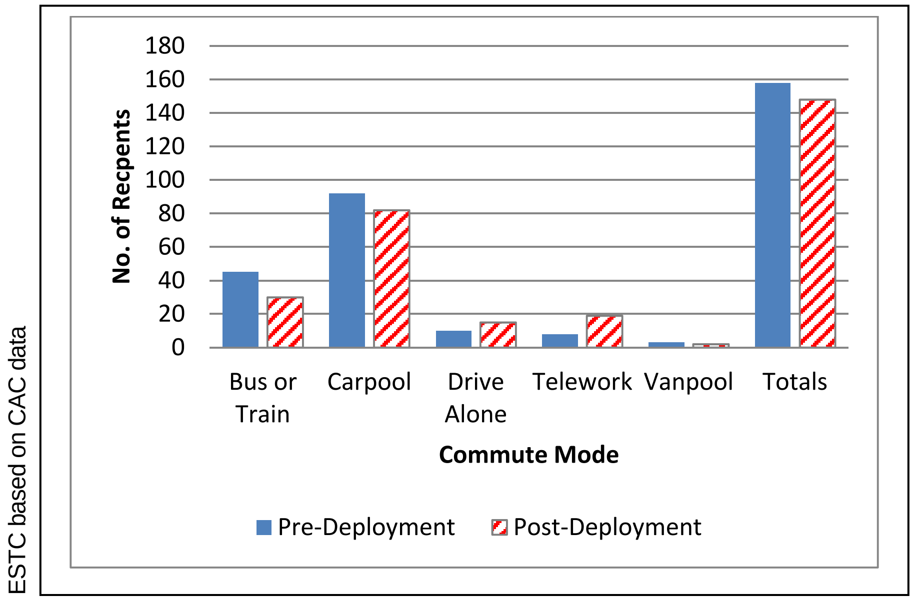
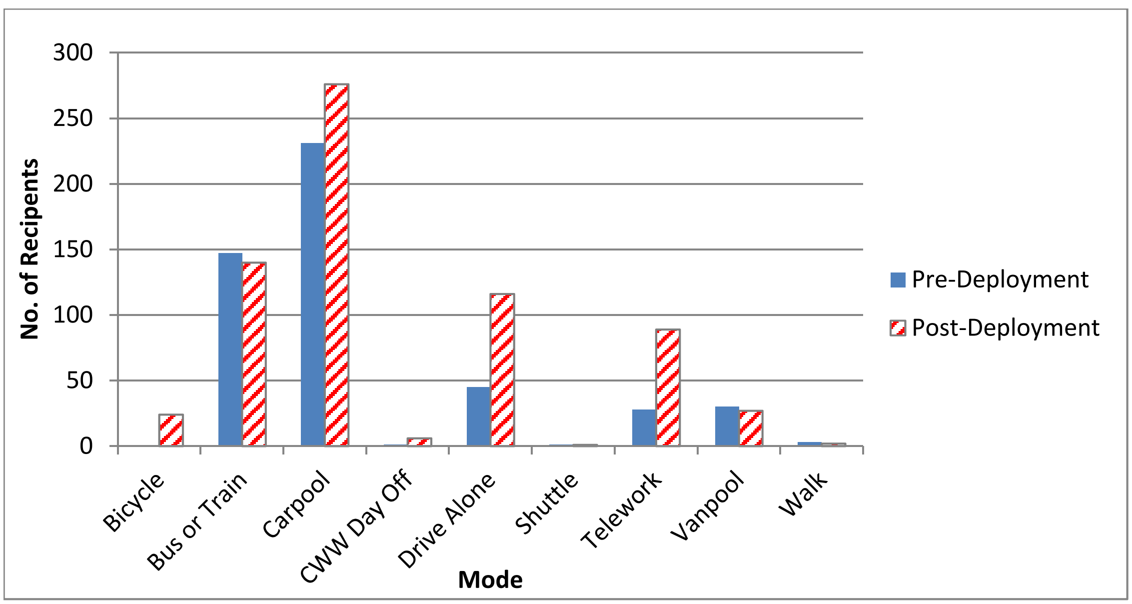


Figure D-2. Cash for Commuters Recipients

Commuter Prizes. The Commuter Prize program had 486 commuters participate between October 2010 and September 2011, with anyone using an alternative mode becoming eligible for a monthly drawing of $25 gift cards. As shown in Figure D-3 the largest group to participate in the Commuter Prize program was 231 carpools (48 percent), followed by 147 bus and train riders (30 percent). During the post-deployment period, a total of 681 Commuter Prize participants were eligible for the program. However, the growth in interest in this program did not correspond to the opening of the Express Lanes (only 17 added in the three months following the opening) but to the expansion of the database as discussed earlier. In the post-deployment period, there was an increase in the number of commuter prize participants who were carpoolers (276 or 41 percent) and a slight decrease in the number who were bus and train riders (140 or 21 percent). The greatest growth was in telework, with 28 teleworkers eligible for the prizes before implementation (6 percent) and 89 teleworkers after deployment (13 percent).



ESTC based on CAC data

CWW Day Off = Compressed work week with a day off

Figure D-3. Commuter Prizes Recipients

Ridematching and Vanpooling. Two desirable outcomes of increased marketing, outreach and incentives were increased demand for rideshare matching services and vanpool services. In terms of ridematching, CAC forwards requests for ridematching services to the Atlanta Regional Council, who operates the regional Commute Options program. In the pre-deployment period October 2010 to September 2011 CAC forwarded 235 requests for ridematching services to ARC, of which 33 were successfully placed into carpools. Since the opening of the Express Lanes, some 426 requests were forwarded to ARC with 31 placed into carpools. The greatest success in carpool placement occurred in May and June, 2011 before the start of tolling. Vanpooling, at least as reported by regional vanpool operators, did not appreciably change during the evaluation period. During both the before and after period, 47 vanpools had been operating in the corridor. The number of total riders had increased from 315 to 326 vanpoolers.

Vehicle Trip and VMT Reduction. As part of CAC's incentive programs, the utilization of alternative modes is tracked using the Georgia Commute Options logging system and, therefore, mode shift was documented. VMT reduction is the primary performance measure, as derived from vehicle trip reduction resulting from mode shift attributable to Cash for Commuters (CFC), Commuter Prizes (CP) and Carpool Rewards (CPR). Figure D-4 compares the pre- and post-deployment VMT reductions. For the pre-deployment period, the estimated VMT reduction was 6,674,821 miles for incentive recipients in the I-85 corridor, with the Commuter Prizes program (the reward for all existing registered alternative mode users) contributing the most—89 percent miles of travel saved—compared to driving alone. Commuters making a mode switch during the pre-deployment period accounted for 5 percent of all VMT reduced, or about 365,000 miles. During the post-deployment period, CAC calculated 7,322,576 miles reduced from its various programs, again with a vast majority (83 percent) attributable to Commuter Prizes and only 10 percent from mode shift, about 750,000 miles.

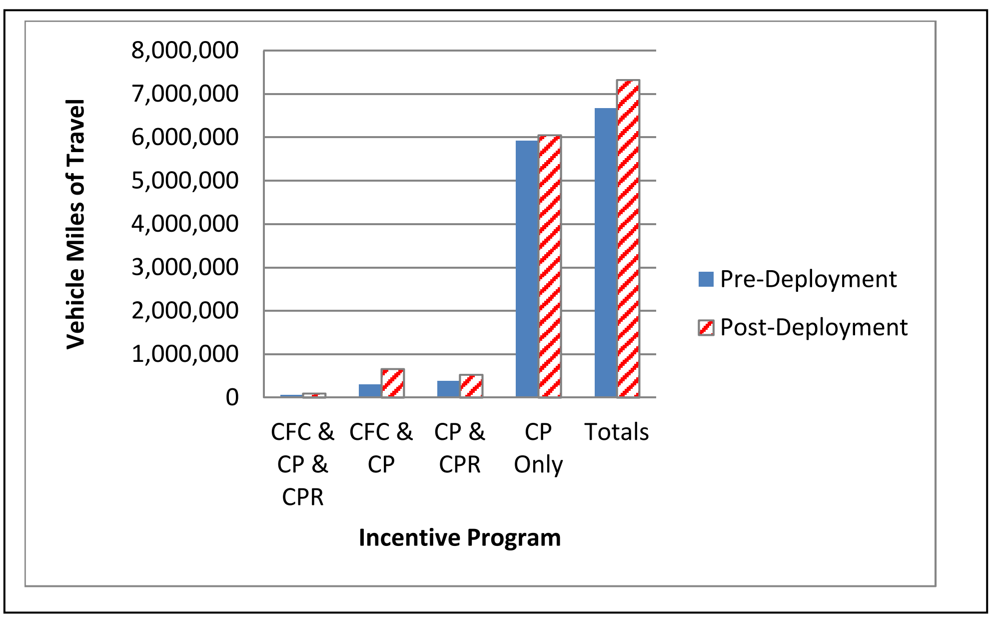


Figure D-4. VMT Reduction of CAC Incentive Programs

In conclusion, while several indicators of CAC program effectiveness, especially the use of Commuter Prizes and VMT reduction, improved during the post-deployment period, these impacts seemed to be attributable to normal cyclical increases in the CAC database in the second half of the post-deployment period, unrelated to the Express Lanes project.

D.5 Impact of CRD Project on Carpooling in the I-85 Corridor

The following data were used to evaluate carpool impacts resulting from the conversion from HOV to Express Lanes:

1. Person throughput from Appendix A – Congestion Analysis
2. Carpool patterns based on occupancy data from Appendix B – Tolling Analysis
3. Casual carpooling data assembled by Xpress Bus drivers at park-and-ride lots
4. The Volpe household travel survey
5. SRTA carpooler survey.

Table D-3 presents average vehicle occupancy (AVO) as well as estimates of vehicle and person throughput (excluding transit) from the congestion analysis in Appendix A. The total number of vehicles using the CRD corridor in the peak periods declined by 3.3 percent in the morning and 5.4 percent in the afternoon. The number of people served in the corridor during peak periods declined by 6.2 percent in the a.m. and 8.3 percent in the p.m. peak periods. AVO increased by about 5 percent in the general purpose lanes and declined by 38 percent in the Express Lanes. These changes were observed in both the morning and the afternoon peak periods and indicate a shift of multi-occupant vehicles from the Express Lanes to the general purpose lanes.

Table D-3. Comparison of Pre- and Post-Deployment Vehicle Throughput, AVO, and Person-Throughput (Excluding Transit)

	Month	General Purpose Lanes Before	General Purpose Lanes After	Change (%)	Express Lanes Before	Express Lanes After	Change (%)	Total Both Lanes Before	Total Both Lanes After	Change (%)
Morning Peak (6 – 10 a.m.)	Vehicle Throughput	34,007	32,856	-3.4	4,283	4,168	-2.7	38,289	37,024	-3.3
	AVO	1.06	1.11	+5.0	1.99	1.22	-38.7	NA	NA	NA
	Person Throughput	35,809	36,667	+2.4	8,587	4,960	-42.2	44,395	41,627	-6.2
Afternoon Peak (3 – 7 p.m.)	Vehicle Throughput	37,527	35,946	-4.2	5,146	4,436	-13.8	42,673	40,381	-5.4
	AVO	1.10	1.15	+4.7	2.03	1.26	-38.0	NA	NA	NA
	Person Throughput	40,529	41,338	+2.0	10,466	5,420	-48.2	50,996	46,758	-8.3

NA = data not available

Source: Texas A&M Transportation Institute based on data from GDOT

While Table D-3 suggests a shift of HOVs into the general purpose lanes in the post-deployment period, Table D-4 and Table D-5 (from Appendix A – Congestion Analysis) more clearly delineate the movement by showing the distribution and number of vehicles according to the number of occupants. (It should be noted that the peak period in Table D-4 was two hours, a reflection of when the field data were collected, whereas the throughput analysis in Table D-3 was based on a four-hour peak period.) In both the morning and afternoon 2-occupant vehicles approximately doubled their presence in the general purpose lanes.

Table D-4. Percent of Vehicles by Occupancy Level (Excluding Transit), Before and After Opening of I-85 Express Lanes

Lane Type	Time Period	Percent of Vehicles by Occupancy			
		1	2	3	4+
Southbound Morning Peak Period (7:00 – 9:00 a.m.)					
HOV/Express Lanes	Before	7.4	87.1	3.1	2.4
	After	85.3	12.1	0.9	1.7
General Purpose	Before	95.1	4.6	0.2	0.1
	After	89.2	10.2	0.4	0.2
Northbound Afternoon Peak Period (4:30 – 6:30 p.m.)					
HOV/Express Lanes	Before	8.0	83.7	5.2	3.1
	After	83.4	13.5	1.0	2.2
General Purpose	Before	92.7	6.6	0.4	0.2
	After	86.5	12.4	0.7	0.4

Source: Texas A&M Transportation Institute based on GDOT data.

Table D-5. Number of Vehicles by Occupancy Level (Excluding Transit), Before and After Opening of I-85 Express Lanes

Lane Type	Time Period	Estimated Vehicle Throughput by Occupancy				
		1	2	3	4+	Total
Southbound Morning Peak Period (6:00– 10:00 a.m.)						
HOV/Express Lane	Before	317	3,730	133	103	4,283
	After	3,555	504	38	71	4,168
General Purpose	Before	32,341	1,564	68	34	34,007
	After	29,308	3,351	131	66	32,856
Total	Before	32,658	5,294	201	137	38,290
	After	32,863	3,855	169	137	37,024
Northbound Afternoon Peak Period (3:00 – 7:00 p.m.)						
HOV/Express Lane	Before	412	4307	268	160	5,146
	After	3,698	598	43	97	4,436
General Purpose	Before	34,825	2,477	150	75	37,597
	After	31,093	4,457	252	144	35,946
Total	Before	35,237	6,784	418	235	42,673
	After	34,792	5,056	296	241	40,386

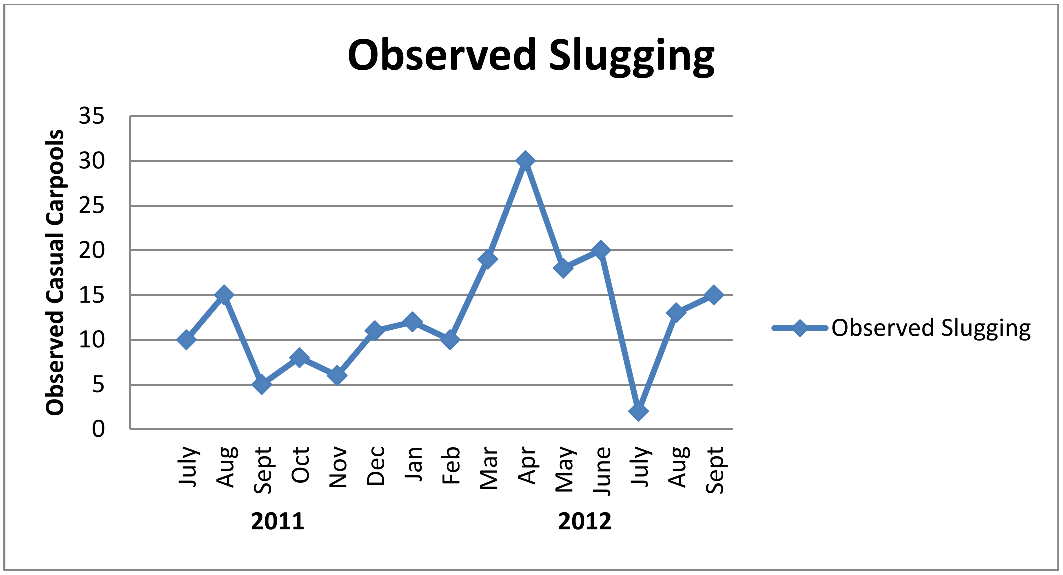
Source: Texas A&M Transportation Institute 2013.

This table also shows that 3-person carpools decreased significantly in the Express Lanes. The CRD partners' desire was to promote 3-person carpools—Section D-4 discussed CAC's efforts to contact carpoolers—as a toll-free alternative. However, this was not realized as seen in the drop in 3-person carpooling in the Express Lanes (which could be attributed to carpools having to register for a Peach Pass and obtain a transponder). Overall, 3-person carpools experienced a net decrease, when considering both the Express Lanes and general purpose lanes.

Casual carpooling was also assessed as part of the evaluation. With tolling and increase in the occupancy requirement for toll-free travel, local partners speculated that some casual carpooling might occur. Casual carpooling, also called slugging, has been observed in conjunction with managed lane facilities that have 3+ occupancy requirements, such as I-95 in northern Virginia. Commuters assemble at park-and-ride facilities and seek rides in cars that want to use the managed lanes and gain travel time savings.

Data on the observed incidence of casual carpooling was collected at six park-and-ride lots, serving eight Xpress bus routes in the I-85 corridor. Xpress bus drivers were instructed to collected data when they observed slugging, and GRTA assembled the data. Figure D-5 provides data on slugging at park-and-ride lots before (July-September 2011) and after implementation (October 2011 – September 2012) of tolling.

During the first year of tolling, 164 casual carpools were formed, with 105 of these at Discover Mills. While slugging was generally higher than pre-deployment levels between March and June 2012, the overall pre- and post-deployment slugging levels remained largely the same. The peak level of casual carpooling occurred in April 2012 with 30 casual carpools formed. Overall, while slugging was observed, the average of 14 casual carpools per month or less than one per day did not have an appreciable impact on carpooling in the Express Lanes.



ESTC based on CAC data

Figure D-5. Observed Slugging at Park-and-Ride Lots July 2011 – September 2012

The survey-based data sources also shed light on the impact of the Express Lanes on carpooling. The Volpe household travel survey generated the following findings related to carpooling:

- Carpooling declined in the Express Lanes once converted to HOT lane operations that required a toll on 2-person carpools that had previously used the facility for free. Trip diaries of surveyed households showed that the average vehicle occupancy in the Express Lanes decreased dramatically before (wave 1) and after (wave 2) tolling, from a mean of 2.22 (HOV Lanes) to 1.18 (Express Lanes).
- However, carpooling increased in the general purpose (GP) lanes, presumably as shared ride commuters sought a free alternative. In the GP lanes, there was an increase in vehicle occupancy, from a mean of 1.07 to 1.18, an increase that offsets the decline found in the Express Lanes. Prior to tolling, 4 percent of all trips in the general purpose lanes had 2 occupants, but after tolling the comparable figure rose to 12 percent. When this analysis was confined to the a.m. peak period, 2-person carpools rose from 6 percent in wave 1 to 10 percent in wave 2, an increase largely attributable to the growth in carpools among individuals from the same household. In wave 1, 2 percent of all morning commute trips consisted of 2 person carpools from the same household. In wave 2, this proportion increased to 6 percent.
- Overall, as shown in Table D-6, the drive alone rate in the corridor dropped from 88 percent to 85 percent, while carpooling increased from 9 percent to 13 percent, primarily through growth in the GP lanes.

Table D-6. Modes and Number of Trips on I-85 Trips Before and After Tolling

	Wave 1 (Before Tolling)	Wave 2 (After Tolling)
Drive alone*	88%	83%
Carpool (2+ persons)*	9%	13%
Any transit (bus or rail)	3%	4%
All other modes	0%	1%
Number of trips	6334 trips	5530 trips

* Statistically significant (Chi-square test p<0.0001)

Source: Battelle from Volpe data

The SRTA carpool survey was conducted before and after conversion to HOT operations among existing carpools registered with CAC. That survey specifically asked existing carpoolers what they planned to do in response to the tolling and what they actually did once the Express Lanes became operational. Table D-7 presents this comparison:

Table D-7. Planned and Actual Carpooler Response to Tolling

Planned and Actual Carpooler Response to Tolling	Before Tolling (planned %) N=381	After Tolling (actual %) N=408
Continue as 2-person carpool in the Express Lanes	2	10
Shift as 2-person carpool in the general purpose lanes	45	41
Continue as 3+ carpool in the Express Lanes	21	13
Add a third person to use Express Lanes for free	8	7
Switch to transit	6	4
Telecommute	<1	<1
Switch to driving alone	17	25
Total*	**99**	**100**

* Total does not sum to 100 due to rounding

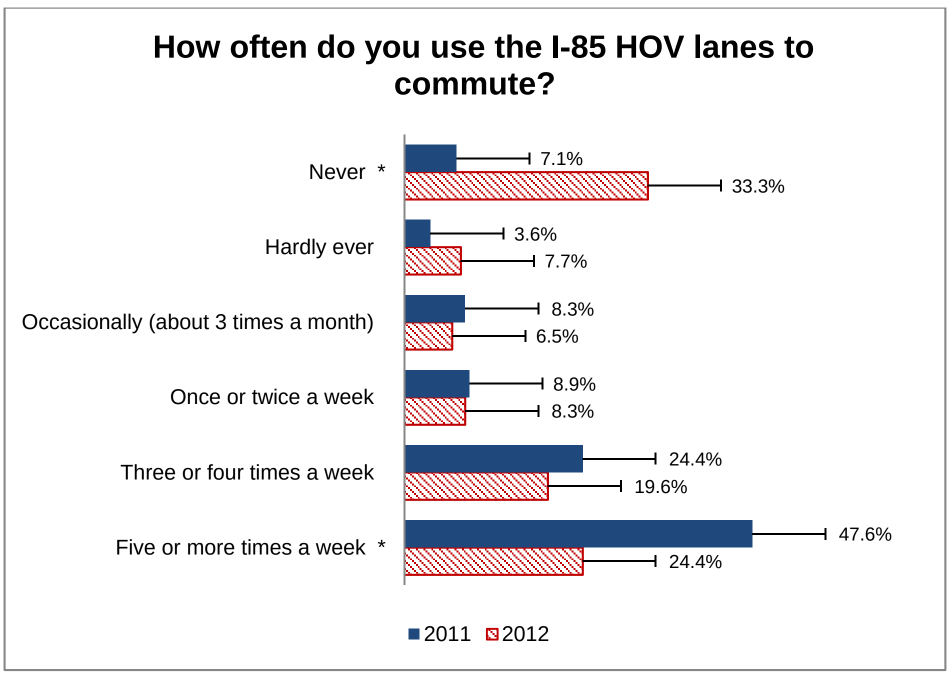
The chi-square test of the distribution of data was significant and had a p value of <0.0001.

Source: Battelle based on SRTA data

The results of this survey, while focused on a unique population of carpoolers (those registered with CAC), were significant. The largest behavior change after tolling was that more carpoolers switched to driving alone than had intended to do so before tolling (25 percent vs. 17 percent). Four out of ten (41 percent) of 2-person carpools shifted from the HOV to the general purpose lane. A total of 30 percent of carpoolers continued to share rides and stay in the Express Lanes, with 10 percent remaining in the lanes and paying the toll as a 2-person carpool, another 13 percent remaining as a 3-person carpool, and only 7 percent adding a third person to remain in the lanes toll-free. The statistic on the proportion of carpoolers who switched to driving alone merits a caution. The pre- and post-deployment surveys were cross-sectional. Among the 408 respondents in the “after tolling” column are 72 respondents who were no longer carpooling (and did not shift due to a change in their job location or schedule). Although they were terminated from the post-deployment survey after a brief screening interview, they were included in the category “switch to driving alone” in Table D-7. In addition, a few respondents who completed the full survey and said they had switched to driving alone had indicated that they were carpoolers elsewhere in the survey; it could be inferred that in responding “drove alone” that they did so on a part-time basis.

The comparison of planned to actual behavioral response tracks rather well with two notable exceptions. The number of carpoolers who switched to driving alone was higher than in the planned responses, and the number of carpools that stayed in the Express Lanes and paid the tolls was four and a half times as large in the actual case. These behavior changes, among carpoolers registered with CAC provided more evidence that 2-person carpools were largely displaced from the HOV lanes upon conversion to Express Lanes, although many shared-ride arrangements survived by shifting to the GP lanes.

Figure D-6 provides additional insight on the erosion of use of the Express Lane by carpoolers by focusing on the subset of surveyed carpoolers who responded to both the pre- and post-deployment surveys. The biggest changes were among those who never used the Express Lanes and those who used it most frequently, i.e., 5 or more times per week. In 2012, there were more carpoolers who never used the I-85 Express lanes to commute compared to the HOV lanes in 2011. In 2011, nearly half of carpoolers (47.6 percent) used the I-85 HOV lanes at least five times per week, compared to less than a quarter of carpoolers (24.4 percent) on the Express Lanes in 2012.



Battelle based on SRTA data.

* Fisher’s Exact test was significant at the 0.05 level.

Figure D-6. Frequency of Use of I-85 HOV/Express Lanes by Carpoolers in Both Pre- and Post-Deployment Surveys

The primary data elements—vehicle occupancy data, the Volpe household travel survey and the SRTA carpool survey--exhibited some discrepancies, namely the household survey suggested some increases in carpooling overall while the other two sources suggested a net decrease. This may be partially due to the nature of the data set, with occupancy and carpooler survey data focused on the peak commute trips and the household survey focusing on all trips in the I-85 corridor. Additionally, the Volpe survey was a panel survey and the SRTA survey was a cross-sectional survey.

D.6 Summary of TDM Impacts

Table D-8 summarizes the impacts of the TDM program across the three hypotheses in the national evaluation. As presented in the table, the TDM programs did not support all three hypotheses. With the primary focus of the TDM programs being encouragement of alternate modes, with particular attention on 3-person carpool formation, the data showed that carpooling was negatively impacted during the post-deployment period. Fewer carpools used the Express Lanes and many 2-person carpools that persisted more frequently used the general purpose lanes.

Table D-8. Summary of Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
Promotion of commute alternatives removes trips and vehicle miles traveled (VMT) from I-85.	Supported, but likely not due to Express Lanes	The incentive programs were estimated by CAC to have reduced vehicle trips and VMT from I-85. During the demonstration period, the incentives were responsible for reducing 7.3 million miles, about 750,000 miles coming from new mode shift. However, the VMT reduction impacts from CAC cannot be attributed to the CRD projects.
CAC incentives support formation of 3+ carpools and vanpools on I-85.	Not supported	Only 18 3-person carpools were formed by CAC's direct outreach efforts, among CAC-registered carpoolers. Overall, 3-person carpools declined in the Express Lanes during peak periods compared to the previous HOV lane. Vanpooling remained static in the I-85 corridor.
What was the relative contribution of the Atlanta CRD TDM initiatives on reducing I-85 vehicle trips/VMT?	None detected	Any changes in vehicle volumes and VMT were likely due to tolling and exogenous variables and not to the TDM element of the CRD.

Source: ESTC

Appendix E. Technology Analysis

This appendix contains the technology-related analysis of the Atlanta Congestion Reduction Demonstration (CRD) projects. Table E-1 presents the technology hypothesis, which was that the use of advanced technology to enhance enforcement would reduce the rate and type of violations in the corridor. Although technologies underlie many of Atlanta's CRD enhancements, this technology analysis focused on a unique technological application—an automated enforcement system.
The analysis was not intended to be an assessment of the technology itself; rather, the technology assessment was intended to assess whether the automated enforcement system reduced the level and types of violations that occurred in the Express Lanes.

Table E-1. CRD Technology Analysis Hypothesis

Hypothesis
Using advanced technology to enhance enforcement will reduce the rate and type of violators in the corridor.

Source: Battelle

The remainder of this appendix is divided into six sections. The data sources used in the technology analysis are presented next in Section E.1. The types of violations targeted by enforcement activities during the post-deployment period and the types of enforcement technologies deployed are examined in Section E.2. Express Lane violations and manual citations are discussed in Section E.3 and Section E.4, respectively. Technology-related information from operator feedback is summarized in Section E.5. Section E.6 presents a summary of the technology analysis in relation to the hypothesis.

E.1   Data Sources

Several data sources were utilized for the technology analysis. The State Road and Tollway Authority (SRTA) was responsible for providing data on violations in the Express Lanes. Violation data were available for the post-deployment period only. Another source of data came from interviews conducted by the national evaluation team with SRTA operators about their experience with the enforcement technologies.

E.2   Enforcement

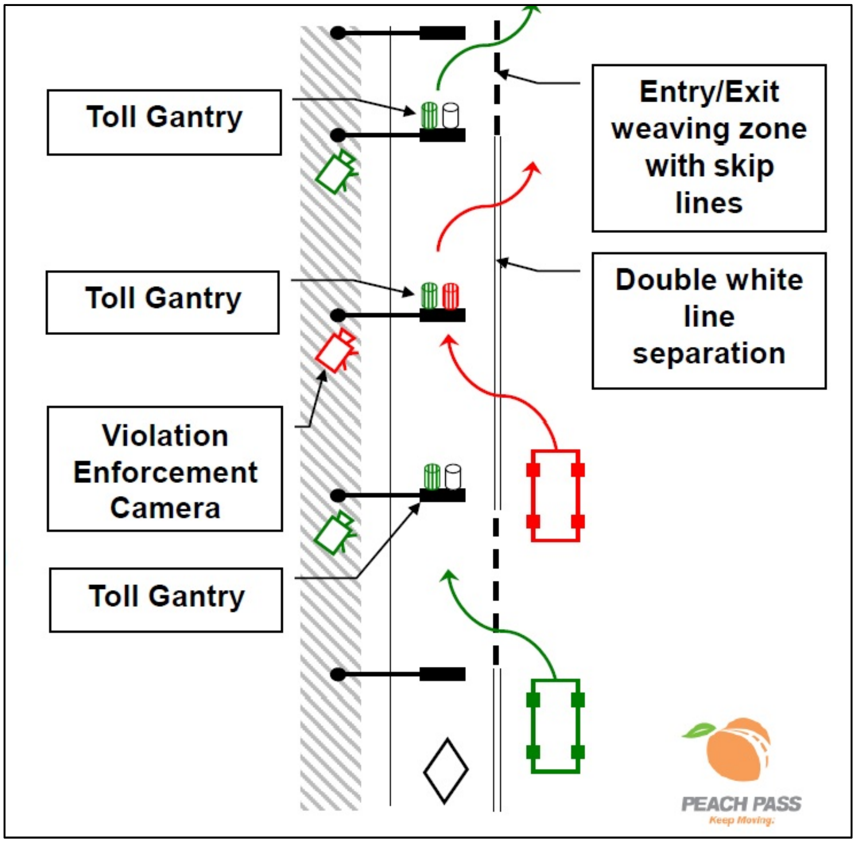
This section describes the types of violations targeted by enforcement activities and the types of enforcement technologies deployed. Enforcement activities during the post-deployment period focused on identifying the following types of violations:

- *Use by Unregistered Vehicle Violations* – SRTA required that all users of the Express Lanes be equipped with transponders. These were vehicle users that were using the Express Lanes but either did not have a transponder on their vehicle or had not yet registered their transponder with SRTA. The automated technology compared license plate images to the registration database to ensure that vehicles were authorized to use the lane. If an unregistered vehicle was detected, the system automatically issued a toll violation notice to the owner of the vehicle. The owner of the vehicle was then charged a $25.00 administrative fee plus the toll for each violation.

- *Entering/Exiting Violations* – Because no physical barrier existed separating the Express Lanes from the general purpose lanes (other than a double white line and a small buffer space), the local partners were concerned about potential violators moving in and out of the Express Lane between established access points. The gantry-controlled access system was designed to detect vehicles moving in and out of the Express Lane between toll collection stations and to automatically issue toll violation notices. Violators were issued a $25 violation fee and could receive an additional citation from law enforcement if they are pulled over.
- *Occupant-Requirement Violations* – Under the pricing structure during the post-deployment period, vehicles with three or more passengers were not required to pay a toll; only those passenger vehicles with one and two occupants were charged. Other toll exempt vehicles include alternative fuel vehicle (AVF) with valid Georgia AVF license plates, motorcycles, over-the-road buses, and emergency vehicles. To qualify as a toll-exempt user, carpoolers were required to self-declare whether they qualified for HOV status. Spot enforcement was done by enforcement personnel in the field using technology in their vehicle to verify that a vehicle conforms to their declared occupant status.

Two types of enforcement technologies were deployed as part of the Express Lane conversion to target these violations and are discussed below:

- *Gantry Controlled Access (GCA) Technology* – The access points and gantries system were designed to provide automated enforcement. Overhead transponder readers were placed on gantries spaced at regular intervals (approximately every ½ mile) within the corridor. The spacing was selected to minimize the possibility of a vehicle "dodging" around transponder readers. Vehicle movements were monitored from gantry to gantry to detect entry/exit violations. When a vehicle was identified as having entered the system illegally, the system recorded the identity of the vehicle for enforcement purposes via license plate readers and a video enforcement system. Logic in the system was used to issue toll violation notifications to the owner of the vehicle, based on the number of gantries missed during the trip. Figure E-1 provides an illustration of the concept.
- *Vehicle-Based Enforcement Technology* – Enforcement activities in the corridor were provided by the Department of Public Safety (DPS). These officers performed both dedicated patrol as well as spot enforcement activities at entry points into the Express Lanes. To aid in identifying violators, enforcement personnel were equipped with mobile automated license plate readers that allowed them to verify the declared occupancy status of vehicles in the Express Lanes. These devices were linked to SRTA's back office via a wireless communication system, allowing the officer to immediately determine if the vehicle was registered as a "toll exempt" user, and alerting the officer to check the occupancy of the vehicle. The system allowed enforcement personnel to compare license plate images to the registration database to ensure that vehicles were authorized to use the lane. If an unregistered vehicle was detected, the owner of the vehicle was issued a citation.



State Road and Tollway Authority. Used with permission.

Figure E-1. Illustration of Gantry Controlled Access Used with Express Lane Deployment

E.3 Express Lanes Violations

As shown in Table E-2, SRTA issued a total of 49,329 violation notices from February 2012 through September 2012. Additionally, SRTA issued 1,207 warning letters during the first three months of operation (November 2011 through January 2012), a grace period in advance to beginning the full violation notification process. Violation notices were generated when an account had at least three violations of the following types:[1]

- Entering or exiting the I-85 Express Lane improperly by crossing the double white pavement striping.
- Unregistered vehicles using the I-85 Express Lanes. All vehicles, even toll exempt vehicles, were required to register for a Peach Pass Account before using the I-85 Express Lanes.
- Adjusting the toll mode listed on a Peach Pass account to reflect more than three occupants in a vehicle (thus qualifying for toll-free travel) and then driving in the I-85 Express Lanes with less than three occupants. In addition to receiving a violation

[1] Peach Pass Website: Toll Violations Frequently Asked Questions. http://www.peachpass.com/faq/#enforcement

notice from SRTA, motorists also ran the risk of being pulled over and issued a citation by law enforcement.

The noticed violations may be on GA 400, the I-85 Express Lanes, or a combination of both. Only warning letter violations were sent during the first three months of Express Lane operations. SRTA placed a hold on issuing violation notices in March/April and again in July due to technical difficulties. When the holds were lifted, the backlog of accumulated notices caused spikes in the number of violation notices sent in May and August.

Table E-2. Number of Violation Notices Issued by SRTA

Month	Number of Violation Notices[1]
November 2011	597[2]
December 2011	160[2]
January 2012	550[2]
February 2012	4,772
Mar 2012	3,100
April 2012	2,950
May 2012	12,680[3]
June 2012	3,552
July 2012	672
August 2012	18,223[3]
September 2012	3,380
Total	**50,636**

[1] SRTA generated a violation notice when an account had at least three violations. The violations may be on GA 400, the I-85 Express Lanes, or both.

[2] Only Warning Letter Notices were sent in November, 2011, December, 2011, January, 2012.

[3] SRTA placed a hold on issuing notices in the March/April time frame and again in July. When the holds were lifted, the backlog of accumulated notices causes spikes in the number of violation notices sent in May and August.

Source: State Road and Tollway Authority.

E.4 Manual Citations

Table E-3 shows the distribution of citations issued by the Department of Public Safety (DPS) enforcement personnel in the field for each month in the post-deployment period. It is important to recognize that the values in the table represent the number of citations issued during spot enforcement activities and do not represent the total number of violations that occurred in the corridor. It is also important to note that a vehicle could have also been issued several citations for a single stop.

Table E-3. Number of Spot Enforcement Citations Issued by the Department of Public Safety in the Post Deployment Period

	Type of Citation						Total
	Occupancy		Double White Lines		Other		
	Number	Percent	Number	Percent	Number	Percent	
December 2011	24	16%	7	5%	117	79%	148
January 2012	25	17%	8	5%	118	78%	151
February 2012	39	12%	19	6%	276	83%	334
March 2012	80	23%	27	8%	244	70%	351
April 2012	36	15%	2	1%	207	84%	245
May 2012	21	9%	24	10%	187	81%	232
June 2012	63	21%	13	4%	229	75%	305
July 2012	65	17%	83	24%	204	58%	352
August 2012	79	31%	21	8%	158	61%	258
September 2012	42	23%	6	3%	134	74%	182

Source: State Road and Tollway Authority.

Over the course of the post-deployment period, DPS reported a total of 2,558 citations issued by enforcement personnel for the Express Lanes. The vast majority of these were for citations other than those associated with operations of the Express Lane (such as insurance violations, driver license violations, license plate violations, etc.). These citations showed an overall level of enforcement in the corridor which was intended to change driver behavior in accordance with the rules of the roadway. Misrepresenting the number of occupants in the vehicle (i.e., occupancy violations) were the second highest reporting type of citation issued by DPS – a total of 474 citations reported in a 10-month period. A total of 210 citations were issued for unlawfully entering the Express Lanes by crossing over the double white line. Disregarding the “other” types of citations, DPS reported an average of 47 citations per month for failing to correctly self-report the number of occupants in the vehicle and 21 citations per month for unlawfully entering the Express Lane by crossing the double white lines.

Table E-3 shows the percentage of occupancy requirement and double white line citations issued each month in the post-deployment period. While the number of citations varied from month to month, the percentage of citations issued by DPS by type remained relatively constant. In the post-deployment period, occupancy violations comprised about 19 percent of the total number of citations while unauthorized entry into the Express Lanes represented about 8 percent of the total citations issued by DPS.

The national evaluation was not able to compare violation rates between the HOV and Express Lane operations to determine whether there had been a change due to limitations with the data. DPS citation data for the pre-deployment time period (November 2010 through October 2011) were not available to the evaluation team. In addition, violation notices issued by SRTA do not represent all violations and, thus, cannot be compared with HOV violation rates prior to tolling. Based on the occupancy study conducted by Georgia Institute of Technology and reported in Appendix A – Congestion Analysis, approximately 7.7 percent of vehicles using the HOV lane during peak periods held one occupant, which provided a rough estimate of the violation rate in the year prior to tolling. The post-tolling occupancy study could not be used for a violation rate, given that it could not distinguish between a 2-person carpool paying a toll and one violating the 3+ occupancy requirement.

E.5 Operator Feedback

In addition to collecting quantitative information on enforcement activities, the national evaluation team also interviewed SRTA administrative and enforcement personnel. The objective of these interviews was to obtain insight into the perceived effectiveness of the enforcement approach used in the deployment and to identify issues and lessons learned associated with using automated enforcement techniques.

