LINCOLN TUNNEL HOT LANE FEASIBILITY STUDY

December 2009 **FINAL REPORT**

THE PORT AUTHORITY OF NY & NJ

WilburSmith
ASSOCIATES

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PURPOSE OF THE STUDY

The Port Authority of New York and New Jersey (PANYNJ) undertook this study as a long-term planning exercise to evaluate alternative concepts for improved bus reliability and capacity into New York City's midtown area and the Port Authority Bus Terminal. This study was not intended to be an implementation plan, or to indicate the PANYNJ's interest in adding lane pricing to the existing toll pricing already in the corridor. Rather, this study was intended to gain some insights into the role that pricing could potentially play in helping to manage and extend transit capacity without major roadway construction and expansion. By offering an understanding of the advantages and disadvantages of such concepts, the PANYNJ and its partners that manage the XBL have gained some additional perspective as future operational and investment planning for the corridor is advanced.

Chapter 1 INTRODUCTION

New Jersey 495 in Hudson County, NJ serves as the primary New York-bound approach to the Lincoln Tunnel, which connects north and central New Jersey with midtown Manhattan. In addition, NJ 495 is a major bus transit corridor given the Lincoln Tunnel's direct connection to the Port Authority Bus Terminal in midtown Manhattan, one of largest bus terminals in the world. The Port Authority of New York and New Jersey (PANYNJ), in cooperation with other NJ transportation agencies, takes advantage of these facilities by operating the Lincoln Tunnel Exclusive Bus Lane, known simply as the XBL. The XBL is a 2.5 mile contra-flow bus only lane that operates weekdays from 6-10 a.m. along NJ 495, connecting the NJ Turnpike and NJ 3 with the Lincoln Tunnel. During the morning peak period, one of the three westbound lanes to New Jersey is reversed for eastbound commuter buses traveling to New York City, while the three normally eastbound lanes serve commuters, trucks, and all other traffic. Opened in December 1970, the XBL was the first contra-flow bus lane on a freeway in the United States, and led to the later development of several similar operations elsewhere.

Each weekday morning, the XBL serves more than 1,800 buses carrying over 65,000 passengers making it the most productive bus lane of its kind. Coupled with the 25,000 morning peak bus riders using the Lincoln Tunnel via local approaches, the Lincoln Tunnel truly becomes a mass transit facility each weekday morning. From 6-10 a.m. the Lincoln Tunnel serves more trans-Hudson transit riders to Midtown Manhattan than the PATH rail system, the ferry services, and commuter rail to Penn Station. The success of the XBL and interstate bus services to Midtown rests with the travel time advantages and one-seat ride that the XBL affords bus riders. Typically the XBL saves commuters 20-30 minutes from the alternative of traveling in the congested New York-bound general purpose lanes of NJ 495. The XBL currently carries approximately the same number of passengers during its four-hour operation as the total number of other vehicles using the Lincoln Tunnel in 24 hours.

While the XBL operation has been enormously successful, the practical capacity of the XBL has been reached and periodically exceeded, with peak-hour volumes of 650 buses or more. As such, the PANYNJ is exploring the feasibility of establishing an additional express bus lane to feed the Lincoln Tunnel. A prior study completed by the PANYNJ in September 2006, entitled ***"Lincoln Tunnel Exclusive Bus Lane Capacity Enhancement Feasibility Study"***, looked at a full range of capacity expansion options from small-scale operating improvements to large-scale capital investment to add lane capacity to the corridor. This prior study concluded that the physical constraints within the corridor, coupled with its high utilization and urban setting, make the construction of an additional lane along NJ 495 a very expensive and disruptive option. The capacity expansion study suggested that converting one of the existing three eastbound lanes for interstate express bus service on weekday mornings was the most feasible short-term capacity expansion alternative for bus service in the corridor.

The development of this concept requires careful consideration since the estimated commuter bus demand would not be high enough to utilize an additional lane fully. Even if high-occupancy vehicles (HOV 3+) were allowed to access a specially designated New York-bound lane on weekday mornings, the lane would remain underutilized based on demand projections for these vehicles. In addition, losing an existing eastbound lane for general purpose traffic in the NJ 495 corridor would have a significant negative impact for autos and trucks approaching the Lincoln Tunnel and NJ waterfront communities from the west, as well as the potential to divert traffic to other already congested interstate corridors.

1.1 STUDY OBJECTIVES

In many respects, the XBL has become a victim of its own success, often operating at or above its theoretical capacity. As bus transit demand continues to rise, the service and reliability advantages of the XBL are at risk with demand far exceeding the available capacity of the XBL operation. To prepare for the projected growth in interstate bus transit demand expected in over the next 20-30 years, the Port Authority has been exploring the feasibility of converting one of the existing eastbound lanes into a priority lane for buses and carpools to complement the XBL. The objective of such a concept would be to allow the existing Lincoln Tunnel to serve more ***passengers*** into New York City, rather than more ***vehicles*** into a constrained Midtown Manhattan.

This study was initiated to evaluate the possibility of operating a new priority lane as a value-priced managed lane during the weekday mornings, where commuter buses and qualified HOVs could access the lane for free and low-occupancy automobiles would also be permitted access for a variable charge. By allowing vehicles other than buses and HOVs access to the converted managed lane, the intent would be to ensure full utilization of the priority lane and balance vehicular demand with the available capacity in the corridor. This concept of operation is often referred to as a high-occupancy toll (HOT) lane. The variable price for access to non-HOVs is intended to regulate use of the managed lane in a manner that maintains the travel times and reliability of the lane for bus services and HOVs, similar to today's XBL operation.

This study was further established to assess the feasibility of using the presence of a new physically separated managed lane to serve small commercial vehicles during non-peak commuting hours. The intent is to explore whether new reliability and travel time advantages could be offered to small package and local delivery services.

The primary purpose of this study is to quantify and address concerns with a potential conversion of a general purpose lane to managed use lane. Particular areas of interest evaluated include:

- the level of service, delay and queuing in the remaining two eastbound general purpose travel lanes on NJ 495;
- impacts on the local street network; and
- the adequacy of capacity in the new managed lane to balance autos and trucks with buses in a way that ensures priority transit treatment.

The study's tasks included:

- updating and expanding traffic simulation models for the corridor to be used to evaluate impacts of alternative scenarios;
- developing, conducting, and analyzing surveys of auto drivers, bus riders and truck operators to understand their value of time and willingness to pay for various travel time improvements;
- developing a predictive travel behavior choice model to assess use of a new managed lane under varying conditions
- defining a set of physical and operating scenarios for analysis and prioritization;
- assessing the regional traffic impacts and diversions of a reduced set of final alternatives; and
- highlighting operating and implementation considerations.

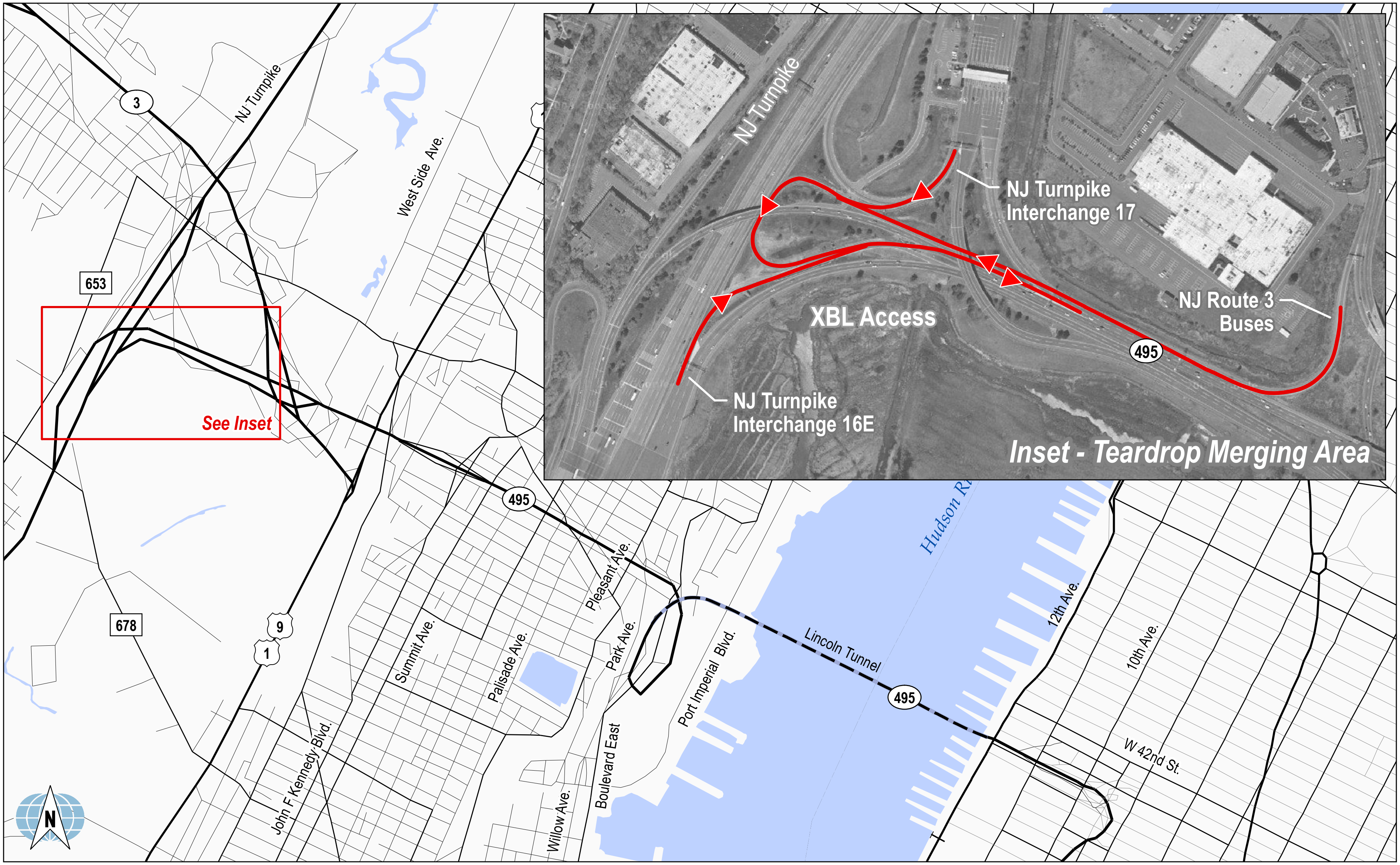
The study involved an extensive data collection effort, including updating the traffic and operations profile in the corridor, a stated-preference survey of corridor users to assess their willingness to pay to use the HOT lane, and updating the traffic operations micro-simulation model for the corridor originally developed by others for PANYNJ. From these data, a model was developed to merge the behavioral characteristics of drivers' reactions to different levels of HOT lane fee and corridor congestion with the travel time impacts of these reactions. A series of eight operating/pricing alternatives were tested within this behavioral model. The resultant traffic loadings from these scenarios were loaded back into the micro simulation-model to develop travel time, delay, and other impacts to assess the relative effectiveness of each alternative.

1.2 PROJECT CORRIDOR

The Lincoln Tunnel's New Jersey approach roads include NJ 495, as the primary east-west connection to the tunnel, and local streets such as John F. Kennedy Boulevard East, Willow Avenue and Park Avenue, which serve the local communities to the north and south of the Tunnel's entrance. These local approaches access the Lincoln Tunnel via the East Ramp and Center Ramp to the toll plaza. The East Ramp resides to the east of the NJ 495 Helix's eastbound roadway and the Center Ramp resides further west, between the Helix's eastbound and westbound roadways.

NJ 495 is the primary focus of this analysis and extends 2.5 miles from the Lincoln Tunnel portals west to NJ 3 and the NJ Turnpike's Eastern Spur (See Figure 1). Access to the Lincoln Tunnel via NJ 495 is provided from the NJ Turnpike Int. 16E approach, the NJ Turnpike Int. 17 approach, NJ 3, and US 1&9 through two interchanges at the western end of the study corridor and from local streets using on-ramps to NJ 495 from John F. Kennedy Boulevard and Pleasant Avenue.