E.5.1 Design of System

Interviews with operations personnel from SRTA indicated that both the GCA and the automated vehicle occupant enforcement tool seemed to be operating as envisioned in the original concept of operations. After experiencing some initial “growing pains” with implementing the system, operations personnel were becoming more comfortable at establishing tolling rates and managing the system (and violations) to protect customer service. The design of the GCA and the automatic license plate recognition system appeared to be effective tools for enforcement of tolling rules and discouraging potential violators.

One of the advantages of the GCA system was that it provided flexibility for fine-tuning how violation zones were established. The system allowed the operator to define the number of gantry points that users could bypass before being classified as a being in violation. This had allowed SRTA operators to fine-tune the configuration of the system to optimize performance.

E.5.2 System Reliability

SRTA reported that system reliability had not been an issue so far. SRTA reported that the technologies seemed to be working well and functioning as designed. No significant issues related to maintenance of the technologies were reported. There had been some minor anomalies in the way that some of the gantries work, but these had not been significant. SRTA reported that a couple of their gantries had been struck by vehicles, but these crashes did not significantly impact operations of the system.

To ensure the system continued to function at optimal performance, SRTA operations personnel performed daily reliability testing of the technologies. System operators performed daily checks of real-time transaction data from each transponder station to ensure that the system was functioning properly. As of the end of the post-deployment period, no issues had been reported concerning the accuracy of the transaction readings. Most inaccuracies were attributed to the placement of the transponder tags inside vehicles or inaccurate account information.

E.5.3 Lessons Learned

Interviews with SRTA operations personnel provided the following important lessons learned through their experience:

- The media can be a valuable resource in terms of disseminating operational changes to the public. SRTA found that when the media were involved in announced changes in operations or tolling policies, violation rates dropped after the change.
- It is important to treat violators as potential customers. SRTA found that many violators were unclear and misinformed about the way the tolling operations in the Express Lane worked. SRTA encouraged their customer service representatives to work with violators to help them establish new accounts or clarify rules so as to turn them into customers of the system.
- It is also critical that agencies establish a policy for what to do when the system is not functioning correctly. SRTA's policy was to have "zero fares/zero violations" when outages occur in the tolling system or communications network.
- Similarly, coordination between emergency response personnel and tolling operations staff is critical during incident events. Tolling agencies needed to know when incident responders were forcing traffic into or out of the Express Lane so that Express Lane users were not issued citations when they were directed to leave or enter the Express Lane.

E.6 Summary of Technology Impacts

Table E-4 summarizes the technology impacts for the hypothesis. The analysis in this appendix suggested that the technology aids enforcement but some results were inconclusive. SRTA operators feel the enforcement technologies operate as envisioned and are reliable. However, data were not sufficient to determine actual number of violations, but only those that were detected manually or with the enforcement technology and were for the post-deployment period only. The analysis indicated that recorded violations and manual citations remained fairly constant throughout the post-deployment evaluation period.

Table E-4. Summary of Impacts for the Hypothesis

Hypotheses/Questions	Result	Evidence
• Using advanced technology to enhance enforcement will reduce the rate and type of violators in the corridor.	Inconclusive	Recorded violations and manual citations remained fairly constant throughout the post-deployment evaluation period. Data were not sufficient to determine actual number of violations, but only those that were detected manually or with the enforcement technology. SRTA operators felt the enforcement technologies operated as envisioned and were reliable.

Source: Battelle.

This page intentionally left blank.

Appendix F. Safety Analysis

This appendix contains the safety-related analysis of the Atlanta Congestion Reduction Demonstration (CRD) projects. Table F-1 presents the three safety hypotheses. The first hypothesis was that the collective impacts of the CRD improvements would be safety neutral or safety positive. The second hypothesis focused on reducing incidents related to violations from vehicles crossing the double white line separating the Express Lanes from the general purpose freeway lane due to the introduction of the gantry-controlled access technology. The third hypothesis was that the tolling strategies entailing unfamiliar signing would not adversely affect highway safety.

Table F-1. CRD Safety Analysis Hypotheses

Hypotheses/Questions
• The collective impacts of the CRD improvements will be safety neutral or safety positive.
• Gantry-controlled access technology will reduce incidents related to violations for crossing the double white line.
• Tolling strategies that entail unfamiliar signage will not adversely affect highway safety.

Source: Atlanta CRD National Evaluation: Safety Data Test Plan, FHWA, 2011.

The remainder of this appendix is divided into four sections. The data sources used in the safety analysis are presented next in Section F.1. The potential influences from the CRD projects on safety on I-85 are examined in Section F.2. Data from the technology analysis on violations from vehicles crossing the double white line separating the Express Lanes and the general purpose lanes are summarized. Crash data from the Georgia Department of Transportation (GDOT) are presented and analyzed using the before-after evaluation with yoked comparisons (YC) method. Safety-related information from surveys, interviews, and focus groups is also summarized. Section F.3 presents a summary of the safety analysis in relation to the hypotheses. Section F.4 provides a more detailed description of the YC analysis method.

F.1   Data Sources

Four data sources were used in the safety analysis. First, data from the State Road and Tollway Authority (SRTA) on the number of manual citations issued for selective months in 2012 were used to analyze the number of vehicles violating the double white line to enter and exit the Express Lanes to and from the general purpose lanes. Second, data from the GDOT Crash Reporting Unit on the number of crashes on the Express Lane corridor of I-85 and I-75 in Cobb County, which served as the control corridor, were obtained and analyzed. Third, the responses from safety-related questions in the Atlanta household travel survey sponsored by the Volpe National Transportation Systems Center were reviewed and analyzed. Fourth, the summary of the GDOT-sponsored focus groups with HERO operators, Georgia Regional Transportation Authority (GRTA) operators, Gwinnett bus operators, and business representatives was reviewed and analyzed. The potential limitations with some of these data sources are discussed in the relevant sections.

F.2 Potential Study Implications of the CRD Projects on I-85

This section presents safety-related information on the implications of the Express Lanes, the gantry-controlled access system, and signing on the operation of I-85. Information on the number of citations issued in the post-deployment period for unlawfully entering or exiting the I-85 Express Lanes by crossing the double white line is discussed in F.2.1. Pre- and post-deployment crash data for the section of I-85 with the Express Lanes (Express Lanes and the general purpose lanes), as well as the I-75 control corridor, are presented and analyzed in F.2.2. Safety-related perceptions from the Volpe household travel survey and the focus groups with HERO operators, bus operators, and business representatives sponsored by GDOT are summarized in F.2.3.

F.2.1 Gantry-Controlled Access and Violations for Crossing the Double White Line

There was no physical barrier separating the I-85 Express Lanes from the general purpose lanes in the evaluation period. Rather, a double white line and a small buffer space were used to separate the Express Lanes from the adjacent general purpose lanes. A gantry-controlled access (GCA) system was designed and implemented to detect vehicles entering and exiting the Express Lanes between toll collection stations by crossing the double white line and automatically issuing a $25 toll violation notice to the owner of those vehicles. Additional citations could be issued by law enforcement personnel, if a vehicle was pulled over.

The GCA was examined as an enforcement tool in Appendix E – Technology Analysis. The analysis included a review of the citations issued by the Georgia Department of Public Safety during spot enforcement activities from December 2011 through September 2012. The data were provided by SRTA. As presented in Table F-2, 210 or 8 percent of the 2,558 manual citations issued during the ten-month period were citations for crossing the double white lines. The number of manual citations issued each month for double white line violations varied – ranging from a high of 27 in March to none in April to 21 in August.

Table F-2. Citations Issued by DPS in the Post-Deployment Period

Violation Type	Number of Citations Issued										Total	Average
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		
Occupancy Violations*	24	25	39	80	36	21	63	65	79	42	474	47
Double White Lines Violations	7	8	19	27	2	24	13	83	21	6	210	21
Other	117	118	276	244	207	187	229	204	158	134	1874	187
Total	**148**	**151**	**334**	**351**	**245**	**232**	**305**	**352**	**258**	**182**	**2558**	**256**

*These represent citations issued for misrepresenting the number of occupants in the vehicle.

Source: Texas A&M Transportation Institute from data provided by SRTA

Pre- and post-deployment crash data are presented and analyzed in the next section.

F.2.2 Analysis of Crash Data for the I-85 Corridor

This analysis examined the potential safety impacts of the Express Lanes on approximately 15.5 miles of I-85 in Atlanta. The safety impacts of the Express Lanes were determined by reviewing crash data before and after the deployment of the Express Lanes. A before-and-after evaluation with yoked comparisons (YC), which is known to be more robust than a naïve comparison method, was used as the statistical evaluation method. The YC method assumed that the change in crashes between the before-and-after periods at a comparison site was representative of the change in crashes that would have occurred for the corresponding treatment site had the treatment – in this case, primarily the Express Lanes – at that site not been made. The YC method could account for the change in crashes due to extraneous factors (such as weather, driving behavior, reporting practice, economy, etc.) between the before-and-after periods in the safety effectiveness estimate. A more detailed description of the steps of YC is provided in Section F.4 with a reference to Harwood et al.[1]

As outlined in the Atlanta CRD Safety Data Test Plan, crash data from the GDOT Crash Reporting Unit were utilized in the analysis. The crash data for the 15.5-mile Express Lane corridor of I-85 and the 17.8-mile control corridor of I-75 were obtained from GDOT.

Table F-3 contains the yearly crash counts for the I-85 Express Lane corridor and the I-75 control corridor for different severity levels. The AADT from South of Oriole Ln. SE (traffic counter number 2741) of I-75 and AADT from North of Beaver Ruin Rd. (traffic counter number 294) of I-85 for each year, which were used in the analysis, are also presented in the table.

Figure F-1 illustrates the crash rates (crashes per million vehicle miles traveled) based on the data in Table F-3 for total, injury, fatal and property damage only (PDO) crashes on (a) the I-85 CRD corridor and (b) the I-75 control corridor, respectively. It can be observed from Figure F-1 that there was a large decrease in crash rates on the I-85 CRD corridor from 2007 to 2008 and another noticeable decrease from 2009 to 2010 during the pre-deployment period. In 2012, after the Express Lanes were implemented, however, the crash rates increased sharply. For I-75 Corridor, the crash data were not obtained for 2007, so only the crash rates for 5 years (from 2008 to 2012) could be plotted. The crash rates on the I-75 corridor decreased in general during the pre-deployment period and then increased in 2012 in the post-deployment period. The magnitude of the increase in crash rate in 2012 on the I-75 corridor, however, was smaller than that on the I-85 CRD corridor. For total crashes, the increase in crash rate was 0.2 on I-75 corridor and 0.35 on I-85 CRD corridor.

[1] Harwood, D.W. et al. *Safety Effectiveness of Intersection Left-and Right-Turn Lanes*, FHWA-RD-02-089, July 2002.

Table F-3. Yearly Crash Counts by Severity on I-75 within Cobb County and the I-85 Express Lane Corridor

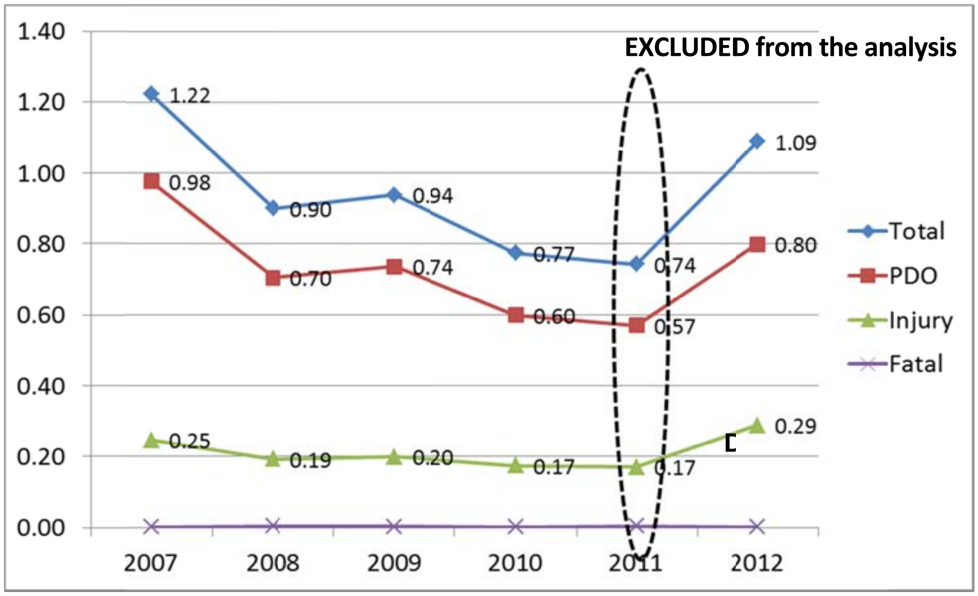
	Pre-Deployment Period								Year of Implementation of HOT Lanes		Post-Deployment Period	
	2007		2008		2009		2010		2011		2012	
	I-75[1]	I-85	I-75	I-85	I-75	I-85	I-75	I-85	I-75	I-85	I-75	I-85
Severity												
Fatal		1	7	4	2	3	2	2	5	5	7	1
Injury		373	363	280	342	295	304	294	292	277	376	463
PDO		1,480	1,510	1,027	1,430	1,090	1,331	1,012	1,078	926	1,300	1,284
Total		1,854	1,880	1,312	1,774	1,388	1,637	1,308	1,375	1,208	1,683	1,748
AADT	I-75 – 296,550 I-85 – 268,100		I-75 – 244,100 I-85 – 257,590		I-75 – 259,870 I-85 – 261,520		I-75 – 257,850 I-85 – 298,550		I-75 – 256,640 I-85 – 287,170		I-75 – 254,800 I-85 – 283,790	

Note: PDO stands for Property Damage Only.

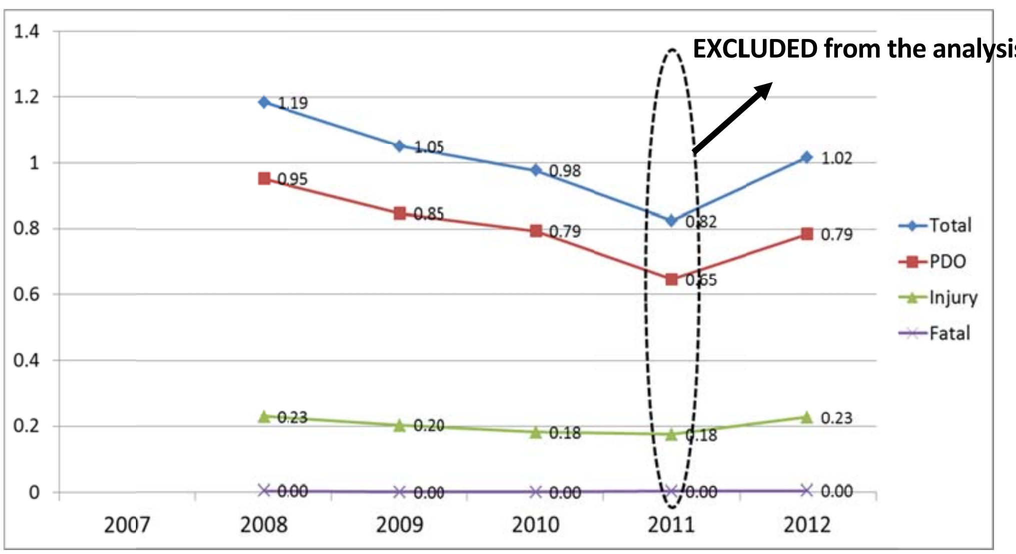
[1] Crash data for I-75 were not obtained.

Source for AADT: Georgia Department of Transportation, State Traffic and Road Statistics (STARS)

Data provided by Georgia Department of Transportation and Analysis by Texas A&M Transportation Institute



(a) I-85 CRD Corridor



(b) I-75 Corridor

Figure F-1. Crash Rates for (a) I-85 CRD Corridor and (b) I-75 Corridor for Total, Injury, Fatal, and PDO Crashes

Table F-4 presents the aggregated crash counts for the pre- and post-deployment periods, as well as the estimates of the safety effectiveness index for I-85 CRD corridor and the percent change in crashes of different severity, using I-85 CRD corridor as a treatment site and I-75 corridor as a comparison site. The pre- and post-deployment periods used in this analysis were 2008 to 2010 (3 years) and 2012 (1 year), respectively. The 2011 crash data were excluded from the analysis because the ADTs that correspond to each of the months before and after the implementation of HOT lanes in 2011 were not available (although it is likely that the ADTs were affected by tolling). The following provides the descriptions for the column and row headings of the table:

- BT= Sum of crashes during the before period at the treatment site;
- AT= Sum of crashes during the after period at the treatment site;
- BC= Sum of crashes during the before period at the comparison site;
- AC= Sum of crashes during the after period at the comparison site;
- $\hat{\theta}_T$: safety effectiveness index estimate accounting for ADT changes between before-and-after periods; and
- PC_T= Percent Change in crashes accounting for ADT changes between before-and-after periods, adjusted also for changes of other factors at the comparison site = $100\left(\hat{\theta}_T - 1\right)$.

The results presented in Table F-4 indicate that injury and PDO crashes increased and fatal crashes decreased in I-85 CRD corridor after the implementation of the Express Lanes and the other CRD elements. As noted previously, the increase in observed injury and PDO crashes from the before to after periods on the I-85 CRD corridor was larger compared to that on I-75 corridor, which was why the percent change estimate in those crashes, even after adjusted for changes at the comparison site, was positive. The percent change in fatal crashes was not statistically significant due to an extremely small sample size, which was not surprising given the rarity of fatal crashes relative to other types of crashes. The percent changes in injury and PDO crashes were statistically significant. A limitation of the analysis was that the one-year post-deployment period was too short for robust estimation of safety effects of HOT Lanes. Typically, a minimum of three years of safety data for each of the before and after periods is desired to develop a reliable estimate, because it is likely that any one year could have a much higher or lower number of crashes than the typical year.[2]

Another potential limitation of the study was the possibility that other exogenous factors may have influenced the increase/decrease in crashes, and the use of the I-75 control corridor may not have completely controlled for their effect. As illustrated in Figure F-1, the crash trends on I-85 CRD corridor and I-75 corridor were slightly different, although both show a generally decreasing trend in the pre-deployment period. For a site to serve as a valid comparison site, the trend of crashes at that site during the pre-deployment period should match well with that of the treatment site. The assessment of the relevance of I-75 as a valid comparison site was somewhat subjective.

[2] See for example http://safety.fhwa.dot.gov/local_rural/training/ fhwasaxx1210/s3.cfm).

Table F-4. Before-After Evaluation Results for Fatal, Injury, and PDO Crashes on I-85 CRD Corridor with Using I-75 Corridor as a Comparison Site

Crash Severity	BT	AT	BC	AC	$\hat{\theta}_T$	PC_T (%)	95% CI for PC_T (%)
Fatal	9	1	11	7	0.17	-83.2	(-98.7, 122.4)
Injury	869	463	1,009	376	**1.38**	**37.8**	(12.1, 69.4)
PDO	3,129	1,284	4,271	1,300	**1.30**	**29.9**	(16.3, 45.1)
Fatal+Injury	878	464	1020	383	**1.36**	**35.6**	(10.4, 66.5)

Notes: 1. PDO stands for Property Damage Only; 2. Statistically significant percent changes at 95 percent confidence level are shown in bold.

Source: Data from the Georgia Department of Transportation and Analysis by the Texas A&M Transportation Institute.

The evaluation team also examined an alternative comparison group consisting of the Interstates in the 8-county Atlanta metropolitan area, with the Express Lane section of I-85 removed. GDOT provided the VMT, the crash data, and the crash rates for all the Interstates in the 8-county region excluding the 15.5 mile Express Lane section of I-85. Table F-5 presents the data provided by GDOT for 2007 through 2012. Figure F-2 presents the crash rates per million VMT from the data in Table F-5.

The purpose of this analysis was to compare regionwide trends in crash rates to those observed on the I-85 Express Lane segment. Comparison of Figure F-1 and Figure F-2 indicated different trends on the I-85 Express Lanes segment with those in other Interstates in the region. During the before period, crash rates on the I-85 Express Lane segment of I-85 declined between 2007 and 2008, increased slightly from 2008 to 2009, declined from 2009 to 2011, and increased from 2011 to 2012. The crash rates on the Interstates increased from 2007 to 2008, decreased from 2008 to 2010, and increased from 2010 to 2012. While crash rates on both the I-85 Express Lane segment and the Interstates increased from 2011 to 2012, crash rates on the Express Lane segment experienced a higher increase. The trend of crash rates on Atlanta Interstates during the pre-deployment period appeared to be less consistent with that of the I-85 Express Lanes segment compared to the trend of I-75 corridor. Although the I-75 corridor was still deemed to be a better comparison site than other Atlanta Interstates, the analysis using Atlanta Interstates as a comparison site was performed as another check on the findings.

Table F-6 presents the aggregated crash counts for the pre- and post-deployment periods, as well as the estimates of the safety effectiveness index for I-85 Express Lane segment and the percent change in crashes of different severity, using I-85 Express Lane segment as a treatment site and the Atlanta Interstates, without the I-85 Express Lane segment as a comparison site. The pre- and post-deployment periods used in this analysis were 2007 to 2010 (4 years) and 2012 (1 year), respectively. The 2011 crash data were again excluded from the analysis due to the same reason previously mentioned.

The results presented in Table F-6 again indicated that injury and PDO crashes increased and fatal crashes decreased in I-85 Express Lane segment after the implementation of the Express Lanes. The magnitude of the percent changes were smaller compared to those of Table F-4 and the percent change in PDO crashes became statistically insignificant. The conclusion was the same as those from the analysis of using the I-75 as a comparison site, however, which was that crashes in the Express Lane corridor of I-85 increased after implementation of the CRD projects for injury and property damage only crashes and decreased for fatal crashes.

Table F-5. VMT and Yearly Crash Counts by Severity on Atlanta Interstates with the I-85 Express Lane Segment Removed

Metro Atlanta Interstate Annual VMT w/o HOT Lane Section						
	2007	**2008**	**2009**	**2010**	**2011**	**2012**
Clayton	1,067,260,000	1,017,255,000	1,038,790,000	1,030,395,000	1,033,315,000	1,052,295,000
Cobb	2,244,750,000	2,012,245,000	2,053,855,000	1,983,045,000	1,996,185,000	1,970,635,000
DeKalb	3,530,645,000	3,454,725,000	3,412,385,000	3,379,535,000	3,281,715,000	3,274,050,000
Douglas	627,435,000	593,855,000	607,360,000	555,165,000	592,760,000	572,685,000
Fulton	4,558,485,000	4,350,435,000	4,389,125,000	4,324,155,000	4,278,895,000	4,289,845,000
Gwinnett	994,753,845	960,010,955	943,403,090	938,058,030	915,532,420	904,842,300
Henry	869,065,000	825,265,000	839,135,000	838,405,000	821,980,000	817,600,000
Rockdale	304,045,000	293,825,000	303,315,000	291,635,000	282,510,000	284,335,000
TOTAL	**14,196,438,845**	**13,507,615,955**	**13,587,368,090**	**13,340,393,030**	**13,202,892,420**	**13,166,287,300**
Total Crashes	22,570	21,970	20,093	16,005	17,646	19,635
PDO Crashes	17,375	16,801	15,124	12,127	13,268	14,605
Injury Crashes	5,115	5,106	4,906	3,826	4,329	4,990
Fatal Crashes	80	63	63	52	49	40

Source: Georgia Department of Transportation.

Data from the Georgia Department of Transportation and Analysis by the Texas A&M Transportation Institute.

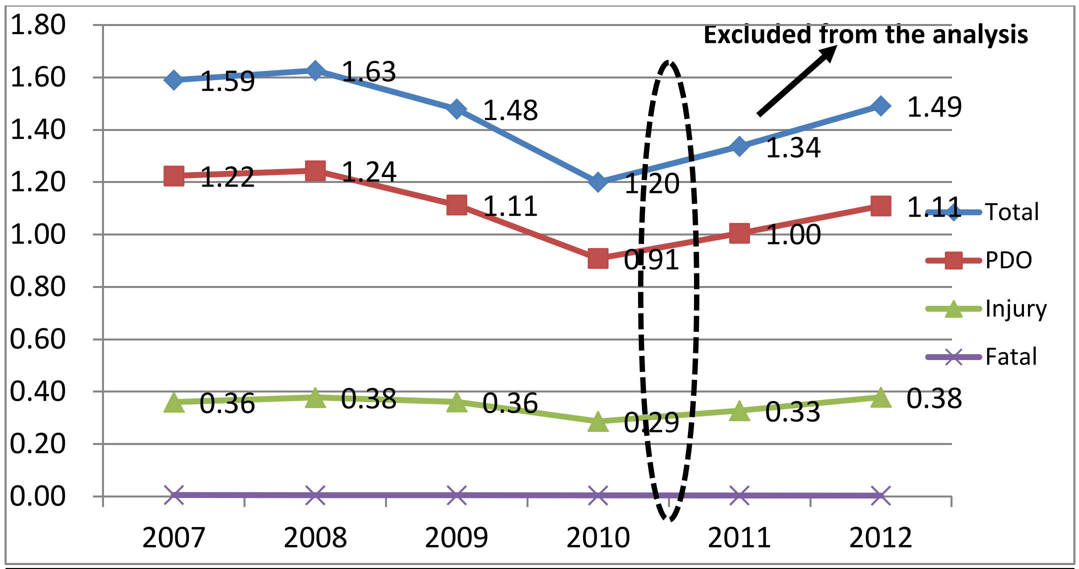


Figure F-2. Crash Rates (in crashes per million vehicle miles traveled) for Atlanta Interstates with the I-85 Express Lane Segment Removed

Table F-6. Before-After Evaluation Results for Fatal, Injury, and PDO Crashes on I-85 Express Lanes Segment with Using Atlanta Interstates, with the I-85 Express Lane Section Removed, as a Comparison Site

Crash Severity	BT	AT	BC	AC	$\hat{\theta}_T$	PC_T (%)	95% CI for PC_T (%)
Fatal	10	1	258	40	0.59	-40.5%	(-94.3, 516.6)
Injury	1242	463	18,953	4,990	**1.31**	**30.6%**	(12.7, 51.3)
PDO	4609	1,284	61,427	14,605	1.08	8.0%	(-0.5, 17.3)
Fatal+Injury	1252	464	19,211	5,030	**1.31**	**30.5%**	(12.7, 51.2)

Notes: 1. PDO stands for Property Damage Only; 2. Statistically significant percent changes at 95 percent confidence level are shown in bold.

Source: Data from the Georgia Department of Transportation and Analysis by the Texas A&M Transportation Institute.

F.2.3 Atlanta Household Travel Survey

To assist in evaluating the impacts of converting the existing HOV lanes on I-85 into Express Lanes, Volpe sponsored a pre- and post-deployment household travel panel survey. The same households were surveyed before and after the I-85 HOV-to-HOT conversion to assess changes in travel behavior, perceptions toward the Express Lanes, and satisfaction levels with use of I-85. The survey consisted of a demographic questionnaire, a 48-hour travel diary, and follow-up questions on current travel patterns and attitudes. More detailed information on the household travel panel study methodology was provided in Appendix A – Congestion Analysis.

One of the attitude questions in the post-deployment survey addressed safety. Panel members were asked to respond to the statement, “I am concerned about my safety when I use the Express Lanes” using a seven-point scale of strongly disagree, disagree, somewhat disagree, neutral, somewhat agree, agree, and strongly agree. Participants were also able to respond that they “don’t know.”

Overall, respondents indicating safety was not a concern outnumbered those expressing safety as a concern, although many people provided a neutral or don’t know response. A total of 33 percent of the respondents indicated safety was not a major concern (11 percent strongly disagreed, 16 percent disagreed, and 6 percent somewhat disagreed). A total of 19 percent agreed with the statement they were concerned about their safety when using the I-85 Express Lanes (5 percent strongly agreed, 6 percent agreed, and 8 percent somewhat agreed). A total of 19 percent provided a neutral response and 29 percent reported they did not know. Individuals who use the Express Lanes at least weekly were significantly more likely to be concerned about safety, which may be a consequence of the overall negative attitudes toward tolling and the growth in negative attitudes from wave 1 to wave 2. A total of 36 percent indicated some level of agreement with this statement (9 percent strongly agree, 10 percent agree and 17 percent somewhat agree), 18 percent were neutral, and 44 percent indicated some level of disagreement (12 percent strongly disagree, 23 percent disagree and 9 percent somewhat disagree). Only 2 percent responded “don’t know.”

F.2.4 Safety Perceptions of I-85 User Groups

Noble Insight, Inc., under contract to SRTA, conducted focus groups with specific user groups as part of the National Evaluation. The purpose of the focus groups was to obtain reactions to the Express Lanes from bus and HERO operators and from business owners in the CRD area. The composition and number of participants in each of the five focus groups were:

- GRTA Bus Operators – 5 participants;
- Gwinnett Bus Operators – 5 participants;
- HERO Operators – 6 participants;
- CRD Area Small Business Owners with Commercial Trucks – 8 participants; and
- CRD Area Small/Larger Business Owners – 9 participants.

The focus groups were conducted in August and September 2012. The bus and HERO operators had all been driving on or patrolling the I-85 HOV lanes prior to the implementation of the Express Lanes. The focus group script included questions on the participants’ perceptions of changes in congestion, motorist’s behavior, traffic and safety, crashes and incidents, and Express Lane signing. The focus groups with business representatives also included questions on use of the Express Lanes, impacts on businesses, and impacts on customers.

The general reaction from participants in all five focus groups was that safety had not improved with the implementation of the Express Lanes. Participants suggested that drivers had become more aggressive with the increased congestion in the I-85 general purpose lanes. HERO operators suggested that while they were unsure of specific changes in the number of crashes or incidents, the potential of crashes was higher with the Express Lanes. Another HERO operator suggested that lower impact crashes were more frequent with the Express Lanes. The HERO operators suggested that their response time to incidents had decreased with the implementation of the Express Lanes.

F.3 Summary of Safety Impacts

Table F-7 summarizes the safety impacts across the hypotheses. The analysis in this appendix presented inconclusive results on the safety impacts of the CRD projects, principally the I-85 Express Lanes. The analysis indicated that crashes increased on I-85 CRD corridor for injury and property-damage-only crashes, while fatal crashes decreased. The results from the household travel survey and the focus groups with different user groups indicated some safety concerns with the operation of the Express Lanes and the impacts on travel in the general purpose lanes. Analysis of data on the I-85 Express Lanes section over a longer post-deployment period than available for this evaluation is needed to better assess the safety impacts of the I-85 CRD projects. An assessment over 3-years is suggested.

Table F-7. Summary of Impacts across Hypotheses

Hypotheses/Questions	Result	Evidence
• The collective impacts of the CRD improvements will be safety neutral or safety positive.	Inconclusive	The number of crashes in the Express Lane corridor of I-85 increased after implementation of the CRD projects for injury and property damage only crashes and decreased for fatal crashes. Analysis of data on the I-85 Express Lanes section over a longer post-deployment period (at least 3 years) than currently available for this evaluation is needed to fully assess the safety impacts of the I-85 CRD projects. The results from the household travel survey and the focus groups with different user groups indicate some safety concerns with the operation of the I-85 Express Lanes and general purpose lanes.
• Gantry-controlled access technology will reduce incidents related to violations for crossing the double white line.	Inconclusive	The number of manual citations for crossing the double white line varied during the eight months in 2012 of on-site enforcement, but did not decline significantly over time. Analysis of additional crash data such as side-swipe and angle crashes specific to the Express Lanes is needed to fully assess the impacts of the GCA system on reducing incidents related to vehicles illegally crossing the double white line.
• Tolling strategies that entail unfamiliar signage will not adversely affect highway safety.	Not able to determine	No data were available to assess the potential impact of unfamiliar signage due to the tolling strategies on safety on I-85.

Source: Texas A&M Transportation Institute

F.4 Explanation of Before-and-After Evaluation with Yoked Comparisons

This section presents a more detailed description of the YC analysis method used in Section F.2.2. Let *K* be the observed crash count of a road segment during the before period (pre-deployment period) and *L* be the observed crash count during the after period (post deployment period). Similarly, let *M* and *N* be the number of before crashes and the number of after crashes at the comparison site, respectively. Let λ be the expected number of crashes after the treatment and π be the predicted number of crashes that would have been without the treatment at the treatment site. The effect of the treatment on safety can be assessed by estimating the safety effectiveness index, the ratio of the expected number of crashes after the treatment to what it would have been without the treatment, θ ($=\lambda/\pi$).

The steps of YC procedure used in this study to obtain the estimate of θ ($\hat{\theta}$) are:
Step 1. Find estimates of λ and π.

$$\hat{\lambda} = L$$

$$\hat{\pi} = \frac{N}{M} \times K \ .$$

Step 2. Find an estimate of the index of effectiveness θ:

$$\hat{\theta} = \hat{\lambda} / \hat{\pi} = \frac{LM}{KN} \ .$$

Step 3. Calculate the log odds ratio, *R,* as follows:

$$R = \ln\left(\frac{LM}{KN}\right) = \ln \hat{\theta} \ .$$

Step 4. Calculate the squared standard error for *R* by:

$$\left\{s.e.\left(R\right)\right\}^2 = Va\hat{r}\left(R\right) = \frac{1}{K} + \frac{1}{L} + \frac{1}{M} + \frac{1}{N} \ .$$

Step 5. Calculate the standard error and the approximate 95 percent confidence interval for *R:*

$$s.e.\left(R\right) = \sqrt{\frac{1}{K} + \frac{1}{L} + \frac{1}{M} + \frac{1}{N}} \ ;$$

$$R_{upper} = R + 1.96 s.e.\left(R\right) \ ;$$

and

$$R_{lower} = R - 1.96 s.e.\left(R\right) \ .$$

Where:

R_{upper} and R_{lower} stand for the upper and lower limit of the approximate 95 percent confidence interval, respectively.

Step 6. The 95 percent confidence interval for the index of effectiveness (θ) can be obtained by exponentiating R_{upper} and, R_{lower}, respectively, as:

$$U_{\theta} = e^{R_{upper}};$$

and

$$L_{\theta} = e^{R_{lower}}.$$

Step 7. The estimate for the percent change in crashes and the associated 95 percent confidence interval can then be calculated using the following:

Percent change= $\left(\hat{\theta} - 1\right) \times 100$;

$$\left(L_{\theta} - 1\right) \times 100;$$

and

$$\left(U_{\theta} - 1\right) \times 100.$$

Note that the above procedure is applicable if both the treatment and comparison groups have approximately the same (in terms of magnitude and direction) traffic volume changes from the before-to-after periods. Otherwise, the traffic volume changes from the before to the after periods need to be incorporated into θ. In that case, the before crash count at the treatment site (K) will need to be replaced by $K \times \frac{ADT^{AT}}{ADT^{BT}}$ where ADT^{BT} and ADT^{AT} are the average traffic volume during the before period at the treatment site and the average traffic volume during the after period at the treatment site, respectively. Similarly, the before crash count at the comparison site (M) will need to be replaced by $M \times \frac{ADT^{AC}}{ADT^{BC}}$ where ADT^{BC} and ADT^{AC} are the average traffic volume during the before period at the comparison site and the average traffic volume during the after period at the comparison site, respectively.

Appendix G. Equity Analysis

This analysis examines potential equity concerns associated with the Atlanta CRD projects. It assesses whether the positive or negative effects of the Express Lanes and other CRD projects fall disproportionately on different user groups as well as different geographic areas.

Table G-1 presents the four questions in the equity analysis. The first question focused on the potential impacts of the I-85 CRD projects on various users of I-85, such as those paying tolls, transit riders and carpoolers, and those in the general purpose lanes. The second question sought to understand how users from different geographic areas in the Atlanta region were affected by the I-85 CRD projects. The third question looked at the distribution of air quality impacts by geographic area and socio-economic groups. The fourth question focused on the reinvestment of revenues generated by the Express Lanes and how that reinvestment impacts different user groups.

Table G-1. Equity Analysis Questions

Hypotheses/Questions
• How do the impacts from the I-85 CRD projects affect different transportation user groups? • How do the impacts from the I-85 CRD differ across geographic areas? • Are the air quality impacts from the I-85 CRD projects different across geographic and socio-economic groups? • How does reinvestment of potential revenues from the I-85 Express Lanes impact various transportation system users?

Source: Battelle

The remainder of the appendix is divided into six sections. Section G.1 describes the data sources used in the equity analysis. Section G.2 presents the analysis of potential equity impacts to the different I-85 user groups. Analysis of geographic equity is presented in Section G.3. Section G.4 examines the air quality impacts from the I-85 CRD projects across geographic and socio-economic groups. Section G.5 discusses the planned reinvestment of potential revenues from the I-85 tolls. The appendix concludes with a summary of the potential equity impacts in Section G.6.

G.1 Data Sources

The equity analysis drew on data from several other analyses in the national evaluation. Travel times and vehicle miles traveled (VMT) based on traffic sensor data were obtained from the congestion analysis in Appendix A, as were the findings from the Volpe Household Travel Survey. Appendix B – Tolling Analysis provided data on tolling transactions based on Peach Pass toll tags. Appendix C – Transit Analysis provided data on ridership, results of an on-board transit survey, and transit rates. Carpooler survey results came from Appendix D – TDM Analysis, and Appendix H – Environmental Analysis provided input for assessing air quality impacts.

The data from those parts of the national evaluation were supplemented with socio-economic data from the U.S. Census Bureau and with vehicle operating costs from the American Automobile Association (AAA).

G.2 Potential Equity Impact on I-85 User Groups

The evaluation examined the potential variation of benefits and costs experienced by different users of I-85 before and after the implementation of the Express Lanes. Owing to the Express Lanes' anticipated improvements for travelers in the corridor, especially the cars and buses using the HOT lanes, it was reasonable to expect that some users might benefit more. At the same time, for those paying a toll, travel costs could be higher.

Data for assessing the equity impacts on user groups included mean travel time drawn from the congestion analysis in Appendix A and average toll rates from the tolling analysis in Appendix B. The AAA's annual estimate of operating costs for travel in 2012 was the basis for estimating cost of travel by private vehicle, and the Georgia Regional Transportation Authority (GRTA) published fares for Xpress buses were used to estimate costs for transit riders.

Also presented are the perceptions of equity or fairness for different users of I-85. Questions addressing equity were included in the Volpe household travel survey, on-board transit survey, and the carpooler survey, described in Appendix A, Appendix C, and Appendix D respectively. The surveys provided data for analysis of perceptions, and these findings were presented in the latter part of this section.

Table G-2 compares the mean travel time and costs incurred by user groups on I-85 before and after the Express Lanes began operations. The peak period was 6 to 10 a.m. in the southbound lanes and 3 to 7 p.m. in the northbound lanes. Costs were normalized to 2012 values to enable before and after comparisons and represent only those costs for travel on the CRD corridor itself. The findings for each group are discussed below. Travel times and costs in Table G-2 are averages, and individual travelers may have experienced greater or lesser travel times and toll costs.

Table G-2. Comparison of Travel Time and Costs Per Trip on I-85 by User Group in the Morning and Afternoon Peak Travel Periods

User Group	Mean Travel Time[1]		Costs[2]	
	Before	After	Before	After
General Purpose Lane Travelers				
a.m. peak	16.1	16.9	$7.03	$7.03
p.m. peak	16.1	17.8	$7.13	$7.13
Carpoolers, HOV2+ before and HOV3+ after tolling				
a.m. peak	14.1	13.8	$7.03	$7.03
p.m. peak	14.3	13.8	$7.13	$7.13
Transit Riders				
a.m. peak	14.1	13.8	$5.00	$5.00
p.m. peak	14.3	13.8	$5.00	$5.00
Express Lane Toll Payers				
a.m. peak	NA	13.8	NA	$10.98[3]
p.m. peak	NA	13.8	NA	$ 9.40[3]

[1] Mean travel time in minutes obtained from Appendix A – Congestion Analysis. Times are for 11.75 miles northbound (NB) and 11.56 miles southbound (SB) where traffic sensor data were judged to be useable.

[2] Vehicle operating cost per mile of 60.8 cents per mile for average sedan driven 15,000 miles per year from 2013 AAA "Your Driving Costs" multiplied by the NB and SB miles used in the travel time calculations. Transit cost is based on the cash fare for Xpress bus trip from the Sugar Mills (formerly Discover Mills) park and ride lot to downtown or midtown. 2012 costs were used for both before and after to enable cross-mode comparisons.

[3] Vehicle operating costs of $7.03 for 11.56 SB miles and $7.13 for 11.75 NB miles plus average toll of $3.95 SB and $2.27 NB for the maximum trip distance in September 2012.

Source: Battelle

General Purpose Lane Users

Travelers in the general purpose lanes experienced slightly slower travel during the morning and afternoon peaks after the Express Lanes opened. During the a.m. peak the mean travel time increased by 0.8 minutes and in the p.m. peak by 1.7 minutes. However, they did not experience the additional costs of toll-paying Express Lane travelers, and their costs reflected only the average vehicle operating costs along the corridor.

Carpoolers

Carpoolers experienced a very slight improvement in travel time on average in the Express Lanes: 0.3 minutes in the a.m. peak and 0.5 minutes in the p.m. peak. From a cost standpoint, carpools with 3 or more people who registered as carpools did not pay a toll, and, thus, their costs were no different than before. However, two-person carpools, which traveled for free in the previous HOV lanes, were required to pay to use the Express Lanes, with their costs the same as other Express Lane toll payers in the after period shown in Table G-2.

Two-person carpools on average paid $3.95 more during the a.m. peak and $2.27 more in the p.m. peak when they used the Express Lanes.

Transit Riders

Xpress buses used both the previous HOV and the Express Lanes in the CRD corridor and, thus, experienced the same travel time savings after tolling began as did carpoolers: an average of 0.3 minutes in the a.m. peak and 0.5 minutes in the p.m. peak. Their cost to use the corridor was $5.00 each way, the lowest of all the user groups.

Toll Payers

Express Lane toll payers included drivers of single-occupant vehicles, which previously could not use the HOV lane, and two-person carpools that chose to use the lane and pay a toll. Both types of users gain a travel-time advantage of 3.1 minutes in the a.m. peak and 4.0 minutes in the p.m. peak over the general purpose lanes during the after period. The additional costs to obtain that advantage were $3.95 and $2.27 in the a.m. and p.m. peak periods, respectively. Their total costs, not surprisingly, were the highest among all users.

Perceptions of Fairness

As noted previously, three surveys conducted during the course of the evaluation provided data for examining the perception of fairness of tolling on I-85.

The Volpe household travel survey compared changes in opinion toward tolling before (2011 survey) and after (2012 survey) tolls were implemented. Before tolls were implemented, 74 percent of respondents agreed with the statement that “highway tolls are unfair to people with limited incomes.” In 2012 that figure dropped to 57 percent. However, as shown in Figure G-1, the proportion who strongly agreed that the tolls are unfair to people with limited incomes remained the same [i.e., 31 percent in wave 1 (2011) and 30 percent in wave 2 (2012)]. One explanation for the apparent drop in concern about fairness for low-income groups after tolling began was that I-85 travelers may have come to view the tolls as unfair for all income groups.

Volpe. Used with Permission.

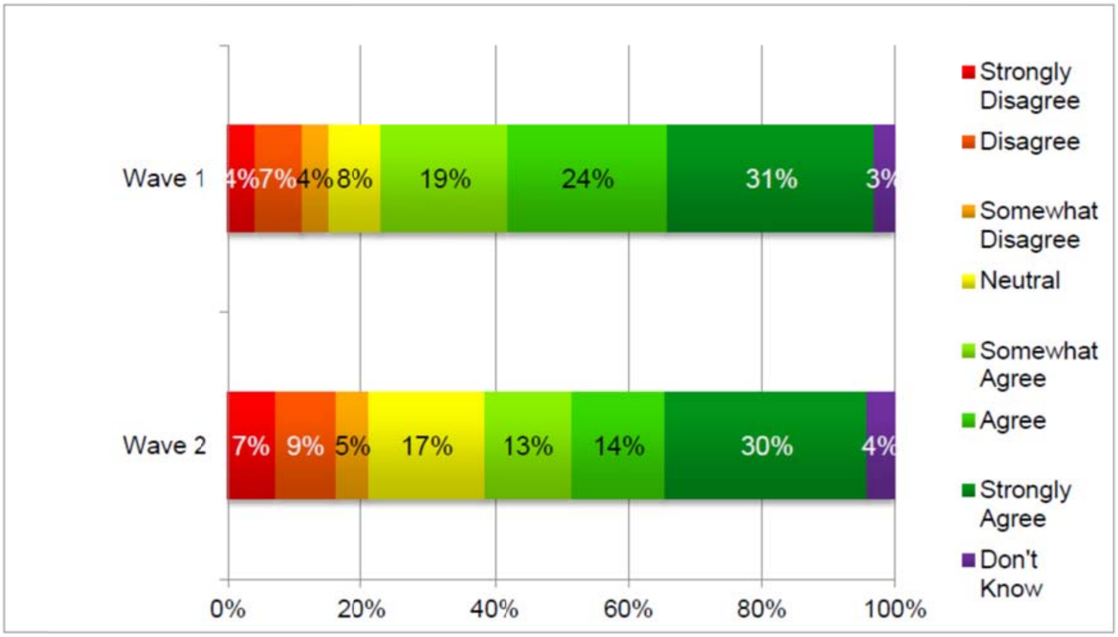


Figure G-1. Changes in Opinion toward Tolling: Highway Tolls are Unfair to People with Limited Incomes

In the on-board transit survey, riders of the Xpress bus service on I-85 were asked the extent to which they agreed to the following statement: “The tolls on I-85 are unfair to people with limited incomes.” As shown in Table G-3, a slight majority of 52.2 percent (±2.9 percent standard error) agreed or strongly agreed that tolls on I-85 are unfair to people with limited incomes, a perception that was held by a majority of riders of all income levels.

Table G-3. Transit Riders’ Response to Question: “The tolls on I-85 are unfair to people with limited incomes.”

Response	Frequency	Percent
Strongly Disagree	74	8.4%
Disagree	101	11.4%
Neutral	247	28.0%
Agree	206	23.3%
Strongly Agree	255	28.9%
Total	**883**	**100.0%**

Source: Center for Urban Transportation Research based on data from GRTA

A different type of question on fairness was asked of I-85 carpoolers in the 2012 survey: "Do you think that it is fair to allow single-occupant vehicles to use the Express Lanes if they pay the toll?" Table G-4 through Table G-7 presents the responses to this question according to the race, gender, income, and age of the respondents. Carpoolers did not seem to mind sharing the lane with toll paying vehicles, as only a minority of carpoolers of all socio-economic characteristics felt that it was probably not or definitely not fair. There was no significant difference in their perceptions based on race, gender, or income. In the case of the age of the respondent, however, some difference was detected. A total of 18.5 percent of the youngest group (ages 16 to 34 years) said that they were not sure about the fairness of allowing single-occupant vehicles to use Express Lanes. This number decreased with age groups, as fewer than 3 percent of those 45 years and older expressed uncertainty over fairness.

Table G-4. Carpoolers' Perception of Fairness of Allowing Single-Occupant Vehicles to Use Express Lanes by Race

Do you think that it is fair to allow single-occupant vehicles to use the Express Lanes if they pay the toll?	Race *	
	White	Non-white
1-Definitely yes	24.4%	28.9%
2-Probably yes	28.6	18.6
3-Not sure	5.6	10.3
4-Probably no	12.8	9.3
5-Definitely no	28.6	33.0
Total	**100.0%**	**100.0%**
Mean Perception Score	**2.9**	**3.0**

* Fisher's Exact test was not significant at the 0.05 level (p=0.1531).

Source: Battelle

Table G-5. Carpoolers' Perception of Fairness of Allowing Single-Occupant Vehicles to use Express Lanes by Gender

Do you think that it is fair to allow single-occupant vehicles to use the Express Lanes if they pay the toll?	Gender*	
	Male	Female
1-Definitely yes	21.5%	29.5%
2-Probably yes	27.8	23.7
3-Not sure	5.1	8.7
4-Probably no	10.1	13.3
5-Definitely no	35.4	24.9
Total	**100.0%**	**100.0%**
Mean Perception Score	**3.1**	**2.8**

* Fisher's Exact test was not significant at the 0.05 level (p=0.0971).

Source: Battelle

Table G-6. Carpoolers' Perception of Fairness of Allowing Single-Occupant Vehicles to Use Express Lanes by Income

Do you think that it is fair to allow single-occupant vehicles to use the Express Lanes if they pay the toll?	Income*				
	<$50,000	$50,000-$74,999	$75,000-$99,999	$100,000-$149,000	≥$150,000
1-Definitely yes	40.7%	25.9%	18.6%	21.9%	27.1%
2-Probably yes	13.0	16.7	27.1	34.3	29.2
3-Not sure	7.4	13.0	7.1	4.8	4.2
4-Probably no	16.7	5.6	12.9	12.4	10.4
5-Definitely no	22.2	38.9	34.3	26.7	29.2
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Mean Perception Score	**2.7**	**3.1**	**3.2**	**2.9**	**2.9**

* Fisher's Exact test was not significant at the 0.05 level (p=0.0626).

Source: Battelle

Table G-7. Carpoolers' Perception of Fairness of Allowing Single-Occupant Vehicles to use Express Lanes by Age

Do you think that it is fair to allow single-occupant vehicles to use the Express Lanes if they pay the toll?	Age*			
	16-34 years	35-44 years	45-54 years	≥55 years
1-Definitely yes	16.7%	33.7%	24.6%	22.6%
2-Probably yes	24.1	25.7	21.9	33.9
3-Not sure	18.5	8.9	2.6	1.6
4-Probably no	11.1	7.9	14.9	12.9
5-Definitely no	29.6	23.8	36.0	29.0
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Mean Perception Score	**3.1**	**2.6**	**3.2**	**2.9**

* Fisher's Exact test was significant at the 0.05 level (p=0.0098).

Source: Battelle

Results of the Volpe survey of households using I-85 and the transit rider survey indicated a general unease with the fairness of tolling on low-income groups among the majority of respondents. In the survey of carpoolers, the fairness question focused on opening up the lane formerly used by carpools and transit to single-occupant vehicles. Carpoolers indicated that they do not mind sharing the Express Lanes with drivers who pay a toll for the privilege.

G.3 Potential Equity Impacts by Geographic Areas

Analysis of geographic equity sought to understand whether the impacts of the CRD, positive or negative, varied according to locations and, consequently, to the people living in those locations. Of course, the CRD itself was designed to improve travel in a specific geographic area—the I-85 corridor in Gwinnett County—and thus the question could be reframed to assess variation in impacts within parts of the corridor and elsewhere. Potential impacts by geographic areas were assessed by examining the geographic attributes of users of the CRD-funded Xpress bus service and the I-85 Express Lanes.

Appendix C described the transit enhancements that were part of the CRD deployment. Three new park-and-ride lots were built and one existing lot (I-985/GA 20) was expanded. In addition, the CRD funded the purchase of 20 new buses that enabled five new bus routes to begin operation from the park-and-ride lots. Table G-8 summarizes the transit enhancements.

Table G-8. Park-and-Ride Lots and New Xpress Bus Routes on I-85 Corridor

Park-and-Ride Lot	Routes Served		Route Start Date
I-985/GA 20	101	(Buford to Downtown)	Prior to CRD
Hamilton Mill	413	(Hamilton Mill to Downtown)	Aug-11
	414	(Hamilton Mill to Midtown)	Jul-12
Mall of Georgia	411	(Mall of Georgia to Midtown)	Aug-10
Hebron Baptist	416	Dacula to Downtown)	Jul-11
	417	Dacula to Midtown)	Jul-12

Source: Center for Urban Transportation Research

The transit enhancements were meant to provide a reliable commute and an alternative to paying a toll for travelers on the I-85 corridor, since buses use the Express Lanes without a toll. Thus, all the new park-and-ride lots are conveniently situated near the start of the Express Lanes in Gwinnett County.

To assess the geographic equity of the transit enhancement, an analysis of ZIP code of the origin of users of the Xpress bus service was performed. Of the 61 different ZIP codes provided by respondents in an on-board survey, 53 were for towns in Georgia, two were out-of-state, and six were invalid. The 53 Georgia ZIP codes were the origin locations of 593 bus riders (a weighted estimate) using the I-85 Xpress bus service at the time of the transit survey in May 2012. More details of the survey are presented in Appendix C.

To aid in analysis, the number of riders was aggregated according to the town in which their ZIP codes were located. Table G-9 shows the number and percentage of riders by town along with the associated county, in declining order of the percent of riders by town.

Table G-9. Number and Percentage of I-85 Xpress Bus Riders by Town of ZIP Code Origin

Town	County	Riders	Percent of Riders by Town	Cumulative Percent
Lawrenceville	Gwinnett	227	38%	38%
Suwanee	Gwinnett	83	14%	52%
Buford	Gwinnett	70	12%	64%
Dacula	Gwinnett	41	7%	71%
Duluth	Gwinnett	39	7%	78%
Lilburn	Gwinnett	17	3%	80%
Norcross	Gwinnett	16	3%	83%
Gainesville	Hall	13	2%	85%
Hoschton	Barrow & Jackson	12	2%	87%
Flowery Branch	Hall	12	2%	89%
Braselton	Hall, Jackson, Barrow, & Gwinnett	9	1%	91%
Winder	Barrow	8	1%	92%
Auburn	Barrow	6	1%	93%
Grayson	Gwinnett	6	1%	94%
Snellville	Gwinnett	5	1%	95%
Atlanta	Fulton	5	1%	96%
Bethlehem	Barrow	4	1%	96%
Loganville	Walton & Gwinnett	4	1%	97%
16 Other Towns with Each Less Than 1% of Riders	Various	18	3%	100%
All Towns	All	593	100%	

Source: Battelle

Riders originating in towns in Gwinnett County accounted for the vast majority of riders (over 85 percent), with the town of Lawrenceville contributing 38 percent of all riders. The predominant usage of Xpress buses by riders from Gwinnett County was consistent with location of the four CRD-funded park-and-ride lots located there and the bus routes serving those lots. Riders were also drawn from towns in Hall, Barrow, and Jackson Counties that are at greater distances along the I-85 corridor from Atlanta, together representing about 10 percent of the ridership. Thus, from a geographic equity standpoint, it appeared that the population in closest proximity to the CRD-funded transit enhancements, i.e. Gwinnett County towns along I-85, received the benefits of those enhancements.

The geographic distribution of users of the I-85 Express Lanes was examined based on the town associated with the ZIP code of each Peach Pass. Peach Pass holders provided their ZIP code at the time of registration. Of the 1321 unique ZIP codes, 521 were for locations within Georgia, 759 were for other states, and 41 were not valid. For the purpose of the equity analysis, only Georgia ZIP codes were used. Out-of-state ZIP codes represented only 1 percent of all trips for I-85 users with valid Peach Pass ZIP codes.

Based on the toll transaction data described in Appendix B – Tolling Analysis, Table G-10 shows one year of Express Lane trips in both directions according to the towns and counties associated with the ZIP codes. The trips included those taken by SOV, HOV3+, alternative fuel vehicles, and motorcycles. Transit vehicles and emergency service vehicles were not included. The results are presented in declining order of the percent of Express Lane trips by town.

Table G-10. Number and Percent of I-85 Express Lane Trips by Town of ZIP Code of Peach Pass Holder, October 2011 – September 2012*

Town of ZIP Code	County	All Express Lane Trips	Percent of Express Lane Trips	Cumulative Percent of Trips
Lawrenceville	Gwinnett	909789	28%	28%
Buford	Gwinnett	340487	11%	39%
Suwanee	Gwinnett	323658	10%	49%
Atlanta	Fulton	276252	9%	58%
Duluth	Gwinnett	241761	7%	65%
Dacula	Gwinnett	217202	7%	72%
Lilburn	Gwinnett	138236	4%	76%
Flowery Branch	Hall	87567	3%	79%
Gainesville	Hall	65699	2%	81%
Hoschton	Barrow & Jackson	65212	2%	83%
Winder	Barrow	43030	1%	84%
Braselton	Hall, Jackson, Barrow, & Gwinnett	39930	1%	85%
Auburn	Barrow	39464	1%	86%
Jefferson	Jackson	30355	1%	87%
Grayson	Gwinnett	29834	1%	88%
Marietta	Cobb	24241	1%	89%
Bethlehem	Barrow	22284	1%	90%
Athens	Clarke	22032	1%	91%
Loganville	Walton	19334	1%	92%
Decatur	DeKalb	19106	1%	93%
Alpharetta	Fulton	18568	1%	94%
All Other Towns Each with Less Than 1% Transactions	Various	267968	6%	100%
Total Trips	All	3242009	100%	

* The data included usage of the Express Lanes by both new Peach Pass registrants as well as holders of the Cruise Card already used on the Georgia 400 toll road. Cruise Cards accounts transitioned to Peach Pass accounts in June, 2011, but the Cruise Card transponder could be used on I-85.

Source: Battelle

Similar to the Xpress bus users, residents of the towns in Gwinnett County accounted for the highest percentage of Express Lane users—68 percent—with towns northeast of Gwinnett in Hall, Jackson, and Barrow Counties contributing 12 percent. However, unlike the bus riders, Peach Pass holders using the I-85 Express Lanes were more dispersed, with approximately 20 percent of all trips coming from towns throughout the region in Fulton, Cobb, DeKalb, and Walton Counties, in addition to more distant Clarke County, where the city of Athens is located. Thus, while the I-85 Express Lanes benefited the population in closest proximity, other users in the region were taking advantage of lanes as well.

Another perspective on the usage of the Express Lanes was available from the Volpe Household Travel Survey. Details about the survey are presented in the congestion analysis in Appendix A. Data presented here are from the self-reported number of weekly trips taken on I-85 by individuals in a household and the number of those trips that were in the Express Lanes, with a round trip counted as two trips. For analysis purposes the ZIP codes of the households were aggregated by their associated town. Table G-11 shows the usage of the Express Lanes by the sampled households. It is important to note that the data were not weighted according to the number of people in a ZIP code or town, and the results may reflect a low number of sampled households in a particular ZIP code.

Table G-11. Trips on I-85 Express Lanes as Percent of All I-85 Trips by Surveyed Household According to Town of Households' ZIP Codes, Spring 2012 (unweighted sample)

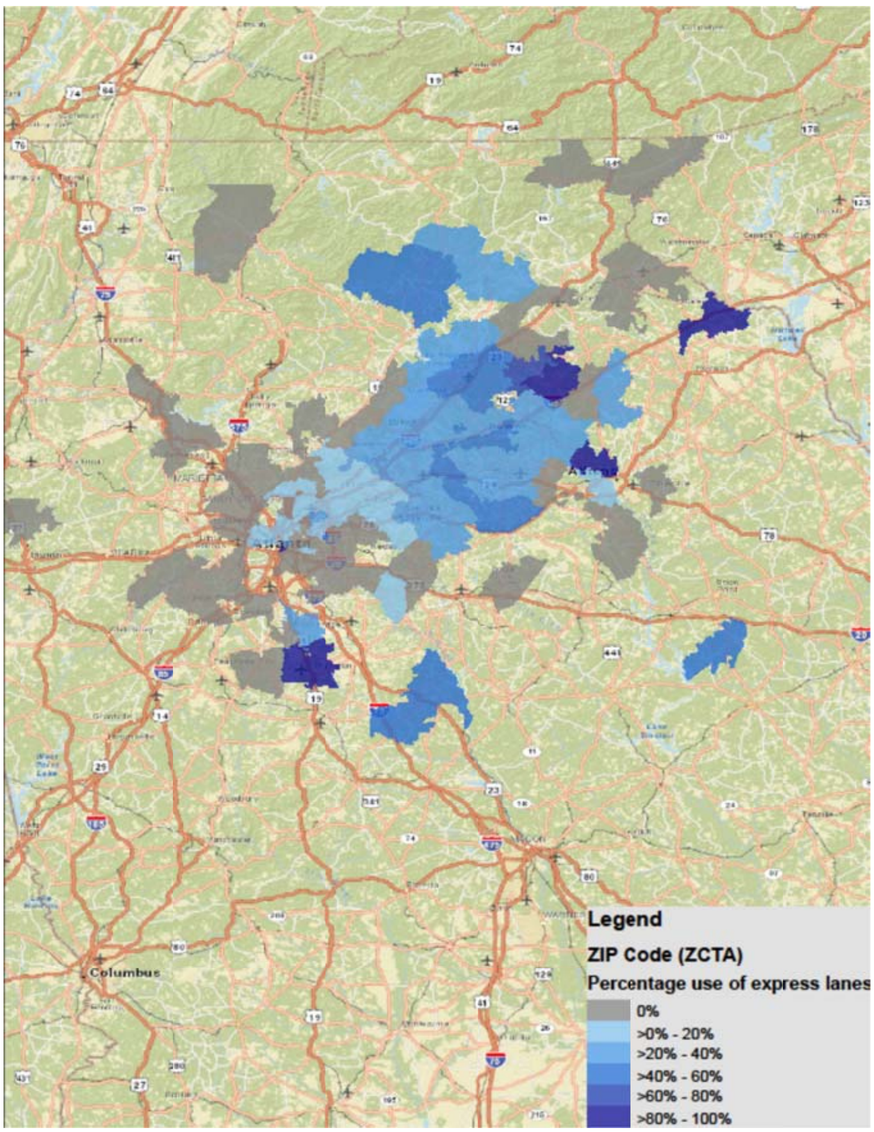
Town	County	Town Total Household Trips on I-85	Town Household Trips on I-85 Express Lanes	Percent of Household I-85 Trips on Express Lanes
Lavonia	Franklin	10	10	100%
Hampton	Henry	1	1	100%
Maysville	Banks & Jackson	11	10	91%
Norcross	Gwinnett	12	10	83%
Gillsville	Banks & Hall	16	10	63%
White Plains	Greene	10	6	60%
Dahlonega	Lumpkin	5	3	60%
Oakwood	Hall	54	29	54%
Monroe	Walton	15	8	53%
Hoschton	Barrow & Jackson	257	131	51%
Ailey	Montgomery	20	10	50%
Scottdale	DeKalb	6	3	50%
Griffin	Spalding	4	2	50%
Dacula	Gwinnett	674	300	45%
Gainesville	Hall	138	58	42%
Pendergrass	Jackson	31	11	35%

Table G-11. Trips on I-85 Express Lanes as Percent of All I-85 Trips by Surveyed Household According to Town of Households' ZIP Codes, Spring 2012 (unweighted sample) (Continued)

Town	County	Town Total Household Trips on I-85	Town Household Trips on I-85 Express Lanes	Percent of Household I-85 Trips on Express Lanes
Loganville	Walton & Gwinnett	108	37	34%
Braselton	Hall, Jackson, Barrow, & Gwinnett	140	47	34%
Athens	Clarke	48	16	33%
Suwanee	Gwinnett	1517	479	32%
Winder	Barrow	125	38	30%
Buford	Gwinnett	1540	467	30%
Flowery Branch	Hall	373	112	30%
Bethlehem	Barrow	100	27	27%
Lawrenceville	Gwinnett	4555	1228	27%
Cleveland	White	16	4	25%
Jefferson	Jackson	58	14	24%
Grayson	Gwinnett	202	48	24%
Jonesboro	Clayton	18	4	22%
Auburn	Barrow	113	25	22%
Commerce	Jackson	51	8	16%
Duluth	Gwinnett	1612	244	15%
Lilburn	Gwinnett	1715	200	12%
Conyers	Rockdale	26	3	12%
Snellville	Gwinnett	29	3	10%
Decatur	DeKalb	153	15	10%
Atlanta	Fulton, DeKalb	915	81	9%
Tucker	DeKalb	115	10	9%
Alpharetta	Fulton	113	3	3%

Source: Battelle based on Volpe data

Towns in Table G-11 are ordered according to surveyed households' reliance on the Express Lanes as a percentage of all I-85 trips. The data are presented on a map in Figure G-2. These data present a very different view of Express Lane usage than those in Table G-10, as the map suggests that those households residing farther away from I-85—in towns located in counties such as Banks, Barrow, Franklin, Greene, Hall, Henry, Jackson, Lumpkin, Montgomery, Spalding, and Walton—relied on the Express Lanes for more of their I-85 trips than those closer to I-85. One explanation is that such households used I-85 primarily for the morning and evening commute and were willing to pay a toll, or carpool or use the bus, to take advantage of a faster trip on the Express Lanes. Residents close to the I-85 corridor, in towns in Gwinnett County, for example, might have used it frequently, but they may not have seen a benefit in using the Express Lanes for a high proportion of their travel. In conclusion, from a geographic equity perspective, the population in closest proximity to I-85 used it frequently but relied on the Express Lanes for a smaller portion of their I-85 travel, whereas other users living at greater distances from the CRD corridor relied more heavily on the Express Lanes when they needed to travel on I-85.



Volpe. Used with Permission.

Figure G-2. Percent of I-85 Household Trips that Used Express Lanes

G.4 Potential Air Quality Impacts by Geographic Area and Socio-Economic Groups

The environmental analysis reported in Appendix H showed an overall improvement in air quality in the corridor as a whole in the year following the implementation of the Express Lanes on I-85. However, the air quality impacts might not be constant over the entire corridor, if changes in traffic volumes and speed varied by road segment. To determine the potential variation in air quality impacts, vehicle miles traveled (VMT) from the congestion analysis (Appendix A) were examined by road segment. In this analysis, VMT served as a proxy for air quality impacts since emissions are a function of miles traveled. Speed is also a key factor, but emissions analysis using both VMT and speed at the segment level was beyond the scope of the analysis.

Table G-12 shows the road segments based on the location of GDOT's traffic sensors from Steve Reynolds Boulevard at the northern end of the CRD corridor to Chamblee-Tucker Road at the southern end. To obtain a general measure of change by segment, the VMT on the general purpose and the Express Lanes were combined as were the VMT in the northbound and southbound directions. The percent change in VMT by road segment indicated a reduction or virtually no change in VMT by road segment, but the greatest reductions were in the three northernmost segments—Indian Trail, Beaver Ruin Rd., and Steve Reynolds Blvd. With respect to air quality impacts, the analysis suggested that there were no adverse impacts within areas adjacent to I-85 based on VMT alone. Areas at the northern end of the corridor experienced the greatest reductions in VMT, and, by extrapolation, reductions in emissions.

Table G-12. Change in Vehicle Miles Traveled on I-85 Corridor by Road Segment Location

Road Segments Based on GDOT Traffic Sensor Locations from North to South	Pre-CRD NB & SB	Post-CRD NB & SB	Net Change NB & SB	Percent Change NB & SB
Steve Reynolds Blvd.	219249	201088	-18160	-8.3%
Beaver Ruin Rd.	106507	94087	-12420	-11.7%
Indian Trail	99596	92281	-7315	-7.3%
Center Way	47503	47519	16	0.0%
Jimmy Carter Blvd.	70566	66666	-3900	-5.5%
Jimmy Carter So. of Blvd.	137857	136102	-1755	-1.3%
Pleasantdale Rd.	70168	68199	-1969	-2.8%
Northcrest Rd.	43785	43166	-619	-1.4%
I-285 Interchange	29189	29214	25	0.1%
Chamblee-Tucker Rd.	65330	64570	-760	-1.2%

Source: Battelle

Census data on socio-demographic characteristics of communities adjacent to the corridor were used to assess the impact of VMT changes, and hence air quality changes, on the population. Specifically, did minority or lower income populations experience different air quality effects than other populations of the corridor? To make this determination, ZIP codes associated with the I-85 road segments were identified and the census data for those ZIP codes were examined.

Figure G-3 shows the ZIP codes through which the I-85 CRD corridor runs. Where I-85 formed the boundary between ZIP code areas, two ZIP codes were associated with the same road segment in the northbound and southbound direction. Conversely, some ZIP codes encompassed multiple road segments because the road segment was smaller geographically than the ZIP code area. The road segments mapped to ZIP codes are shown in Table G-13 along with the VMT changes as previously reported in Table G-12.

Atlanta Regional Commission, used with permission.

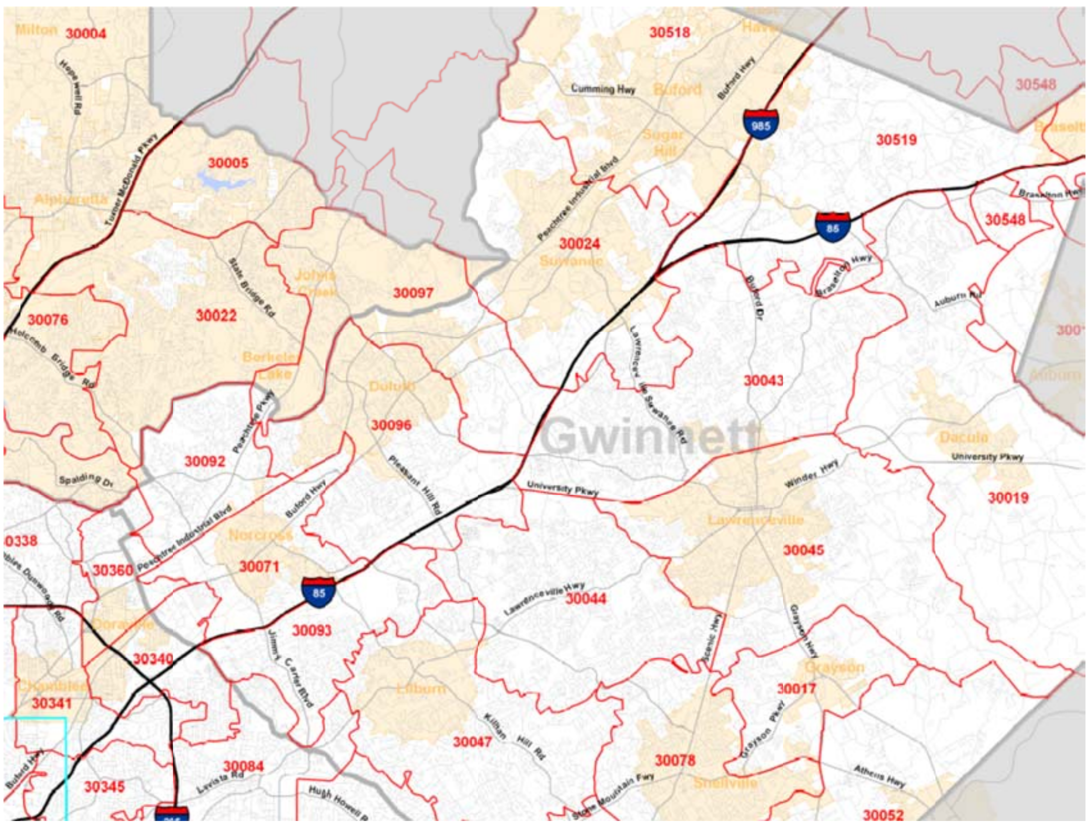


Figure G-3. ZIP Codes and Communities Adjacent to the I-85 CRD Corridor

Table G-13. ZIP Codes for Road Segments along I-85 Corridor

Road Segments Based on GDOT Traffic Sensor Locations from North to South	ZIP Code Northbound (NB)	ZIP Code Southbound (SB)	Net VMT Change NB & SB	Percent VMT Change NB & SB
Steve Reynolds Blvd.	30096	30096	-18160	-8.3%
Beaver Ruin Rd.	30096	30096	-12420	-11.7%
Indian Trail	30071	30093	-7315	-7.3%
Center Way	30071	30093	16	0.0%
Jimmy Carter Blvd.	30071	30093	-3900	-5.5%
Jimmy Carter So. of Blvd.	30071	30093	-1755	-1.3%
Pleasantdale Rd.	30340	30093	-1969	-2.8%
Northcrest Rd.	30340	30340	-619	-1.4%
I-285 Interchange	30340	30340	25	0.1%
Chamblee-Tucker Rd	30341	30345	-760	-1.2%

Source: Battelle

The VMT change was fairly small for six of the ten road segments, predominantly the southern segments, ranging from a negligible increase of 0.1 percent at the I-285 interchange to a decrease of 2.8 percent for the Pleasantdale Rd. segment. These six road segments were associated with five ZIP codes: 30071, 30093, 30340, 30341, and 30345. On the other hand, the three northernmost road segments experienced the greatest decrease in VMT and the associated emissions, and thereby enjoyed the greatest benefit in air quality reduction relative to the other segments of I-85. The northernmost segments were associated with three ZIP codes: 30071, 30093, and 30096. The road segment “Jimmy Carter So. Of Blvd.” in the middle of the corridor experienced a 5.5 percent decrease in VMT and was associated with ZIP codes 30071 and 30093.

Given the overlap in ZIP codes among several road segments, teasing out the relationship between population characteristics and VMT was difficult. However, ZIP code 30096 was unique to the two northernmost road segments that had the greatest VMT decline and, therefore, could be singled out for scrutiny. Thus, the equity question was, does the population in ZIP code 30096 differ from the population of the other ZIP code areas in terms of minority and income status?

Table G-14 presents socio-economic characteristics of the population for the ZIP codes associated with the I-85 CRD road segments. Relative to the Atlanta region as a whole (i.e., the characteristics of the Atlanta-Sandy Springs-Marietta, GA Metro Area) the population of the six ZIP codes area had a lower percentage of Blacks or African-Americans and a higher percentage of Asians and Hispanics or Latinos. The percentage of whites and the median household income varied considerably among the six ZIP codes relative to the regional figure.

Compared to other ZIP codes in the corridor, ZIP code 30096 had a population that was slightly more female, in the middle with respect to age distribution, lower in percentage white and higher in black/African-American and Asian, and lower in Hispanic or Latino. Its median household income lied in the middle and its unemployment rate was slightly higher than the norm for the corridor.

From an environmental equity standpoint, it did not appear that minority or low-income households in the CRD corridor were adversely affected by air quality impacts of the CRD projects. For all road segments on the corridor, the VMT-based emissions either improved or did not change significantly. The examination of the area receiving the greatest benefit from reductions in VMT and the socio-economic characteristics of the population in that area suggested that some minority racial groups benefited.

Table G-14. Socio-economic Characteristics of Population by ZIP Codes Adjacent to I-85 CRD Corridor

Socio-Economic Characteristics	ZIP Codes						
	Atlanta-Sandy Springs-Marietta, GA Metro Area	30071	30093	30096	30340	30341	30345
Total Population	5,213,854	21,976	52,371	63,801	30,548	27,746	24,408
Male %	48.7	54.5	52.6	48.2	54.4	53.3	52.5
Female %	51.3	45.5	47.4	51.8	45.6	46.7	47.5
Age							
Under 20 years %	29.4	31.4	31.7	28.2	27.8	23.3	24.1
20 – 44 years %	37.3	45.9	49.0	41.8	46.2	48.5	42.2
45 – 64 years %	24.8	17.4	16.4	24.3	19.4	21.1	22.5
65 years and over %	8.8	5.3	2.9	5.8	6.7	7.1	11.2
Median age (years)	34.7	30.4	28.9	31.9	30.1	32.4	33.3
Race							
White %	56.6	36.1	29.8	41.8	51.4	56.4	71.9
Black or African American %	32.2	17.4	21.9	21.4	16.2	16.0	9.2
American Indian and Alaska Native %	0.3	0.3	0.4	0.2	0.5	0.6	0.0
Asian %	4.8	13.7	9.4	19.5	11.1	10.6	6.4
Native Hawaiian and Other Pacific Islander %	0.0	0.1	0.0	0.0	0.2	0.1	0.0
Other race %	4.3	30.4	36.3	14.1	19.3	14.4	11.5

Socio-Economic Characteristics	ZIP Codes						
	Atlanta-Sandy Springs-Marietta, GA Metro Area	30071	30093	30096	30340	30341	30345
Hispanic or Latino							
Hispanic or Latino %	10.1	47.4	56.3	22.9	45.9	27.8	27.6
Not Hispanic or Latino %	89.9	52.6	43.7	77.1	54.1	72.2	72.4
Employment Status							
Population 16 years and older	3,981,271	16,378	38,164	48,884	23,781	22,440	19,232
In civilian labor force %	69.5	76.0	77.1	73.1	74.3	77.6	74.1
Employed %	62.5	69.1	69.2	65.6	67.5	73.1	69.3
Unemployed %	7.0	6.9	7.9	7.5	6.7	4.5	4.8
Household Income and Benefits*							
Total households	1,890,208	7,064	16,826	23,996	10,110	10,998	9,161
Less than $25,000 %	19.8	24.4	29.0	20.5	26.6	21.6	19.0
$25,000 to $49,999 %	23.6	30.3	39.7	28.9	29.5	24.1	19.8
$50,000 to $99,999 %	31.8	29.7	25.2	31.8	29.7	30.2	24.2
$100,000 or more %	24.8	15.5	6.1	18.7	14.2	24.2	37.1
Median household income (dollars)	57,783	44,158	35,814	50,453	43,068	56,557	69,539

*In 2011 inflation-adjusted dollars

Source: Battelle based on 2007 – 2011 American Community Survey 5-Year Estimates

G.5 Impact of Planned Re-investment of Potential Express Lane Revenues

One measure of equity is how revenues collected by the tolling system were used. For example, were revenues collected by Express Lane users applied to other transportation modes or facilities, or were these revenues used to subsidize certain groups of users of the Express Lanes?

Over the course of the one-year post-deployment period, monthly toll revenues gradually rose from $106,000 in October 2011 to $401,000 in September 2012 for a total of $3,454,627 collected in the first year of operation. The trend in toll revenues is shown in Figure G-4.