New Jersey Rt. 495 begins from the eastbound approach from the NJ Turnpike Interchange 16E, with two lanes eastbound. The NJ Turnpike Interchange 17 approach joins NJ 495 as a one-lane



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LOCATION MAP

FIGURE 1

auxiliary lane that is dropped at the next exit ramp at NJ 3/U.S. 1 & 9. Two lanes serve the NJ Turnpike traffic from this point. The NJ 3 approach to the Lincoln Tunnel merges with NJ 495 approximately one-half mile downstream from the NJ Turnpike. Since the traffic from NJ 3 does not need to merge with the traffic on NJ 495, vehicles typically can proceed relatively unimpeded onto NJ 495 in most hours outside the peak hours. Approximately 0.4 miles downstream from the NJ 3 interchange, the right lane of NJ 495 drops at the exit for J.F. Kennedy Boulevard, leaving three lanes to continue to the Lincoln Tunnel.

The Lincoln Tunnel facility is comprised of three separate tubes of two lanes each. The North Tube is used for westbound traffic, destined for New Jersey. The South Tube is used for eastbound traffic, which is destined for Manhattan. The Center Tube offers the flexibility of reversible lanes during the course of the day to provide capacity in the peak direction of flow. Trucks are banned from the Center Tube when the other tubes are open.

Tolls are collected in the eastbound direction toward New York only. The toll plaza is located immediately before the tunnel entrance on the New Jersey side of the Hudson River. The toll plaza is currently 13 lanes wide, plus one non-stop lane that is used by the XBL traffic that is to the left of the plaza in the normally westbound roadway. A number of toll lanes are dedicated to vehicles equipped with E-ZPass® electronic toll collection transponders; other toll lanes are staffed for cash payments, carpool transactions, and accept E-ZPass® electronic transactions as well.

During the weekday 6-10 a.m. period, one westbound lane of NJ 495 is converted to the contra-flow eastbound XBL, which is separated by rubber pylons, and extends from the “teardrop”-shaped interchange between the NJ Turnpike and NJ 495 to a dedicated free-flow toll lane in the toll plaza. The XBL is also provided exclusive use of the north lane of the Center Tube. The south lane of the Center Tube is shared by traffic from the Center Ramp and a portion of the traffic from the left lane of the Helix while the South Tube accommodates all other Helix traffic plus traffic from the East Ramp.

In the morning, the center tube operates eastbound (to NY) with priority for high-occupancy vehicles (with three or more passengers) and bus traffic. From 6-10 a.m., the left lane of the center tube serves the bus traffic from the XBL. During this same period, the right lane of the center tube is used by HOV-3+ and local bus traffic entering from the Willow Avenue approach to the tunnel.

From approximately 7-9 a.m., the flow of traffic from the different approaches through the toll plaza and to the Lincoln Tunnel portals is typically separated using traffic cones to minimize turbulence and weaving. The decision on exactly when to start and end this channelization is made on a daily basis based on the operating conditions of that day. During this time, the high-occupancy traffic from Willow Avenue entering on the center ramp is limited to the left three lanes of the toll plaza. The traffic from NJ 495, approaching from the Helix structure, is channelized to the center six lanes at the toll plaza, and the local cars and trucks from Boulevard East and low-occupancy traffic from Willow Avenue are channelized into the right four lanes. An aerial photograph of this arrangement is shown in Figure 2.

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TYPICAL TOLL PLAZA CHANNELIZATION - 7:00-9:00 A.M.

FIGURE 2

Since mid-2008, an additional level of channelization has been used during most morning peaks to improve flow – the left lane of the NJ 495 (on the Helix approach) is channelized toward lanes 4 and 5 at the toll plaza. After the tollbooths, traffic in Lane 4 is channelized toward the center tube and traffic in Lane 5 is channelized toward the south tube. Since these two toll lanes are E-ZPass-only, traffic does not need to stop and a high flow rate can be achieved, particularly through Lane 4. Lane 5 is used less since merging with south tube traffic is difficult from this lane.

During other hours of the morning before 6:00 a.m. and after 10:00 a.m., lane restrictions are lifted, but due to the skew of the roadways, only the left side of the toll plaza typically uses the center tube. In the middle of the day, the center tube is usually operated with one lane in each direction in a two-way mode.

At approximately 3:30 p.m., the PANYNJ operations staff begins a procedure to convert the Center Tube from a two-way mode to a westbound traffic only operation. From 4-8 p.m., the tunnel is operated with four westbound lanes and two eastbound lanes. The number of open lanes at the toll plaza is reduced to nine, typically.

Since the XBL operates only during the morning peak period, most of the alternatives tested in this feasibility study were focused on the morning eastbound peak direction. An operational model was also developed for the PM peak period to test a potential option for establishing priority treatment in afternoon peak period. These scenarios were intended to consider the need for greater reliability of bus traffic that is traveling eastbound in the afternoons from remoter parking locations in New Jersey for evening westbound service from the Port Authority Bus Terminal.

The Lincoln Tunnel processes approximately 18,800 vehicles, including XBL buses, in the eastbound direction from 6-10 a.m. and 25,500 vehicles in the eastbound direction from 5-11 a.m. On NJ 495, at a location between NJ 3 and John F. Kennedy Boulevard, the road carries approximately 19,350 vehicles from 6-10 a.m. and 26,450 vehicles from 5-11 a.m.

During the PM peak period, the Lincoln Tunnel processes approximately 7,900 eastbound vehicles from 4:00 p.m.-7:00 p.m. and 12,600 eastbound vehicles from 3-8 p.m. During a typical weekday in 2007, the Lincoln Tunnel processed 62,200 vehicles in the eastbound direction.

The current XBL operates as a contra-flow lane by reversing a single lane of the westbound roadway. This is accomplished by inserting 560 cylindrical 1.5 foot bright yellow plastic traffic posts for the entire 2.5 miles of bus lane. In addition, motorists are alerted to the closed lane by overhead signals that display red X's and green arrows to indicate closed and open lanes. Access to the XBL is available to buses approaching from southbound NJ 3 and both directions from the NJ Turnpike. Currently, southbound NJ 3 traffic must first travel west to the "teardrop" area, making a 270-degree turn near the turnpike to turn around before traveling east in the XBL. Southbound traffic from the NJ Turnpike Interchange 17 must also navigate through the turn in the "teardrop" area to access the XBL. Buses from the northbound NJ Turnpike approach, via

Interchange 16E, also uses a portion of the "teardrop" roadway, but accesses NJ 495 in a more direct manner than the other approaches. During the morning peak hour, approximately 650 buses converge in the "teardrop" area to merge before proceeding east toward the Lincoln Tunnel. Once in the XBL, the buses are permitted to travel at the posted speed of 35 mph, without stopping, to the tunnel. Often during the peak hour, buses are affected by operations at the toll plaza, which spills back to affect speeds along the XBL.

1.3 STUDY APPROACH

A detailed traffic operations profile was compiled over the entire length of the corridor in both directions, and used as the foundation for new traffic micro-simulation models for weekday corridor operations from 5-11 a.m. and 3-8 p.m. These simulation models provided a structured basis for analyses of alternatives in pricing structures and operating conditions by providing an array of measures-of-effectiveness that were standardized for each scenario assessed. Demand for the proposed managed lane conversion was estimated through the development of a travel behavior choice model, which was based upon responses to a stated preference survey of corridor users. The stated-preference surveys were used to support estimates of traffic volumes for the proposed managed lane based on travel time savings, values-of-time, and pricing for the 5-11 a.m. and 3-8 p.m. periods for auto drivers, bus passengers, and drivers/dispatchers of commercial vehicles in the Lincoln Tunnel corridor, as well as auto drivers at the George Washington Bridge and Holland Tunnel, to estimate traffic attraction and diversion potential for the interstate corridors immediately to the north and south of the Lincoln Tunnel.

An array of existing and new data was employed in this study. New data collected at selected ramps were used to supplement counts that were performed in 2002 and 2004 to develop a 2007 traffic profile for the corridor. Traffic volumes from the toll plaza were used to evaluate hourly and seasonal variations in travel demand. These data were supplemented by travel time and delay runs that were conducted for both AM and PM peak periods to measure current patterns of delay. Aerial photography, used by PANYNJ to assess toll plaza delays and queuing on an ongoing basis, was also employed to estimate travel demand profiles for the corridor that were used as input and calibration targets for the micro-simulation models used for the alternatives evaluations in this study.

The analysis year for this study is 2015. Growth patterns to 2015 levels were developed by reviewing previous forecasts for the corridor. Since this study is the next phase of a corridor capacity enhancement study, it was important that traffic forecasts be consistent between the two studies, as well as with major regional projects, including the major regional rail expansion being advanced in the Access to the Region's Core project.

A travel behavior choice model was developed to estimate the share of traffic between the general purpose lanes and the proposed variably-priced managed lane for each alternative. The micro-simulation model was used to estimate changes in travel time under varying shares of traffic between the general purpose lanes and new priced lane, as well as to estimate future delays in the corridor due primarily to demand growth.

Eight alternative scenarios were defined to depict various operations and physical options for corridor operations. The scenarios included variations in lane access designs, pricing of carpools, and access for two- and three-axle small single-unit trucks. The evaluations of these alternatives employed an iterative application of the traffic micro-simulation models and the travel behavior choice model. Two preferred alternatives were selected for further analysis and consideration of implementation issues and planning. Alternatives ranged from an option that allowed access to the HOT lane without new construction to an option that requires construction of a new bridge with three overpasses to access the new HOT lane.

1.4 PROJECT OVERSIGHT AND ADVISORY COMMITTEES

A Project Oversight Committee met several times during the course of the study to help direct the scenarios to be tested and to provide feedback on the analysis results. The selected alternatives for further implementation planning were chosen in consultation with the Project Oversight Committee. The committee consisted of representatives from the New Jersey Department of Transportation and the New Jersey Turnpike Authority.

A meeting of the Project Advisory Committee was held midway through the course of the study to provide a status report on the project, to obtain agreement on the source of growth assumptions, and to present the alternatives to be studied.

Chapter 2 EXISTING CONDITIONS

The evaluation of the feasibility of a HOT lane project such as the one proposed for NJ 495 typically begins with the development of a detailed traffic and operations profile. Motorists' willingness to pay an additional fee to use the HOT lane is dependent on the level of congestion in the general purpose lanes and the time savings that can be achieved by using the HOT lane. Additionally, in the case of this NJ 495 facility, overall performance of operations for all corridor traffic must be considered in evaluating alternatives. The impact of various alternatives on local parallel roadways and parallel interstate travel corridors also required examination given the interdependence and congestion levels on these routes.

This section presents a summary of the detailed traffic and operations profile developed for NJ 495 and the Lincoln Tunnel used for this study. It includes analysis of the hourly travel demand profile for AM and PM peak periods, toll plaza statistics, summaries of the travel time runs, and observations on queuing characteristics.