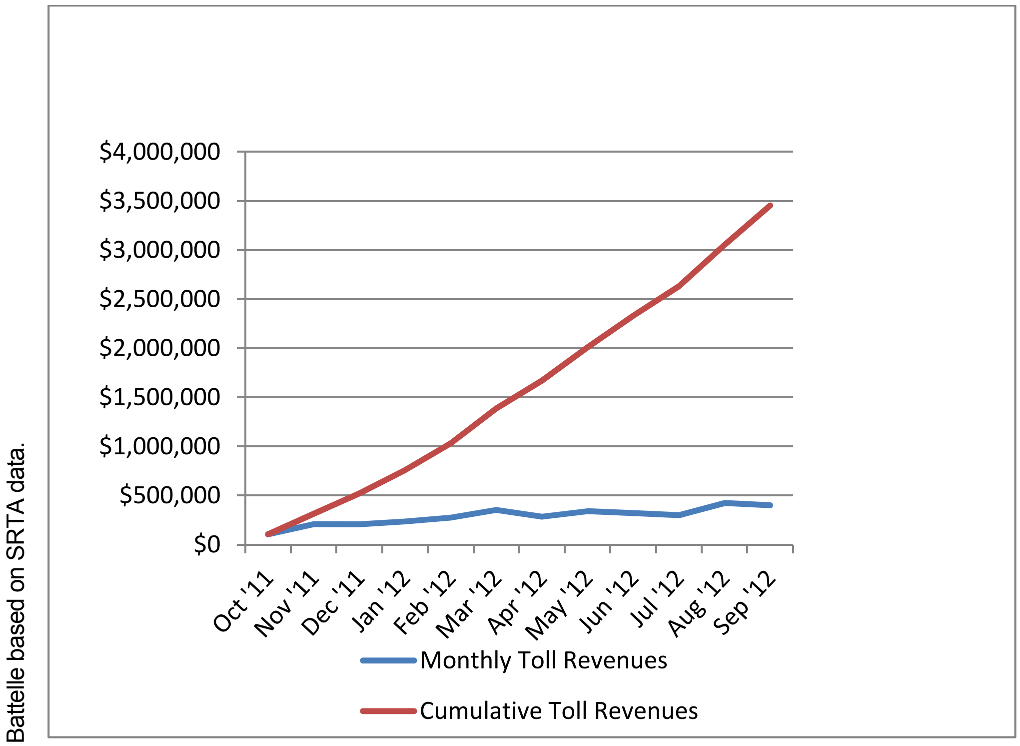


Figure G-4. I-85 Express Lane Toll Revenues by Month, October 2011 through September 2012

As of September 2012 there were no excess revenues generated by the tolling operation. The State Road and Tollway Authority (SRTA) used the revenues to pay for the operation of the toll system, and operational costs slightly exceeded revenues.[1] This was not a surprising result, given that excess revenues were not anticipated in the first year of an HOV-to-HOT conversion project.

In the event that revenues exceed operational costs in the future, SRTA had no formal written policy on how excess revenues were to be used. In interviews conducted with the local partners as part of the non-technical success factors analysis (Appendix K), some interviewees commented on the uncertainty about how potential excess revenues would be used. One potential issue was that funds for I-85 that come from state motor fuel taxes could only be used on roads and bridges and not transit.

[1] Personal communication with SRTA representative, May 14, 2013.

Also noted was that any decisions made about excess funds would be intensely political as they involve two boards appointed by different branches of government: the SRTA board appointed by the governor and the State Transportation Board appointed by the legislature.

G.6 Summary of Equity Analysis

Table G-15 presents a summary of the equity analysis across the four questions. The first question examined how impacts of I-85 CRD projects affected different user groups. Among the four groups examined, it could be argued that Xpress bus riders benefited the most as they had the lowest cost and benefited from faster travel on the Express Lanes. Other users of the Express Lanes benefited from faster travel, but unless they were carpools of 3 or more persons their costs increased by the cost of the toll (average of $2.27 in the p.m. and $3.95 in the a.m. peaks for the entire corridor trip) compared to users in the slower general purpose lanes. Unfairness of I-85 tolling on people with limited income continued to be a perception held by I-85 travelers in general, as well as transit riders who were surveyed. However, carpoolers responded positively to sharing the Express Lanes with those willing to pay the toll to gain a faster ride.

Analysis of the second question that examined geographic equity showed that proximity made a difference in usage of the CRD-funded enhancements in the I-85 corridor. Gwinnett County, where the CRD corridor was located, contributed the greatest percent of Xpress bus riders on the new routes (85 percent), as well as the most frequent users of the Express Lanes (68 percent). However, the Express Lanes drew from a wider area, especially from towns beyond the northern terminus. In addition, it was observed that I-85 travelers from more remote locations relied to a greater extent on Express Lanes when they traveled on I-85 than households closer to the corridor.

The third question focused on environmental justice—whether air quality impacts varied by location or socio-economic status. Importantly, all along the corridor the estimated impacts were judged to be positive or neutral in terms of VMT-based emissions. The northernmost section of the corridor experienced the greatest decline in VMT and the associated emissions. No adverse impacts on minority or low-income groups were discerned.

In the fourth question, the impact of reinvestment of toll-generated revenues was examined. No revenues in excess of operating expenses had been generated during the post-deployment period, and, thus, the issue had not been faced. SRTA did not have a policy regarding how excess revenues would be used, and in one-on-one interviews with local partners some concern was raised about potential institutional barriers to developing a policy. For example, could tolls be used for non-highway uses, such as transit?

Table G-15. Summary of Equity Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
How do the impacts from the I-85 CRD projects affect different transportation user groups?	Before/after variation in peak period travel times and travel costs by user group. Majority concerned about fairness of tolling on limited-income groups, but carpoolers not concerned about single-occupant vehicles paying toll to use Express Lanes.	General purpose lane users experienced slower travel as did 2-person carpoolers that switched to the general purpose lane to avoid paying a toll; 3-person carpools using the Express Lanes had faster travel at no additional cost; transit riders had the least cost and lower travel time as buses use the Express Lanes; Express Lane toll payers had the highest cost but faster travel than their general purpose lane counterparts. 57 percent of households in the Volpe survey that used I-85 in 2012 agreed that tolls were unfair to people with limited incomes as did 52 percent of Xpress bus riders in the transit survey. However, a majority in the carpooler survey agreed it was fair to allow SOVs to use the Express Lanes, which was consistent across socio-economic groups.
How do the impacts from the I-85 CRD differ across geographic areas?	CRD transit enhancements used by the nearest population. Express Lanes used primarily by nearest population, but also by more dispersed users. Reliance on the Express Lanes for I-85 trips varies by proximity to the CRD corridor.	85 percent of Xpress bus riders were from Gwinnett County, the closest to the new bus routes and park-and-ride lots. 68 percent of Express Lane trips originated in Gwinnett County, with remainder from towns throughout the region or state. As a percent of all trips taken on I-85, households in closest proximity used I-85 more frequently but with a lower percentage of trips in the Express Lanes than households farther away from the corridor.
Are the air quality impacts from the I-85 CRD projects different across geographic and socio-economic groups?	Northernmost sections of corridor experienced greatest decline in vehicle miles traveled and associate emissions. No adverse air quality impacts on minority or low-income groups.	While VMT-based emissions either improved or did not change significantly, two northeast road segments of the corridor had VMT reductions of 8.3 percent and 11.7 percent. Those sections had higher black/African-American and Asian populations, lower Hispanic or Latino populations, median income in the middle, and unemployment rates slightly higher than the norm for the corridor.
How does reinvestment of potential revenues from the I-85 Express Lanes impact various transportation system users?	No impact	Operating costs had been higher than revenues, and as a result there had been no excess revenues in the post-deployment period to reinvest. In addition, no policy existed for how excess revenues, when they occur, would be invested.

Source: Battelle

Appendix H. Environmental and Energy Analysis

The environmental and energy analysis of the Atlanta CRD focused on the potential impacts of the projects on air quality and energy consumption in the I-85 corridor. Table H-1 lists the questions included in the environmental and energy analysis. The first question addressed the air quality impacts of the Atlanta CRD. The second question explored the potential impacts of the CRD on energy consumption.

Table H-1. Environmental and Energy Analysis Questions

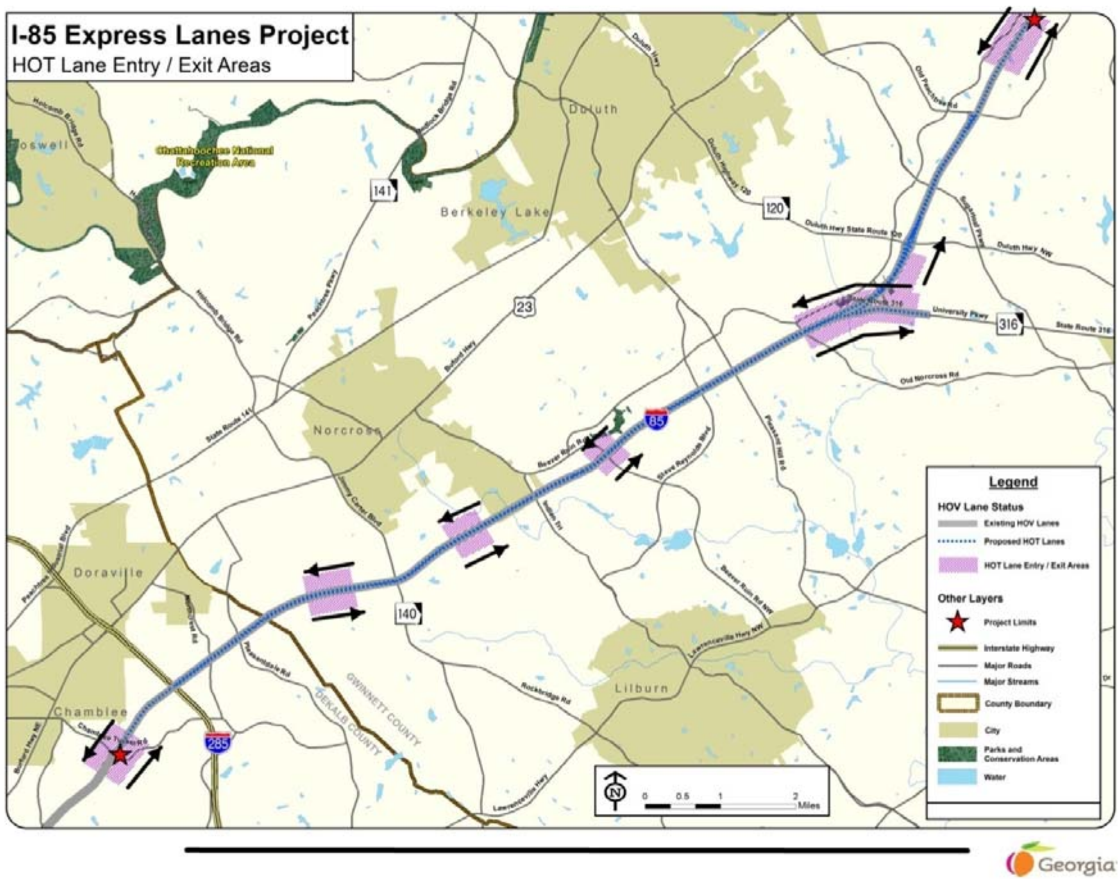
Questions
• What are the impacts of the Atlanta CRD strategies on air quality?
• What are the impacts on energy consumption?

Source: Battelle

Question one was addressed by quantifying the change in ozone precursors – volatile organic compounds (VOC) and nitrogen oxides (NOx), carbon monoxide (CO), small particulate matters ($PM_{2.5)}$ and carbon dioxide (CO_2), as an indicator of greenhouse gas potential. Question two was addressed by quantifying energy use, expressed in gallons of fuel use.

The Atlanta CRD projects were focused on reducing traffic congestion along the I-85 corridor. The centerpiece of the Atlanta CRD was the conversion of existing 2+ person high occupancy vehicle (HOV) lanes to dynamically-priced 3+ person high-occupancy toll (HOT) lanes, locally called Express Lanes, on approximately 16 miles of I-85 northeast of Atlanta. The analysis presented here focused on the impacts of the Express Lanes on emissions of air pollutants and fuel consumption.

Figure H-1 presents a map of the Express Lane area.



Georgia Department of Transportation, used with permission.

Figure H-1. I-85 HOT Lane Entry and Exit Points

The remainder of this appendix is divided into four sections. The data sources used in the analysis are presented in Section H.2. The analysis methods used in the air quality and energy assessment are discussed in Section H.3. The results of the analysis of the air quality and energy impacts on I-85 are summarized in Section H.4. In Section H.5 the appendix concludes with a summary of the findings of the environmental and energy analysis relative to the evaluation questions.

H.2 Data Sources

The air quality emissions and energy analysis was based on the emissions rates of vehicles utilizing the freeway facilities in the Atlanta metropolitan area, and the volumes and speed of those vehicles. Emission rates were provided by the Atlanta Regional Commission (ARC), the metropolitan planning organization (MPO) for the region. The volume and speed of the vehicles using the affected portions of the I-85 corridor in the pre- and post-deployment periods were measured by the Georgia Department of Transportation (GDOT) freeway management system, known as the NaviGAtor System. The system used video detection cameras spaced at regular intervals in the corridor to measure speed and volume in the general purpose and Express Lanes. These data were processed by the national evaluation team. Additional details on these data are included in Appendix A – Congestion Analysis.

The emission analysis evaluated changes in nitrogen oxides, (NOx), volatile organic compounds (VOC), carbon monoxide, (CO), fine particulate matter less than 2.5 microns ($PM_{2.5}$), and carbon dioxide (CO_2). NOx and VOC are the principal components of ozone, a lung irritant for which there are federal standards. CO is a colorless, odorless pollutant that can cause dizziness or even death in high concentrations and is also regulated by federal standards. CO_2 is a greenhouse gas.

Emission and Fuel Consumption Rates

Emissions and fuel consumption rates were estimated using the Environmental Protection Agency's (EPA) mobile source emissions factor models and were expressed in terms of grams of pollutant per mile of travel and gallons of fuel per mile of travel. ARC provided emission factors from the newest EPA motor vehicle emission factor model known as the Motor Vehicle Emissions Simulator (MOVES).

MOVES is EPA's latest available, state-of-the-art tool for estimating mobile source emissions from highway vehicles. MOVES replaced the MOBILE6 emissions model for use in state implementation plans (SIPs) and transportation conformity analyses. It must be used for new SIP development and for all conformity determinations after a three-year conformity grace period ending on March 2, 2013.

In order to transition to MOVES, ARC and Georgia Department of Environmental Protection (EPD) jointly developed MOVES-based methodologies to estimate emissions inventories for the Atlanta region. The computed emissions rates utilized a database of measured emissions from vehicles of different types and ages along with estimates of the mix of vehicle types (e.g., motorcycles, passenger cars, small trucks, and long-haul trucks), and their distribution by vehicle age in the Atlanta region. This set of vehicles and ages is referred to as the fleet mix, and is specific to the type of roadway facility. For example, a fleet mix for freeways contains more long-haul trucks than a fleet mix for arterials. Other factors considered in the development of the emissions factors include air temperatures, fuels used and their vapor content, and the presence or absence of a vehicle inspection and maintenance program.

The MOVES emission factors used in this analysis were for the Atlanta area vehicle fleet and conditions expected on the urban restricted freeway roadway class. The latest available distribution of the age of vehicles in the Atlanta region was converted by ARC from a MOBILE6 to a MOVES format using an EPA converter. MOBILE6 age distributions were shown over 25 years, but MOVES required age distributions over 30 years. The EPA converter spreadsheet made assumptions about how vehicles that are 25-30 years old are distributed over the oldest 5 years. MOBILE6 distributions were derived from 2002 R.L. Polk & Co. registration data for the 13 and 7 county areas[1] separately for all vehicle types, except for one of the heavy duty diesel truck categories for which defaults were used. The inputs described below were provided by the ARC to document the assumptions underlying the emission factors used in the analysis presented in this appendix.

MOVES defaults for fuel characteristics in Fulton County (13-county) and Bartow County (7-county) were reviewed and determined to accurately reflect the local fuel in use, which has the following characteristics:

- Fuel – Phase 2 Low Sulfur, Low RVP Georgia Gasoline
- 100 percent market share of 10 percent ethanol-blend gasoline (E10) assumed
- Volatility waiver for E10 allows 1.0 psi RVP increase

[1] In the Atlanta region the nonattainment area boundaries were composed of different sets of counties depending on the pollutant for which the nonattainment classification applies.

Different temperature, meteorology and similar profiles were used for different pollutants. For example, the Atlanta area fine particulate matter ($PM_{2.5}$) nonattainment status was for the annual standard, and thus an annual average day condition was used as input to MOVES to estimate $PM_{2.5}$ emission rates. However, ozone is a summer pollutant, and so July average conditions were used as inputs to estimate the ozone precursors VOC and NOx emission rates.

The 13-county area had an inspection/maintenance program that was modeled in MOVES, although 7 of the counties do not. ARC inspected the MOVES defaults for Fulton County and modified them to provide the correct model years covered and testing methods used as summarized in the following inspection/maintenance program characteristics:

<u>Stage II Refueling Vapor Recovery</u>

- Started in 1992
- Three phase in years
- 81 percent efficiency

<u>Exhaust and Evaporative (OBD and gas cap pressure test) for 1996 and Newer Vehicles</u>

- Annual inspection required
- Computerized test and repair OBD – Exhaust
- Computerized test and repair OBD & GC – Evaporative
- Applies to all LDG vehicle types
- Three year grace period
- 3 percent waiver rate for all vehicles – Exhaust test
- 0 percent waiver rate for all vehicles – Evaporative test
- 97 percent compliance

<u>Exhaust and Evaporative Test for 1975 – 1995 Vehicles</u>
Annual inspection required

Computerized test and repair ASM 2525/5015 Phase-in – Exhaust

Computerized test and repair GC – Evaporative

- Applies to all LDG vehicle types
- 3 percent waiver rate for all vehicles – Exhaust
- 0 percent waiver rate for all vehicles – Evaporative
- 97 percent compliance
- 25 year and older model years are exempt

The above inputs were used in MOVES model runs to develop emission factors by speed for the ozone precursors NOx and VOC, for $PM_{2.5}$, carbon monoxide, and greenhouse gases represented by carbon dioxide equivalent (CO_2e). Fuel consumption rates, also by speed, were developed in miles per gallon.

A major improvement in the use of MOVES over the earlier MOBILE6 model was the ability to model the effects of travel speed on emissions of particulate matter, CO, CO_2, and fuel consumption. The MOBILE6 model could do this only for NOx and VOC. The speed of travel has an enormous effect on emission rates. In fact, the effect is so large that vehicle miles travelled can change in one direction while emission totals change in the opposite. For example, one would expect an increase in VMT to result in an increase in emission. However, if that increase is accompanied by a change in travel speeds it is possible for the VMT increase to be overshadowed by even a relatively small change in speeds (say, by 5 mph) resulting in an overall emission decrease.

The MOVES factors developed by ARC were graphed by the national evaluation team to help inform the analysis of the results presented later. Figure H-2 through Figure H-5 present the MOVES emission factors for the Atlanta region for ozone precursors VOC and NOx, CO, CO_2, and fuel consumption.

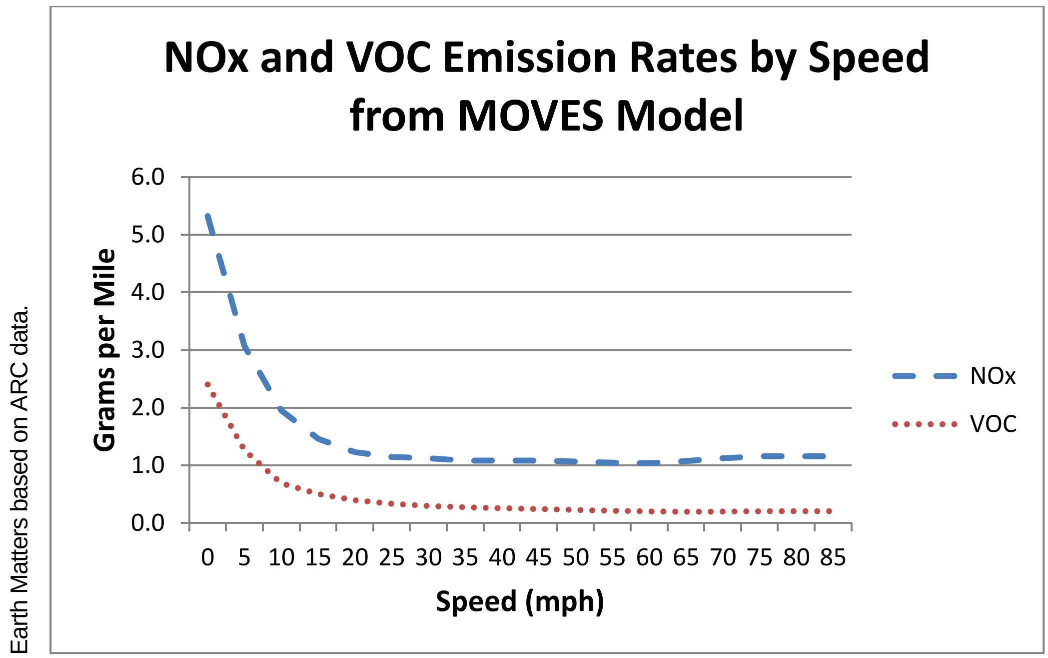


Figure H-2. Ozone Precursor Emission Rates of NOx and VOC by Speed Output by the EPA MOVES Model for the Atlanta Region

Earth Matters based on ARC data.

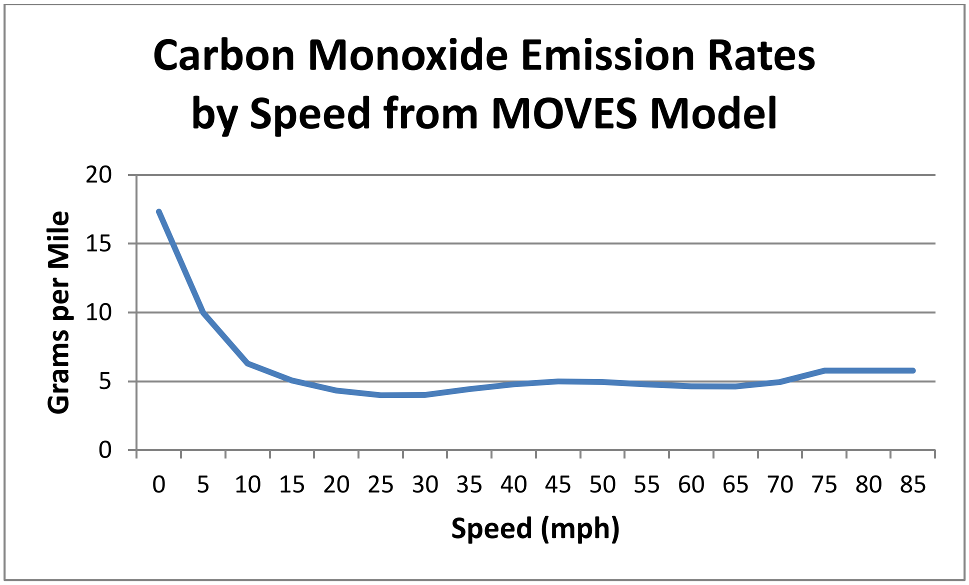


Figure H-3. Carbon Monoxide Emission Rates by Speed Output by the EPA MOVES Model for the Atlanta Region

Earth Matters based on MOVES output provided by ARC to Battelle

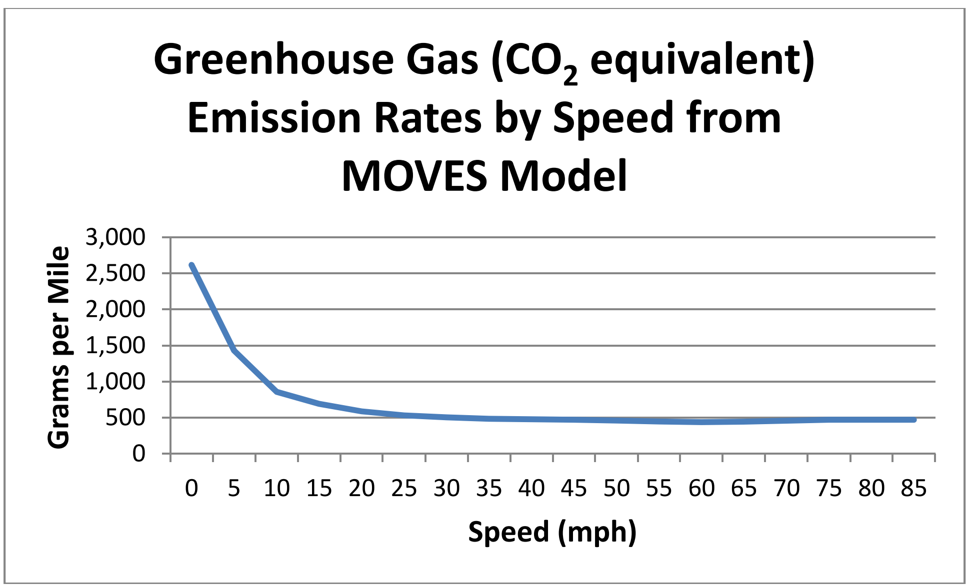


Figure H-4. Carbon Dioxide Emission Rates by Speed Output by the EPA MOVES Model for the Atlanta Region

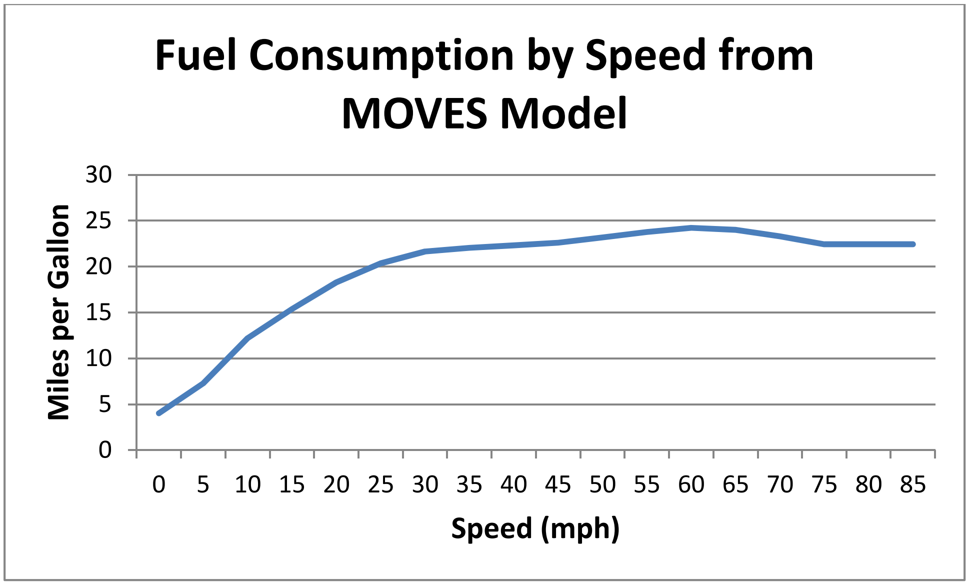


Figure H-5. Fuel Consumption Rates by Speed Output by the EPA MOVES Model for the Atlanta Region

Figure H-2 through Figure H-5 illustrate that it is also possible for emissions to change in different ways for different pollutants while being evaluated for the same change in traffic volume. This fact is important in interpreting the emission results presented later. It is important to note that changes in speeds in the range of 0 to 30 mph have the most dramatic impacts on emission results.

Traffic Data

The volume and speed data for the national evaluation were based on GDOT's NaviGAtor System. Owing to an upgrade of the software system from NaviGAtor I to NaviGAtor II completed in February 2011, only data collected after that date were considered usable for the evaluation for reasons of consistency. As discussed in Appendix A – Congestion Analysis, data quality checks were performed on the NaviGAtor II data by the national evaluation team resulting in the elimination of data from sensors that did not meet certain quality criteria. The data selected for the congestion analysis, and used in the environmental and energy analysis, were for all non-holiday weekdays for April through August 2011 for the pre-deployment period and April through August 2012 for the post-deployment period. The data represented averages over for the a.m. and p.m. peak periods, which are 6:00 a.m. to 10:00 a.m. in southbound direction of travel and 3:00 p.m. to 7:00 p.m. in the northbound travel direction. These time periods also correspond to the peak periods defined in the congestion analysis.

The traffic data used in the environmental and energy analysis include volume, expressed as the number of vehicles passing a traffic detector during a 5-minute sampling period, and speed, also measured in 5-minute sampling periods. Changes in the amount and speed of travel are what change air quality and energy use. Summaries of the traffic data prepared specifically for the environmental and energy analysis are presented in Sections H.3.

H.3 Air Quality and Energy Analysis Methodology

The Atlanta CRD projects had the ability to change congestion levels, travel speeds, and the amount of traffic (volume) on I-85. These impacts cause changes in air quality and energy use. The speed, volume and congestion impacts on air quality and energy use were evaluated using the MOVES emissions model factors for the speeds and volumes available from the traffic data.

As illustrated in Figure H-2 through Figure H-5, emissions factors and fuel consumption in the region changed significantly at different speeds. As illustrated in these figures, extremely low speeds caused emissions per mile of travel to rise. At higher speeds, emission increases also occurred, though not as dramatically. This means measures that improved traffic flow did not necessarily improve air quality. For example, if traffic flow increased from 60 to 70 mph, emissions could increase. Projects and measures that increased speeds that were previously extremely low would significantly decrease some pollutant emissions such as NOx or CO, but could slightly increase VOC emissions.

Speeds have a different effect on fuel consumption. The higher the speed, the better the fuel consumption until approximately 60 mph. Fuel economy declines for speeds higher than 60 mph. For most vehicles fuel consumption typically increases for speeds higher than 60 mph.

Emissions change as a result of both speeds and the amount of travel. It is common for VMT to be the predominant "driver" of changes in emissions, as it was for this analysis. However it is inaccurate to evaluate emission effects from VMT only since speeds also have a strong effect and can even sometimes be the predominant factor. It is for this reason that the emission *rates* at different speeds, and the changes in speeds for the pre- and post-deployment cases, are discussed in some detail.

Traffic data were analyzed only for the I-85 CRD corridor between Chamblee Tucker Road and Old Peachtree Road. No data were evaluated on other parts of I-85 or other freeway facilities and are not available for arterials adjacent to I-85.

Tables describing before and after traffic volumes and the frequency of speeds between 1 and 80 mph were developed as part of the environmental analysis and are presented in Section H.4. Detailed figures showing the frequency of speeds in the pre- and post-deployment periods are presented later in this section. The needs of the environmental analysis differ somewhat from those of the congestion analysis and, therefore, required analysis additional to that prepared and presented in Appendix A.

Observed traffic volumes (referred to alternately as VMT) declined in the post-deployment period relative to the pre-deployment period for both the Express Lanes and the general purpose lanes and in both the a.m. and the p.m. peak periods. In the a.m. peak VMT declined by 7.4 percent in the Express Lanes and 8.8 percent in the general purpose lanes. During the p.m. peak period VMT declined by 3.8 percent in the Express Lanes and 1.1 percent in the general purpose lanes.

The changes in traffic volumes played the dominant role in the reduced emissions and energy use presented later in this Appendix. The changes in traffic volumes were likely the result of a combination many factors, including the HOV-to-HOT conversion, changes in carpooling and transit use, possibly changes in time of travel such as travel moving from peak to off-peak periods, and economic factors, such as gasoline prices and unemployment, that could affect the amount of travel in the corridor.

Evidence for some of these changes was reported in Appendix D – TDM Analysis and the congestion analysis in Appendix A. They showed that peak period average vehicle occupancy dropped in the Express Lanes and increased slightly in the general purpose lanes after tolling as significant numbers of two-person carpools shifted to the general purpose lanes from the previous HOV lanes. There was a decrease in vehicle throughput in both lanes, and, although transit usage increased, person throughput declined as well.

As discussed previously and illustrated in Figure H-2 through Figure H-5, emission and fuel consumption changes were strongly influenced by travel speeds. As discussed later in Section H.4, the effect of changes in travel speed sometimes overshadowed the changes in traffic volumes. For example in some cases, traffic volume decreased but emissions of some pollutants increased.

Because of the key role played by travel speeds in the environmental analysis, along with the need to adequately represent the changes in stop-and-go traffic observed in the I-85 corridor after deployment of the CRD projects, an analysis was made of the percent of time drivers spent at each speed between 1 mph and 80 mph in the pre-and post-deployment periods for the Express Lanes and for the general purpose lanes. The resulting frequency distribution was used in the environmental analysis by evaluating the emissions resulting from the peak period volumes at each speed from 1 mph to 80 mph and then weighting the emissions by the percentage of time at each speed. Doing this ensured that changes in the frequency with which certain speeds were observed were reflected in the emission analysis. For example, if speeds changed from 10 mph to 20 mph but only for 1/10 of a percent of the time, that should not be treated in the same way as if the change occurred for 2 percent of the time.

Figure H-6 through Figure H-9 illustrate the a.m. and p.m. peak period travel speeds for the Express Lanes in the pre-deployment and post-deployment periods. Figure H-10 through Figure H-13 present similar information for the adjacent general purpose lanes.

The Express Lane figures show that speeds between 25 and 35 mph were more frequent in the post-deployment period for the a.m. peak period than in the pre-deployment period even though traffic volumes were lower. In the p.m. peak period, speeds between 25 and 35 mph were only observed in the pre-deployment period.

In addition, differences could be observed between the pre- and post-deployment speed distributions in the a.m. and p.m. peak. The a.m. peak post-deployment speeds showed much more frequency at speeds greater than 65 mph than in pre-deployment. The p.m. peak period post-deployment speeds showed approximately the same pre- and post-deployment frequency of speeds greater than 65 mph. At the lower extreme of 25 to 35 mph, the a.m. peak showed a little more time at these speeds in the post-deployment period than the pre-deployment period. In the p.m. peak there were virtually no pre-deployment speeds in this range and no post-deployment speeds.

Figure H-8 shows the frequency distribution of speeds in the Express Lanes during the p.m. peak period. Speeds less than 36 mph occurred sometimes in the pre-deployment period but never in the post-deployment period. The graph suggests that speeds were often higher in the pre-deployment period than in the post-deployment period, but Figure H-9 shows this is not quite true.

Figure H-9 shows that the amount of travel at slower speeds (less than 45 mph) decreased in the post deployment period in the p.m. peak period, while speeds above 46 miles an hour were more frequent in the post-deployment than the pre-deployment periods.