2.1 EXISTING TRAFFIC PROFILE

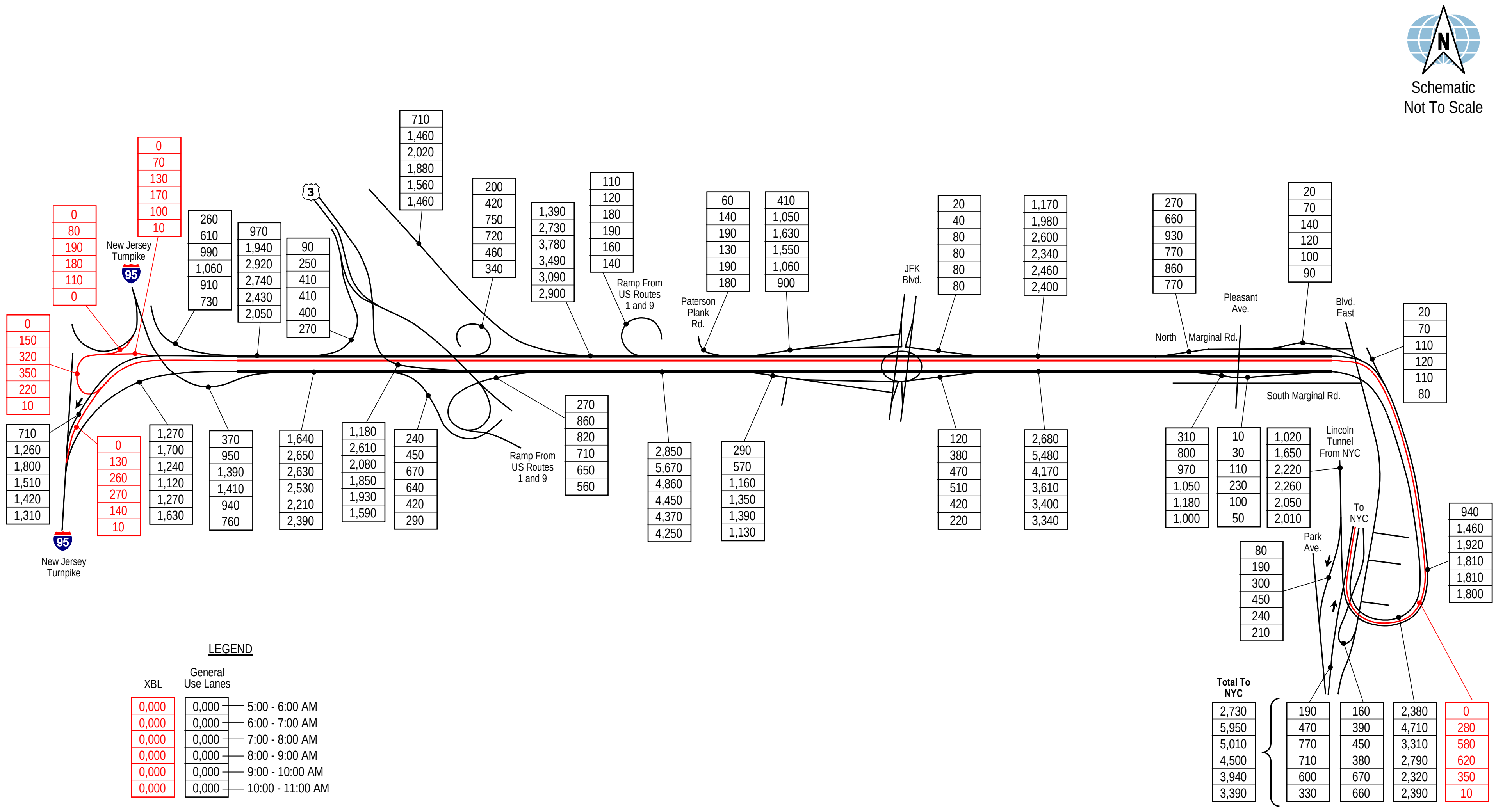
Existing traffic counts at the Lincoln Tunnel toll plaza were supplemented by new traffic counts acquired through both manual and machine-based collection methods to develop an updated traffic profile for the corridor. Traffic counts for this study were conducted in December 2006 and March 2007. A summary of the new traffic count locations and the raw data are provided as Appendix A of this report.

2.1.1 HOURLY TRAFFIC PROFILE

The estimated 5-11 a.m. peak period hourly traffic demand profile for 2007 is shown in Figure 3 and the 3-8 p.m. peak period profile is shown in Figure 4. A key control point was the Lincoln Tunnel toll plaza, which provided total eastbound throughput and demand over the two peak periods. Since the toll plaza itself is a constraint, travel demand was estimated based on a review of the hourly queuing patterns on the plaza approaches, and on NJ 495 in particular.

As shown in Figure 3, the demand on NJ 495 is relatively consistent on mainline segments from NJ 3 to the toll plaza. The peak hours of demand on NJ 495 are from 6-8 a.m., with 8,020 vehicles approaching the toll plaza from the Helix approach. The total hourly demand on NJ 495 itself does not exceed the theoretical capacity of three lanes but operational constraints at the toll plaza and the tunnel can cause delays that spread back along the NJ 495 approach, as far as the NJ Turnpike.

Typical bus volumes on the XBL are also shown in these graphics. As shown, 130 buses originate from NJ 3 from 7-8 a.m. and travel westbound to the "teardrop" area to access the XBL. In addition to using a circuitous routing, these buses must use the local lanes of the NJ 3 approach to travel westbound, which can be more affected by spill back of delays on NJ 495 than



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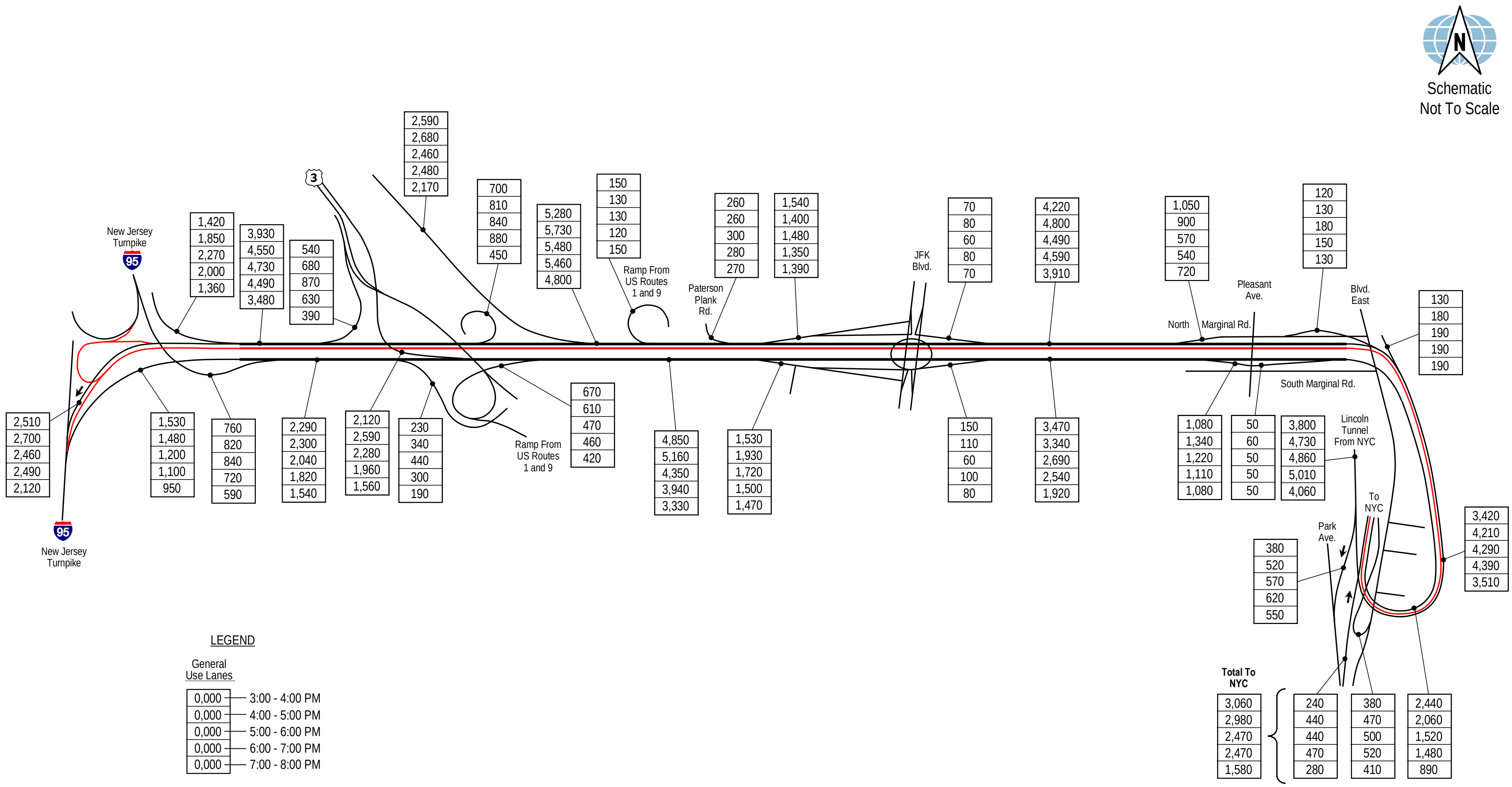
TOTAL HOURLY TRAFFIC DEMAND - 2007
A.M. PEAK PERIOD

FIGURE 3



TOTAL HOURLY TRAFFIC DEMAND - 2007
P.M. PEAK PERIOD

FIGURE 4

the express lanes. As shown in Figure 4, the peak demand on NJ 495 during the PM hours is from 3-5 p.m. with 4,500 vehicles on the helix approach to the tunnel.

During the morning period, from 6-10 a.m., approximately 51.8 percent of the traffic demand on the western end of the corridor enters from NJ 3 and 48.2 percent enters from the two approaches from the NJ Turnpike. Some of the traffic from the NJ Turnpike exits at NJ 3 and US 1&9. During this same period, of all traffic at the tunnel, just over 77 percent comes from the helix approach (including from the XBL) while 23 percent originates from the local community immediately adjacent to the tunnel (primarily Hoboken and Weehawken).

2.1.2 CONSTRAINT TO MAXIMUM HOT LANE VOLUMES

The traffic volumes in Figure 3 help illustrate a potential external constraint to the amount of traffic that can be allowed into the HOT lane. While most single-lane HOT lanes are designed to operate at between 1,500 and 1,600 vehicles per hour to maintain freeflow speeds, the Route 495 HOT lane may need to be limited to a lower volume during the most congested peak hours due to the need to merge with another traffic stream before entering the Lincoln Tunnel.

At the east end, the critical constraint point to maximizing HOT lane volume is the amount of traffic entering the Lincoln Tunnel from the Center Ramp approach. During the a.m. peak period from 6-10 a.m., the total volume approaching the Lincoln Tunnel from Hoboken and Weehawken via the Center Ramp is 2,550 vehicles, with a peak hour volume of approximately 770 vehicles. The majority of these vehicles are buses and shuttle buses that originate locally. The traffic volume on this approach is a critical constraint to the maximum volume that can be accommodated in the HOT lane because the traffic from the HOT lane must merge with the traffic from the Center Ramp approach before continuing to the right lane of the Center Tube; for operational efficiencies, it has been assumed that the XBL will continue to have exclusive access to the left lane of the Center Tube. Each lane of the Center Tube is assumed to be able to accommodate 1,400-1,600 vehicles per hour (depending on the mix of cars vs. buses). However, the practical capacity of the HOT lane approach may be lower due to the need to merge that traffic vehicles from the Center Ramp approach

2.1.3 CURRENT E-ZPASS® PARTICIPATION RATES

Toll plaza statistics for a typical weekday in 2007 are shown in Table 1 by hour and by vehicle class. As shown, the peak hour of throughput of the plaza is from 6-7 a.m., with 5,109 vehicles. After this time, the accumulated volume in the system, along with the channelization procedures around the toll plaza and tunnel portals results in reduced throughput. Vehicles processed at the plaza are then relatively constant after the peak period.