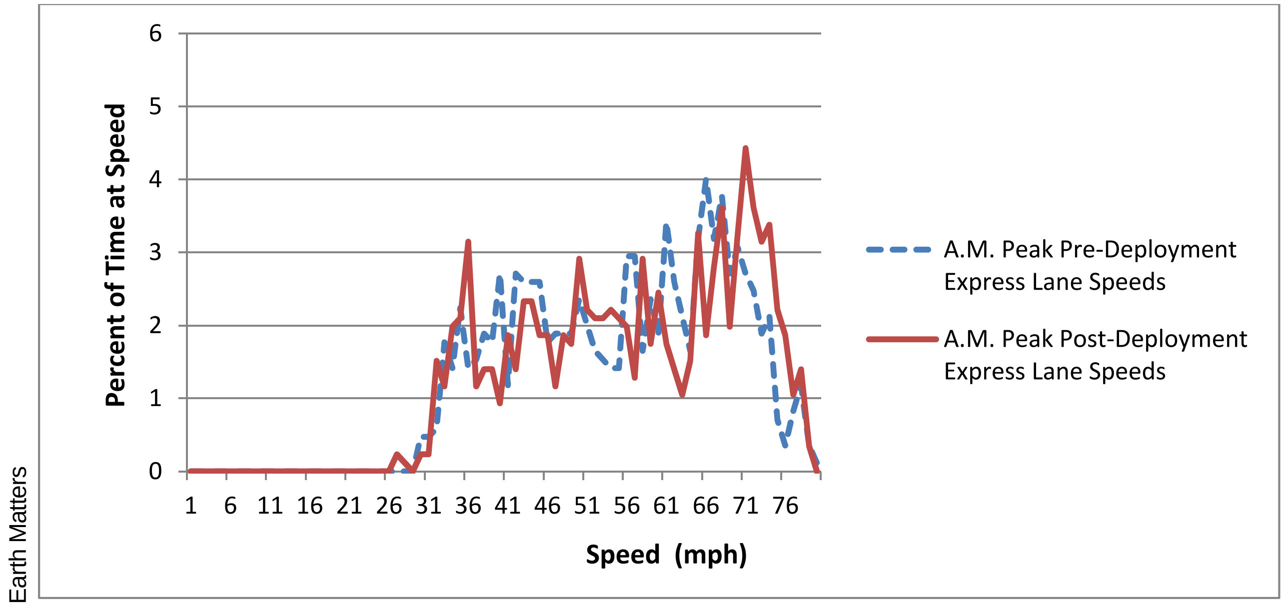


Figure H-6. Pre- and Post-Deployment Frequency Distribution of Speeds in Express Lanes in the A.M. Peak Period

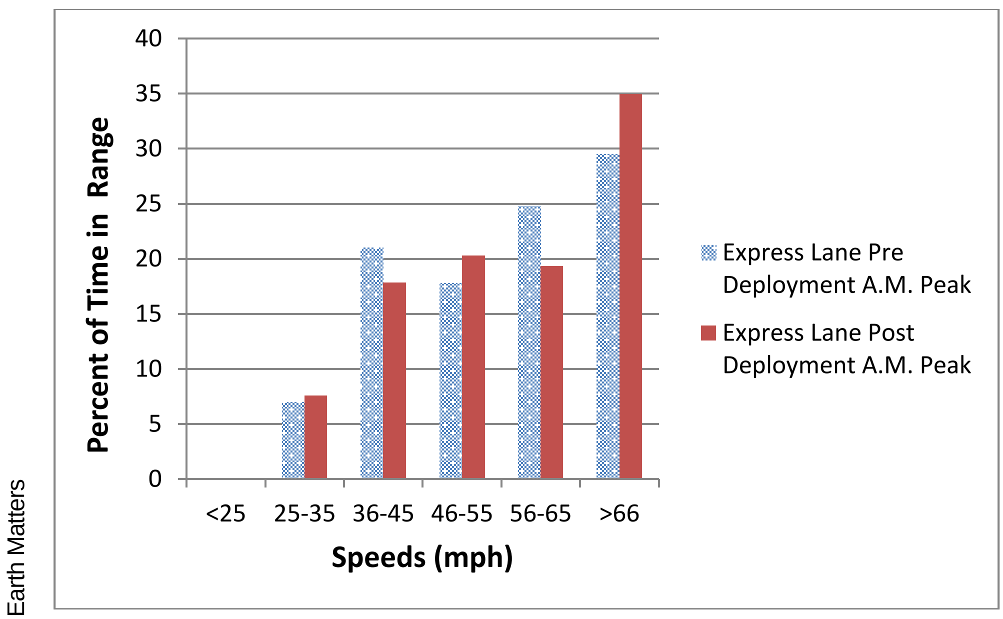


Figure H-7. Percentage of Time in Ranges of Speeds for Express Lanes in the A.M. Peak Period

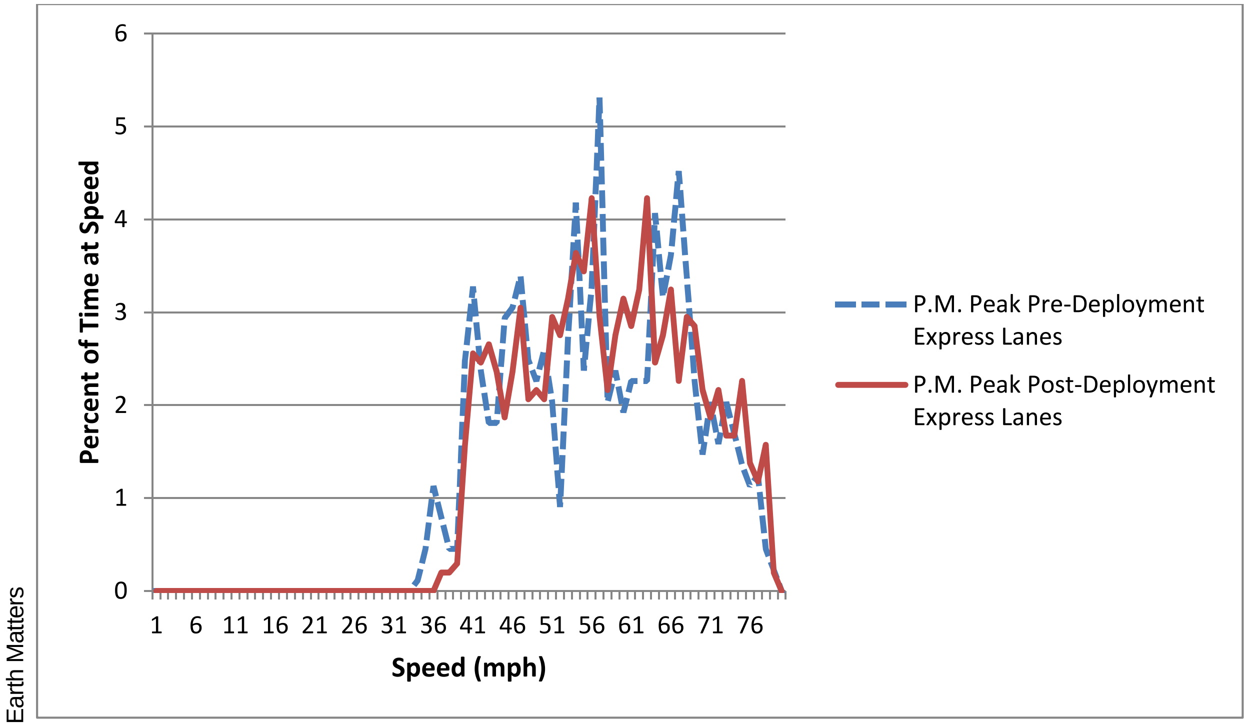


Figure H-8. Pre- and Post-Deployment Frequency Distribution of Speeds in the Express Lanes in the P.M. Peak Period

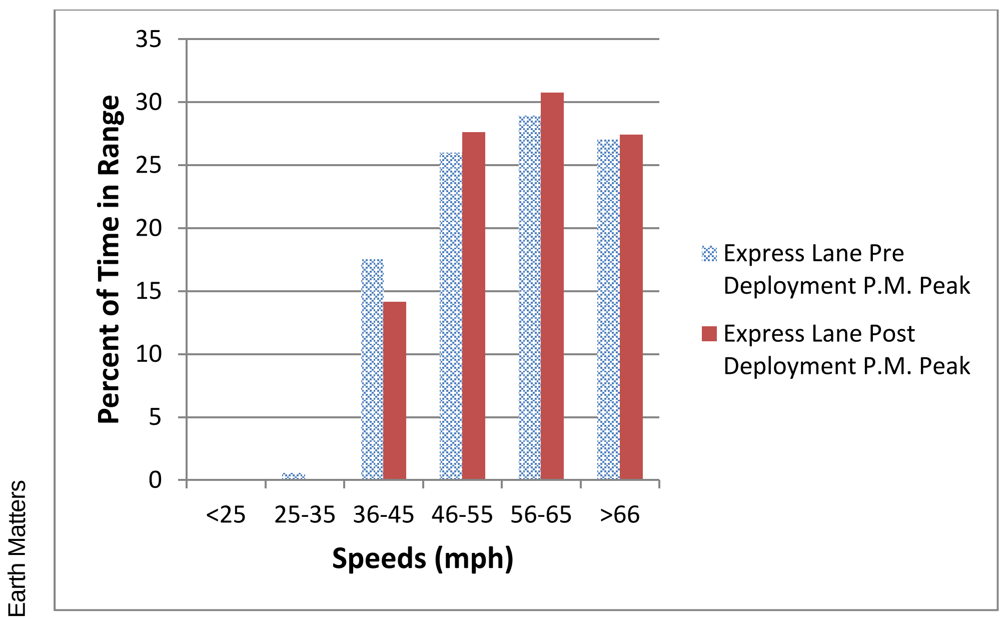


Figure H-9. Percentage of Time in Ranges of Speeds in the Express Lanes in the P.M. Peak Period

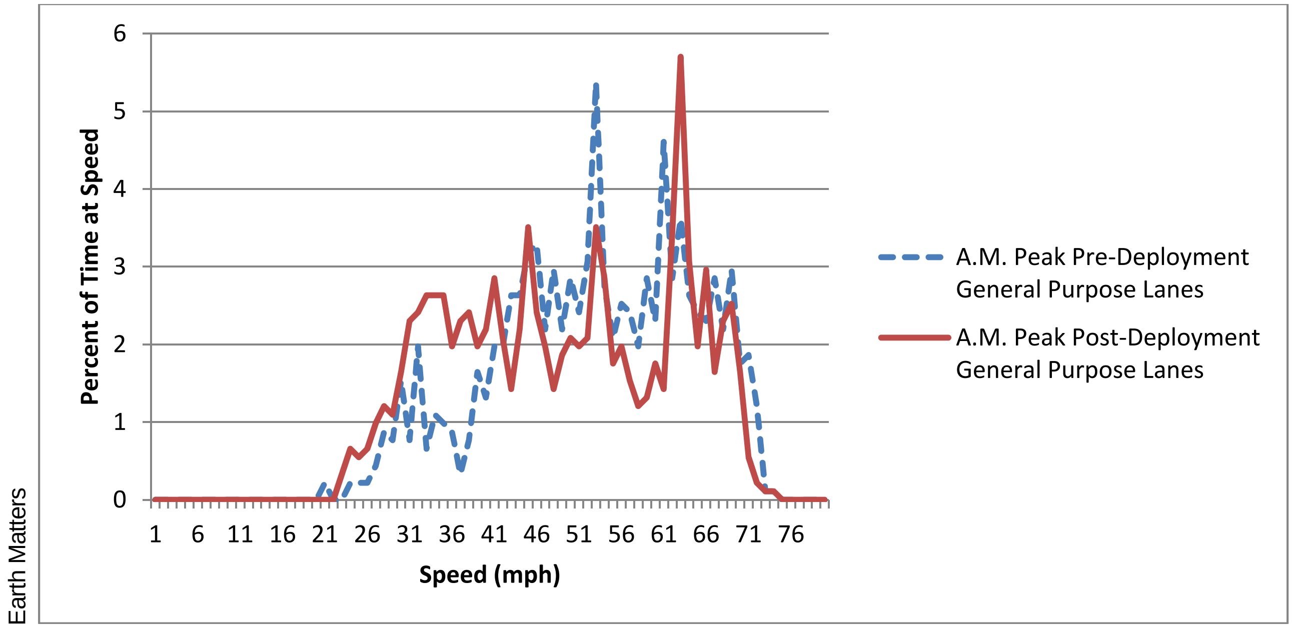


Figure H-10. Pre- and Post-Deployment Frequency Distribution of Speeds in the General Purpose Lanes in the A.M. Peak Period

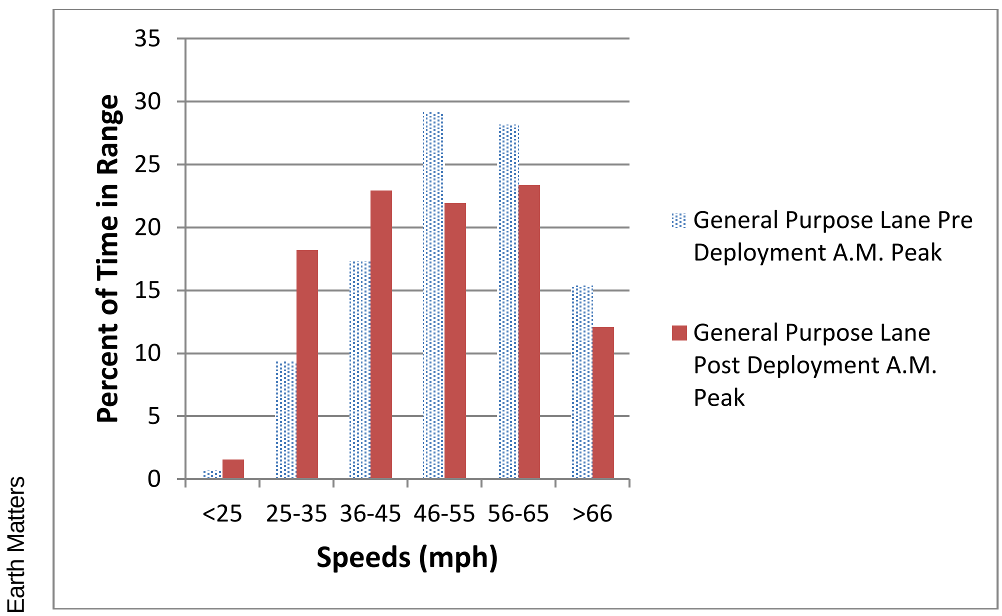


Figure H-11. Percentage of time in Ranges of Speeds for General Purpose Lanes in the A.M. Peak Period

In the general purpose lanes speeds got generally slower during the a.m. peak, as shown in Figure H-10 and Figure H-11. Speeds of less than 45 mph were more frequent in the post-deployment period while speeds greater than 45 were more frequent in the pre-deployment period.

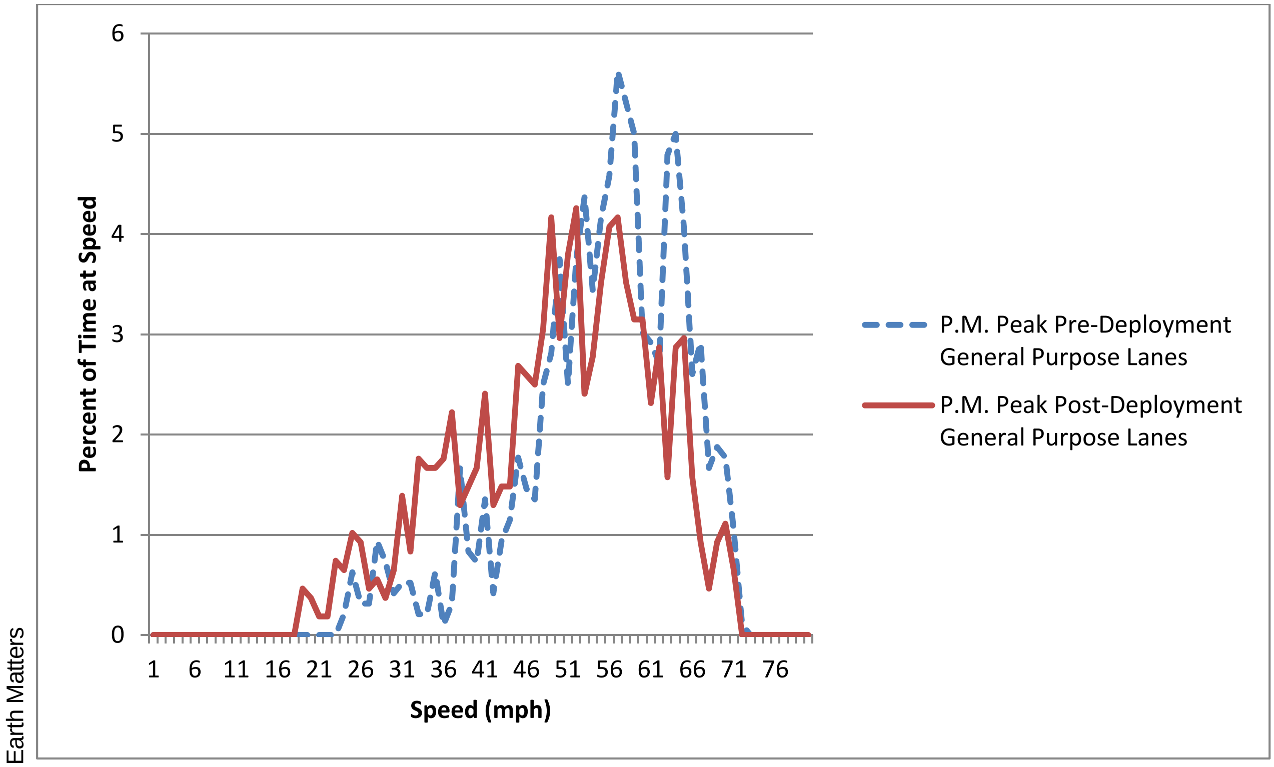


Figure H-12. Pre- and Post-Deployment Frequency Distribution of Speeds in General Purpose Lanes During the P.M. Peak Period

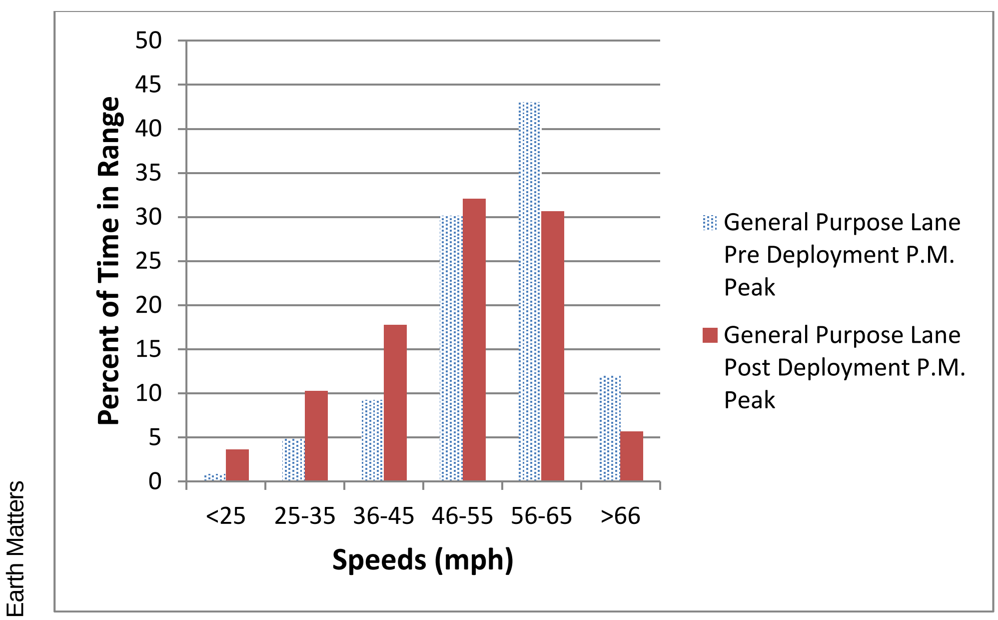


Figure H-13. Percentage of Time in Ranges of Speeds for General Purpose Lanes in the P.M. Peak Period

The p.m. peak period showed some variation. As in the a.m. peak period, post-deployment speeds of less than 45 mph were more frequent than they were in the pre-deployment period. Mid-range speeds of 46 – 55 mph were slightly more frequent post-deployment. Speeds greater than 56 mph were more frequent in the pre-deployment period.

VMT Analysis

The volume data were evaluated at the 5-minute level, and summed over the a.m. and p.m. peak periods consistent with the traffic analysis presented in Appendix A. VMT was estimated by multiplying the observed throughput in a given segment by the length of that segment. In some cases segment lengths had to be adjusted (increased) to adjust for segments with missing data. A common example would be when multiple segments existed between exits and one or two of the traffic sensors were “down” for extended periods.

H.4 Findings from the Air Quality and Energy Analysis

This section presents the results of the air quality and energy analysis for the CRD projects in the Atlanta region. Table H-2, Table H-3 and Table H-4 present the results for the Express Lanes, general purpose lanes, and both lanes combined, respectively.

The values presented in Table H-2 through Table H-4 represent average daily emissions, VMT, and speeds during the a.m. and p.m. peak periods along the affected portions of I-85. As noted in Section H.2, the period April through August was used for the pre- and post-deployment analysis periods, coinciding with the time period used in the congestion analysis presented in Appendix A.

Table H-2. Pre- and Post-Deployment Traffic Volumes, Emissions, and Energy Use on I-85 Express Lanes from Chamblee Tucker Rd. to the North of Old Peachtree Road

	A.M. Peak			P.M. Peak			Combined A.M. and P.M. Peak Values		Net Change	
	Pre-Deployment	Post-Deployment	Percent Change	Pre-Deployment	Post-Deployment	Percent Change	Pre-Deployment	Post-Deployment	Amount	Percent
Average Speed	50.1	51.5	+2.8	50.3	51.6	+2.6	50.2	51.6	1.4	+2.8
VMT	45,546	42,176	-7.4	51,881	49,935	-3.8	97,427	89,111	-8,316	-8.5
VOC (lbs)	21.6	20	-7.4	24.1	21.6	-10.4	45.7	41.6	-4.1	-9.0
NOx (lbs)	108.4	100.9	-6.9	123.0	113.0	-8.1	231.4	213.9	-17.5	-7.6
$PM_{2.5}$	2.2	2.1	-4.5	2.5	2.2	-12.0	4.7	4.3	-0.4	-8.5
CO (lbs)	476.2	444.8	-6.6	549.3	500.0	-9.0	1,025.5	944.8	-80.7	-7.9
CO_2 (tons)	23.1	21.4	-7.4	26.0	23.5	-9.6	49.1	44.9	-4.2	-8.6
Fuel Use (gal)	1,959	1,821	-7.0	2,214	2,002	-9.6	4,173	3,823	-350	-8.4

Source: Earth Matters

Table H-3. Pre- and Post-Deployment Traffic Volumes, Emissions, and Energy Use on I-85 General Purpose Lanes between Chamblee Tucker Rd. to the North of Old Peachtree Road

	A.M. Peak			P.M. Peak			Combined A.M. and P.M. Peak Values		Net Change	
	Pre-Deployment	Post-Deployment	Percent Change	Pre-Deployment	Post-Deployment	Percent Change	Pre-Deployment	Post-Deployment	Amount	Percent
Speeds	46.1	43.9	-4.8	45.1	41.0	-9.1	45.6	42.4	-3.2	-6.9
VMT	377,811	344,456	-8.8	412,780	408,412	-1.1	790,591	752,868	-37,723	-4.8
VOC (lbs)	181.2	172.0	-5.1	191.8	201.7	+5.2	373	373.7	+0.7	+0.2
NOx (lbs)	893.8	819.2	-8.3	969.2	965.1	-0.42	1,863	1,784.3	-78.7	-4.2
$PM_{2.5}$	19.2	18.6	-3.1	19.9	21.3	+7.0	39.1	39.9	+0.8	+2
CO (lbs)	3,915.2	3,505.2	-10.5	4,283.5	4,216.3	-1.6	8,198.7	1,784.3	-477.2	-5.8
CO_2 (tons)	191.9	177.4	-7.6	206.9	209.5	+1.3	398.8	386.9	-11.9	-3.0
Fuel Use (gal)	16,118	16,352	+1.4	17,553	17,578	+`0.1	33,671	33,930	+259	+0.8

Source: Earth Matters

Table H-4. Total Pre- and Post-Deployment Traffic Volumes, Emissions, and Energy Use on I-85 Express and General Purpose Lanes between Chamblee Tucker Rd. to the North of Old Peachtree Road

	A.M. Peak			P.M. Peak			Combined A.M. and P.M. Peak Values		Net Change	
	Pre-Deployment	Post-Deployment	Percent Change	Pre-Deployment	Post-Deployment	Percent Change	Pre-Deployment	Post-Deployment	Amount	Percent
VMT	423,357	386,632	-8.7	464,661	458,347	-1.4	888,018	841,979	-46,039	-5.2
VOC (lbs)	202.8	192.0	-5.3	215.9	223.3	+3.4	418.7	415.3	-3.4	-0.8
NOx (lbs)	1,002.2	920.1	-8.2	1,092.2	1,078.1	-1.3	2,094.4	1,998.2	-96.2	-4.6
$PM_{2.5}$	21.4	20.7	-3.3	22.4	23.5	+4.9	43.8	44.2	+0.4	+1
CO (lbs)	4,391.4	3,950.0	-10.0	4,832.8	4,716.3	-2.4	9,224.2	8,663.3	-557.9	-6.0
CO_2 (tons)	215.0	198.8	-7.5	232.9	233.0	+.04	447.9	431.8	-16.1	-3.6
Fuel Use (gal)	18,077	18,173	+0.5	19,767	19,580	-0.9	37,844	37,753	-91	-0.2

Source: Earth Matters

For the Express Lanes, as presented in Table H-2, average speeds improved by nearly 3.0 percent in both the a.m. and p.m. peak periods while VMT decreased by between 3.8 percent (p.m.) and 7.4 percent (a.m.). Emissions of all pollutants decreased by between 4.5 percent and 12 percent, depending on the pollutant and time period. The emission reductions in the p.m. peak period were larger than changes in the a.m. peak period for all pollutants. Fuel consumption also decreased: by 7.0 percent in the a.m. peak and by 9.6 percent during the p.m. peak.

In the general purpose lanes, presented in Table H-3, average speeds decreased by 4.8 percent during the a.m. peak period and by 9.1 percent during the p.m. peak. VMT during those periods decreased by 8.8 percent and 1.1 percent in the a.m. and p.m. peak periods respectively. The emission changes in the general purpose lanes highlighted the important role played by changes in travel speed. In the a.m. peak, there is a 3.1 to 10.5 percent decrease in emissions and a 1.4 percent increase in fuel consumption. The different values for the emission changes and the opposite direction of change for fuel consumption were occurring because of the changes in speed since each pollutant was evaluated for the same VMT change.

The general purpose lanes in the p.m. peak period had a smaller decrease in emissions, ranging from 0.4 to 7.0 percent. Fuel consumption still increased though by a smaller amount (0.1 percent) than it did in the a.m. peak.

Table H-4 presents the combined sum of VMT, pollutants and fuel consumption for Express Lanes and general purpose lanes. Overall fuel use declined by 0.2 percent while most air pollutants also decreased. VOC decreased by 0.8 percent, CO_2 by 3.6 percent, CO by 6 percent, and NOx by 4.6 percent. Emissions of $PM_{2.5}$ increased slightly (by 1 percent).

Overall, the impact of the CRD projects was an improvement in emissions of nearly all pollutants as well as lower fuel consumption.

H.5 Summary of Environmental Analysis

Table H-5 presents a summary of the questions examined in the environmental analysis of the Atlanta CRD projects. As discussed in this appendix, the projects had mostly positive impacts on air quality and energy consumption. The analysis of the I-85 CRD corridor indicated generally positive impacts on air quality (0.8 to 6.0 percent reduction in emissions of everything except $PM_{2.5}$, which increased by 1.0 percent). Fuel consumption declined by 0.2 percent. The emission and fuel use reductions were predominant in the Express Lanes, ranging from 7.6 to 9.0 percent. The adjacent general purpose lanes experienced both increases and decreases in emissions and energy use, depending on the pollutant.

Table H-5. Summary of Impacts Across Questions

Questions	Result	Evidence
What are the impacts of the Atlanta CRD strategies on air quality?	Positive impacts overall	Positive impacts in the Express Lanes ranging from 7.6 to 9.0 percent decreased air pollutant emissions. The combination of Express and general purpose lanes also exhibited positive impacts with the exception of a one percent increase in one pollutant ($PM_{2.5}$). The other four pollutants all decreased.
What are the impacts on energy consumption?	Positive impacts in Express Lanes, and overall.	Reduction in fuel use of 8.4 percent in the Express Lanes. Increased fuel consumption (0.8 percent) in the general purpose lanes. Overall combined reduction of 0.2 percent.

Source: Earth Matters

This page intentionally left blank.

Appendix I. Goods Movement Analysis

This analysis examined potential effects of the Atlanta CRD projects on commercial vehicle operators. The Atlanta CRD projects did not focus specifically on goods movement in the I-85 corridor or in the metropolitan area as a whole. However, given the economic importance of goods movement to the Atlanta region, understanding the impacts of the Atlanta CRD projects on this sector was important. While vehicles with more than six wheels (with the exception of over-the-road buses or emergency vehicles) and multi-unit vehicles are prohibited from using the Express Lanes, the reduction of congestion on the general purpose lanes of I-85 could have reduced travel times for commercial vehicle operators (CVOs), allowing faster movement of long-haul semi-trucks and vehicles used for short-haul delivery and by service providers.

Also, some commercial operators with light-duty trucks (such as package deliverers and service vehicles) may have realized travel-time savings and improved trip-time reliability through use of the Express Lanes. At the same time, the tolls associated with the Express Lanes represented an added cost of doing business for such commercial entities, which must be weighed against the potential gains made in travel time.

Table I-1 presents the four hypotheses in the goods movement analysis. The first hypothesis was that commercial vehicles on I-85 general-purpose lanes would realize travel-time savings due to the overall reduction in congestion resulting from the deployment of the CRD projects. The second hypothesis looked at the trends in usage of the Express Lanes by commercial operators. The third and fourth hypotheses related to the commercial vehicle operators' perceptions of the Express Lanes and tolling, specifically on the perceived advantages and disadvantages of tolling and the ability to make operational changes due to the CRD projects.

Table I-1. Goods Movement Analysis Questions

Hypotheses/Questions
• Commercial vehicle operators (CVOs) will experience reduced travel time by reduced congestion on general purpose lanes.
• Operators with light-duty trucks will prefer to use Express Lanes to general purpose lanes for faster travel times.
• Operators delivering goods will perceive the net benefit of tolling strategies (e.g., benefits such as faster service and greater customer satisfaction outweigh higher operating costs due to tolls).
• Operators report changing operational decisions due to use of Express Lanes (e.g., changing delivery times).

Source: Battelle

The remainder of this appendix is divided into three sections. The data sources used in the analysis are described next in Section I.1. Section I.2 presents the analysis of potential impacts on goods movement, including the potential for reduced congestion experienced on general purpose lanes by commercial vehicle operators, operator preference to use the Express Lanes versus general purpose lanes for faster travel times, operators' perception of tolling benefits, and operators changing operational decisions due to the Express Lanes. The appendix concludes with a summary of the potential business impacts in Section I.3.

I.1 Data Sources

Data for the goods movement analysis were obtained from the focus group and interview summaries of small business owners that had small and large commercial trucks and with small business owners in the community improvement district (CID). These focus groups and interviews were conducted by Noble Insight for the Georgia Department of Transportation (GDOT) and State Road and Toll Authority (SRTA). Two focus groups were conducted following the general approach and questions presented in the Atlanta CRD Surveys and Interviews Test Plan.[1] Businesses located in ZIP codes along the I-85 corridor were recruited and selected to incorporate a variety of viewpoints, including businesses that owned small and/or large commercial vehicles, and businesses using and not using a Peach Pass. One focus group included eight participants representing small business owners with small and/or large commercial trucks and the other comprised of nine participants representing small business owners in the community improvement district (CID). These participants discussed topics that included perceptions of congestion and safety before and after the conversion of the I-85 Express Lanes from HOV lanes, why they chose to or not to purchase a Peach Pass, and personal experiences of employees. Owing to the small number of participants, the findings were not intended to provide statistically significant data. Rather, focus groups offered insights into the businesses' response to the CRD projects.

Other data used in the analysis are travel time values for both the general purpose lanes and Express Lanes obtained from Appendix A – Congestion Analysis. As reported in Appendix B – Tolling Analysis, the toll classifications used by SRTA include a couple of commercial vehicles categories—commercial toll accounts for fleets and post-paid accounts allowing tolls to be invoiced monthly. It was possible to determine the usage of the Express Lanes by companies with those types of accounts. It should also be noted that some data of potential use for the goods movement analysis were not available. The occupancy study conducted by Georgia Tech for GDOT focused on the number of people in a vehicle, and the national evaluation team was not provided any data on the frequency of trucks using I-85. Thus, the analysis was limited to data from the focus groups, I-85 travel time, and the toll transactions.

I.2 Analysis of the CRD Impacts on Goods Movement

Travel Time in the I-85 Corridor. Commercial vehicles transporting goods in the Atlanta region were part of the traffic flow in the I-85 corridor and, therefore, were impacted by the changes in travel time resulting from the CRD projects. The Express Lanes are available to smaller commercial vehicles meeting size restrictions either by paying a toll or riding toll-free with three or more persons in the vehicle. Thus, the Express Lanes could provide travel time savings to businesses, if their vehicles

[1] Battelle. "Atlanta Congestion Reduction Demonstration, National Evaluation: Surveys and Interviews Test Plan," August 16, 2011. FHWA-JPO-11-104.

qualify for the Express Lanes. Larger commercial vehicles must use the general purpose lanes and, therefore, were affected by the travel time changes in those lanes.

To assess the impact of the CRD on goods movement, the change in travel time in the Express Lanes and general purpose lanes was examined. Table I-2 presents change in peak period travel time for the Express Lanes and general purpose lanes obtained from Appendix A – Congestion Analysis. The data indicated that trips by commercial vehicles in the general purpose lanes probably took longer on average after the start of tolling. The a.m. peak took 5.1 percent more time and the p.m. peak increased by 10.2 percent. Commercial vehicles that were qualified to use the Express Lanes and chose to do so not only had an average 3 to 4 minute advantage over those in the general purpose lanes, but the advantage was greater in the post-deployment period. Average time in the Express Lane in the a.m. peak declined by 2.2 percent and by 3.8 percent in the p.m. peak.

Table I-2. Pre- and Post-Deployment Mean Corridor Peak-Period Travel Times (in Minutes) for the I-85 General Purpose and Express Lanes – Peak Direction of Travel

Peak Period (Direction of Flow)	Lane Type	Mean Corridor Travel Time (Minutes)[1]			
		Pre-Deployment	Post-Deployment	Change	Percent Change
A.M. Peak (Southbound)	General Purpose	16.1	16.9	0.8	5.1%
	Express	14.1	13.8	-0.3	-2.2%
P.M. Peak (Northbound)	General Purpose	16.1	17.8	1.7	10.2%
	Express	14.3	13.8	-0.5	-3.8%

[1] Based on NaviGAtor II data only.

Source: Texas A&M Transportation Institute.

Since commercial vehicle operators may have been concerned about on-time deliveries, the amount of “buffer time”, or *extra* time they needed to add to ensure that they arrived on time at their destination, was examined. The buffer time is the percent more time for a trip that the CVO would need to add to peak-hour travel to guarantee an on-time arrival. A large buffer time implies that travel times are highly variable on the route and more time needs to be allotted to the trip to account for this variability.

In the congestion analysis buffer times for the CRD corridor were calculated and are shown in Table I-3. The buffer time is computed as the difference between the 95th percentile travel time and the average travel time during a particular period of travel, expressed as a percentage of the normal travel time. The percentage of extra time to guarantee travel through the corridor using the general purpose lanes declined in the both the a.m. and p.m. peaks, and declined in the p.m. peak for the Express Lanes. In the Express Lanes in the a.m. peak, however, an additional 13 percent more buffer time would need to be added to account for variations in travel time. Thus, it was concluded that while most CVOs using the general purpose lanes likely spent on average a few more minutes traveling the CRD corridor in the post-deployment, they probably did not need to add as much buffer time as in the pre-deployment period.

Table I-3. Peak Period Pre- and Post-Deployment Buffer Time for the I-85 General Purpose Lanes and Express Lanes – Peak Direction of Travel

Peak Period (Direction of Flow)	Lane Type	Buffer[1] Pre-Deployment	Post-Deployment	Change
A.M. Peak (Southbound)	General Purpose	77%	66%	-11%
	Express	44%	57%	13%
P.M. Peak (Northbound)	General Purpose	58%	54%	-4%
	Express	55%	38%	-17%

[1] Based on NaviGAtor II data only.

Source: Texas A&M Transportation Institute.

Operators' Response to the Express Lanes. Small business owners with small and large commercial trucks were interviewed to assess whether they perceived the net benefit of tolling strategies by converting the I-85 HOV lanes to Express Lanes. It should be noted that vehicles with over 2 axels and/or over 6 wheels are not allowed in HOV and Express Lanes statewide in Georgia.[2] All respondents had commercial vehicles that were eligible to drive in the HOV and Express Lanes, although some also had large commercial vehicles that were prohibited from traveling in these lanes. All respondents heavily depended on I-85 for their business, with many taking more than 10-50 trips every week through the corridor.

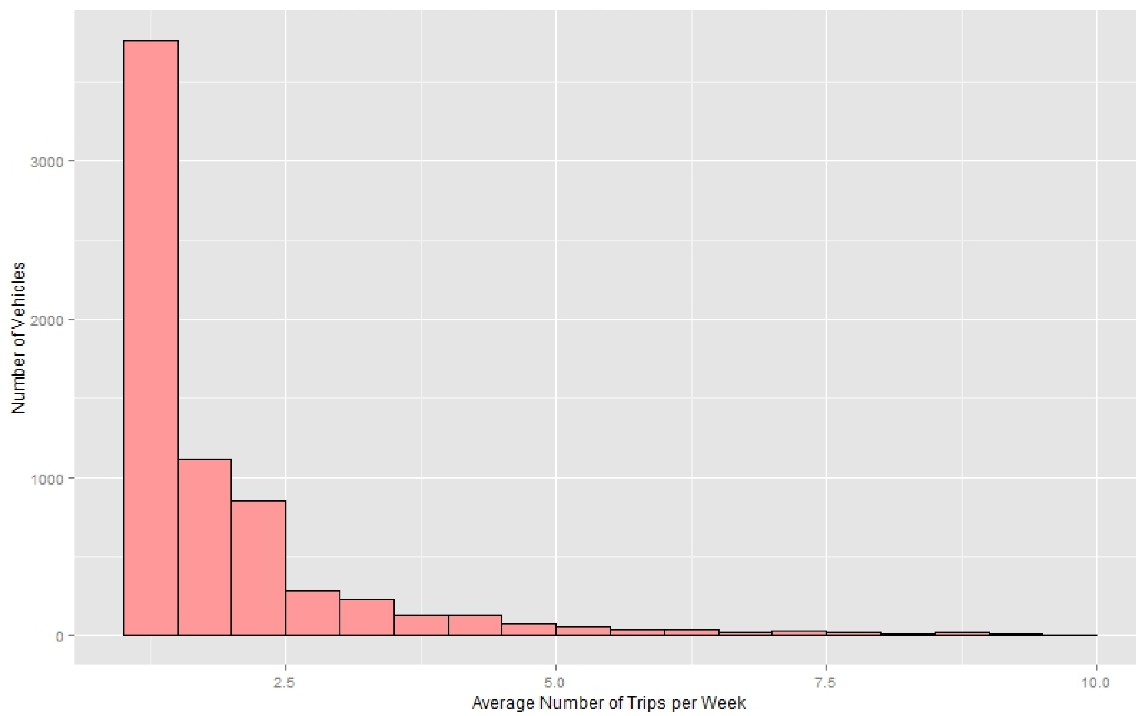
The business operators were asked whether they had changed operational decisions (e.g., changed delivery times) after the conversion of the I-85 HOV lanes to Express Lanes. Respondents that chose not to utilize the Express Lanes either planned their trips around peak times but recognized a trip could be longer or more difficult, or used back roads, while others who run businesses requiring early starts to the day made trips prior to peak traffic times.

Although some respondents had adapted to the new Express Lanes, others had not. Four of the eight businesses have Peach Passes for their commercial vehicles. One respondent noted prior use of the I-85 HOV lane with two people in the truck, and continued use of the Express Lane with only two people, noting that time was more important than the cost. Another respondent, however, said that despite frequent use of the HOV lane, the Express Lanes were too expensive for business use. Overall, respondents were mostly negative in their overall impressions of the Express Lanes, feeling that congestion was worse than with the HOV lanes prior to opening the Express Lanes. Thus, among CVO operators the usage of the Express Lane and opinions about tolling were much the same as those of other I-85 travelers based on survey results reported in Appendix A – Congestion Analysis. Some took advantage of the Express Lane for the benefits it offered them, but public opinion tended toward the negative.

[2] For more information, see: http://dps.georgia.gov/i-85-expres-lanes-hot-lanes.

Toll Transactions by Commercial and Post-Paid Accounts. Even though vehicles with more than six wheels (with the exception of over-the-road buses or emergency vehicles) and multi-unit vehicles are prohibited from using the Express Lane facilities, a number of commercial and post-paid corporate Peach Pass accounts were active on the I-85 corridor. Specifically, 6,904 commercial vehicle transponders, about 6 percent of the total number of transponders, were used at least once in the corridor over the course of the one-year post-deployment evaluation. Toll transactions from these tags revealed a median use of 2 trips per month and 1.33 trips per week. Figure I-1 shows the frequency of trips per week by vehicles with commercial and post-paid Peach Pass accounts. (Further information on account types was reported in Appendix B – Tolling Analysis.)

It should be noted that the data were not specific enough to exclude vehicles that were not involved with goods movements. While commercial and post-paid accounts are corporate accounts, the vehicles could include passenger cars, e.g., rental car or corporate car fleets. Instead, these data were given as a rough indicator on the number of accounts and Express Lane usage by businesses, some of which involved goods movements.



Texas A&M Transportation Institute.

Figure I-1. Frequency of Trips Per Week by Corporate Users with Commercial and Post-Paid Accounts

I.3 Summary of Goods Movement Analysis

Table I-4 presents a summary of the goods movement analysis across the four hypotheses. The Atlanta CRD projects seemed to have had negligible or negative impacts on goods movement. Examination of travel times and buffer times for the general purpose lanes and Express Lanes gave mixed results on impacts on goods movement. Small business owners held mostly negative perceptions of the Express Lanes citing either the same or worse congestion levels since the conversion from HOV lanes. Regarding the third hypothesis, about half of the small business owners with small commercial trucks registered for Peach Passes to enable them to use the Express Lanes, believing the time savings to be more valuable than the additional cost, while others thought the Express Lanes were too expensive despite worsened congestion. Additionally, small business owners reported making changes in route choice or timing of trips if they chose not to use the Express Lanes. Finally, transponder and toll transaction data from commercial and post-paid accounts indicated that the Express Lanes were being utilized by corporate vehicles that may have been involved with goods movements.

Table I-4. Summary of Goods Movement Analysis Across Hypotheses

Hypotheses/Questions	Result	Evidence
Commercial vehicle operators (CVOs) will experience reduced travel time by reduced congestion on general purpose lanes.	Partially supported, mixed results.	For small commercial vehicles permitted in the Express Lanes, travel time improved. However, for CVOs using the general purpose lanes, travel time increased in the general purpose lanes by 5.1 percent in the a.m. and 10.2 percent in the p.m. Aiding on-time delivery, buffer time was less in the general purpose lanes in both peaks and in the p.m. peak in the Express Lane.
Operators with light-duty trucks will prefer to use Express Lanes to general purpose lanes for faster travel times.	Neutral	Focus groups participants were not uniform in their company's use of the Express Lanes as they differed in their assessment of time and cost.
Operators delivering goods will perceive the net benefit of tolling strategies (e.g., benefits such as faster service and greater customer satisfaction outweigh higher operating costs due to tolls).	Neutral	Only half of the respondents felt that the travel time benefits exceeded the cost and used the Express Lanes.
Operators report changing operational decisions due to use of Express Lanes (e.g., changing delivery times).	Supported	Adaptations included use of back roads or making trips prior to peak traffic times.