During the 5-11 a.m. period, small trucks (i.e., two and three axles) account for 8.9 percent of traffic, while large trucks with four or more axles account for 1.2 percent. All buses, including XBL and local buses, account for 12.2 percent of the total demand for the Lincoln Tunnel, representing a market share that is five to ten times the share of buses at any other Port Authority crossing. A majority of traffic uses E-ZPass® to pay their tolls. The average E-ZPass® share is 84.0 percent of traffic during the 6-10 a.m. peak period, and 82.8 percent from 5-11 a.m. For the

Table 1
Typical Peak Period Traffic by Hour, Method of Payment and Vehicle Class (2007)

Hour Beginning	Cash				E-ZPass				Total[1]	Percent E-ZPass[2]				
	Auto	Small Truck	Large Truck	Bus	Auto	Small Truck	Large Truck	Bus		Auto	Small Truck	Large Truck	Bus	Total
5:00	403	60	4	7	1,677	364	92	127	2,734	80.6	85.8	95.8	94.8	82.7
6:00	751	60	13	12	3,419	351	59	444	5,109	82.0	85.4	81.9	97.4	83.6
7:00	551	81	10	15	2,612	257	42	606	4,174	82.6	76.0	80.8	97.6	84.3
8:00	437	83	5	19	2,214	225	14	766	3,763	83.5	73.1	73.7	97.6	85.5
9:00	529	107	2	47	2,512	209	25	518	3,949	82.6	66.1	92.6	91.7	82.7
10:00	750	95	5	30	2,652	220	26	200	3,978	78.0	69.8	83.9	87.0	77.9
Total	3,421	486	39	130	15,086	1,626	258	2,661	23,707	81.5	77.0	86.9	95.3	82.8
15:00	687	34	2	30	1,816	103	12	332	3,016	72.6	75.2	85.7	91.7	75.0
16:00	604	25	3	34	1,346	52	4	502	2,570	69.0	67.5	57.1	93.7	74.1
17:00	426	14	2	30	1,104	31	10	353	1,970	72.2	68.9	83.3	92.2	76.0
18:00	575	26	2	34	1,308	38	3	356	2,342	69.5	59.4	60.0	91.3	72.8
19:00	682	12	1	39	1,532	39	8	312	2,625	69.2	76.5	88.9	88.9	72.0
Total	2,974	111	10	167	7,107	263	37	1,855	12,524	70.5	70.3	78.7	91.7	74.0

(1) Total volume represents typical 2007 weekday volumes processed at the toll plaza.

(2) Percentages were developed from data collected March 29, 2007 and do not include violations.

5-11 a.m. period, approximately 81.5 percent of all passenger cars, 78.2 percent of trucks use E-ZPass, and 95.3 percent of buses use E-ZPass.

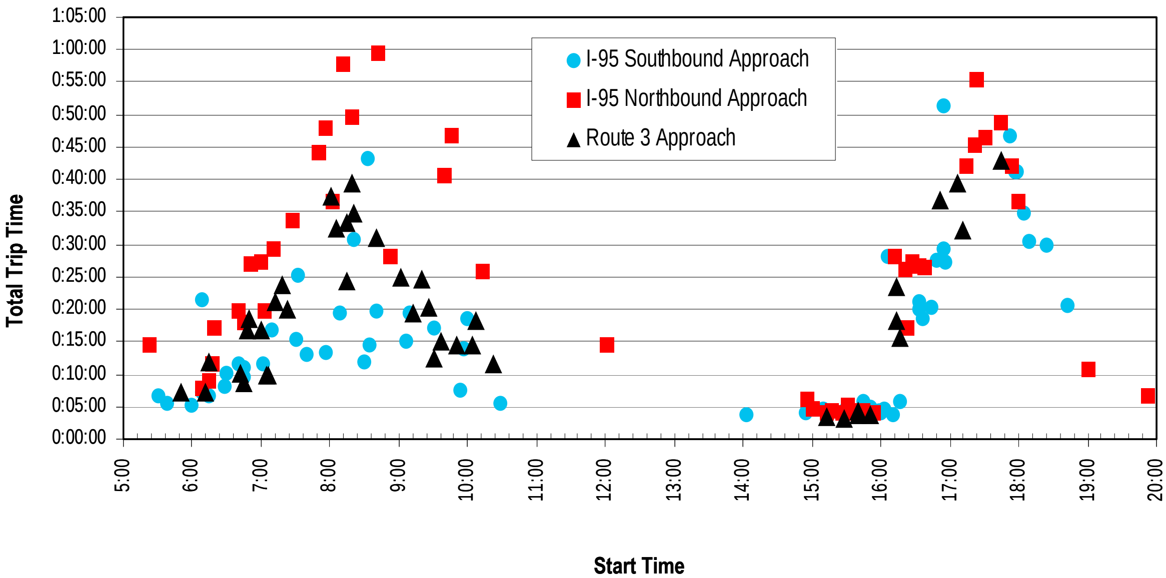
During the 3-8 p.m. period, small trucks (i.e., two and three axles) account for 3.0 percent of traffic while large trucks with for or more axles account for 0.4 percent, and buses are 16.2 percent. Approximately 74.0 percent of all traffic during this period uses E-ZPass, with slightly higher participation levels during the peak two hours.

2.2 EXISTING TRAVEL TIMES

An extensive program of travel time studies was undertaken to provide a detailed picture of the nature of traffic conditions in the Lincoln Tunnel corridor. Vehicles equipped with GPS measuring devices drove the corridor a total of 162 times at different times of day, on different days, and using the three major approaches to the Lincoln Tunnel from NJ 495 (i.e., NJ Turnpike Int. 16E, NJ Turnpike Int. 17, and NJ 3). Speed and distance information was collected for the AM peak and PM peak conditions in the eastbound direction during November and December 2006 and March 2007, concurrent with collection of the traffic count data. The process involved driving these probe vehicles in the normal traffic stream at travel speeds that would keep pace with traffic flow in each lane.

Figure 5 shows the variation in expected travel time from each of the three major approaches to the Lincoln Tunnel portal based on the time of arrival at NJ 495. For the purposes of this graphic, the starting point for travel time runs using the NJ Turnpike Int. 16E approach was a point north of the turnpike toll plaza, at the gore point of the exit ramp to NJ 495. Travel time runs beginning from NJ Turnpike Int. 17 start immediately south of the turnpike toll plaza. Travel time runs from NJ 3 begin on either of the two ramps to NJ 495, approximately 0.1 mile from the merge point with NJ 495. The total distances for the runs vary, with the NJ Turnpike Int. 16E approach being the longest at 2.8 miles, NJ Turnpike Int. 17 approach at 2.7 miles, and NJ 3 at 2.2 miles.

Figure 5: Eastbound Travel Time Profile by Approach (to Tunnel Entrance) - 2007



As shown in Figure 5, at free-flow conditions, the total time to travel the length of NJ 495 from west to east is less than seven minutes. Travel times begin to increase around 6:30 a.m.

Beginning around 6:08 a.m., a run from the NJ Turnpike Int. 16E approach took just under eight minutes to travel to the tunnel, with an average speed of 22 mph. By 7:11 a.m., a run over the same distance took more than 29 minutes, resulting in average speeds falling below 6 mph. The 7:11 a.m. run shows delays in the segment between the NJ Turnpike and NJ 3, and again on the Helix from a point over Boulevard East and the Lincoln Tunnel entrance. Congestion intensifies across the entire corridor by 8:00 a.m., resulting in run times of 50 to 60 minutes and average speeds of approximately 3 mph. Congestion is relieved after 10:00 a.m., when a run that commenced at 10:13 a.m. took a travel time of 26 minutes.

A similar picture of overall travel times and average speeds during the AM peak period can be seen in the travel time runs from the NJ Turnpike Int. 17 approach. As expected, the only area of contrast between the two approaches originating from the NJ Turnpike is within the first 0.3 to 0.4 miles prior to the merge point for the northbound and southbound Turnpike segments. Little or no congestion was observed until the merge point with NJ 495. The short segment between the two Turnpike approaches accounts for no difference in travel time or operating speed during the off-peak hours, but can account for more than 15 minutes of additional travel time when using the NJ Turnpike Int. 16E approach during the most congested times of the morning peak period.

From the NJ Turnpike Int. 17 approach, travel time runs started at 6:29 a.m. and 7:02 a.m. completed the 2.67-mile trip in 10 minutes and 12 minutes, respectively, recording average speeds of approximately 15 mph. Travel time increased steadily until peaking around 8:30 a.m. A run beginning at 8:33 a.m. took more than 43 minutes and yielded an average speed of less than 4 mph. By 9:30 a.m., travel time from the NJ Turnpike Int. 17 approach to the tunnel improved to 17 minutes, yielding an average speed of just greater than 9 mph.

During the peak hours, travel speeds from the NJ 3 approach demonstrated relatively similar performance as those of the other approaches. From the NJ 3 approach, a run initiated at 8:15 a.m. is indicative of peak congestion levels, recording a total travel time of 33 minutes and an average speed of less than 4 mph.

Travel times during the PM peak period are also shown in Figure 5. In general, the travel time for runs approaching the Lincoln Tunnel from the NJ Turnpike Int. 16E show shorter travel times than those conducted during the AM peak period. This is largely due to the relative lack of congestion at the merge points at the western end of the system, between the NJ Turnpike and NJ 3, where there is significant delay during the AM peak period. A run from the NJ Turnpike Interchange 16E ramp that began at 3:44 p.m. took less than five minutes to complete, producing an average speed of more than 38 mph. Congestion-related travel delays peak around 5:30 p.m., when travel time totals of more than 46 minutes, resulting in an average speed of less than 4 mph. Travel times return to near off-peak levels by 7:00 p.m.

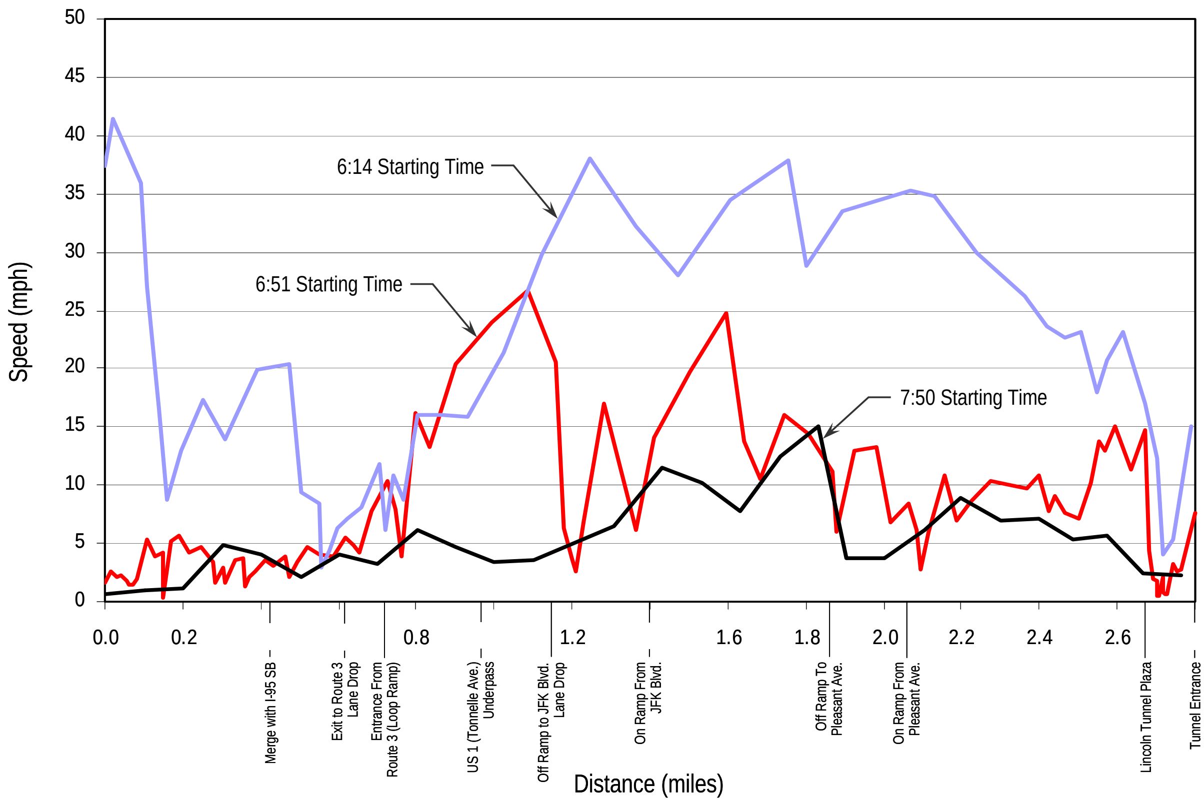
Travel time runs during the PM peak period approaching the Lincoln Tunnel from the NJ Turnpike Int. 17 show little to no difference from those approaching from the northbound direction. Travel times and average speeds observed while entering NJ 495 eastbound from NJ 3 were also similar to those of both NJ Turnpike approaches.

2.2.1 TYPICAL TRAVEL SPEEDS

Measurement of the typical travel speeds in the corridor not only serve to document the existing conditions, but also begin to highlight the challenges of access to the new managed lane for general purpose traffic. The existing XBL has suffered from inefficiencies in access for bus traffic in the past, but improvements introduced jointly by the PANYNJ and the NJ Turnpike have helped to reduce merging conflicts and increase the speed at access points for the XBL. The fact that the XBL serves buses exclusively and that bus traffic is separated prior to the access points of the XBL lanes, makes the access issues more manageable than they are likely to be for a new HOT lane that will serve buses, carpools and other general purpose traffic willing to pay a fee for access.

Figure 6 represents a typical progression of speeds for a vehicle traveling eastbound from the entrance ramp from the NJ Turnpike Int. 16E and ending at the Lincoln Tunnel, a distance of about 2.8 miles. These data illustrate the progression of the development of bottlenecks in the corridor.

Figure 6: Typical Peak Period Speed Profile – 2007 (NJ Turnpike Int. 16E Approach)



The travel time run beginning at 6:14 a.m., shown in blue, is illustrative of the congestion early in the a.m. peak period. Speeds fall below 10 mph immediately prior to the merge with the ramp serving southbound NJ Turnpike traffic and again to 5 mph at the NJ 3/U.S. 1 & 9 off-ramp. At the NJ 3/U.S. 1 & 9 off-ramp, the auxiliary lane added by the NJ Turnpike Int. 17 entrance ramp is dropped. The traffic from the NJ Turnpike Int. 17 approach must fully merge with the traffic from the northbound approach at this point. Speeds recover once past the NJ 3/U.S. 1 & 9 interchange and remain above 28 mph until reaching the Helix. Even during this relatively uncongested run, minor slowdowns can be seen due to merging traffic from John F. Kennedy Boulevard and prior to Pleasant Avenue. The entire trip took less than nine minutes with an average speed of 19 mph. This travel time run in the relatively less congested early portion of the a.m. peak period is instructive of how the access and exiting traffic from the NJ 495 mainline affects congestion and travel time. These effects are amplified later in the a.m. peak period as traffic volumes increase and the turbulence of entering and exiting traffic becomes more disruptive to traffic flow in the corridor's mainline.

A travel time run beginning at 6:51 a.m., shown in red, illustrates congestion stemming from the merging of traffic from the loop ramp serving NJ 3 local/frontage road traffic. Speeds at this location fall below 5 mph and the queue spills back to the ramp from the NJ Turnpike Int. 17. Speeds recover briefly, reaching 25 mph until the lane drop at the JFK Boulevard off-ramp.

From this point eastward, speeds remain largely below 15 mph for the remainder of the run. Travel time for this run was recorded at nearly 27 minutes with an average speed of 6.2 mph.

A travel time run beginning at 7:50 a.m., shown in black, is reflective of the peak hour congestion on NJ 495, when speeds remain below 5 mph for the majority of the trip. The entire run took more than 44 minutes with an average speed of 3.8 mph.

2.3 CORRIDOR ORIGINS AND DESTINATIONS

At the outset of the study, Wilbur Smith Associates obtained the existing micro-simulation model from the PANYNJ. This model has been developed and updated over the past ten years, last being modified by Parsons Brinckerhoff Quade & Douglas as part of the ***"Lincoln Tunnel Exclusive Bus Lane Capacity Enhancement Feasibility Study"*** completed in 2006. One of the key inputs to the model is a set of matrices describing ramp-to-ramp movements for the corridor.

As part of this study, these matrices were updated to reflect the 2007 estimated non-XBL traffic demands shown in Figures 3 and 4. A summary of travel patterns for all traffic, including buses in the XBL, is shown in Table 2. As shown, 62.4 percent of all traffic using the Lincoln Tunnel from the 6-10 a.m. peak period originates from NJ 3 and/or the NJ Turnpike. Of these, just over half originates from the NJ Turnpike.

Of total traffic entering NJ 495 from the three major approaches, 63.3 percent of the NJ Turnpike Int. 16E traffic and 44.7 percent of the NJ Turnpike Int. 17 traffic is estimated to be destined for the Lincoln Tunnel. The remainder of traffic from these approaches exits NJ 495 at either NJ 3/U.S. 1 & 9, John F. Kennedy Boulevard, or Pleasant Avenue. Of the traffic entering from two ramps from NJ 3/US 1&9, 59.8 percent is estimated to be destined for the Lincoln Tunnel. Traffic from NJ 3 wishing to exit to John F. Kennedy Boulevard is more likely to be on the ramp from the NJ 3 frontage road since the distance between NJ 3 and John F. Kennedy Boulevard is a short distance, a challenging, multiple-lane weave if approaching from the left lane of the highway.

These data were critical inputs to the micro-simulation model, but even in their raw form have begun to suggest the challenges that access to the new managed lane on the western end of the corridor will present for a successful project. The fact that NJ Turnpike northbound represents the vast majority of traffic destined for the Lincoln Tunnel from the three major western approaches to NJ 495 is significant since this traffic will have the most difficult time accessing the far left lane of NJ 495. This move requires a minimum of a three-lane weave, creating significant turbulence and congestion at the western end the NJ 405 corridor at the primary access points.

Table 2
Summary of Eastbound Travel Patterns
All Traffic, Incl. XBL Buses

Morning Peak Period (6-10 a.m.)

	Destination				
	Lincoln Tunnel		Other[1]	Total	
Origin	Volume	Percent by Approach	Volume	Volume	Percent to Lincoln Tunnel from Approach
NJ Turnpike NB	3,859	19.9%	2,241	6,100	63.3%
NJ Turnpike SB	2,349	12.1%	2,904	5,253	44.7%
Route 3	5,691	29.4%	3,829	9,520	59.8%
Other[2]	7,469	38.6%			
Total	19,368	100.0%	8,974	20,873	

Afternoon Peak Period (4-7 p.m.)

	Destination				
	Lincoln Tunnel		Other[1]	Total	
Origin	Volume	Percent by Approach	Volume	Volume	Percent to Lincoln Tunnel from Approach
NJ Turnpike NB	1,450	18.4%	2,331	3,781	38.3%
NJ Turnpike SB	649	8.2%	1,732	2,381	27.3%
Route 3	2,403	30.4%	3,841	6,244	38.5%
Other[2]	3,397	43.0%			
Total	7,899	100.0%	7,904	12,406	

(1) Includes NJ3/US 1&9, John F. Kennedy Boulevard, and Pleasant Avenue.

(2) Includes John F. Kennedy Boulevard, Pleasant Avenue, John F. Kenneday Boulevard East, Willow Avenue, and Park Avenue.

Chapter 3 FUTURE TRAFFIC CONDITIONS

3.1 GROWTH ASSUMPTIONS

The growth assumptions used for this study were developed to be as consistent as possible with those developed for previous studies of the corridor and other regional projects that will shape travel demand in the corridor in the future. The following documents were for inputs to the growth assumptions for this study:

- ***"Technical Memorandum: Traffic Forecasts and Operations, Lincoln Tunnel Exclusive Bus Lane Capacity Enhancement Feasibility Study,"*** prepared by Parsons Brinckerhoff Quade & Douglas for the PANYNJ in September 2006.
- ***"Final Environmental Impact Statement, Access to the Region's Core,"*** (Sections 3.1 Public Transportation, 3.2 Station Access and Parking, 3.3 Roadways, 4.8 Indirect and Cumulative Effects, and Chapter 9 Evaluation of Alternatives), NJ Transit, October 2008

3.1.1 GROWTH IN BUS TRAFFIC

The primary focus of this review was the ***"Exclusive Bus Lane Capacity Enhancement Feasibility Study"*** report, since this study of the feasibility of a priced managed lane is one of the next steps resulting from that study and the base data used for this study was developed from that prior study. The following assumptions were developed from the ***"Exclusive Bus Lane Capacity Enhancement Feasibility Study"***:

1. Eastbound bus volume on the XBL in 2030 was forecasted to be 2,034 for the four-hour AM peak period. This was developed based on runs of the NJ Transit Travel Demand Forecast Model (NJTDFM). This forecast reflects the service improvements associated with the Access to the Region's Core (ARC) project and others.
2. Growth in total demand for the Lincoln Tunnel during the AM peak period was forecasted to be 24 percent for the 2030 No-Build condition and 5 percent for the 2030 Operational Alternative 1 condition.
3. Growth in carpool and vanpool demand for the Lincoln Tunnel was forecasted to be 12 percent for the 2030 No-Build case.
4. Both XBL and non-XBL bus volumes are assumed to remain the same under all future scenarios, including the No-Build.

From the FEIS for the ARC project, which is currently scheduled to open in 2017, the counties in New Jersey that would benefit most from the increased transit service are Essex, Middlesex, Bergen, Union, and Monmouth. The projections employed in this study assume that buses serving the counties to the south of the Lincoln Tunnel would be most likely to experience reduced growth due to a shift in travel demand to rail. For this reason, the growth rates in XBL bus volumes from the NJ 3 approach to the Lincoln Tunnel were assumed to be slightly higher than the growth rates in XBL bus volumes from the NJ Turnpike approaches.

Based on these assumptions, the XBL bus growth by approach used for this study is shown in Table 3. The assumed growth in peak period buses was applied uniformly to each hour of the period, with one exception. By 2030, the number of buses in the hour from 8-9 a.m. would have been 684. This was adjusted to 670 buses and the difference was added to the previous hour to recognize that scheduling can be adjusted due to limitations to peak hour volumes in the XBL and at the Port Authority Bus Terminal (PABT).

From the FEIS for ARC, total daily trans-Hudson trips to the PABT is forecasted to grow from 167,700 trips per day in 2005 to 192,964 trips per day in 2030 under the Build alternative. This represents a total growth of 15.1 percent over the 25-year period or an average 0.56 percent annually. Buses on the XBL are forecasted to grow by 10.7 percent over the 23-year period from 2007 through 2030, averaging 0.44 percent annually. Some portion of the additional travel demand is assumed to be absorbed by growth in local buses, which may grow slightly more than 0.56 percent annually and have slightly higher loadings than the XBL buses.

Table 4 shows the growth assumptions for local buses using the Lincoln Tunnel. These growth rates will be applied to all local buses, from all origins and for all methods of payment (i.e., cash and E-ZPass). The same average annual growth rate was assumed for the 2015-2030 period since the ARC FEIS showed small impacts in the immediate study area near the river.

3.1.2 GROWTH IN AUTO AND TRUCK TRAFFIC

From the ***"Exclusive Bus Lane Capacity Enhancement Feasibility Study"***, the total vehicular traffic growth rate during the AM peak period from 2002 through 2030 was forecasted to be 24 percent (or 0.8 percent averaged annually) under No-Build conditions and 5 percent (0.17 percent averaged annually) under that study's Operational Alternative 1. Operational Alternative 1 from the previous study assumed a conversion of the left eastbound lane of NJ 495 to a managed lane equivalent to the lane configuration that this study is assessing, but assumed that the lane would be available to buses and vehicles with three or more occupants only. Chapter 3.3 of the ARC FEIS showed a similar growth rate for weekday Hudson River auto crossings, (i.e., 24 percent growth over the 2000-2030 period, or 0.7 percent annually).

Data from the ***"Exclusive Bus Lane Capacity Enhancement Feasibility Study"*** showed no net change in traffic crossing the Hudson River as a result of Operational Alternative 1. Therefore, the difference between forecasted volumes for the No-Build and Alternative 1 conditions is accounted for by shifts of traffic from the Lincoln Tunnel to other Hudson River crossings resulting from the reduced capacity in the remaining general purpose lanes on NJ 495.