Source: Battelle.

Appendix J. Business Impacts Analysis

This analysis examines potential effects of the Atlanta CRD projects on employers and businesses. For example, implementation of the HOT lanes may have resulted in an improved commute trip leading to employee satisfaction and retention. New and expanded bus services may have resulted in improved employee satisfaction with commuting options. The ability to use a HOT lane may have improved the efficiency of transportation-dependent businesses like taxi operators and couriers.

Table J-1 presents the three questions in the business impacts analysis. The first question focused on the potential impacts of the I-85 CRD projects on employers. The second question addressed the possible impacts to businesses that rely on customers accessing their stores, such as retail establishments. The final question focused on how businesses particularly impacted by transportation costs were affected.

Table J-1. Business Impacts Analysis Questions

Hypotheses/Questions
• What is the impact of the strategies on employers? e.g., o Employee satisfaction with commute (Express Lanes, transit) o Increased employment-shed to downtown/midtown Atlanta
• What is the impact of the strategies on businesses that rely on customers accessing their stores, such as retail and similar establishments?
• How are businesses that are particularly impacted by transportation costs affected (e.g., taxis, couriers, distributers, tradesmen)?

Source: Battelle

The remainder of this appendix is divided into five sections. The data sources used in the analysis are described in Section J.1. Section J.2 presents the analysis of potential impacts on employers, including employee satisfaction and an increased employment-shed. Section J.3 discusses the possible impacts to businesses that rely on customers accessing their stores. Section J.4 examines the impacts to businesses that were particularly impacted by transportation costs. The appendix concludes with a summary of the potential business impacts in Section J.5.

J.1 Data Sources

Data for the business impacts analysis were obtained from two sources. Data came from focus group and interviews with small business owners, including firms that operate small and large commercial trucks and small businesses in the community improvement district (CID). These focus groups and interviews were conducted by Noble Insight for the Georgia Department of Transportation (GDOT) and State Road and Toll Authority (SRTA). The focus groups were conducted following the general approach and questions presented in the Atlanta CRD Surveys and Interviews Test Plan.[1] Businesses located in ZIP codes along the I-85 corridor were recruited and selected to incorporate a variety of viewpoints, including businesses that owned small and/or large commercial vehicles, and businesses using and not using a Peach Pass. The relatively small sizes of each focus group and number of interviewees should be noted, with only eight participants representing small business owners with small/large commercial trucks and nine participants representing small business owners in the general area of the Gwinnett and Perimeter Community Improvement Districts (CIDs). Because there were not enough participants to provide statistically significant findings, these results should be viewed as anecdotal in nature, with their primary value in the participants' insights regarding their opinions and experiences with the CRD projects. The participants discussed topics that included perceptions of congestion and safety before and after the conversion of the I-85 Express Lanes from HOV lanes, why they chose to or not to purchase a Peach Pass, and personal experiences of employees.

The second source of data used in the business impact analysis came from tolling transactions. As reported in Appendix B – Tolling Analysis, the toll classifications used by SRTA included a couple of commercial vehicles categories—commercial toll accounts for fleets and post-paid accounts allowing tolls to be invoiced monthly—and it was possible to determine the usage of the Express Lanes by companies with those types of accounts.

J.2 Potential Impacts on Employers

Small business owners were interviewed to determine the potential impacts on employers resulting from conversion of the HOV lanes on I-85 to Express Lanes. All respondents heavily depended on I-85 for their businesses, including having employees going to their work locations.

Respondents held mixed views about the impacts of the Express Lanes on their businesses. Most said they saved time traveling on the Express Lanes. Yet overall, respondents held negative perceptions of the Express Lanes, not believing them to work as had been promised: to relieve congestion and make the highway safer for commuters. One respondent gave a positive comment noting the Express Lanes as a right step for attracting businesses to Georgia by showing that the state does care about traffic and was taking steps to improve traffic in the community to be more competitive with other areas.

Employers expressed frustration with the unpredictability and reliability issues with traffic and transit alike. One respondent noted lowered morale from students and staff who were frequently late due to traffic and arrived feeling annoyed by traffic. Another respondent expected the Express Lanes to alleviate traffic and minimize traffic jams allowing staff to arrive to work on time refreshed and with good morale. However, the overall perception of these employers was that congestion had either been the same or gotten worse than before the Express Lanes were converted from HOV lanes, and thus employee morale was unchanged.

[1] Battelle. " Atlanta Congestion Reduction Demonstration, National Evaluation: Surveys and Interviews Test Plan," August 16, 2011. FHWA-JPO-11-104.

Respondents noted the loss of employees due to congestion issues. One respondent had fired employees or had employees quit since the HOV lanes were converted to Express Lanes because increased congestions caused employees to not arrive at job sites on time. However, this same respondent did not feel comfortable getting a Peach Pass for the company vehicle that was being used because of the expense. Another respondent had lost 4 of 7 employees due to their frustration with traffic and the time needed to get to the destination.

Respondents seemed resigned to traffic congestion, and none felt that the Express Lanes or transit system changes had any effect, positive or negative, on attracting employees. Given this response, it can be surmised that the employment shed to downtown or midtown Atlanta had not increased as a result of the Express Lanes.

J.3 Potential Impacts on Businesses Relying on Customer Access

Small business owners were interviewed to determine what potential impacts the conversion of the HOV lanes on I-85 to Express Lanes had on businesses relying on customer access. All respondents heavily depended on I-85 daily for their businesses, including customer access.

No respondents felt that the Express Lanes or transit system changes had any effect, positive or negative, on attracting customers. Again, respondents felt that congestion had either stayed the same or gotten worse than before the Express Lanes were converted from HOV lanes. No respondents reported business issues with clients because their businesses had adapted to traffic issues in the region. Thus, although congestion was still bad on I-85, people had learned to work around it and accepted it because it was an issue before the Express Lanes were introduced.

J.4 Potential Impacts on Businesses Affected by Transportation Costs

Small business owners that operated small and large commercial trucks were interviewed to determine what, if any, potential impacts that conversion of the I-85 HOV lanes to Express Lanes had on businesses affected by transportation costs. It should be noted that vehicles with 2+ axels and/or 6+ wheels were not allowed in HOV and Express Lanes statewide in Georgia.[2] All respondents had commercial vehicles that were eligible to drive in the HOV and HOT lanes, although some also had large commercial vehicles that were prohibited from traveling in these lanes. All respondents heavily depended on I-85 for their business, with many taking more than 10-50 trips every week through the corridor.

Although some respondents had adapted to the new Express Lanes, others had not. Four of the eight businesses have Peach Passes for their commercial vehicles. One respondent noted his firm's prior use of the I-85 HOV lane with two people in the truck, but they had continued use of the Express Lane with only two people and paid the toll, since time was more important than the cost. Another respondent, however, said that despite frequent use of the former HOV lanes, the Express Lanes were too expensive for business use.

[2] For more information, see: http://dps.georgia.gov/i-85-expres-lanes-hot-lanes.

Respondents that chose not to utilize the Express Lanes either planned their trips around peak times or used back roads, while others ran businesses requiring early starts to the day prior to peak traffic times.

Overall, respondents were mostly negative in their overall impressions of the Express Lanes, feeling that congestion was worse than with the HOV lanes prior to opening the Express Lanes. One respondent noted that the Express Lanes were bad for business. Attributes that respondents associated with the Express Lanes included “bad idea, facilitates anger, more congestion vs. less, not impressive, confusing, costly, limiting in function, frustrating, and stressful.”

Additionally, Peach Pass transponder and toll transactions data were used as a proxy for examining business usage of the Express Lanes. In the evaluation period, 6,904 commercial vehicle transponders, about 6 percent of the total number of transponders, were used at least once in the corridor. Toll transactions from these tags revealed median use of 2 trips per month and 1.33 trips per week. (Further information on account types is reported in Appendix B – Tolling Analysis.)

It should be noted that the transponder and toll transaction data were not specific enough to exclude vehicles that were not used for business purposes. While commercial and post-paid accounts were corporate accounts, some vehicles may have been used by the general traveling public, e.g., rental car fleets. Instead, the data were given as a rough indicator of the number of accounts and usage by businesses that may have utilized the Express Lanes.

J.5 Summary of Business Impacts Analysis

Table J-2 presents a summary of the business impacts analysis across the three questions. The Atlanta CRD projects seem to have had negligible or negative impacts on small businesses. Small business owners held mostly negative perceptions of the Express Lanes citing either the same or worse congestion levels since the conversion from HOV lanes, resulting in no change of employee morale. No small business owner in the focus groups felt that the CRD changes had any positive or negative effects on attracting employees or customers. Finally, about half of the small business owners in the focus group who had small and large commercial trucks utilized Peach Passes for the Express Lanes believing the time savings to be more valuable than the additional cost. The other half thought the Express Lanes were too expensive despite worsened congestion. Given the small number of respondents, these findings are only anecdotal in nature and should not be extrapolated to all business owners.

Table J-2. Summary of Business Impacts Across Hypotheses

Hypotheses/Questions	Result	Evidence
• What is the impact of the strategies on employers? e.g., o Employee satisfaction with commute (Express Lanes, transit) o Increased employment-shed to downtown/midtown Atlanta	Partially negative	Businesses had mostly negative perceptions of the Express Lanes, as congestion had either been the same or gotten worse than before the Express Lanes were converted from HOV lanes. Thus employee satisfaction was unchanged, and some had lost employees due to increased congestion issues. No respondents felt that the Express Lanes or transit system changes had any positive or negative effects on attracting employees.
• What is the impact of the strategies on businesses that rely on customers accessing their stores, such as retail and similar establishments?	No impact	No respondent felt that the Express Lanes or transit changes had any positive or negative effects on attracting customers.
• How are businesses that are particularly impacted by transportation costs affected (e.g., taxis, couriers, distributers, tradesmen)?	Neutral impacts	Half of the respondents had Peach Passes to use the Express Lanes believing the time savings to be more valuable than the cost, while others felt the Express Lanes were too expensive and congestion had worsened.

Source: Battelle

This page intentionally left blank.

Appendix K. Non-Technical Success Factors Analysis

This analysis examined the non-technical success factors associated with the Atlanta CRD. These non-technical success factors included outreach activities, media coverage, political and community support, and the institutional arrangements used to manage and guide implementation of the Atlanta CRD projects. Information on the non-technical success factors was of benefit to the U.S. DOT, state departments of transportation, MPOs, and local communities interested in planning and deploying similar projects.

Table K-1 presents the questions, measures of effectiveness and data sources associated with the analysis of the non-technical success factors. The first question focused on understanding how a wide range of variables influenced the success of the Atlanta CRD project deployments. The variables were grouped into five major categories: (1) people, (2) process, (3) structures, (4) media, and (5) competencies. The second question guiding this analysis focused on examining public support for the Atlanta CRD projects and whether the public viewed the CRD projects as effective and appropriate ways to reduce congestion.

Table K-1. Non-Technical Success Factors Analysis Approach

Questions	Measures of Effectiveness	Data
What role did factors related to these five areas play in the success of the deployment? People (sponsors, champions, policy entrepreneurs, neutral conveners) Process (forums [including stakeholder outreach], meetings, alignment of policy ideas with favorable politics and agreement on nature of the problem) Structures (networks, connections and partnerships, concentration of power and decision-making authority, conflict-management mechanisms, communications strategies, supportive rules and procedures) Media (media coverage, public education) Competencies (cutting across the preceding areas: persuasion, getting grants, conducting research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets)	Observations from CRD participants	One-on-one interviews followed by group workshops at end of planning and implementation phase and end of CRD one-year operational evaluation period
	Partnership documents (e.g., memoranda of understanding)	CRD partners' documents
	Outreach materials (press releases, brochures, websites, etc.)	CRD partners' outreach materials
	Radio, TV and newspaper coverage	Internet-based tracking of media coverage CRD partners' files
Does the public support the UPA strategies as effective and appropriate ways to reduce congestion?	Public opinion	Survey of general public about the CRD project (if available) Comments at public forums

Source: Battelle

This appendix is divided into seven sections: the data sources used in the analysis are described in Section K.1. Information on the multi-agency organizational structure of the Atlanta CRD is presented in Section K.2 followed by a discussion of the communications and outreach activities in Section K.3 and a content analysis of news media coverage of the Atlanta CRD in Section K.4. The major themes from the interviews and workshops with the local partners are presented in Section K.5 and results from questions measuring public perception of the Atlanta CRD are summarized in Section K.6. In conclusion, a summary of the Atlanta CRD non-technical success factors is presented in Section K.7.

K.1 Data Sources

A variety of data sources was used in the non-technical success factors analysis. First, two rounds of interviews and workshops were conducted by the national evaluation team with representatives of the local partners. Second, news media coverage of the Atlanta CRD projects collected by the national evaluation team were reviewed and analyzed. Third, Atlanta CRD partners shared with the national evaluation team formal partnership documents and outreach materials and activities for examination and analysis. Finally, data on public opinion about the CRD projects, tolling in particular, were available from three surveys conducted as part of the national evaluation: the Volpe household travel survey, the survey of carpoolers funded by SRTA, and a survey of Xpress bus riders conducted by GRTA.

K.2 Atlanta CRD Multi-Agency Organizational Structure

The Atlanta CRD partnership was led by three public agencies—the Georgia Department of Transportation (GDOT), the Georgia Regional Transportation Authority (GRTA), and the State Road and Tollway Authority (SRTA). Other partners included Atlanta Regional Commission (ARC), Georgia Department of Public Safety, Metropolitan Atlanta Rapid Transit Authority (MARTA), Gwinnett County Government, Clean Air Campaign, and Georgia Institute of Technology (Georgia Tech). Figure K-1 presents the organizational structure of the CRD partnership as originally constituted at the start of the national evaluation.

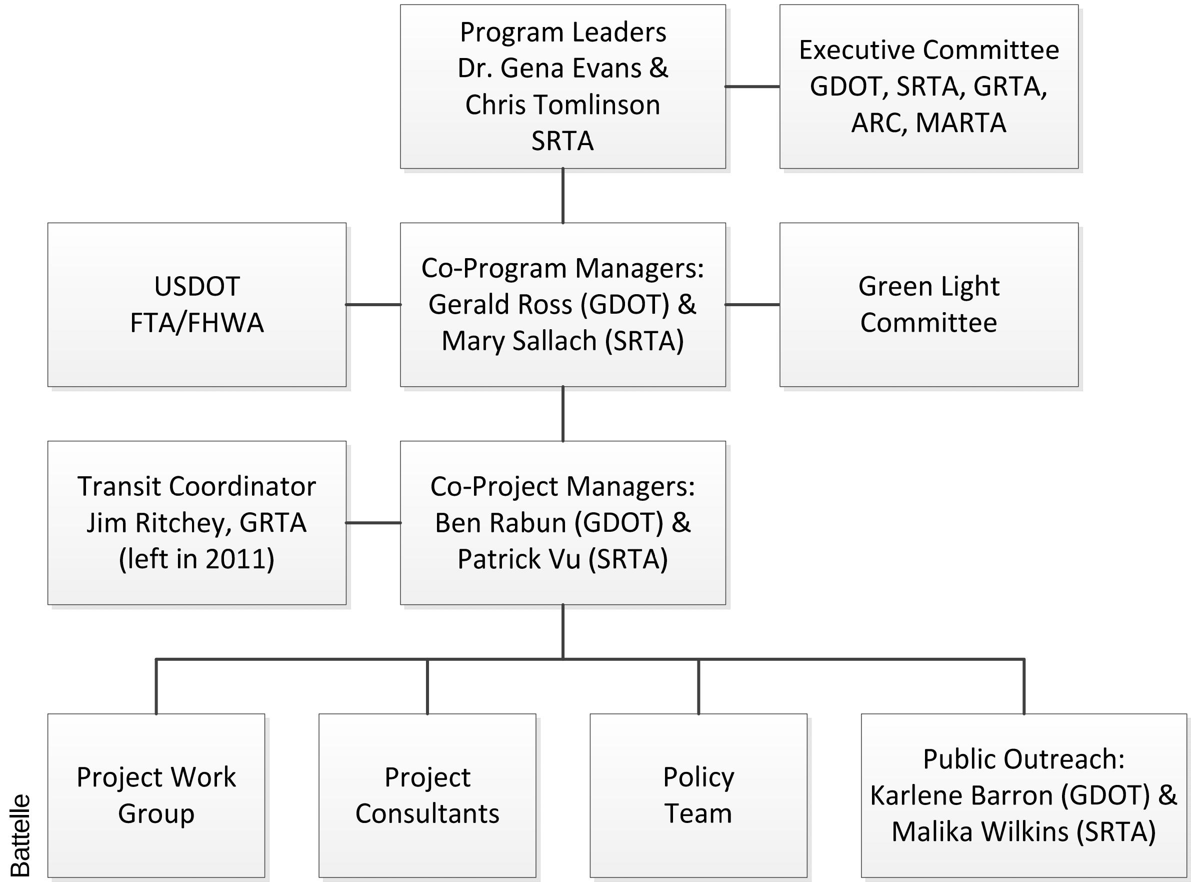


Figure K-1. Atlanta CRD Team

Georgia DOT's role in the CRD reflected its statewide responsibility for planning, constructing, maintaining, and improving the state's roads and bridges. They were responsible for all construction needed for the conversion of the HOV lanes to the Express Lanes on I-85 and in the on-going infrastructure maintenance and operation of all lanes in the demonstration corridor.

GRTA was the state agency responsible for improving Georgia's mobility, air quality, and land-use practices. In that capacity GRTA operates Xpress, a public transportation service in partnership with twelve counties in metropolitan Atlanta. In the CRD, GRTA was responsible for acquiring 36 buses to provide additional service on the I-85 corridor and for construction of new and expanded park-and-ride lots. GRTA worked in concert with Gwinnett County Transit, which operates express bus transportation service in the corridor.

SRTA's role in the CRD was as the toll operator of the HOT lanes, reflecting their responsibility throughout Georgia to operate toll roads. They established the variable toll rates, selected electronic toll technology, marketed the Express Lanes to travelers, and managed tolling operations.

K.3 Public Information and Outreach Activities

The following section describes the outreach approach and activities employed by the local partners as evidenced through the outreach materials and activities shared by the local partners with the national evaluation team and through the interviews and workshops with local partners conducted by the national evaluation team. The section concludes with reflections from the local partners on both the challenges and lessons learned associated with implementing a communications and outreach plan for the Atlanta CRD.

Local Partner Roles and Responsibilities. The three main Atlanta CRD partner agencies (GDOT, SRTA, GRTA) articulated clear and consistent outreach roles from the beginning of the CRD. The outreach and marketing contract resided with SRTA, but all organizations indicated that they worked in tandem on outreach efforts. They consistently expressed across interviews that they had a very good working relationship, which included actively sharing information that each agency thought might benefit the other. As one agency partner put it, "There is a mutual respect for what we do."

Specific agency roles included:

- GDOT, communicating construction phase of Express Lanes
- SRTA, marketing the Peach Pass and recruiting users to the Express Lanes
- GRTA, technically separate marketing for transit, but they partnered with GDOT and SRTA for co-messaging at outreach events.

Communications and Outreach throughout the Project Lifecycle. The majority of communication from GDOT came during the construction phase, whereas SRTA implemented a marketing strategy to educate and recruit users to the Express Lanes that spanned brand creation to nurturing a customer base.

Interviewees from each agency described how they remained deeply involved in each others' outreach work throughout the entire project in order to provide input and to strategize together. This was done primarily through a coordinated communications committee that included the contractors, communications staff, project managers and legal counsel from each organization. This was primarily a coordination of efforts between GDOT, the lead agency for the CRD, and SRTA, the lead agency for marketing and communicating the product, i.e. Peach Pass. GRTA was involved to a lesser extent by co-messaging at outreach events. However, transit remained a minor component of the overall project messaging.

Additionally, interviewees indicated that once the project deployed, each of the three partner agencies were prepared to field questions from the public on any of the project elements, even if it was not something they directly dealt with. This was because the agencies understood that the public may not differentiate among the agencies and their particular roles and responsibilities with the CRD. Therefore, they implemented a coordinated plan sharing talking points and key messages.

Key Messages. The primary focus of all communications and outreach was on the Express Lanes portion of the CRD, with minimal mention of the investment in Xpress bus service and park-and-ride lots or other traffic demand management techniques. However, the messaging on the whole was about creating options for commuters, implying multiple modes. Interviewees described the key messages in the following ways:

- The region is unable to build its way out of congestion
- Express lanes will provide:
  - Reliable trip time (i.e. less congestion)
  - Commuters with mode choices (transit, vanpooling, carpooling, telework)
- Commuters must register to use the Express Lanes.

Key Stakeholders.

- Local, state, federal elected officials along the corridor
- Business community (e.g. chambers of commerce, individual businesses along the corridor)
- Key transportation agencies and officials
- Media outlets and specific reporters
- Key community stakeholders (e.g. neighborhood associations, universities, event facilities)
- General public – with specific recruitment of potential Peach Pass users
- Targeted communication to current corridor commuters, with particular attention to two-person carpoolers in order to help them find a third person
- Targeted cultural groups with language-specific messaging.

Outreach Activities. The Atlanta CRD partners, especially SRTA, deployed their messaging using different methods that targeted specific stakeholders through a variety of venues. This included a large investment of time from top leadership in the partner agencies to deliver these messages to key stakeholders. Interviewees voiced a common goal to inform and educate all key stakeholders, stating they "never wanted to hear from stakeholders that they did not know about the CRD." They might not be able to create project champions, but they would be able to inform everyone who needed to know about the CRD. The various methods used by the Atlanta CRD partners are listed below, including some examples:

In-person Activities

- One-on-one/small group meetings between partner agency leadership staff and elected officials – interviewees indicated that they contacted every elected official along the corridor and met with all officials who were interested, often more than once
- Public meetings
- Booths at malls and events along the corridor
- Press briefing with major media outlets
- Clean Air Campaign and Employer Services Organizations (ESOs) outreach teams to recruit alternative mode use

Print and Online Communications

- Press releases
- Fact sheets
- Websites (GDOT, SRTA, GRTA/Xpress, county sites, PeachPass.com)
- Social media (Facebook, Twitter, YouTube)
- E-newsletter
- Weekly email updates that individuals could sign up for
- 511 telephone and website operated by GDOT
- Prompt responses by partner agencies to correct or clarify any incorrect information about the CRD. This was done via letters to the editor, phone calls to reporters, and posting online.

Figure K-2 illustrates peachpass.com, the website that served as the clearinghouse for information on the Express Lanes. It was designed with the Peach Pass customer in mind, providing people access to manage their existing accounts and the ability to open a new account.

Georgia State Road and Tollway Authority, Used with Permission

Figure K-2. Home Page of Peach Pass Website

Newsletters were published over the course of the CRD projects. Figure K-3 is an example of one of the newsletters. In every edition, an update on the I-85 Express Lanes was given along with facts about tolling. Once the lanes opened, the newsletter was rebranded as the “Peach Pass Press” and it provided updates on additional tolling projects in the region.

I-85 EXPRESS LANES
Partnership for Progress

www.PeachPass.com

JANUARY 2012

The "Peach Pass GO!" Mobile App is Here!

The State Road and Tollway Authority (SRTA) has just made managing your Peach Pass account a little easier with the new "Peach Pass GO!" mobile application, or "app." Now available for iPhone®, iPad® and Android® (versions 2.3 or higher) devices, Peach Pass GO! allows Peach Pass customers to change their toll mode and check their balance without having to call the customer service center or go online.

The "Peach Pass GO!" app can be downloaded at no charge from the iTunes® App Store or Android® Market and PeachPass.com. Once downloaded, Peach Pass GO! provides customers with Peach Pass account access using the same username and password established for online account management. Account balances are automatically displayed when login is completed. A second click takes account holders directly to toll mode change options, allowing customers to update their vehicle occupancy status (tolled/non-tolled) before they use the I-85 Express Lanes. Through a simple splash screen feature, all motorists will be asked to "agree" that they are not using the application while they are driving. If they do not select "I Agree," the application will automatically shut down.

"We're extremely pleased and excited to provide our customers with this new and convenient way of accessing their Peach Pass account and changing their toll mode," said SRTA Executive Director Gena L. Evans, Ph.D. "Now changing your toll mode can be done with a few taps on your mobile device and confirmation of your toll mode change appears in seconds."

To learn more about the Peach Pass GO! app, go to www.PeachPass.com.

In This Issue

- "Peach Pass GO!" Mobile App
- New Southbound Access Point
- Express Lanes Toll Rates Reduced
- Peach Pass Signage on GA 400
- I-85 Express Lanes Update
- FAQs Answered

Malika Reed Wilkins
Director of Marketing & Communications, SRTA
mwilkins@georgiatolls.com

Karlene Barron
Director of Communications, GDOT
kbarron@dot.ga.gov

William Mecke
Deputy Director of Communication, GRTA
wmecke@grta.org

Georgia State Road and Tollway Authority, Used with Permission

Figure K-3. Example of Express Lanes Newsletter

Challenges. The larger social, political, and economic context affected public perception of the CRD project according to interviews with local agency representatives. Namely, the economic crisis and the rising popularity of the Tea Party movement was fodder for strong objections from people who believed the CRD was an attempt to charge money for a public good already paid for by taxes.

Additionally, many commuters felt they were losing road access. In the case of two-person carpools, they were indeed losing their right to travel in the Express Lanes free of charge. However, for the remainder of the commuting public, the CRD communications strategy endeavored to articulate the value of managed lanes as creating additional options for commuters (albeit a paid option) rather than losing a lane.

Since this was the first time the Atlanta region implemented a managed lane program, interviewees expressed uncertainty, prior to project deployment, about how exactly the public would react once the system opened, recognizing that most people would not become fully aware of what was happening until the actual opening. For the most part, interviewees expressed, during post-deployment interviews, satisfaction with the overall reception of the CRD – pointing to the high numbers of Peach Pass purchases and daily lane usage. However, the days immediately following the opening of the Express Lanes produced negative media coverage and the involvement of the Governor in changing the toll rates.

Lessons Learned. During the interviews with local partners—particularly interviews conducted after tolling deployment—agency representatives reflected on the lessons they learned, especially the experiences they would want to share with others trying to do outreach and communications for similar projects. These reflections included both broadly applicable advice such as “do this work early and often,” to specific tips such as “one-on-one and small group meetings were most effective in communicating the purpose and function of a managed lane system.” Additional lessons learned from the interviewees are listed below. These lessons reflect on what worked well for them as they developed and implemented their strategy for communications and outreach.

- Get creative in how you reach out to the public, especially when using the internet or social media. Tapping into ways to conduct hybrid in-person and online meetings may reach a broader audience than doing each as discreet activities.
- The point is to show up and have people feel that they are being heard. You are not going to be able to convince every single person that this is a good idea, but at least give them information and let them give their opinions.
- Find and cultivate project champions.
- Do not be afraid to sit down and speak directly with project naysayers to see if you can address their concerns.
- Be willing to form partnerships in your communications efforts, not just transactions. An example would be how SRTA formed a partnership with paid media outlets where they were not just buying media spots, but the media contributed their ideas and time to communicating the project. This partnership led to more communication by the media outlet than would have occurred through a simple contract.
- Context matters – know your population and the local issues and history that make up your community and that may impact your project. In other words, you cannot cut and paste a method from somewhere else.

Conclusion. The Atlanta CRD partner agencies (GDOT, SRTA, GRTA) created a deliberate, proactive approach to communicating the purpose and impacts of the Atlanta CRD to key stakeholders over the course of the planning, development, and deployment of the Atlanta CRD projects. Their activities focused on education, transparency, and public input as a method of managing expectations while recognizing that their job was not to convince those who are vehemently opposed to tolling because of deeply held values, but rather, to deliver a well-implemented project that attended to its customers’ needs. At the same time, with the outreach focused heavily on tolling, promotion of transit enhancements was for the most part lacking.

K.4 News Media Content Analysis

The following section describes the content analysis for the period that spanned planning through post-deployment of the Atlanta CRD projects in order to understand the nature and occurrences of media coverage and its potential role in both providing information as well as shaping public opinion.

Methods. Media coverage was tracked from the first occurrence in 2008 through September 30, 2012, which was one year after the Atlanta Express Lanes on I-85 went live. All news media coverage was gathered by the national evaluation team, using Lexus Nexus, Proquest Newspapers, and Google News. From these sources 257 individual pieces of news media coverage were found for the time period. The national evaluation team conducted a descriptive analysis for all news media coverage using four categories:

- Mainstream: Included coverage from the major neighborhood, local, regional, national, and international news media outlets.
- Blogs: Included coverage created and/or disseminated by private, individual, blogs. Included online podcasts.
- Op-Ed: Included coverage in mainstream newspaper outlets from the opinion and editorial section. Authors included editorial staff from the newspaper or guest writers who are members of the readership community.
- Industry Publications: Included coverage from national, non-peer reviewed publications from the transportation field.

Due to resource constraints, in-depth content analysis was limited to a 20 percent stratified simple random sample of the coverage. The news media sample was stratified twice, first by media type and then by year. Within each subsample of media type, a proportionate amount of media was chosen from each year of the study to be represented in the sample. Table K-2 shows distribution by media type and year. In instances where the proportion was less than one media item, the number was rounded up, to account for at least one representation of that media type in every year available. After the second stratification, due to rounding up to account for at least one media type in every year available, slightly more than 20 percent of news articles were represented in the sample, with op-eds and industry publications being oversampled. A random number generator was used to collect the stratified sample.

Table K-2. 20 percent Stratified Sample of Atlanta CRD News Media by Media Type & Year

Type of Media	Total # of Articles	Total # of Articles in Stratified Sample	% of Articles from 2012	# in Stratified Sample From 2012	% of Articles from 2011	# in Stratified Sample from 2011	% of Articles from 2010	# in Stratified Sample from 2010	% of Articles from 2009	# in Stratified Sample from 2009	% of Articles from 2008	# in Stratified Sample from 2008
Mainstream	200	41	18%	7	51%	21	15%	6	9%	4	8%	3
Blog	35	7	25%	2	0.75%	5	0	0	0	0	0	0
Op-ed	21	7	33%	2	48%	2	10%	1	5%	1	5%	1
Industry Publications	1	1	0	0	0	0	0	0	0	0	100%	1

Source: University of Minnesota

The content analysis of the sampled news media coverage involved first analyzing the news content by organizing the articles into positive, negative, balanced, and neutral categories. By categorizing the articles, an assessment was made to determine whether the media was shaping opinion in a certain attitudinal direction (the assumption being that news media both informs and influences its readership). A definition of each category is as follows:

- Positive: The coverage presented an overwhelmingly positive case for the Atlanta CRD project(s), typically giving detailed information about the benefits of the project. Sources and quotations came from only a positive perspective.
- Negative: The coverage presented an overwhelmingly negative case for the Atlanta CRD project(s), typically giving detailed information about the risks of the project. Sources and quotations came from a negative perspective, or were put into a negative context.
- Balanced: The coverage presented a balanced story of both the potential benefits and risks of the Atlanta CRD project(s). Sources and quotations may have come from positive and negative perspectives and the author did not give a final verdict on whether the project was a net positive or negative.
- Neutral: Article presented information simply to inform the reading audience of some phenomenon or event without a particular viewpoint.

Next, the major themes and categories of ideas that arose from the topics in the news media coverage were identified by reading each sampled media item and coding for common themes using NVivo software.[1]

[1] NVivo 10, a computer assisted qualitative data analysis software (CAQDAS), was used to conduct a descriptive coding analysis of all news media coverage and an in-depth content analysis of key themes of the news media coverage sample.

Findings. Most media coverage was produced locally with 50 percent (100 articles) coming from two major local publications: Gwinnett Daily Post (28) and The Atlanta Journal Constitution (72). Another 56 articles, 28 percent, were from local television stations, 11 Alive (34) and CBS Atlanta (22). Although the number of individual news media pieces coming from blogs was 35, or 14 percent or the total, the majority of postings (25) came from two blogs dedicated entirely to opposing tolling (i.e. stolenlanes.org and stoppeachpass.org). Figure K-4 shows the distribution of news media by type of coverage further separated by year.

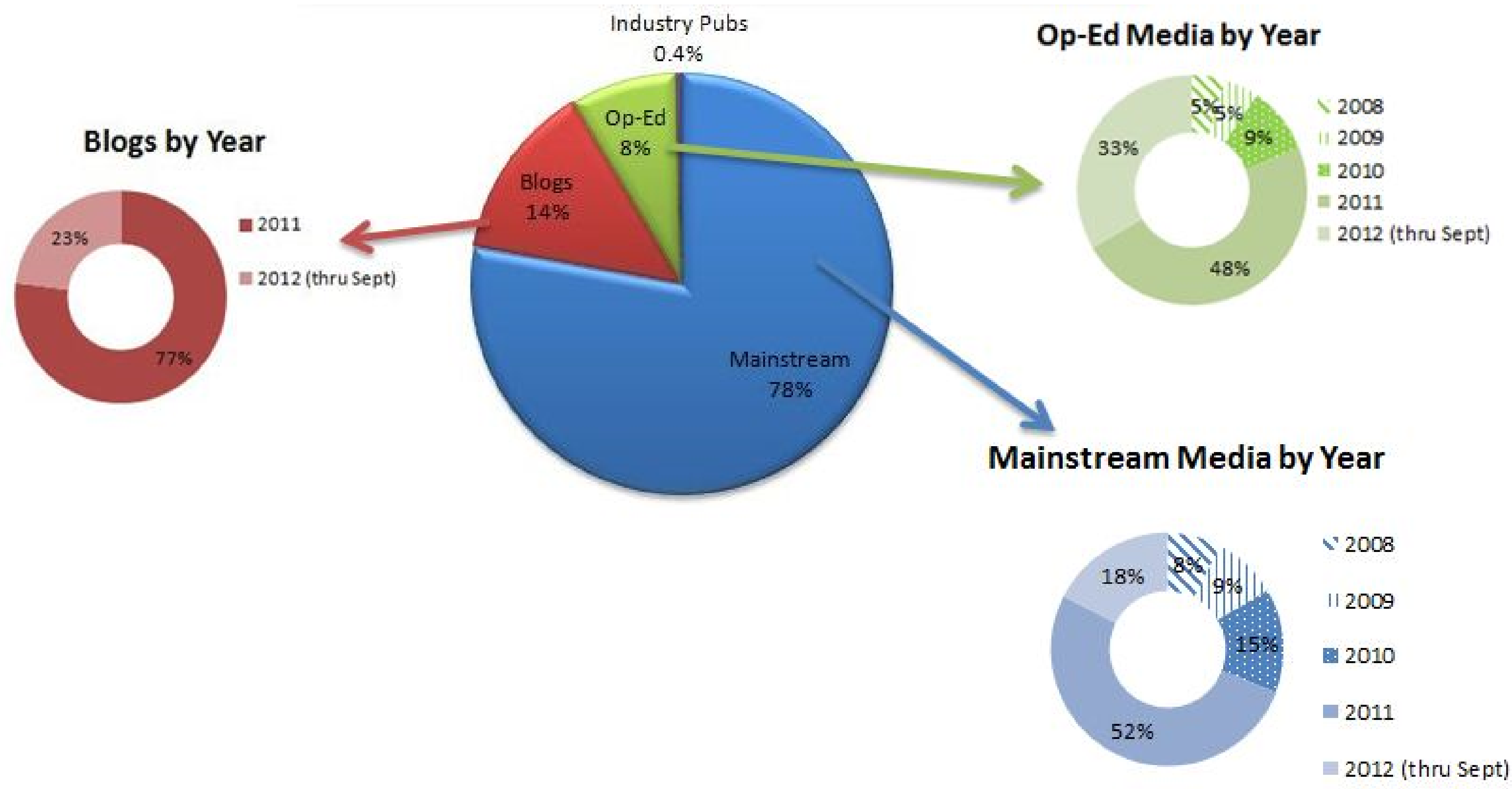


Figure K-4. Percent Total Media Coverage by Type and Year

Figure K-5 shows the distribution of media coverage over time by tracking the number of media coverage by month. The greatest peak in coverage came in late 2011 when the I-85 Express Lanes opened. Coverage during this period included information about the opening and debate of the tolling rates and the purpose of tolling (e.g. "Our taxes already paid for these roads, why are we paying again?").

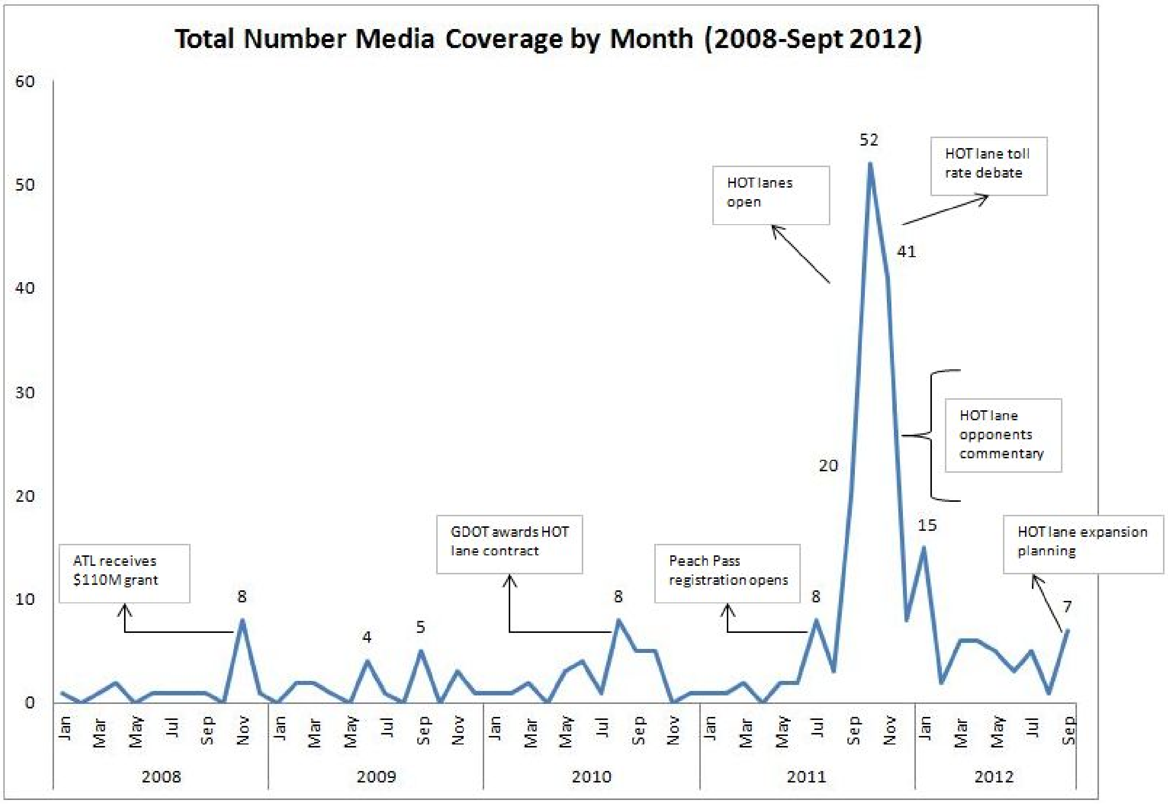


Figure K-5. Total Number Media Coverage by Month (2008-Sept 2012) and Events

Figure K-6 displays the distribution of the 20 percent sample of media coverage by attitudinal direction, with additional detail by year of coverage. Of the 56 pieces of media examined, 39 percent was negative, 13 percent was positive, 21 percent was balanced, and 27 was percent neutral.

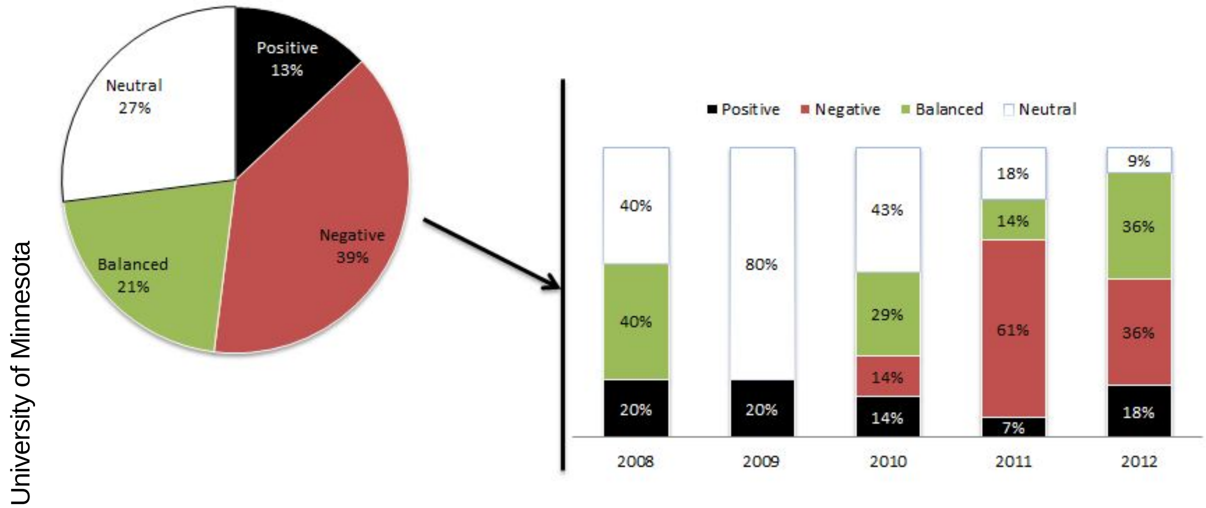


Figure K-6. Percent Sample Media Coverage by Attitudinal Category

Prior to launching the Atlanta CRD projects, the majority of the news media was neutral or balanced, and there were more positive stories written on the Atlanta CRD projects than negative stories. However, soon after the start of tolling on I-85 in October 2011 a number of negative news stories were written. Negative news media focused on commuter complaints of I-85 Express Lanes, including increased congestion in the general purpose lanes, and feeling that I-85 tolls were unaffordable to the average person. In 2012 as time increased from the point that the Express Lanes were launched, negative news media declined and positive and balanced news media grew.

The news coverage focused almost exclusively on I-85 tolling over other aspects of the Atlanta CRD projects, such as the funding for transit. The national evaluation team found very little mention in the media of the transit projects funded as part of the Atlanta CRD. The following key themes emerged from the sample.

- <u>Commuters Dissatisfied with Express Lanes</u>: Newspaper articles reported commuters as having multiple complaints regarding the Atlanta Express Lanes on I-85, with dissatisfaction peaking soon after the lanes opened. First, many reports mentioned that in the weeks soon after the Express Lanes went live, the travel speed in the general lanes was slower than prior to the installation of the Express Lanes. Secondly, there were many reports of individuals being frustrated with having to pay extra to use part of a freeway that was already funded through tax dollars. Some people stressed the multiple times they believed their tax dollars had been used to pay for the highway, from the initial construction of the highway, to the construction of the HOV lanes, to the building of the Express Lanes. Some reports stressed the high cost of the toll, especially if you were planning on using the Express Lanes for a regular commute. Another frustration that commuters had mentioned in the news media was that previously 2-person carpools could use the HOV lane for free, whereas now they would have to pay. An additional grief from commuters was that people didn't like that an existing lane was converted to a toll lane. If there was going to be a lane that was tolled, commuters would prefer that the toll be on a new lane to be put in.

> *"In Atlanta, for example, new congestion-priced lanes have gotten a hostile reception from drivers who complain about the cost and say traffic is as bad as ever. The mere concept of pricing alone tends to be unpopular because many people believe freeways should remain free. Trumble is one such person. "In the part of the country where there aren't toll roads," he says, "We're doing just fine without them." "*[2]

- Frustration with Transportation Officials: Considerable coverage in the media was spent on interviews with frustrated citizens speaking out about how they felt public transportation officials were not taking their concerns into consideration with long term transportation planning. In addition, a lot of the media also covered citizen reports describing their failed attempts to get meaningful answers from transportation officials and transportation officials who would not show up to meetings despite being invited.

> *"On behalf of the "Stolen Lanes" coalition, Chris has extended an offer to both the Georgia State Road and Tollway Authority (SRTA) and the Georgia DOT to discuss this matter in a moderated environment, but both groups have declined as of the writing of this blog….SRTA, if you are so adamant that the HOT lanes are a great thing for Georgia, then why shy away? Seems to me that it is implying that the HOT lanes are simply a money-making deal that amounts to little more than socioeconomic discrimination, hence the term "Lexus Lane"…..If SRTA and GDOT truly care about the people of Georgia, then they would send representatives to hear the concerns of the people and work with them to come up with some kind of solution."*[3]

- Tolling as a Necessary Strategy: When responding to commuter criticism about the I-85 Express Lane project, officials repeatedly focused on the necessity of tolling as a strategy for congestion reduction and for meeting state budgetary needs. Public officials saw increasing lanes as ultimately ineffective and too expensive, believing that tolling was the right option for managing traffic.

> *"[I]n Georgia, the big idea of a toll network doesn't appear to be up for debate. Transportation planners say the tolls are needed to keep traffic flowing and to help pay for the massive road improvements the region needs."*[4]

---

[2] Kubota, T. (2012, July 30). A HOT topic in transit: How high-occupancy toll lanes may mark the end of toll-free driving. Scienceline. Retrieved July 30, 2012, from www.scienceline.org.

[3] Williams, S. (November 10, 2011). SRTA and GDOT, What are you afraid of? The Georgia road geek blog. Retrieved on November 10, 2011, from www.georgiaroadgeed.com.

[4] Hart, A. (April 4, 2012). Your commute HOT lanes; Public: Georgia not heeding toll input. The Atlanta Journal-Constitution.

- Tolling Offers Drivers an Option: Of the positive coverage of the I-85 Express Lanes, one of the themes stressed was that no one was forcing those who do not like the Express Lanes to use them, but that it did provide commuters with a more reliable trip time to their destination.

  "[N]ow commuters have the option, if they absolutely need to be somewhere at a certain time, to pay to use a lane that on most mornings, maintains an average speed of at least 45 miles per hour…It's like having a commuting safety valve."[5]

K.5 Interviews and Workshops with Local Partners

The following section provides an analysis of the interviews and workshops conducted with Atlanta CRD representatives of the local partners. The purpose of the interviews and workshops was to gain additional insights into the institutional arrangements, partnerships, outreach methods, and other activities contributing to planning, deploying, and operating the Atlanta CRD projects.

Two rounds of in-depth interviews were conducted by the national evaluation team with agency personnel involved in the Atlanta CRD project. The first round of interviews occurred in summer 2011 prior to tolling deployment and the second round in summer 2012, approximately one year after tolling deployment.

Interviewees were identified by the national evaluation team with input from the Atlanta CRD local partners. Once interviewing began, the national evaluation team asked interviewees for their recommendations of other stakeholders to interview. Table K-3 identifies the number of individuals from different agencies and organizations that participated in the interviews and workshops.

Interviews were conducted one-on-one over the phone using questions developed by the national evaluation team with input from local partners and federal agency representatives. The questions were included in the *Atlanta CRD Surveys and Interviews Test Plan*.[6] Interviews lasted between 30 and 90 minutes. In most interviews, two members of the national evaluation team were present. One individual led the interview, asking the questions and jotting down notes. The second individual took notes using a laptop computer. All interviews were audio-recorded to produce a verbatim transcript. Interview transcripts were stored, organized, and analyzed using NVivo, a qualitative data analysis software. The software provided document coding and tracking capabilities based on key words and other characteristics.

[5] Arum, M. (September 24, 2012). Toll lane plan brings back old arguments. *The Atlanta Journal-Constitution*.

[6] Zimmerman, Carol et al. Atlanta Congestion Reduction Demonstration: National Evaluation: Surveys and Interviews Test Plan. Publication Number FHWA-JPO-11-104, August 16, 2011.

Table K-3. Stakeholders Interviewed and Workshop Participants

Organization	Number of Participants			
	First Round Stakeholder Interviews	Second Round Stakeholder Interviews	First Round Stakeholder Workshop	Second Round Stakeholder Workshop
Georgia Department of Transportation	2	3	2	3
State Road and Tollway Authority	3	6	4	6
Georgia Regional Transportation Authority	2	1	0	3
Atlanta Regional Commission	2	3	1	2
Gwinnett County	2	1	0	1
Federal Highway Administration			2	6
Total	**11**	**14**	**9**	**21**

Source: University of Minnesota

After each round of interviews, the national evaluation team convened a workshop where all of individuals interviewed were invited, as well as other agency representatives. In addition, U.S.DOT personnel managing the Atlanta CRD national evaluation and other national evaluation team members were in attendance. Both workshops were held in Atlanta, the first in July 2011 and the second in September 2012.

The purpose of the workshop was to follow-up on the individual interviews by discussing the common themes that emerged and to draw lessons learned. To facilitate discussion during the workshop, the common themes from the interviews were summarized and presented. Workshop participants were encouraged to provide additional comments, including highlighting new points or by clarifying or reinforcing the identified themes and topics presented by the national evaluation team. The following key themes from the interviews and workshops are as follows:

- <u>Opportunity seized.</u> The Atlanta region applied for but did not receive funding in the first round of the federal Urban Partnership Agreement Program (UPA). Interviewees indicated that in the time between submitting an application to the UPA and submitting an application to the renamed Congestion Reduction Demonstration Program (CRD), the local partners had the time to further develop and articulate a multi-modal, multi-agency, and multi-jurisdictional approach to managing congestion in the Atlanta region. The local partners felt that they persisted in this approach even after failing to receive UPA funding, because they believed this was the right way to address congestion management. By solidifying a shared understanding to the problem (i.e. they cannot build their way out of congestion) and the solution (i.e., multiple strategies involving the 4T's (tolling, transit, technology, and transportation demand management or TDM), the local partners harnessed the right kinds of conditions to be in place to create a successful project bid when the CRD came along. In one interviewee's words: "I think the CRD helped us to get everything on the same page." And another, "It was the catalyst, the spark…all of a sudden all of these things could be done sooner."

- <u>The politics of congestion pricing.</u> These initial conditions also included important political support from the Governor. As one interviewee stated, "Everyone was on the same page…because the head of the state was behind it." At the point of the first round of interviews and workshop, the local partners saw elected officials as contributing to the successful bid and start of the CRD projects. This included not just the Governor's support but also the Gwinnett County Board. Any challenges had been successfully overcome at this point, including negotiations with the City of Atlanta and Georgia State University on the routes and stop locations for the Xpress bus service into downtown Atlanta. At the time of the second round of interviews and workshop, the political landscape had changed along with the kind of political support for congestion pricing. While no elected official stood directly in their way of successfully deploying the CRD projects, the local partners were left without any elected officials standing up as champions for managed lanes. Interviewees expressed that although political champions would have helped their education and messaging on the managed lane concept, the steady rise in Peach Pass purchases and lane use after the tolling opened demonstrated to the local partners that this was not necessary to a successful deployment. Interviewees also commented that they used the politics of the CRD in a positive way by framing the project as a competitive federal grant that allowed them to leverage federal funds to try new approaches that they would not otherwise have been able to afford with just local funding.
- <u>Project structure matters.</u> Given the multi-agency organizational structure of the CRD, it was important for the partners to clearly define project roles and responsibilities. This was articulated at the outset of the CRD projects through memoranda of understanding among the partners. But it was the ways in which the individuals from each of the partner agencies interacted with each other that translated what was documented on paper into appropriate action as they coordinated both implementing and communicating the CRD projects. Interviewees described a shared expectation among the partners that they would work well together. As one interviewee noted, "So you had three agencies that were working on something for the first time…my observation would be that these agencies worked extremely well together, the project was delivered on time, every deadline was met, every challenge was overcome. They figured out a way to do things, working together, and I, as an outsider, think it was done extremely well." This quotation highlights that a key to implementing a well-articulated project structure is the quality of the relationships.
- <u>Personal relationships matter.</u> Interviewees revealed a high level of respect for the competencies of the individuals involved in the CRD – this respect translated into giving each other space to conduct the work for which they were responsible, without delay. This is not to say that the partners were devoid of project conflicts, rather they maintained a willingness to quickly resolve issues as each held the common goal of successfully completing the CRD. As one interviewee stated, "It [implementing the CRD projects] wasn't smooth, but we got along." Another interviewee described the reality of working with project partners in the following way: "…when you're in the

trenches, things get frustrating. [But], we know that we're stuck with each other and we're [going to] build this thing together." Interviewees all pointed to their frequent in-person and over-the-phone communication as the key to maintaining their good working relationships.

- <u>A compressed timeline helped maintain focus.</u> The CRD timeline was frequently discussed by interviewees and workshop attendees. The CRD timeline imposed by the federal grant was shorter than the local agencies were accustomed to, overlapping planning processes with implementation activities. While a certain level of stress came with the tight timeline, interviewees actually referred positively to the timeline stating that it kept people focused and required that issues were resolved quickly. The quick resolution of problems was in part due to the quality of working relationships but also that project managers had access to people in positions of power who could influence policy and process in order to keep the project on track.
- <u>A proactive, deliberate approach to outreach and marketing pays off.</u> Given this was the first project of its kind in the Atlanta region, local partners involved in the outreach and marketing of the Express Lanes were tasked with educating a public that was unfamiliar, and at times reticent, about converting to toll lanes. The local partners deployed an extensive outreach and marketing plan through a variety of methods and venues. Despite negative press and the absence of political champions, Peach Pass sales exceeded expectations.

K.6 Public Reaction to the CRD Projects

Three surveys revealed the public's reaction to the CRD projects—the Volpe household travel panel survey, SRTA carpooler survey, and GRTA's transit rider survey. Taken together the results showed a weakening of public support for the Express Lanes after deployment compared to attitudes prior to the start of tolling and a general negative response on a number of measures. Drivers using the Express Lanes tended to have a more positive view on some but not all measures than those that did not use the lanes, according to the Volpe survey, but carpoolers surveyed by SRTA were negative regardless of their use of Express Lanes. On the other hand, Xpress bus riders voiced high satisfaction with their I-85 commute. These findings were no doubt a reflection of the rocky start and negative publicity at the outset of the Express Lanes, but they could also indicate that the potential benefits of the Express Lanes were not fully realized in the first year of deployment.

Volpe surveyed a panel of the same households in the spring of 2011 prior to tolling (wave 1) and again in the spring of 2012 after tolling (wave 2). Details about the survey were presented in Appendix A – Congestion Analysis. When polled approximately seven months after the start of tolling, 66 percent of the sampled households had not obtained a Peach Pass to use the Express Lanes, with opposition to tolling in general the reason given by 39 percent of non-Peach Pass households, the third most-cited reason. However, for households that made trips using the Peach Pass in the Express Lanes, the analysis identified a statistically significant increase in satisfaction in terms of travel time, travel speed, and predictability relative to responses prior to tolling as shown in Table K-4. At the same time, those expressing satisfaction were about equal with those expressing dissatisfaction. By comparison, transit riders were satisfied with their trips by a large majority both before and after tolling.

Table K-4. Satisfaction with A.M. Peak Hour HOV/Express Lane Trips

Wave 1: N=93 trips; Wave 2, N=169 trips

	Very Dissatisfied	Dissatisfied	Somewhat Dissatisfied	Neutral	Somewhat Satisfied	Satisfied	Very Satisfied	
Travel Time								
Wave 1	12%	18%	27%	11%	8%	21%	3%	Chi-sq =40.1 sig <0.0001
Wave 2	13%	15%	20%	9%	18%	19%	6%	
Travel Speed								
Wave 1	12%	15%	29%	9%	11%	20%	4%	Chi-sq =34.2; sig <0.0001
Wave 2	15%	16%	15%	10%	20%	18%	5%	
Predictability								
Wave 1	14%	10%	20%	27%	6%	21%	3%	Chi-sq =23.1; sig 0.0008
Wave 2	13%	9%	23%	19%	12%	18%	6%	

Source: Battelle based on Volpe data

In terms of attitudes about tolling, the public was significantly more negative about the Express Lanes in 2012 compared to attitudes the year before tolling began. When asked about agreement with the statement “I will use a toll route if the tolls are reasonable and I will save time,” agreement dropped from 65 percent before tolling to 41 percent after tolling. When asked about agreement with the statement “Highway tolls as are unfair to people with limited incomes,” the majority agreed both before (75 percent) and after (57 percent) tolling, although the drop after tolling could be because of a feeling of unfairness to all income levels.

Other negative attitudes expressed after tolling included 54 percent disagreeing that “overall, my travel along I-85 has been improved by the Express Lanes” and 50 percent agreeing that “congestion has become worse along my other routes in the I-85 Corridor.” However, the drivers who used the Express Lanes exhibited a more positive attitude toward the Express Lanes than those who did not use them.

The SRTA carpooler survey consisted of two cross-sectional surveys of carpoolers registered with the Clean Air Campaign in 2011 and 2012. Details of the survey were presented in Appendix D – TDM Analysis. In 2012 about 70 percent of the surveyed carpoolers rode in 2-person carpools, which could have used the previous HOV lanes for free but were required to pay a toll to use the Express Lanes. This change in status most likely influenced their perceptions of the Express Lanes. Carpoolers who frequently used the Express Lanes tended to be more positive in their assessments, but neither majority of frequent or infrequent users thought the Express Lanes improved their personal commute on I-85: 55.6 percent of frequent users answered probably or definitely not vs. 92.0 percent of infrequent users. On the other hand, when asked “do you think that it is fair to allow single-occupant vehicles to use the Express Lanes if they pay the toll," a slight majority agreed it was fair and there was no difference based on frequency of usage. However, regardless of usage of the Express Lanes, the vast majority of frequent and infrequent carpoolers (over 73.5 percent and 82.5 percent respectively) did not agree "charging 2-persons carpools to use the Express Lanes has been helpful in providing more reliable travel times for more motorists."

The GRTA transit rider survey consisted of two on-board surveys of riders, the first in August 2011 prior to tolling and the second in May 2012, seven months after tolling began. Details of the survey were presented in Appendix C – Transit Analysis. Prior to tolling 59.9 percent of riders disapproved of the plans to convert the HOV lane into a HOT lane, with disapproval consistent across socio-economic groups. Only 9.4 percent approved with the rest being unaware of the plans or undecided in their response. Negative attitudes persisted in the post-deployment survey. The majority disagreed that tolling on I-85 had improved their travel (52.1 percent) or had been good for the Atlanta region (63.6 percent). A majority of 54.5 percent agreed that tolling on I-85 was unfair to people on limited incomes.

Despite their opinions about the HOV to HOT conversion, Xpress bus riders were very enthusiastic about the bus service. As reported in Appendix C, over 90 percent said they either liked it or loved it. When asked to rate their level of satisfaction from 1 to 5 with 1 being poor and 5 being excellent, overall satisfaction was rated 4.1 (very good), and eight of thirteen service aspects were rated over 4.0, including travel time and buses arriving on time. Thus, the transit portions of the CRD were viewed very favorably by their riders.

K.7 Summary of Non-Technical Success Factors

As highlighted in Table K-5, people, process, structures, the media, and competencies all played supporting roles in the implementation, deployment, and operation of the Atlanta CRD projects. The multi-organizational structure, with its well-articulated roles and responsibilities supported the implementation, deployment, and operations of the CRD projects. A team of competent staff who respected each others' work were able to lead the region through the implementation of a technologically complex and politically difficult project. The local partners deployed an ambitious communications and outreach plan, recognizing their responsibility in effectively communicating to the public a project that would significantly change the culture of transportation in the region– a region previously unfamiliar with dynamically priced tolling. Local partners had to balance the challenges of delivering a complex project under tight time constraints with a communications strategy that informed the public of the changes tolling would bring as well as attempt to educate the public on the purpose and potential benefits of congestion pricing. It seemed the media played a role in shaping public opinion of the CRD projects, especially the coverage occurring just after the tolling deployment that emphasized the views of those that vehemently opposed tolling. Surveys also indicated that the public in general had a negative perception of the Express Lanes. One missed opportunity was the limited promotion of the CRD transit enhancements as an attractive alternative to I-85 commuters. Although most interviewees hesitated to use the word "success" when describing the CRD, they all spoke with pride and satisfaction when reflecting on the outcome of the CRD projects as well as an interest in continuing tolling in the region, as new projects were already underway during the second round of interviews and workshop.

Table K-5. Non-Technical Success Factors

Questions	Results	Evidence
What role did the following areas play in the success of the Atlanta CRD projects?		
1. People 2. Processes 3. Structures 4. Media 5. Competencies	1. Effective 2. Effective 3. Effective 4. Problematic 5. Effective	1 and 5. Agency staff held technical expertise and project management skills needed to successful implement the projects. Staff held their colleagues in high regard. 1 and 5. Agency leadership influenced policy and process to keep projects on track. 2. Frequent communication and information sharing among agency partners kept everyone on the same page. 3. Clearly defined roles and responsibilities within the multi-agency organizational structure. 4. Media kept the projects in the public eye, although their contribution to public opinion leaned toward negative during the critical period of the opening of the Express Lanes. Lack of media coverage of transit enhancements reflected agencies' missed opportunity to communicate transit's role as an attractive alternative to commuters.
Does the public support the CRD strategies as effective and appropriate ways to reduce congestion?	Negative	Surveys showed that I-85 travelers in general had a negative attitude toward the Express Lanes, but Express Lane users tended to be more positive about the benefits.

Source: University of Minnesota

Appendix L. Benefit Cost Analysis

The purpose of the benefit cost analysis (BCA) was to quantify and monetize the societal benefits and costs of implementing the Atlanta CRD projects. The net benefit from the CRD projects, which was the difference between the total benefits and the total costs, indicated the net societal benefit of this public investment. As presented in Table L-1, the BCA focuses on quantifying the overall benefits, costs, and net benefits from the Atlanta CRD projects on I-85. The term cost benefit analysis (CBA) was used in the Atlanta CRD test plan. The use of BCA has become the commonly accepted term in the transportation community and was used in this appendix.

Table L-1. Question for the BCA

Question
What are the overall benefits, costs, and net benefits from the Atlanta CRD projects?

Source: Texas A&M Transportation Institute

The timeframe used for the BCA encompasses the planning, implementation, and ten years of post-deployment operation. This approach included all costs of the Atlanta CRD projects from their planning stages to 10-years post-implementation and all benefits of the projects for a 10-year period after implementation. Within this evaluation time frame, the BCA estimated and compared the total benefits and costs between two scenarios – with and without the implementation of the Atlanta CRD projects.

The remainder of this appendix includes five sections. The Atlanta CRD projects included in the BCA along with the data sources used in the BCA are presented in Section L.1. Cost information on the Atlanta CRD projects included in the BCA is presented in Section L.2. The estimation of the benefits from the projects is described in Section L.3. The appendix concludes with a summary of the analysis in Section L.4.

L.1 Atlanta CRD Projects and Data Sources

The Atlanta CRD projects focused on the conversion of HOV lanes to high occupancy toll (HOT) lanes and enhanced transit on I-85 northeast of Atlanta. As listed below, the projects associated with this CRD include the HOT lanes, known as Express Lanes in Atlanta, new buses and resulting new routes along this corridor, park-and-ride lot enhancements, carpooling outreach programs, and enforcement technologies used with the Express Lanes. Thus the Atlanta CRD projects included in the BCA were:

- Conversion of the I-85 HOV2+ lane to Express Lanes. This included any construction costs, the automated enforcement systems, signing, toll collection systems, operations and maintenance, and other costs over and above the costs of the previous HOV lane. It also included the cost of public outreach regarding this change.
- 12 new buses added to the commuter bus fleet enabling the creation of 3 new routes along the corridor. This included the cost of purchasing the buses along with operations and maintenance costs for these buses. Eight buses were purchased for

Xpress Bus routes not on I-85, and the costs and the benefits from these other buses were not included in this analysis.

- Three new park-and-ride lots (Mall of Georgia, Hamilton Mill, and Hebron Baptist Dacula) along with one expanded lot (I-985/GA 20). All costs associated with ownership/leasing and operations of these facilities were included.
- Carpooling outreach. In the early phases of this project the Clean Air Campaign undertook public outreach to increase the number of 3-person carpools in the I-85 Express Lanes corridor.

Data on the capital costs of the projects listed above were obtained from the State Road and Tollway Authority (SRTA), the Georgia Department of Transportation (GDOT), and the Georgia Regional Transportation Authority (GRTA). Data on the operation and maintenance costs associated with the projects were obtained from these same agencies.

Information on 10-year projections of benefits in travel-time savings and savings in vehicle operating costs savings were obtained from the urban area travel demand model developed and run by the Atlanta Regional Commission (ARC). Emissions reductions were obtained from analysis of observed travel volumes and speed and were calculated as shown in Appendix H – Environmental Analysis.

L.2 Atlanta CRD Projects – Costs

Data on the capital costs, the implementation costs, the operating and maintenance costs, and the replacement and re-investment costs for the CRD projects were obtained from SRTA, GDOT, and GRTA. To convert any future year costs to year 2011 dollars,[1] a real discount rate of 7 percent per year was used based on federal guidance.[2]

As outlined in the *Atlanta CRD National Evaluation Plan*,[3] a 10-year post-deployment timeframe was used for the BCA since many aspects of the projects were technology- or pricing-related. Both technology and pricing systems have relatively short life spans. Thus, only expenditures prior to September of 2021 incurred as a result of implementing the CRD projects were considered. In addition, only the marginal costs associated with the CRD projects were included in the cost data. The BCA timeframe began with the first expenses incurred and ends in 2021, after 10 years of operations. The Atlanta CRD projects with useful lives longer than 10 years, such as new buses, were accounted for by reducing the cost of that item by its salvage value in year 10.

The U.S. DOT allocated $110 million for the Atlanta CRD projects. The funding was used to plan, design, and construct the various projects – along with operating the new system in the early years. Operating and maintaining the projects over the BCA timeframe of 10 years requires additional funding. To address costs incurred in years after 2011, those costs were adjusted to a common year using a discount rate of 7 percent. Therefore, determining the costs of the CRD projects was more difficult than simply assuming that the costs total $110 million. The following section, along with

---

[1] The Express Lanes began operation on October 1, 2011. The national evaluation uses this as the start date for the project and the start of benefits analysis.

[2] Office of Management and Budget guidance (http://www.whitehouse.gov/omb/assets/a94/a094.pdf (page 9)) and current FHWA guidance (Federal Register, Vol. 75, No. 104, p. 30476)).

[3] Atlanta Congestion Demonstration National Evaluation Plan, FHWA-JPO-11-003, April 6, 2011. Available at http://ntl.bts.gov/lib/42000/42800/42820/atlantaupa_R3_.pdf.

Table L-2 and Table L-3, provide details regarding the cost estimate of the Atlanta CRD projects in 2011 dollars for the purpose of the BCA.

Table L-2. Atlanta CRD Project Planning, Design and Construction Costs

CRD Project Component	Planning, Design, and Construction/Purchase Costs (2011 dollars)
HOT Lanes on I-85	
Highway Design	$6,755,030
Construction for Tolling (gantries, fiber, signs…)*	$16,490,211
Tolling System (development, equipment, readers…)	$24,068,187
Marketing and Communications	$3,300,000
Customer Service Center Start up	$1,600,000
Enforcement	$573,000
TOTAL	$52,786,428
12 New Buses with 3 New Bus Routes*	$5,793,912
Park-and-ride Lots (3 new and 1 expanded)	
Mall of Georgia (lease)	$1,040,000
Dacula / Hebron Baptist (lease)	$495,000
I-985 / GA20 (expansion)*	$2,484,181
Hamilton Mill (new)*	$5,005,736
TOTAL	$9,024,917
Carpooling Outreach	
Clean Air Campaign Lead	$57,000
SRTA Lead	$173,522
TOTAL	$230,522
Monitoring and Evaluation	
National Evaluation	$625,000
Performance Monitoring	$2,000,000
TOTAL	$2,625,000
GRAND TOTAL	$70,460,779

Source: Texas A&M Transportation Institute.

* indicates this item will have a salvage value after 10 years.

Table L-3. Atlanta CRD Project Operating and Maintenance Costs

CRD Project Component	Operation and Maintenance Costs (years 2011 to 2021 in 2011 dollars)
HOT Lanes on I-85	
Overhead	$9,230,080
Traffic Operations Center	$3,130,908
Customer Service Center/Violations	$13,784,128
Lane Equipment	$8,498,179
ITS	$2,764,958
Enforcement	$1,870,413
Other	$1,382,479
TOTAL	$40,661,145
12 New Buses with 3 New Bus Routes	$15,121,391
Park-and-ride lots (3 new and 1 expanded)	$114,189
GRAND TOTAL	$55,896,725

Source: Texas A&M Transportation Institute

In December 2021 some of the above items will still have value, which is known as salvage value. These are indicated with an asterisk (*) in Table L-2. The salvage value was subtracted from the total cost above ($126,357,504) to determine the net cost over the 10 year BCA timeframe. Minnesota's BCA guidance[4] provided the following formula to obtain the salvage value:

$$\text{Salvage Value} = \frac{(1+r)^n \times \left[\left(\frac{(1+r)^L - 1}{r(1+r)^L}\right) - \left(\frac{(1+r)^n - 1}{r(1+r)^n}\right)\right]}{\left(\frac{(1+r)^L - 1}{r(1+r)^L}\right)}$$

Where r = the discount rate (0.07)

n = number of years in the analysis period (10)

L = useful life of the asset

[4] Minnesota Department of Transportation, "Benefit-Cost Analysis for Transportation Projects," available at http://www.dot.state.mn.us/planning/program/benefitcost.html

This same guidance suggested the useful life of surface (pavement) to be 25 years, sub-base and base were 40 years, and major structures have longer timeframes. For the surface parking lots and construction for tolling (such as signs), a life span of 25 years was chosen. The salvage value was therefore:

$$\text{Salvage Value} = \frac{(1+0.07)^{10} \times \left[\left(\frac{(1+0.07)^{25}-1}{0.07 \times (1+0.07)^{25}} \right) - \left(\frac{(1+0.07)^{10}-1}{0.07 \times (1+0.07)^{10}} \right) \right]}{\left(\frac{(1+0.07)^{25}-1}{0.07 \times (1+0.07)^{25}} \right)} = \frac{1.97 \times (11.65 - 7.02)}{11.65} = 0.782 = 78.2\%$$

Salvage value = 78.2% x (value of construction for tolling + value of the I-985/GA20 P&R lot + value of the Hamilton Mill P&R Lot) = 78.2% x ($16,490,211 + $2,484,181 + $5,005,736) = 78.2% x $23,980,128 = $18,741,784. Two P&R lots (Mall of Georgia and Dacula) were leased and, therefore, will not have salvage value at the end of the BCA timeframe.

The one remaining item was the salvage value of the 12 new buses after 10 years of service. Assuming that the buses have a useful life of 12 years then the salvage value equals: $5,793,912 x 22.8% = $1,318,886.

Therefore, the resulting 10-year costs from the Atlanta CRD projects were $126,357,504 – ($18,741,784 + $1,318,886) = $106,296,834.

L.3 Atlanta CRD Projects – Benefits

The benefits of the Atlanta CRD projects were similar to benefits from many transportation infrastructure projects and the calculation methodology followed standard practice as provided by the Transportation Research Board committee on transportation economics[5] and the Federal Highway Administration.[6] This section highlights how the benefits were calculated for the CRD projects.

The preferred option to estimate the impacts, and therefore benefits, of the CRD projects was to use the Atlanta Regional Commission's travel demand model. Fortunately, the output from the model for the before period (October 2010 to September 2011) and the after period (October 2011 to September 2012) was similar to the results based on GDOT's NaviGAtor traffic data collection system as discussed in Appendix A – Congestion Analysis. Thus, the model could be used to capture the change in travel time and vehicle operating costs caused by the CRD projects.

Emissions experts at both ARC and the national evaluation team felt using an area-wide model to measure the emissions impact from projects on this one corridor was not the best method. Therefore, estimates of the change in emissions were based on observed changes in traffic volume and travel speeds on I-85 as discussed in Appendix H – Environmental Analysis. Finally, the ARC model did not estimate the impact of the CRD projects on safety (crash rates), and, therefore, crash data from Appendix F – Safety Analysis would have been used to estimate the impact of the CRD on crashes. However, there was only one year of crash data available, but three or more years of data are

---

[5] http://bca.transportationeconomics.org/

[6] Federal Highway Administration, TIGER BCA Resource Guide, http://www.dot.gov/sites/dot.dev/files/docs/USDOT%20BCA%20Guidance.pdf

recommended to obtain reliable results, as noted in Appendix F. Therefore, the change in crashes due to the CRD projects was not included.

The ARC travel demand model covers a 20-county area encompassing metropolitan Atlanta. It is based on a household travel survey of 8,000 households plus an on-board transit survey (http://www.atlantaregional.com/File%20Library/Transportation/Travel%20Demand%20Model/tp_arcmodeldocumentation_022212.pdf[7]). It is used extensively by transportation planners in the Atlanta area for determining the impacts of potential transportation projects. The ARC chose to use 2015 as the future year due to other projects that are planned for the area. According to ARC's Surveys and Transportation Model Development Manager, Guy Rousseau, "Using 2015 instead of 2020 turns out to be a better "apples to apples" comparison, due to the scope and nature of other projects in the region, when looking at our TIP (Transportation Improvement Program)."[8]

L.3.1 Benefits – Travel Time Savings

For most transportation projects the largest societal benefits are a result of the travel time savings gained through reduced congestion. The amount of travel time savings from the project was obtained from ARC's model. The model was run four times:

1. Base year 2010 without the CRD projects,
2. Base year 2010 with the CRD projects,
3. Future year 2015 without the CRD projects,
4. Future year 2015 with the CRD projects.

The base and future years indicate the population, demographics, and road network for those years. For the initial (opening) year of the project in late 2011 the results from the 2010 models were used. For the years from 2012 to 2014 a linear change in benefits from the 2010 model results to the 2015 model results was assumed. For the years 2015 onwards the results from the 2015 models were used. The impact of the CRD projects was taken as the difference in the model results from the two models for that year. It should be noted that the models showed small improvements in travel times due to the CRD projects in the early years. However, in later years the models showed negative impacts of the CRD projects on travel times. Both models predicted travel time impacts were very small. The empirical analysis of post-deployment data presented in Appendix A also found very small changes in travel time.

The amount of time saved by travelers was converted to monetary benefits based on FHWA guidance.[9] The value of time (VOT) for auto travelers in the year 2009 was $12.50 per hour based on local travel, weighted by the average of both business and other travel. This value was based on average household income of $49,777 in 2009. For 2011, the $12.50 per hour was adjusted upwards by 0.6 percent to $12.57 per hour since the average household income rose 0.6 percent to $50,054.[10] The 2011 value was adjusted for future values of time by increasing it by 1.6 percent per year (prior to

---

[7] Atlanta Regional Commission, The Travel Forecasting Model Set for the Atlanta Region, 2010 Documentation.http://www.atlantaregional.com/File%20Library/Transportation/Travel%20Demand%20Model/tp_arcmodeldocumentation_022212.pdf

[8] Personal communication with Mark Burris of Texas A&M University.

[9] Federal Highway Administration, http://ostpxweb.dot.gov/policy/reports/vot_guidance_092811c.pdf, Table 4

[10] http://www.census.gov/hhes/www/income/data/statistics/index.html

applying the discount rate) as outlined in the FHWA value of time guidance document.[11] As shown in Table L-4, automobile drivers saved a total of 121,892 hours with a benefit of $1,529,313 in 2011 dollars.

Table L-4. Atlanta CRD Automobile Travel Time Benefits

Year	Household Income ($)	Auto VOT* ($)	Auto VOT* (2011 $)	Hours Saved	Benefit (2011 $)
2011	50,054	12.57	12.57	52,726	662,743
2012	50,855	13.51	12.63	39214	495,254
2013	51,669	13.73	11.99	25701	308,218
2014	52,495	13.95	11.39	12189	138,799
2015	53,335	14.17	10.81	-1,323	-14,305
2016	54,189	14.40	10.27	-1,323	-13,583
2017	55,056	14.63	9.75	-1,323	-12,897
2018	55,936	14.86	9.26	-1,323	-12,246
2019	56,831	15.10	8.79	-1,323	-11,628
2020	57,741	15.34	8.35	-1,323	-11,042
TOTALS				**121,893**	**$1,529,313**

*VOT = value of time (one hour)

Source: Texas A&M Transportation Institute

Next the value of travel time savings for trucks was estimated. Again, the ARC model provided the number of hours saved in travel time for the opening year (the difference in truck travel time for the 2010 models) and for future years (the difference in truck travel time for the 2015 models). As with automobiles, the number of hours saved in 2011 was taken from the 2010 model runs. The number of hours saved in the years 2012 to 2014 as assumed to change linearly between the results of the 2010 and 2015 models. From the year 2015 onwards the results of the 2015 model were used.

The value of time for trucks was estimated somewhat differently than for automobiles: it is the value of time of the driver and not the goods carried. FHWA guidance[12] on the value of time for truck drivers was $24.70 per hour in 2011. This was inflated by 1.6 percent for every year past 2011. The total amount of time saved by trucks due to the CRD projects was 80,687 for a benefit of $1,982,556 in 2011 dollars as shown in Table L-5.

[11] Federal Highway Administration, http://ostpxweb.dot.gov/policy/reports/vot_guidance_092811c.pdf.

[12] Federal Highway Administration, http://ostpxweb.dot.gov/policy/reports/vot_guidance_092811c.pdf.