Table 3
Forecasted XBL Bus Demand by Approach

Hour	2007				2015				2030			
	NJ 3	NJTP 16E	NJTP 17	Total	NJ 3	NJTP 16E	NJTP 17	Total	NJ 3	NJTP 16E	NJTP 17	Total
5:00-6:00	0	0	0	0	0	0	0	0	0	0	0	0
6:00-7:00	73	130	76	279	76	136	80	292	82	143	84	309
7:00-8:00	130	259	189	578	136	271	198	605	151	291	212	654
8:00-9:00	168	267	183	618	177	281	192	650	185	288	197	670
9:00-10:00	102	136	113	351	107	142	118	367	115	149	124	388
10:00-11:00	7	5	0	12	7	5	0	12	8	5	0	13
Total	480	797	561	1838	503	835	588	1926	541	876	617	2034
Percent Share	26.1%	43.4%	30.5%	100.0%	26.1%	43.4%	30.5%	100.0%	26.6%	43.1%	30.3%	100.0%
Growth vs. 2007					23	38	27	88	61	79	56	196
% Diff vs. 2007					4.8%	4.8%	4.8%	4.8%	12.7%	9.9%	10.0%	10.7%
Growth vs. 2015									38	41	29	108
% Diff vs. 2015									7.6%	4.9%	4.9%	5.6%

Table 4
Forecasted Local (Non-XBL) Bus Demand

Hour	2007	2015	2030
5:00-6:00	149	158	174
6:00-7:00	209	221	244
7:00-8:00	262	278	306
8:00-9:00	308	326	359
9:00-10:00	210	222	245
10-:00-11:00	208	220	243
Total	1,346	1,425	1,571
Growth over 2007		79	225
% Growth over 2007		5.9%	16.7%
Growth over 2015			146
% Growth over 2015			10.2%

The ***"Exclusive Bus Lane Capacity Enhancement Feasibility Study"*** report also showed that HOV-3+ traffic through the Lincoln Tunnel is forecasted to increase significantly between No-Build and Operational Alternative 1. With no net change in total auto trips on the Hudson River screenline, it is assumed that most of the additional HOV-3+ traffic at the Lincoln Tunnel was diverted from other bridges and tunnels, along with a portion of induced auto travel that was assumed to "backfill" the roadway space created by carpool formation.

The managed lane configuration being considered in this study represents the same physical lane assignments as the "***Exclusive Bus Lane Capacity Enhancement Feasibility Study"***, but with carpool traffic growth conditions resting somewhere between the No-Build condition and Operational Alternative 1 of the prior study. While the proposed HOT lane will physically reduce the number of general purpose lanes available to non-bus traffic on NJ 495 similar to Operational Alternative 1, the objective of using pricing on the lane is to keep as much traffic in the lane as possible while maintaining acceptable travel speeds.

For the traffic and revenue analysis of the proposed HOT lane, a travel behavior choice model has been developed to estimate the amount of traffic that will be willing to pay an additional fee to use the proposed HOT lane, shift to carpool, shift to alternative routes, or shift to transit. Since some of these behavioral shifts will account for the differences in traffic between the No-Build and Operational Alternative 1, the average annual growth rate of 0.8 percent from the No-Build scenario has been used as the basis for traffic growth in this assessment of the proposed HOT lane. Since the base year volumes for this HOT lane study are from 2007, a total growth of 20.1 percent for all traffic was assumed for total traffic to reach 2030 levels. This will yield slightly lower total volumes in 2030 than the ***"Exclusive Bus Lane Capacity Enhancement Feasibility Study"*** since the peak period base traffic volumes have not changed substantially between 2002 and 2007.

Since total buses are assumed to grow by 13.5 percent from 2007 through 2030 (after weighting between XBL and non-XBL buses), it was assumed that auto and truck traffic will grow by 21.1 percent to achieve the corridor average of 20.1 percent by 2030. This growth was applied uniformly to all approaches and all auto and truck classes in the morning peak period.

The resulting 2015 and 2030 traffic volumes and the net growth rates from the 2007 base year are shown in Table 5.

Table 5
Forecasted Auto and Truck Demand

	2007			**2015**			**2030**		
Hour	Auto	Truck	Total	Auto	Truck	Total	Auto	Truck	Total
5:00-6:00	2,067	508	2,575	2,209	543	2,752	2,503	615	3,118
6:00-7:00	4,813	612	5,425	5,144	654	5,798	5,828	741	6,569
7:00-8:00	3,664	470	4,134	3,916	502	4,418	4,437	569	5,006
8:00-9:00	3,186	396	3,582	3,405	423	3,828	3,858	479	4,337
9:00-10:00	3,033	347	3,380	3,242	371	3,613	3,672	420	4,092
10:00-11:00	2,911	263	3,174	3,111	281	3,392	3,525	318	3,843
Total	19,674	2,596	22,270	21,027	2,774	23,801	23,823	3,142	26,965
Growth vs. 2007				1353	178	1531	4149	546	4695
% Diff vs. 2007				6.9%	6.9%	6.9%	21.1%	21.0%	21.1%
Growth vs. 2015							2796	368	3164
% Diff vs. 2015							13.3%	13.3%	13.3%

Chapter 4 STATED PREFERENCE SURVEYS

This section describes the stated-preference surveys conducted for this study of automobile drivers, commercial vehicle drivers and dispatchers, and bus passengers in order to help assess future travel choices in the Lincoln Tunnel corridor if a HOT Lane was implemented using an eastbound general purpose lane along NJ 495. The purpose of the Lincoln Tunnel HOT Lane stated preference surveys was to obtain detailed information that could be used to determine how sensitive travelers would be to the managed lane prices and travel time changes that would result from the implementation of a HOT lane to the New York City-bound roadway of NJ 495 leading to the Lincoln Tunnel. Estimates of travelers' toll price sensitivities are used to support estimates of highway traffic and toll revenue impacts.

A series of stated-preference surveys were developed and implemented by Resource Systems Group, Inc. (RSG). These surveys gathered information from five primary groups of travelers who could use the proposed Lincoln Tunnel HOT Lane. The five groups of travelers surveyed were:

1. Automobile travelers who use the Lincoln Tunnel in the toll direction (eastbound toward Manhattan) during peak time periods.
2. Automobile travelers who use the Lincoln Tunnel in the toll direction (eastbound toward Manhattan) during shoulder time periods.
3. Bus passengers who use the Lincoln Tunnel in the toll direction (eastbound toward Manhattan) during peak and shoulder time periods.
4. Commercial vehicle drivers of two- or three-axle trucks (or the dispatchers and managers who make routing decisions for such vehicles) who use the Lincoln Tunnel in the toll direction (eastbound toward Manhattan) during peak and shoulder time periods.
5. Automobile travelers who use the George Washington Bridge or Holland Tunnel in the toll direction (eastbound toward Manhattan) during peak and shoulder time periods.

The stated-preference surveys collected data on the respondents' current trip and travel behavior and presented basic information about the concept of HOT lanes and how the proposed Lincoln Tunnel HOT Lane might operate. The surveys also employed stated-preference experiments designed to collect information that can be used to estimate travelers' values of time and propensity to use the Lincoln Tunnel HOT Lane under a range of possible future conditions.

The stated-preference survey was administered in July 2007. This section of the report summarizes the survey approach and administration, describes characteristics of the data collected, and finally, presents the choice models estimated with the stated-preference data. This information is documented in a more complete manner in the full report from RSG that is included as Appendix B.

4.1 SURVEY APPROACH

4.1.1 OVERVIEW

The stated preference survey was designed and administered to identify the travel patterns and preferences of automobile, commercial vehicle, and bus passenger travelers who could reasonably use the proposed Lincoln Tunnel HOT Lane. As such, the sampling plan considered groups of travelers who currently use the Lincoln Tunnel by all modes, as well as E-ZPass® auto users traveling at the George Washington Bridge or Holland Tunnel, the crossings immediately to the north and south of the Lincoln Tunnel, in order to capture the likelihood of future traffic diversions to and from these corridors in the presence of a HOT lane. The surveys collected data during the 6-10 a.m. morning peak and 4-7 p.m. peak, as well as information in the shoulder hours before and after these peak periods, in order to capture the potential for time shifts as a consequence of the HOT lane. The sampling plan was designed to reach travelers who use each of the two toll payment methods—cash and E-ZPass—employing two separate administration methods to collect these data.

4.1.2 SAMPLING PLAN

Sampling was based on eight segments (see Table 6). For all segments, data were required for weekdays for the time period from 5-11 a.m. and 3-8 p.m. The peak and shoulder time periods employed in this study matched those used in the PANYNJ's 2006 Auto Trans-Hudson Crossing Origin-Destination Survey.

Table 6
Stated Preference Survey Target Segments

Facility	Vehicle Type	Payment Method	Survey Distribution Method
Lincoln Tunnel	Peak Automobile	Cash E-ZPass	Hand out at Lincoln Tunnel Toll Plaza Mail to E-ZPass billing address
	Shoulder Automobile	Cash E-ZPass	Hand out at Lincoln Tunnel Toll Plaza Mail to E-ZPass billing address
	Commercial Vehicle	Cash E-ZPass	Hand out at Lincoln Tunnel Toll Plaza Mail to E-ZPass billing address
	Bus	Cash	Hand out at Port Authority Bus Terminal
George Washington Bridge & Holland Tunnel	Automobile	E-ZPass	Mail to E-ZPass billing address

Cash customers were handed surveys at the Lincoln Tunnel toll plaza, immediately prior to toll payment. Because E-ZPass® customers do not stop at the Lincoln Tunnel toll plaza, E-ZPass® customers who passed through the facility during the same time period that the cash customer surveys were handed out were mailed a survey to their E-ZPass® billing address. Lastly, bus passengers were handed surveys at the Port Authority Bus Terminal. In total, 27,400 questionnaires were mailed to automobile and commercial vehicle E-ZPass® holders, while 8,600 questionnaires were handed out at the Lincoln Tunnel Toll Plaza to automobile and commercial vehicle cash customers. Lastly, 2,000 questionnaires were distributed at the Port Authority Bus Terminal to bus passengers. Table 7 provides a summary of the survey distribution and response rates determined as the number of usable surveys returned.

Table 7
Stated Preference Survey Surveys Distributed and Returned

Method of Payment	Survey Type	Date of Distribution	Surveys Distributed	Usable Surveys
Cash	Peak Period Automobile	July 17, 2007	4,400	278
	Shoulder Period Automobile	July 17, 2007	2,200	
	Commercial Vehicle	July 17&18, 2007	2,000	66
E-ZPass	Peak Period Automobile	July 10&11, 2007	14,300	2,423
	Shoulder Period Automobile	July 10&11, 2007	7,100	
	Commercial Vehicle	July 10-13, 2007	2,000	128
	George Washington Bridge Automobile	July 10, 2007	2,000	299
	Holland Tunnel Automobile	July 10, 2007	2,000	
Bus	Bus Passengers	July 19, 2007	2,000	256

The stated-preference survey employed a paper survey booklet (7.0 inches by 8.5 inches) that included information about the study, instructions, and survey questions. Automobile, commercial vehicle, and bus passenger respondents who received the paper survey had the choice of completing it and mailing it back (postage-paid via Business Reply Mail) or going online to complete the survey. Respondents who chose to complete the survey online logged on to the web site printed in the instructions of the survey booklet and entered the unique password provided on the cover of the survey booklet.

The survey format for Lincoln Tunnel auto and commercial vehicle users is summarized in this below. A full discussion of the surveys used for all segments is included in Appendix A.