Table L-5. Atlanta CRD Truck Travel Time Benefits

Year	Driver Wages ($)	Truck VOT* ($)	Truck VOT* (2011 $)	Hours Saved	Benefit (2011 $)
2011	17.09	25.50	25.50	34,357	875,991
2012	17.37	25.90	24.21	25,594	619,636
2013	17.65	26.32	22.99	16,832	386,925
2014	17.93	26.74	21.83	8,069	176,125
2015	18.21	27.17	20.73	-694	-14,384
2016	18.51	27.60	19.68	-694	-13,658
2017	18.80	28.04	18.69	-694	-12,969
2018	19.10	28.49	17.74	-694	-12,314
2019	19.41	28.95	16.85	-694	-11,693
2020	19.72	29.41	16.00	-694	-11,103
TOTALS				**80,687**	**$1,982,556**

*VOT = value of time (one hour)

Source: Texas A&M Transportation Institute

Lastly, the travel time saved by transit users due to the CRD projects was estimated. The ARC model did not provide travel time estimates for transit riders, and, thus, actual data from the transit system from April to June 2011 (before) and April to June 2012 (after) were used. These months provide data that were controlled for seasonal variation and avoid potential impacts of winter weather. For consistency, and to provide a conservative estimate, the 2012 travel time savings were decreased to 0 by the year 2015 since the ARC model showed no travel time savings due to the CRD projects by that year.

The amount of travel time savings for transit was taken from Tables C-4 and Table C-5 in Appendix C—Transit Analysis and summarized here in Table L-6 and Table L-7. Savings are for peak times only as the CRD projects would have minimal impact off peak. The total daily travel time savings for transit riders in 2012 was 74.1 hours per day. Assuming 250 days with congestion (weekdays) per year this equates to 18,528 hours in 2012. The future year travel time savings estimates are shown in Table L-8.

Table L-6. Travel Time Savings During the Morning Peak Period

Route	April to June 2011		April to June 2012		Travel Time Savings per Rider (min) Per Day	Total Travel Time Savings for All Riders (hours) Per Day
	Riders	Travel Time (min)	Riders	Travel Time (min)		
101	300	0:47:09	230	0:42:21	4.8	18.4
102	120	0:23:52	111	0:24:08	-0.267	-0.5
103	532	0:36:27	477	0:37:39	-1.2	-9.5
410	103	0:35:05	90	0:35:17	-0.2	-0.3
411	88	0:46:48	163	0:41:50	5.033	13.7
412	223	0:40:01	212	0:40:28	-0.45	-1.6
413			87	0:43:58	N/A	N/A
416			89	0:44:30	N/A	N/A
TOTAL						**20.1**

Source: Texas A&M Transportation Institute

Table L-7. Travel Time Savings During the Evening Peak Period

Route	April to June 2011		April to June 2012		Travel Time Savings per Rider (min) Per Day	Total Travel Time Savings for All Riders (hours) Per Day
	Riders	Travel Time (min)	Riders	Travel Time (min)		
101	291	0:51:33	218	0:48:00	3.55	12.9
102	116	0:31:36	109	0:30:15	1.35	2.5
103	549	0:46:05	493	0:41:51	4.23	34.8
410	77	0:44:07	74	0:38:36	5.52	6.8
411	88	0:44:22	160	0:46:02	-1.67	-4.5
412	244	0:42:29	225	0:42:05	0.4	1.5
413			87	0:54:41	N/A	N/A
416			87	0:57:22	N/A	N/A
TOTAL						**54.0**

Source: Texas A&M Transportation Institute

Table L-8. Benefits from Transit Travel Time Savings

Year	Time Saved (hours)	Transit VOT* ($)	Transit VOT* (2011 $)	Benefits (2011 $)
2012	18528	13.51	12.63	234001
2013	12352	13.73	11.99	148128
2014	6176	13.95	11.39	70326
2015	0	14.17	10.81	0
2016	0	14.40	10.27	0
2017	0	14.63	9.75	0
2018	0	14.86	9.26	0
2019	0	15.10	8.79	0
2020	0	15.34	8.35	0
2021	0	15.59	7.92	0
TOTALS				**452,455**

*VOT = value of time (one hour)

Source: Texas A&M Transportation Institute

The total benefits from a change in travel time were:

- Automobile travelers: $1,529,313
- Truck drivers: $1,982,556
- Transit Riders: $452,455
- TOTAL: $3,964,324

L.3.2 Benefits – Emissions

The shift in vehicles between the different lanes, plus shifts of travelers between modes has the potential to change the amount of emissions from vehicles. These emissions are harmful to humans and the environment and as such, a reduction or increase in emissions would result in a societal benefit or cost. The change in emissions due to the Atlanta CRD projects was calculated in Appendix H – Environmental Analysis and summarized in Table L-9. These included only changes during the peak hours of travel (6 a.m. to 10 a.m. and 3 p.m. to 7 p.m.) during work days (assumed to be 250 per year). Changes in emissions due to the CRD projects during other days and times would be negligible.

Table L-9. Volume of Reduced Emissions

Pollutant	Reduction in Emissions (pounds per day)	Reduction in Emissions (tons per year)
VOC	-3.4	-0.4
NO_X	-96.2	-12.0
$PM_{2.5}$	+0.4	+0.05
CO	-557.9	-69.7
CO_2	-32,200	-4025.0

Source: Texas A&M Transportation Institute

The changes in emissions were derived from actual travel speeds observed along the I-85 corridor in both the general purpose lanes and Express Lanes. As such they were an accurate estimation of the change in emissions from shortly before the Express Lanes began (April to August of 2011) to shortly after the Express Lanes were in operation (April to August of 2012). These values were considered more accurate than attempting to use an area-wide transportation planning model (i.e., Atlanta Regional Commissions' travel demand model) to estimate changes in emissions along a single corridor, such the I-85 CRD corridor. Therefore, these changes in emissions were used throughout the 10 year timeframe of the BCA.

The current year value of the societal benefit from reduced pollution was derived from the U.S. Environmental Protection Agency estimates of the value of health and welfare-related damages (incurred or avoided) and are recommended for use in current FHWA guidance.[13] The values were found in the report Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks[14] and are shown in Table L-10.

[13] Federal Register, Vol. 75, No. 104, p. 30479

[14] Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, National Highway Transportation Safety Administration, March 2009 (http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CAFE_Final_Rule_MY2011_FRIA.pdf, Table VIII-5, page VIII-60)

Table L-10. Values of Reduced Emissions (in 2007 $)

Pollutant	Cost in 2009	Cost in 2015	Cost in 2020
CO			
VOC	$1,700 per ton	$1,200 per ton	$1,300 per ton
CO_2	$21 per metric ton	$24 per metric ton	$26 per metric ton
NO_X	$4,000 per ton	$4,900 per ton	$5,300 per ton
$PM_{2.5}$	$168,000 per ton	$270,000 per ton	$290,000 per ton

Source: Texas A&M Transportation Institute
http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CAFE_Final_Rule_MY2011_FRIA.pdf

Future year values were taken from the Highway Economic Requirements System documentation[15] and are also shown in Table L-10. Neither of the references used in Table L-10 provides a value per ton of CO, and, therefore, CO was not included in the calculation.

The values in Table L-10 were interpolated (assuming a linear change in values per year) to obtain the monetary benefit of the four pollutants in each year from 2012 to 2021. Multiplying these values by the amount of pollution reduced (Table L-9), then adjusting the 2007 dollars to 2011 dollars using a discount rate of 7 percent, resulted in a total benefit of $7,476 from VOC, $770,462 from NO_x, and $1,160,202 from CO_2. The increases in PM2.5 led to a cost of $169,093 from increased particulate matter. Combining the costs of these individual emissions resulted in a total environmental benefit of $1,769,048.

L.3.3 Benefits – Fuel

A reduction in congestion had the potential to change the vehicle operating cost of passenger vehicles and trucks. These operating costs were comprised of items such as maintenance, reduced wear and tear on a vehicle, reduced fuel use, and other factors due to reduced congestion and a smoother driving cycle. The reduction in fuel use is often the largest change from a monetary perspective. For this analysis, the change in fuel use was the only vehicle operating cost calculated since the urban planning model did not provide details on the other changes.

The change in fuel use for both automobiles and trucks was calculated from the 2010 and 2015 ARC travel demand models. As with travel time saving, for the initial (opening) year of the CRD project in late 2011 the results from the 2010 models were used. For the years from 2012 to 2014 a linear change in benefits was assumed from the 2010 model results to the 2015 model results. For the years 2015 onwards the results from the 2015 models were used. The impact of the CRD projects was taken as the difference in the model results from the two models (without the CRD projects minus with the CRD projects) for that year.

The cost of fuel (minus taxes) for 2012 and 2021 was obtained from the U.S. Energy Information Administration and was for all grades of gasoline for an entire year for the lower Atlantic area.[16] Taxes

[15] Highway Economic Requirements System, Federal Highway Administration http://www.fhwa.dot.gov/infrastructure/asstmgmt/hersdoc.cfm.

[16] U.S. Energy Information Administration, http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_smn_a.htm

of 18.4 cents (federal) and 28.5 cents (State of Georgia) on gasoline were then removed from the final amount shown in Table L-11. The estimated cost of fuel (minus taxes) for future years was obtained from Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks.[17] Table L-11 also presents actual and estimated future year gas prices based on the CAFE document, which includes both automobiles and trucks. The total benefits from reduced fuel used were $1,552,330 (2011 dollars).

Table L-11. Gasoline Savings*

Year	Actual Gasoline Price Excluding Taxes	Actual Gasoline Price Excluding Taxes Adjusted to 2011 $/gallon	Gas Saved (Gallons)	Benefits (2011 $)
2011	3.149 (2012 $/gallon)	3.369	176,541	594,767
Year	**Forecast Gasoline Price Excluding Taxes in 2007 $/gallon**	**Forecast Gasoline Price Excluding Taxes Adjusted to 2011 $/gallon**		
2012	2.611	3.422	132,766	454,325
2013	2.668	3.497	88,991	311,202
2014	2.688	3.523	45,216	159,296
2015	2.736	3.586	1,441	5,167
2016	2.801	3.672	1,441	5,291
2017	2.846	3.731	1,441	5,376
2018	2.909	3.813	1,441	5,495
2019	2.975	3.900	1,441	5,620
2020	3.066	4.019	1,441	5,791
		TOTALS	**452,160**	**$1,552,330**

*The year 2012 gas price was used for the initial year of the CRD projects which ran from October 2011 to September 2012. Therefore, the table row 2011 contains 2012 gas prices and fuels savings for October 2011 to September 2012.

Source: Texas A&M Transportation Institute

[17] Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, National Highway Transportation Safety Administration, March 2009 (http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CAFE_Final_Rule_MY2011_FRIA.pdf)

L.4 Summary of BCA

The benefits of the Atlanta CRD projects are summarized below:

- Travel time savings: $3,964,324
- Reduced auto fuel use: $1,552,330
- Reduced emissions: $1,769,048
- TOTAL: $7,285,702

Most benefits from transportation projects are derived from reduced travel time (and thus reduced fuel use and reduced emissions). In the case of the Atlanta CRD there was little change in travel times and, thus, the societal benefits as measured by the BCA were relatively small. However, as noted in Section 3.2 of the main report, the Express Lanes were implemented to address the deteriorating performance of the previous HOV lanes that would have continued to worsen without the CRD projects.

The cost of the CRD projects, in 2011 dollars, was $106,296,834.

This BCA examined the net societal costs and benefits of the Atlanta CRD projects. As presented in Table L-12, the benefit-to-cost ratio for the Atlanta CRD projects was 0.07 and the net societal benefit was -$99,011,132.

The analysis had several limitations and required numerous assumptions. For example, vehicle operating costs included only reduced fuel consumption for automobile and truck travel. Data on possible reduction in fuel used by buses were not available. Several of the estimates were based on ARC's travel demand model of future traffic on this corridor. These estimates were based on predicting tolled and carpooling use of the ELs into the future – a very difficult task. The future year costs and benefits represented the best estimates available, but they are only estimates, and the actual costs and benefits could vary substantially.

Table L-12. Question for the BCA

Hypotheses/Questions	Result	Evidence	
What are the overall benefits, costs, and net benefits from the Atlanta CRD projects?	Negative societal benefits	Benefits:	$7,285,702
		Costs:	$106,296,834
		Net Benefits:	-$99,011,132
		Benefit-to-cost ratio:	0.07

Source: Texas A&M Transportation Institute

Appendix M. Exogenous Factors

The effectiveness of the CRD strategies might have been influenced by factors external to the projects themselves. To account for these factors, the national evaluation team monitored exogenous factors throughout the pre- and post-deployment periods. Information on unemployment rates and gasoline prices were examined. Information in this appendix provided a resource for use in the other analysis areas.

This appendix is divided into three sections. Unemployment rates in the Atlanta metropolitan area and the state, which reached highs in 2010 before beginning to decline in the last half of 2011, are described in Section M.1. Gasoline prices, which have fluctuated over the course of deploying the CRD projects, are discussed in Section M.2. A discussion of corridors used as control sites are presented in Section M.3.

M.1 Unemployment Rates

Unemployment rates were monitored throughout the pre- and post-deployment as the change in the number of people traveling to and from work influences traffic levels and bus ridership. The recession began before most of the Atlanta CRD projects became operational. Information on unemployment rates was used to help examine the potential effects of the economic downturn on the CRD projects in the different analyses.

The U.S. Bureau of Labor Statistics tracks historic unemployment data at the state level. The information was available through the U.S. Bureau of Labor Statistics website. Georgia Department of Labor (DoL) tracks unemployment rates at the state, metropolitan, and county levels. The information was available through the Georgia DoL website. For the Atlanta CRD national evaluation, the seasonally-adjusted annual and monthly state unemployment rate and the not-seasonally-adjusted unemployment statistics for the 10-county Atlanta Regional Commission (ARC) were monitored. The not-seasonally-adjusted unemployment rate was used for the region, as it was the only available data from the Georgia DoL at the regional level. Data from 2000 to September 2012 were examined.

Table M-1 presents the annual average state seasonally-adjusted unemployment rates for 2000 through 2012 from the U.S. Bureau of Labor Statistics. Table M-2 contains the monthly state seasonally-adjusted unemployment statistics for September 2009 through September 2012, which captured a one-year baseline period prior to the start of the first CRD-funded transit routes in August 2010. As shown in Table M-1, the annual seasonally-adjusted rate increased from 3.5 percent in 2000 to 10.2 percent in 2010, and declined to 9.8 percent in 2011 and to 9.1 percent in 2012 through September. The Georgia monthly seasonally-adjusted unemployment rate had remained relatively stable during the three-year period in Table M-2, although trending downward from 10.5 percent in October 2009 to 9.0 percent in September 2012.

Table M-1. Georgia Annual Average Unemployment Rate, Seasonally-Adjusted

Year	Percentage – Annual Average
2000	3.5
2001	4.0
2002	4.8
2003	4.8
2004	4.7
2005	5.2
2006	4.7
2007	4.6
2008	6.3
2009	9.8
2010	10.2
2011	9.8
2012*	9.1

*Note: Average for January-September, 2012.

Source: U.S. Bureau of Labor Statistics. http://data.bls.gov/timeseries/LASST13000003.

Table M-2. Georgia Monthly Unemployment Rate, Seasonally-Adjusted

Period	Year	Month	Unemployment Rate
Baseline	2009	September	10.4
Baseline	2009	October	10.5
Baseline	2009	November	10.5
Baseline	2009	December	10.5
Baseline	2010	January	10.5
Baseline	2010	February	10.4
Baseline	2010	March	10.3
Baseline	2010	April	10.2
Baseline	2010	May	10.1
Baseline	2010	June	10.0
Baseline	2010	July	10.1
Baseline	2010	August	10.2
Baseline	2010	September	10.2
Baseline	2010	October	10.3
Baseline	2010	November	10.3
Baseline	2010	December	10.2
Baseline	2011	January	10.1
Baseline	2011	February	9.9
Baseline	2011	March	9.8
Baseline	2011	April	9.8
Baseline	2011	May	9.8
Baseline	2011	June	9.9
Baseline	2011	July	10.0
Baseline	2011	August	9.9
Post-Deployment	2011	September	9.8
Post-Deployment	2011	October	9.7
Post-Deployment	2011	November	9.5
Post-Deployment	2011	December	9.4
Post-Deployment	2012	January	9.2
Post-Deployment	2012	February	9.1
Post-Deployment	2012	March	9.0
Post-Deployment	2012	April	8.9
Post-Deployment	2012	May	8.9
Post-Deployment	2012	June	9.0
Post-Deployment	2012	July	9.2
Post-Deployment	2012	August	9.2
Post-Deployment	2012	September	9.0

Source: U.S. Bureau of Labor Statistics. http://data.bls.gov/timeseries/LASST13000003.

Table M-3 presents the not-seasonally-adjusted annual average unemployment rate for the ARC 10-county area from 2000 to 2012. Table M-4 highlights the monthly not-seasonally-adjusted unemployment rate for the ARC 10-county area for October 2009 through September 2012. Table M-3 shows that the not-seasonally-adjusted annual average unemployment rate increased from 3.0 percent in 2000 to 10.1 percent in 2010, before declining to 9.6 percent in 2011 when the Express Lanes were opened in October, and falling to 8.9 percent through September of 2011 in the post-deployment period. Table M-4 shows that the monthly not-seasonally-adjusted unemployment rate for the ARC fluctuated between 9.3 percent and 10.5 percent from October 2009 through September 2011 in the pre-deployment period. High points during this period were reached in January 2010 (10.5 percent), August 2010 (10.4 percent), and June 2011 (10.2 percent), which were interspersed with low points in April 2010 (9.6 percent) and April 2011 (9.3 percent). During the post-deployment period, the not-seasonally adjusted monthly unemployment rate continued to decrease and fluctuate between 8.5 percent and 9.2 percent from November 2011 through September 2012.

Table M-3. Atlanta Region* Annual Average Unemployment Rate, Not-Seasonally-Adjusted

Year	Percentage – Annual Average
2000	3.0
2001	3.6
2002	4.9
2003	4.8
2004	4.7
2005	5.3
2006	4.6
2007	4.5
2008	6.1
2009	9.5
2010	10.1
2011	9.6
2012*	8.9

*Data for the 10-county region comprising the Atlanta Regional Commission.

**Note: Average for January-September, 2012.

Source: Georgia Department of Labor. http://explorer.dol.state.ga.us/gsipub/index.asp?docid=418.

Table M-4. Atlanta Region* Monthly Unemployment Rate, Not-Seasonally-Adjusted

	Year	Month	Unemployment Rate
Baseline	2009	September	10.2
		October	10.2
		November	10.0
		December	10.0
	2010	January	10.5
		February	10.3
		March	9.9
		April	9.6
		May	9.7
		June	10.3
		July	10.3
		August	10.4
		September	10.2
		October	10.1
		November	10.2
		December	10.1
	2011	January	10.1
		February	9.9
		March	9.5
		April	9.3
		May	9.5
		June	10.2
		July	10.0
		August	10.0
		September	9.7
Post-Deployment		October	9.4
		November	8.9
		December	8.9
	2012	January	9.1
		February	9.0
		March	8.6
		April	8.5
		May	8.6
		June	9.2
		July	9.2
		August	8.9
		September	8.4

*Data for the 10-county region comprising the Atlanta Regional Commission.

Source: Georgia Department of Labor. http://explorer.dol.state.ga.us/gsipub/index.asp?docid=422.

M.2 Gasoline Prices

Gasoline prices were monitored by the national evaluation team as changes in price might influence the demand for travel, which in turn could influence vehicles miles of travel (VMT) and total trips. Increases in gasoline might also influence commuters who typically drive alone to carpool, take transit, or telecommute.

The U.S. Energy Information Administration monitors gasoline prices by selected regions, including the Lower Atlantic region that includes Georgia, Florida, South Carolina, North Carolina, Virginia, and West Virginia. Data on weekly and monthly retail gasoline prices for various grades since 2000 were available online on the Energy Information Administration website. Table M-5 presents the monthly average retail gasoline prices in the region from the Energy Information Administration website. Figure M-1 shows a longer time series of the price of a gallon of regular conventional retail gasoline in Atlanta from 2006 through 2012 from atlantagasprices.com, a commercial website.

During the evaluation period gasoline prices reached a high of $4.10 per gallon in July 2008, as shown in Figure M-1. The major decline in gasoline prices in late 2008 reflected the decline in world crude oil prices, which dropped from a then high of $147 per barrel in July to $70 per barrel in October and to $40 per barrel in December 2008. Figure M-1 shows that the price for a gallon of gasoline bottomed out at $1.69 in January 2009. In the pre-deployment period one year before the Express Lanes opened in October 2011, the price increased from $2.70 the week of September 27, 2010 to a peak of $3.97 in May 2011 to $3.51 the week of September 26, 2011. For the post-deployment period, the price fluctuated between $3.26 and $4.00 from October 2011 through September 2012, with a price of $3.82 at the end of the post-deployment period the last week of September 2012.

Table M-5. Lower Atlantic Region (GA, FL, NC, SC, VA, WV) Monthly Retail Regular Gasoline Prices

Year	Month	Average Monthly Retail Regular Gasoline Price
2010	October	2.724
	November	2.782
	December	2.948
2011	January	3.051
	February	3.161
	March	3.513
	April	3.711
	May	3.816
	June	3.570
	July	3.594
	August	3.606
	September	3.529
	October	3.375
	November	3.333
	December	3.237
2012	January	3.400
	February	3.624
	March	3.786
	April	3.856
	May	3.568
	June	3.316
	July	3.301
	August	3.628
	September	3.777

Source: U.S. Energy Information Administration; http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_r1z_w.htm.

GasBuddy.com; http://www.atlantagasprices.com/retail_price_chart.aspx.

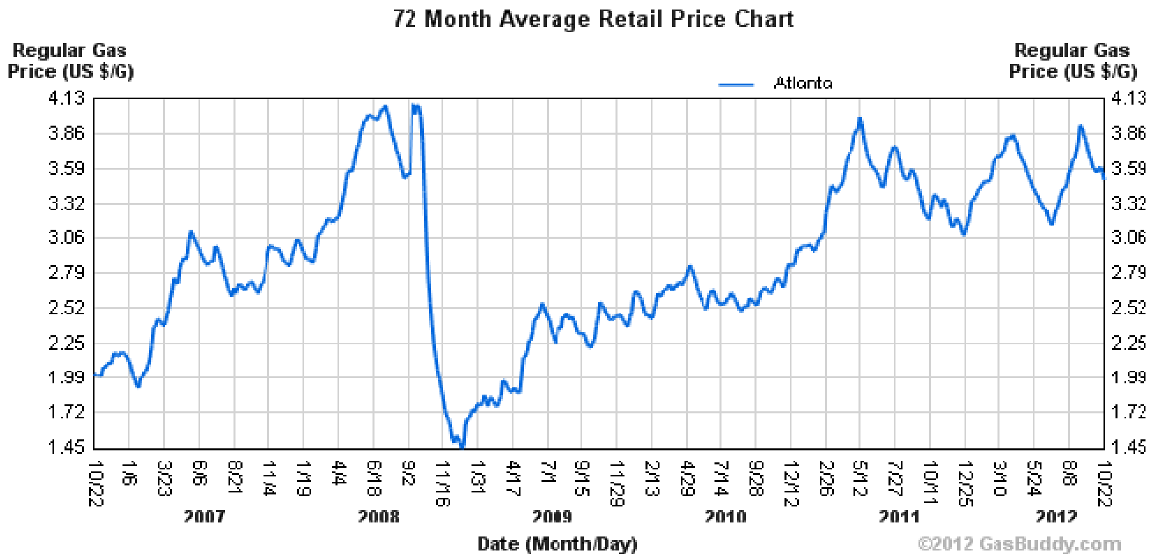


Figure M-1. Atlanta Historical Daily Regular Gasoline Prices – 2006 to 2012

M.3 Comparison of Traffic Volume at Control Sites

Traffic sensor data from several facilities located in the north/northeast portion of the Atlanta area were used as a control corridor to test for the effects of exogenous factors, such as regional economic conditions, on traffic operations. These locations included the following:

- I-75 North of I-575 interchange, south of Shiloh Road NW.
- I-75 South of I-575 interchange, south of Oriole Lane SE.
- I-285 at East of N. Shallowford Road
- I-75 Inside Perimeter at the Fulton County Line
- GA400 at North of Shiloh Road.

The approximate location of these control sites are shown in Figure M-2.

Texas A&M Transportation Institute

Figure M-2. Location of AADT Count Station used as Control Sites for UPA/CRD Atlanta National Evaluation

These control sites were identified by the local partners as exhibiting the following operating characteristics that made them comparable to sites on I-85 in the study corridor:

- The sites could not be located on corridors that were so overly-congested during the peak that any change in demand leading to reduced traffic levels would likely be compensated by latent demand.
- The sites should represent fairly similar economic and employment demographics as the HOT corridor.
- The sites were not on the fringe of the urban area where they might be directly impacted by local land-use development and local growth.

The National Evaluation team extracted annual average daily traffic (AADT) volumes from the control sites from 2005 to 2012 using GDOT's *State Traffic and Report Statistics* (STARS) system. The STARS system provided access to AADT counts collected from permanent and portable traffic collection device for every segment of Georgia's State Highway System. The system was accessed through a web interface at the following URL: http://www.dot.ga.gov/informationcenter/statistics/TrafficData/Pages/default.aspx.

Table M-6 shows a comparison of the AADT volumes for I-85 and the control sites from 2005 through 2012. Figure M-3 shows the relative change in the AADT since 2005 while Figure M-4 shows the relative percent change in AADT since 2005. The figures show that AADT on I-85 in the study corridor remained relatively constant between 2005 and 2009 before experiencing a dramatically rise in 2010 and then declining slightly in 2011 and 2012. AADT values on I-75 steadily declined between 2005 and 2008, before stabilizing at around the 2008 values. In contrast, AADT volumes on I-285 and GA 400 had remained relatively constant since 2005. It should be noted that AADT values in the study corridor dropped by 5 percent between 2010 and 2011 and by 1 percent between 2011 and 2012. This drop in AADT may have had an influence on the changes in vehicle throughputs and VMTs in the Congestion Analyses.

Table M-6. Comparison of the AADT Volumes for I-85 and Other Control Sites in the Atlanta Region from 2005 through 2012

Roadway	County	Location Description	Traffic Counter Number	Annual Average Daily Traffic (AADT) Year 2005	2006	2007	2008	2009	2010	2011	2012
I-85	Gwinnett	North of Beaver Ruin Rd.	0294	262,310	267,900	268,100	257,590	261,520	298,550	287,170	283,790
I-285	DeKalb	East of N. Shallowford Rd.	3374	215,310	222,150	218,240	211,990	209,100	210,740	208,330	204,860
I-75	Cobb	South of Oriole Ln. SE	2741	291,030	291,460	296,550	244,100	259,870	257,850	256,640	254,800
I-75	Cobb	South of Shiloh Rd. NW	0756	163,930	139,380	137,960	117,040	116,030	126,470	121,620	121,630
I-75	Fulton	Fulton County Line	6370	207,740	188,780	190,960	168,610	172,020	174,800	171,430	176,160
GA 400	Forsyth	North of Shiloh Rd.	0081	64,330	61,260	66,410	57,840	60,490	66,790	69,140	70,980

Source: Georgia Department of Transportation, State Traffic and Road Statistics (STARS).

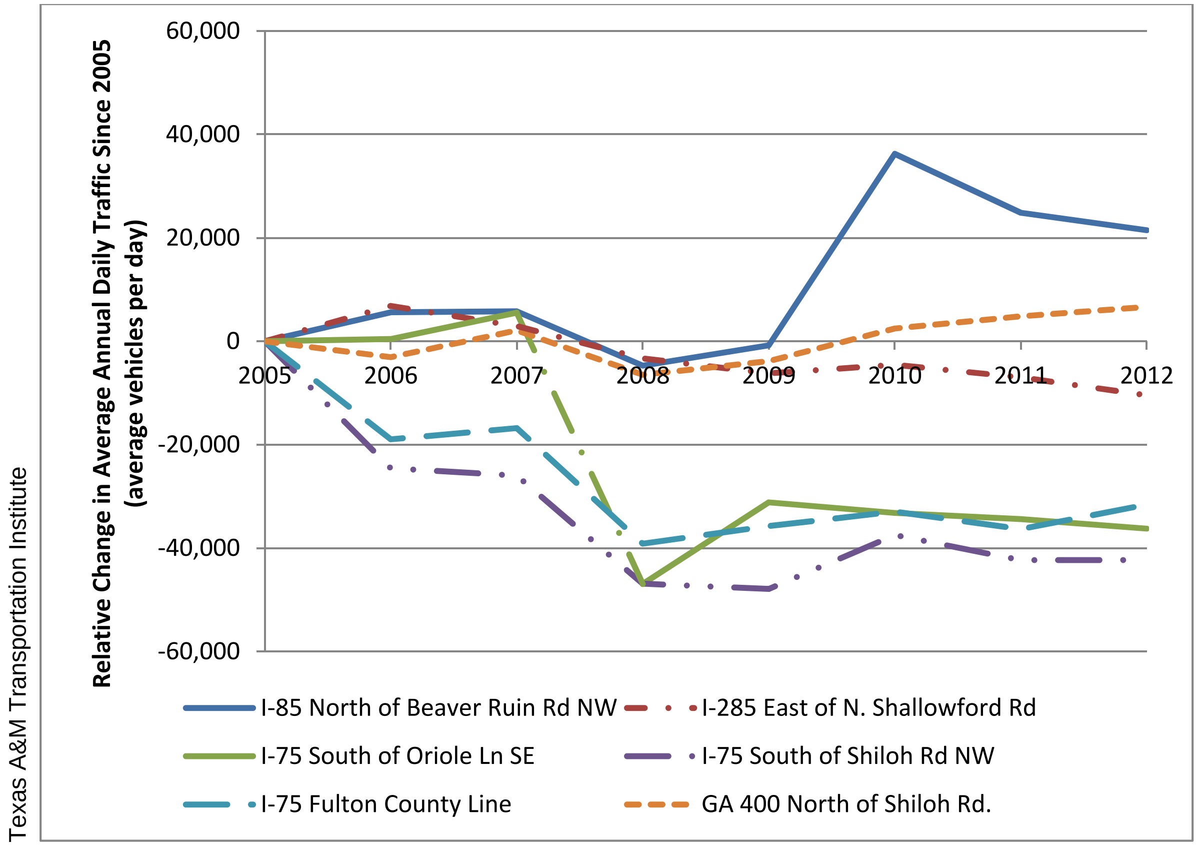


Figure M-3. Relative Change in Average Daily Traffic since 2005 on Control Corridors

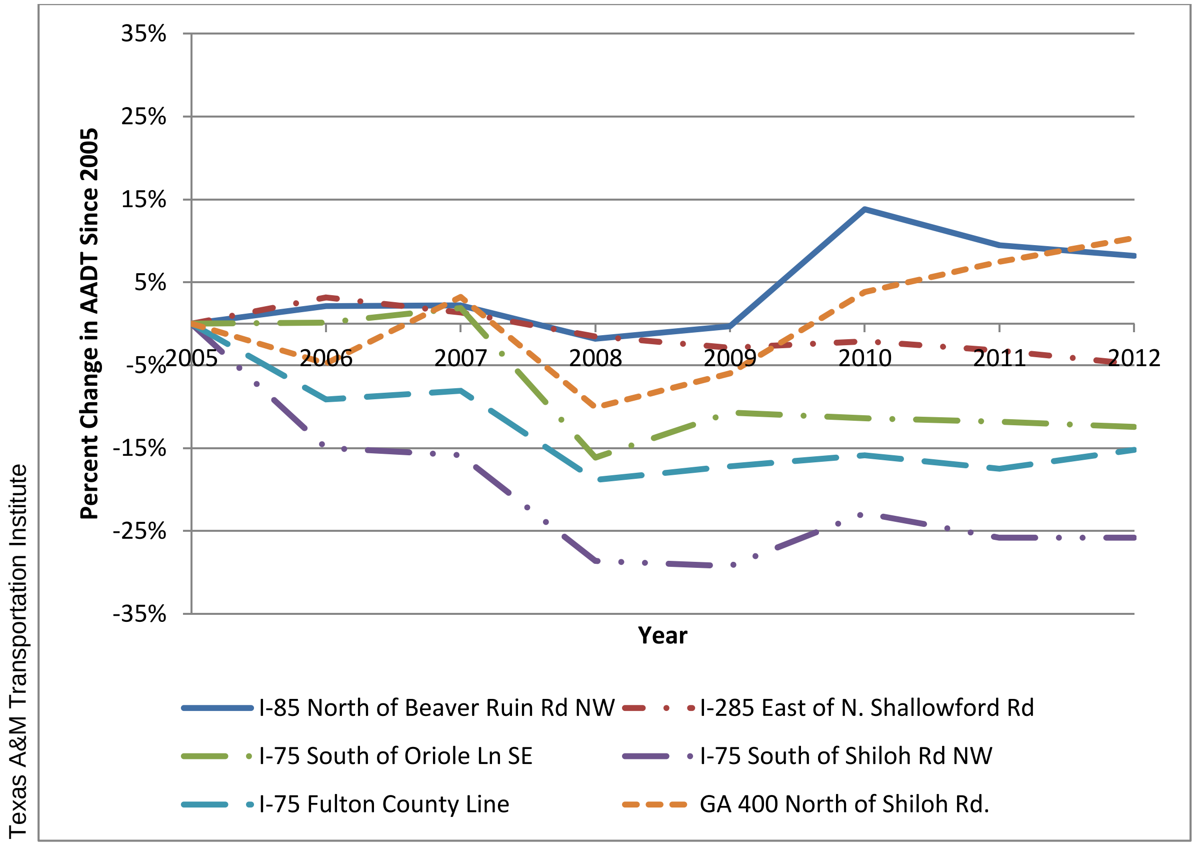


Figure M-4. Relative Percent Change in Average Daily Traffic since 2005 on Control Corridors

This page intentionally left blank.

Appendix N. Compilation of Hypotheses/Questions for the Atlanta CRD National Evaluation

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Congestion	AtlCong-1	Converting the I-85 HOV lanes to HOT operations will improve travel time and average travel speeds on both the general purpose and high occupancy lanes on I-85
	AtlCong-2	Converting the I-85 HOV lanes to HOT operations will improve travel time reliability and reduce variability on both the general purpose and high occupancy lanes on I-85
	AtlCong-3	Deploying the CRD improvements will result in more vehicles and persons being served on I-85
	AtlCong-4	Implementing the CRD improvements in the I-85 corridor will reduce the spatial and temporal extent of congestion
	AtlCong-5	As a result of the CRD improvements, the perception of travelers is that congestion has been reduced in the I-85 corridor
Pricing	AtlTolling-1	Tolling will increase vehicular throughput on I-85 Express Lanes and improve travel reliability
	AtlTolling-2	What changes in usage will occur as a result of the conversion of the HOV2+ lanes to HOV3+ lanes?
	AtlTolling-3	How much will travelers utilize the I-85 Express Lanes system?
	AtlTolling-4	Variable pricing on the I-85 Express Lanes will regulate vehicular access so as to improve the operation of the lanes
Transit	AtlTransit-1	Atlanta CRD project will enhance transit performance in the I-85 corridor
	AtlTransit-2	Atlanta CRD project will increase ridership and facilitate a mode shift to transit within the I-85 corridor
	AtlTransit-3	Increased ridership / mode shift to transit will contribute to congestion mitigation within the I-85 corridor
	AtlTransit-4	What was the relative contribution of each Atlanta CRD project element to increased ridership and/or mode shift to transit within the I-85 corridor?
TDM	AtlTDM-1	Promotion of commute alternatives removes trips and vehicle miles traveled (VMT) from I-85
	AtlTDM-2	CAC incentives support formation of 3+ carpools and vanpools on I-85
	AtlTDM-3	What was the relative contribution of the Atlanta CRD TDM initiatives on reducing I-85 vehicle trips/VMT?
Technology	AtlTech-1	Using advanced technology to enhance enforcement will reduce the rate and type of violators in the corridor

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Safety	AtlSafety-1	The collective impacts of CRD improvements will be safety neutral or safety positive
	AtlSafety-2	Gantry-controlled access technology will reduce incidents related to violations for crossing the double white line
	AtlSafety-3	Tolling strategies that entail unfamiliar signage will not adversely affect highway safety
Equity	AtlEquity-1	What are the direct social effects (travel times, tolls, and adaptation costs) for various transportation system user groups from tolling and other CRD strategies?
	AtlEquity-2	What is the spatial distribution of aggregate out-of-pocket and inconvenience costs, and travel-time and mobility benefits?
	AtlEquity-3	Are there any differential environmental impacts on certain socio-economic groups?
	AtlEquity-4	How does reinvestment of toll revenues impact various transportation system users?
Environmental	AtlEnv-1	What are the impacts of the Express Lanes project in the I-85 corridor on air quality?
	AtlEnv-2	What are the impacts on energy consumption?
Goods Movement	AtlGoods-1	Commercial vehicle operators (CVOs) will experience reduced travel time by reduced congestion on general purpose lanes
	AtlGoods-2	Operators with light-duty trucks will prefer to use Express Lanes to general purpose lanes for faster travel times
	AtlGoods-3	Operators delivering goods will perceive the net benefit of tolling strategies (e.g., benefits such as faster service and greater customer satisfaction outweigh higher operating costs due to tolls)
	AtlGoods-4	Operators report changing operational decisions due to use of Express Lanes (e.g., changing delivery times)
Business	AtlBusiness-1	What is the impact of the strategies on employers? e.g., employee satisfaction with commute and increased employment-shed to downtown/mid-town Atlanta
	AtlBusiness-2	What is the impact of the strategies on businesses that rely on customers accessing their stores, such as retail and similar establishments?
	AtlBusiness-3	How are businesses that are particularly impacted by transportation costs affected (e.g., taxis, couriers, distributors, tradesmen)?

Evaluation Analysis	Hypothesis/ Question Number	Hypothesis/Question
Non-Technical	AtlNonTech-1	What role did factors related to “people” play in the success of the deployment? People (sponsors, champions, policy entrepreneurs, neutral conveners)
	AtlNonTech-2	What role did factors related to “process” play in the success of the deployment? Process (forums including stakeholder outreach, meetings, alignment of policy ideas with favorable politics, and agreement on nature of the problem)
	AtlNonTech-3	What role did factors related to “structures” play in the success of the deployment? Structures (networks, connections and partnerships, concentration of power and decision-making authority, conflict-management mechanisms, communications strategies, supportive rules and procedures)
	AtlNonTech-4	What role did factors related to “media” play in the success of the deployment? Media (media coverage, public education)
	AtlNonTech-5	What role did factors related to “competencies” play in the success of the deployment? Competencies (cutting across the preceding areas: persuasion, getting grants, doing research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets)
	AtlNonTech-6	Does the public support the UPA/CRD strategies as effective and appropriate ways to reduce congestion?
Cost Benefit	AtlCBA-1	What is the net benefit (benefits minus costs) of the Atlanta CRD projects?

Source: Battelle

This page intentionally left blank

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free "Help Line" 866-367-7487
www.its.dot.gov

FHWA-JPO-14-152

U.S. Department of Transportation