4.2 INIDIVIDUAL IN-DEPTH INTERVIEWS

Prior to finalizing the survey questionnaires, RSG conducted individual in-depth interviews with cash and E-ZPass® automobile customers, Lincoln Tunnel bus passengers, and commercial vehicle drivers and manager/dispatchers. The purpose of these interviews was to test the final draft of the survey questionnaires for clarity and understanding of the concepts as presented. A total of 29 individuals participated: 17 Lincoln Tunnel automobile travelers, 6 Lincoln Tunnel bus passengers, and 6 commercial vehicle drivers/dispatchers. These participants were recruited from a list of individuals who had previously completed various surveys for PANYNJ and who indicated a willingness to participate in future surveys. Efforts were made to recruit a diverse group of participants across gender, age, income, employment category, household size, number of household drivers, number of household vehicles, and toll payment type (cash or E-ZPass).

These interviews were conducted in May 2007. Final revisions, including wording changes and clarification to the questionnaire introduction, order of questions, and layout and formatting changes to improve respondent ease of completion were made as a result of these interviews prior to printing.

4.3 LINCOLN TUNNEL AUTO QUESTIONNAIRE

The Lincoln Tunnel peak period and shoulder period questionnaires are described together in this section of the report. The Lincoln Tunnel automobile questionnaires consisted of four parts: context questions about each respondent's trip, stated preference trade-off questions, debrief, and demographic questions. The sample of each of the questionnaires is included in Appendix B.

4.3.1 CONTEXT QUESTIONS

The survey began with a letter from the Port Authority of NY & NJ inviting respondents to complete the survey, basic survey instructions, the purpose of the survey, and a brief explanation of the proposed Lincoln Tunnel HOT Lane. Respondents were asked to provide details of their most recent weekday trip using the Lincoln Tunnel in the eastbound (tolled) direction. Both peak-period and shoulder-hour respondents were asked to report their most recent weekday trip during the entire survey period (5-11 a.m. or 3-8 p.m.), allowing respondents to report their most recent trip without restrictions.

Respondents reported on the following details of their trip:

- Day of week
- Time of day
- Trip purpose
- Trip mode and number of people in the vehicle
- Roads used to access the tunnel or bridge
- Trip frequency for the same purpose and other purposes
- Reasons for not carpooling (if not a carpool)
- Where trip began
- Where trip ended
- Whether they made intermediate stops
- Whether they experienced delay
- Was their trip time selected specifically to avoid congestion and if so, what their preferred travel time was (shoulder period respondents only)
- Total door-to-door travel time
- Toll paid

- Who paid the toll
- Payment method
- Reasons for not having an E-ZPass® transponder (if paid by cash)
- Which tunnel or bridge they would use if they had to use a crossing other than the Lincoln Tunnel and the estimated travel time to complete their trip using this alternate crossing
- Which forms of transit they would use if they had to make their trip using transit, how long their trip by transit would take, and how much their transit fare would be
- Reasons why they did not use transit for their trip
- Flexibility of their schedule including estimate of how many minutes earlier and later they could make their trip

The paper version of the survey used check boxes with fixed ranges for some of the questions with numerical answers listed above, while the online survey allowed respondents to enter specific values in their response.

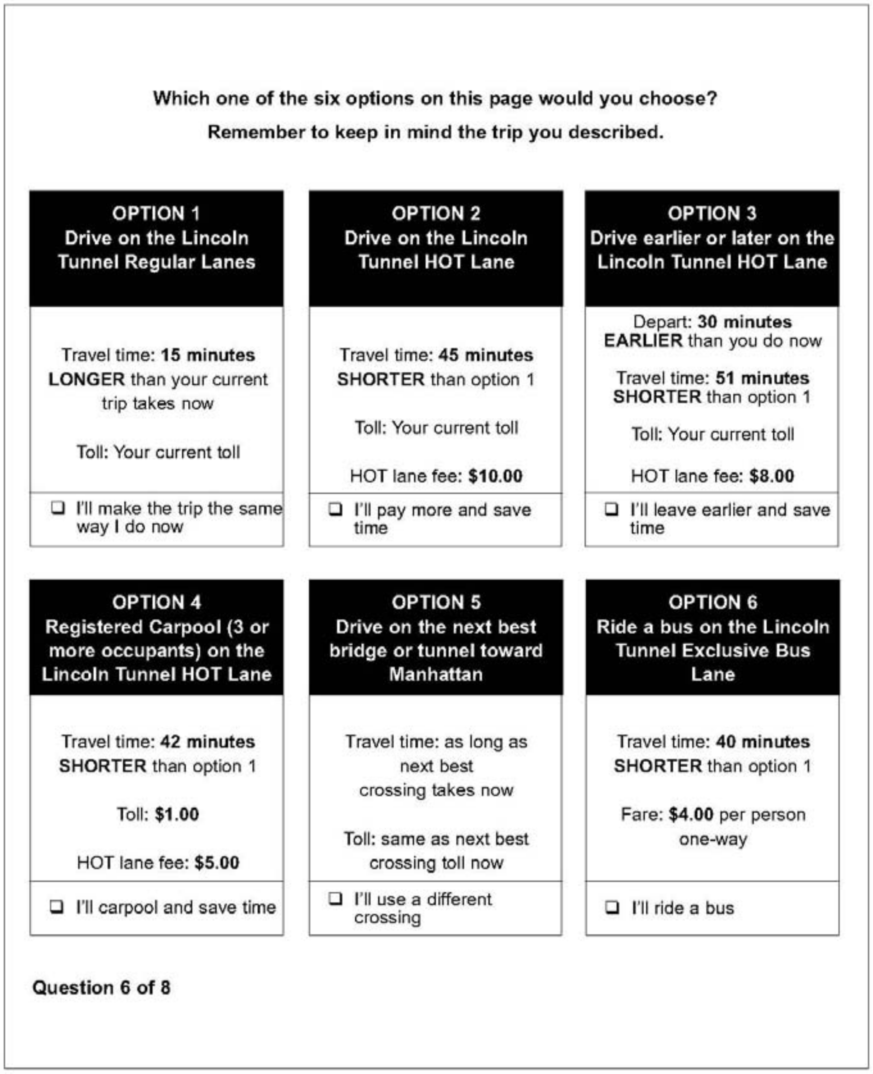
4.3.2 STATED PREFERENCE QUESTIONS

Before beginning the stated preference trade-off questions, respondents were presented with introductory information and reintroduced to a description of the proposed Lincoln Tunnel HOT Lane. The stated-preference section of the questionnaire was designed to construct quantitative experiments to evaluate respondents' preference for one of six options:

1. Current route driving on the Lincoln Tunnel regular general purpose lanes
2. Driving on the proposed Lincoln Tunnel HOT Lane
3. Driving earlier or later on the proposed Lincoln Tunnel HOT Lane
4. Driving in a registered carpool (three or more occupants) on the proposed Lincoln Tunnel HOT Lane
5. Driving on the next best bridge or tunnel toward Manhattan
6. Riding a bus on the Lincoln Tunnel Exclusive Bus Lane (XBL)

The survey presented each respondent with eight stated preference trade-off scenarios designed as choice experiments with these six travel options. A sample page from one of the choice scenarios is shown in Figure 7.

Figure 7: Lincoln Tunnel Automobile Paper Survey Stated Preference Example


Which one of the six options on this page would you choose?

Remember to keep in mind the trip you described.

OPTION 1 Drive on the Lincoln Tunnel Regular Lanes	OPTION 2 Drive on the Lincoln Tunnel HOT Lane	OPTION 3 Drive earlier or later on the Lincoln Tunnel HOT Lane
Travel time: **15 minutes LONGER** than your current trip takes now Toll: Your current toll	Travel time: **45 minutes SHORTER** than option 1 Toll: Your current toll HOT lane fee: **$10.00**	Depart: **30 minutes EARLIER** than you do now Travel time: **51 minutes SHORTER** than option 1 Toll: Your current toll HOT lane fee: **$8.00**
❑ I'll make the trip the same way I do now	❑ I'll pay more and save time	❑ I'll leave earlier and save time

OPTION 4 Registered Carpool (3 or more occupants) on the Lincoln Tunnel HOT Lane	OPTION 5 Drive on the next best bridge or tunnel toward Manhattan	OPTION 6 Ride a bus on the Lincoln Tunnel Exclusive Bus Lane
Travel time: **42 minutes SHORTER** than option 1 Toll: **$1.00** HOT lane fee: **$5.00**	Travel time: as long as next best crossing takes now Toll: same as next best crossing toll now	Travel time: **40 minutes SHORTER** than option 1 Fare: **$4.00** per person one-way
❑ I'll carpool and save time	❑ I'll use a different crossing	❑ I'll ride a bus

Question 6 of 8

The specific values assigned in each stated preference scenario are determined by using an orthogonal experimental design, which ensures that information is collected from respondents in a statistically efficient manner. This technique is commonly used in constructing experimental plans. The experimental design for this survey contained 32 experiments that were divided into four groups of eight.

Each group of eight experiments was randomly ordered and that order was printed in one of four versions of the paper survey. Therefore, each survey segment had four printed versions of the paper survey. The base values for the attributes were varied by multiplying or adding one of several factors to give the level required by the experimental design for that particular scenario. Each respondent was presented with different amounts of time savings for different costs, allowing them to demonstrate their travel preferences across a range of values of time. A sample of the ranges of values tested is shown in Table 8.

For respondents completing the survey online, one of the four groups of experiments was randomly chosen for each respondent and the eight experiments within that group were shown to the respondent in a random order. For online respondents, specific details, such as travel time and toll, were customized based on responses to questions regarding the respondents' reported Lincoln Tunnel trip. This reduced the burden for online respondents because the survey made calculations for the respondent and provided values based on their reported trip.

To reduce the burden on respondents completing the paper survey, the stated-preference experiments were arranged into two groups of four. The first group of four questions was slightly simpler than the second four, with the travel time for the first alternative (such as, "Drive on the Lincoln Tunnel Regular Lanes") the same as their reported trip time. Each respondent's second set of four questions showed a travel time for the first alternative longer than their current trip time.

4.3.3 DEBRIEF QUESTIONS

At the conclusion of the stated-preference scenarios, respondents who did not choose any of the HOT lane alternatives in any of the stated-preference scenarios were asked to indicate their reasons for never selecting the proposed Lincoln Tunnel HOT Lane. This question was only seen by online respondents, as it was added to the questionnaire after the paper questionnaire was printed.

At the conclusion of the stated-preference scenarios, all respondents were asked four debrief questions and four opinion questions. Respondents first answered how often they anticipated they would use the proposed Lincoln Tunnel HOT Lane and their overall opinion of the proposed Lincoln Tunnel HOT Lane concept. Peak-period respondents were asked how often they would use the proposed HOT lane if they saved 20 minutes for an extra HOT lane fee of $10.00, while shoulder period respondents were asked how often they would use the proposed HOT lane if they saved 10 minutes for an extra HOT lane fee of $5.00.

Secondly, respondents were introduced to the concept of FAIR lanes and told that, if the HOT lane were implemented, it may be possible that travelers who used the regular Lincoln Tunnel lanes and paid their tolls with an E-ZPass® transponder could earn credits toward free trips on the HOT lane. Respondents were then asked how often they anticipated using the Lincoln Tunnel HOT Lane if they could earn credits toward free trips in the HOT lane by driving in the regular lanes.

Table 8
Stated Preference Attributes and Levels for Lincoln Tunnel Automobiles

Alternative		Attributes	Peak Time Period Levels	Shoulder Time Period Levels
Option 1	Lincoln Tunnel Regular Lanes at the same time of day	Travel Time	Current time Current time Current time + 15 minutes Current time + 30 minutes	Same as Peak Period
		Toll Cost	Current toll (not varied)	
Option 2	Lincoln Tunnel HOT Lane at the same time of day	Travel Time	Current time - 5 minutes Current time - 10 minutes Current time - 20 minutes Current time - 30 minutes	Current time - 5 minutes Current time - 10 minutes Current time - 15 minutes Current time - 20 minutes
		Toll Cost	Current toll (not varied)	Same as Peak Period
		HOT Lane Fee	$5.00 $7.50 $10.00 $12.50 $15.00 $20.00 $25.00 $30.00	
Option 3	Lincoln Tunnel HOT Lane at a different time of day	Travel time	Option 2 time - 0 minutes Option 2 time - 3 minutes Option 2 time - 6 minutes Option 2 time - 9 minutes	Same as Peak Period
		Time shift amount	30 minutes 45 minutes 60 minutes 75 minutes	15 minutes 30 minutes 45 minutes 60 minutes
		Time shift direction	Earlier Later	Same as Peak Period
		Toll cost	Current toll (not varied)	
		HOT lane fee	Save $2.00 over Option 2 Save $4.00 over Option 2	
Option 4	Lincoln Tunnel HOT Lane, Registered Carpool (3+) at the same time of day	Travel time	Option 2 time + 3 minutes (not varied)	Same as Peak Period
		Toll cost	$1.00 (current carpool toll) (not varied)	
		HOT lane fee	$0 (total = current carpool toll of $1) 15% of option 2 toll 30% of option 2 toll 50% of option 2 toll	
Option 5	Alternate Crossing	Travel time	Alternate crossing time (not varied)	Same as Peak Period
		Toll cost	Alternate crossing toll (not varied)	
Option 6	Bus on the XBL	Travel time	Option 2 time + 5 minutes (not varied)	Same as Peak Period
		Toll cost	$4.00 $6.00 $8.00 $10.00	

Note: Current tolls used in survey were before 2008 toll increase.

The fourth debrief question asked respondents about their opinion of the proposed Lincoln Tunnel HOT Lane concept if it were possible to earn credits toward free trips on the HOT lane by driving in the regular purpose lanes. This question was designed to learn if the potential for credits improved public acceptance of the HOT lane concept. The number of trips in the regular general purpose Lincoln Tunnel approach lanes required to earn credits toward a free trip in the Lincoln Tunnel HOT Lane varied, testing free travel after five, ten, twenty and thirty trips in the regular travel lanes. For respondents completing the survey online, the number of regular trips (i.e., 5, 10, 20, or 30) for a free HOT lane trip was randomly selected and shown on the computer screen.

Finally, respondents were asked how strongly they agreed or disagreed with four statements related to their general opinion of toll-related projects. The four statements were:

- "I will use a HOT lane if the fees are reasonable and I will save time."
- "I support using tolls or fees to pay for highway improvements that relieve congestion."
- "I can generally afford to pay tolls."
- "I am comfortable driving in a lane with buses."

The responses to these questions are useful in gauging a respondent's potential bias toward paying tolls or using the proposed Lincoln Tunnel HOT Lane. The four statements were randomly ordered in the online survey.

4.3.4 DEMOGRAPHIC QUESTIONS

To conclude the questionnaire, nine demographic questions were asked to verify that the sample contained a diverse cross section of the population that would be served by the proposed Lincoln Tunnel HOT Lane. Respondents were assured that their responses would be kept confidential and that any personal information they recorded would not be shared or sold to a third party.

Respondents answered a series of questions having to do with home zip code, household size, number of household vehicles, gender, age, occupation, and annual income to attain information about the sample and to determine differences in responses among different traveler segments. Respondents were also asked if they owned any electric, hybrid, or alternatively fueled vehicles and their opinion of allowing these vehicles to use the proposed HOT lane for a discounted HOT lane fee.

To conclude, respondents were asked about their willingness to be contacted by the Port Authority of NY & NJ for future travel surveys, and if so, to provide their contact information. Respondents were also given the opportunity to leave comments about the survey or about the proposed Lincoln Tunnel HOT Lane.

4.4 LINCOLN TUNNEL COMMERCIAL VEHICLE QUESTIONNAIRE

The Lincoln Tunnel commercial vehicle questionnaire consisted of four parts: (1) company and background questions, (2) context questions on details on the respondent's trip and role, (3) stated preference trade-off questions, and (4) debrief questions.

4.4.1 CONTEXT QUESTIONS

To begin the commercial vehicle questionnaire, respondents were asked a series of company background questions including role in the company, location of the company headquarters, the total number of company vehicles, the number and type of company vehicles that travel through the Lincoln Tunnel, the number of one-way daily trips through the Lincoln Tunnel, the average trip length, the type of goods typically carried, the category of shipments, toll payment responsibility, and the manner of passing toll payments along to customers.

Having provided company background information, respondents were asked to think about their or their driver's most recent weekday trip that used the Lincoln Tunnel in the eastbound toll direction for the remaining survey questions. Each respondent reported the details of their trip, including the route of travel, vehicle type, trip purpose, day of week, time of day, total travel time, trip frequency, and approximate amount of time delayed.

Respondents also reported how they paid the toll (cash or E-ZPass) and their preferred alternate bridge or tunnel crossing and expected travel time if they were unable to use the Lincoln Tunnel. Commercial vehicle respondents were asked to identify the locations where their trip began and ended. As with the automobile survey, the origin and destination information was geo-coded.

4.4.2 STATED-PREFERENCE QUESTIONS

Before beginning the stated preference trade-off questions, respondents were presented with introductory information and introduced to the four travel alternatives that would be presented. Like the automobile survey, the commercial survey presented each respondent with eight stated preference trade-off scenarios designed as choice experiments with these four travel options:

1. Current route driving on the Lincoln Tunnel regular general purpose lanes
2. Drive on the proposed Lincoln Tunnel HOT Lane
3. Drive earlier or later on the proposed Lincoln Tunnel HOT Lane
4. Driving on the next best bridge or tunnel toward Manhattan

The survey presented each respondent with eight stated preference trade-off scenarios designed as choice experiments with these four travel options. The orthogonal experiment design and method for ordering experiments is the same as that used for Lincoln Tunnel automobile respondents.

4.4.3 DEBRIEF QUESTIONS

At the conclusion of the stated preference scenarios, respondents were asked their opinion of the proposed HOT lane concept on the Lincoln Tunnel approach. Those in favor of the HOT lane were asked why and those opposed where asked the main reason why they were opposed. For online respondents of the commercial vehicle survey, the answer choices to these two questions were randomly ordered.

To conclude, commercial vehicle survey respondents were also asked their willingness to be contacted by the Port Authority of NY & NJ for future travel surveys, and given the opportunity to leave comments about the survey or about the proposed Lincoln Tunnel HOT Lane.

4.5 OTHER SURVEYS

The surveys for other market segments were similar in nature, but customized for the particular market in question. A critical aspect of the surveys of bus passengers and auto drivers at the crossings immediately to the north and south of the Lincoln Tunnel was to understand the potential of mode shift within the Lincoln Tunnel corridor, as well as the potential for traffic diversion to or from the Lincoln Tunnel corridor as a result of the presence of a HOT lane. The bus passengers were asked their propensity to switch to auto if a HOT lane was available and users of other facilities were asked their propensity to switch to the Lincoln Tunnel if a HOT lane were available.

4.6 SURVEY RESULTS

The survey was designed to produce a generally representative sample of automobile, commercial vehicle, and bus travelers who would potentially use the proposed Lincoln Tunnel HOT Lane. It was important to sample a sufficient range of travelers and trip types to support the statistical estimation of coefficients of a choice model. By collecting data from a range of traveler and trip types, it is possible to identify the ways in which different characteristics affect route, lane, and mode choice behavior. These differences can then be reflected in the structure and coefficients of the resulting choice model. The survey sample that supports choice model estimation does not need to be perfectly proportional to the population as long as: (a) any behavioral differences are properly represented in the model and (b) the model is applied for forecasting using appropriate population proportions and/or sample weights.

The results of the automobile driver surveys are described in this section. The results of the other surveys can be found in the full survey report in Appendix B.

4.6.1 AUTOMOBILE DRIVER SURVEY RESULTS

A total of 2,701 automobile travelers who made a trip through the Lincoln Tunnel completed the Lincoln Tunnel HOT Lane survey. The brief descriptive analysis of the data presented in this section of the report is based on these 2,701 responses and is provided in three sections: (1) trip characteristics, (2) debrief, and (3) demographics. The full details for all traveler segments are included in the full report in Appendix B. It should be noted that the percentages presented here are unweighted by time of day and are intended to show the range of the sample, and not necessarily the values used in the analysis.

Trip Purpose - Lincoln Tunnel automobile respondents were segmented according to the trip purpose that they reported, as shown in Table 9. The 586 respondents who reported other purpose trips were comprised of 53 percent social or recreational trips, 4 percent school trips, 3 percent shopping trips, and 40 percent other personal business trips such as medial appointments.

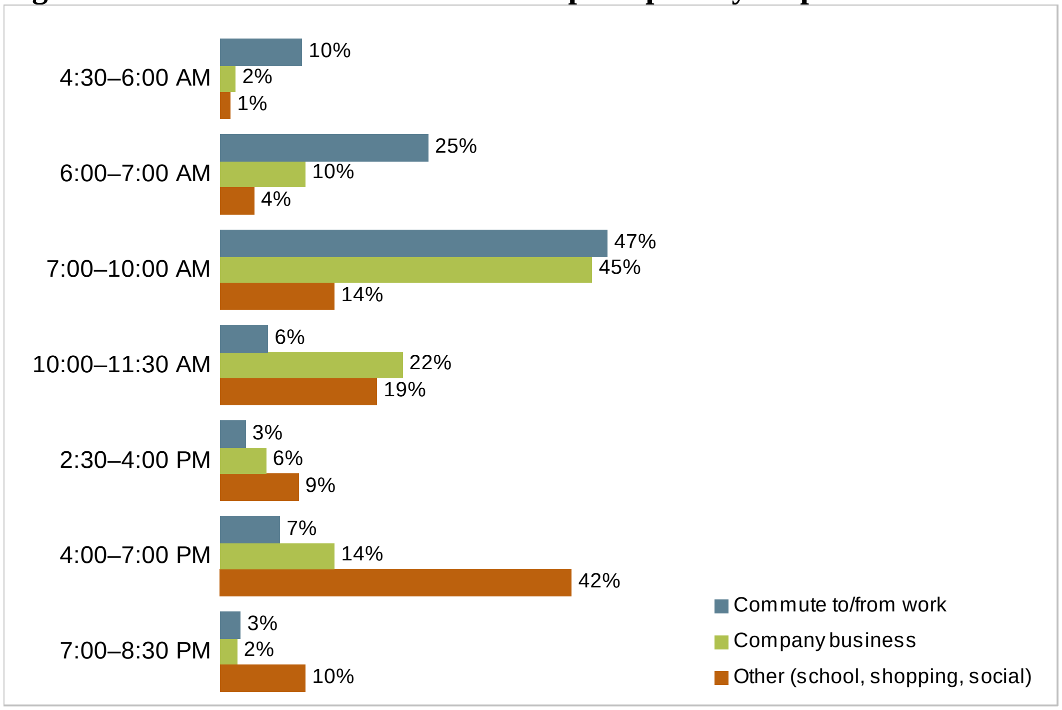
Table 9
Lincoln Tunnel Automobile Trip Purpose Segment

Trip Purpose	Count	Percentage
Commute to/from work	1,664	61%
Company business	451	17%
Other (school, shopping, social)	586	22%
Total	2,701	100%

Work commute respondents formed the majority of early morning and morning peak-period trips, with work commute respondents accounting for 92 percent of travelers from 4:30 a.m.-6:00 a.m., 86 percent of travelers from 6:00 a.m.-7:00 a.m., and 73 percent of travelers from 7:00 a.m.-10:00 a.m. Other purpose respondents were well represented in the afternoon, accounting for 42 percent of travelers from 2:30 p.m.-4:00 p.m., 58 percent of travelers from 4:00 p.m.-7:00 p.m., and 54 percent of travelers from 7:00 p.m.-8:30 p.m.

Across time periods, trips were distributed as shown in Figure 8. The majority (82 percent) of eastbound work commute trips were made before 10 a.m., two-thirds (67 percent) of company business trips were made from 7-11 a.m., and 62 percent of other purpose trips were made in the afternoon peak and shoulder time periods.

Figure 8: Lincoln Tunnel Automobile Trip Purpose by Trip Time Period



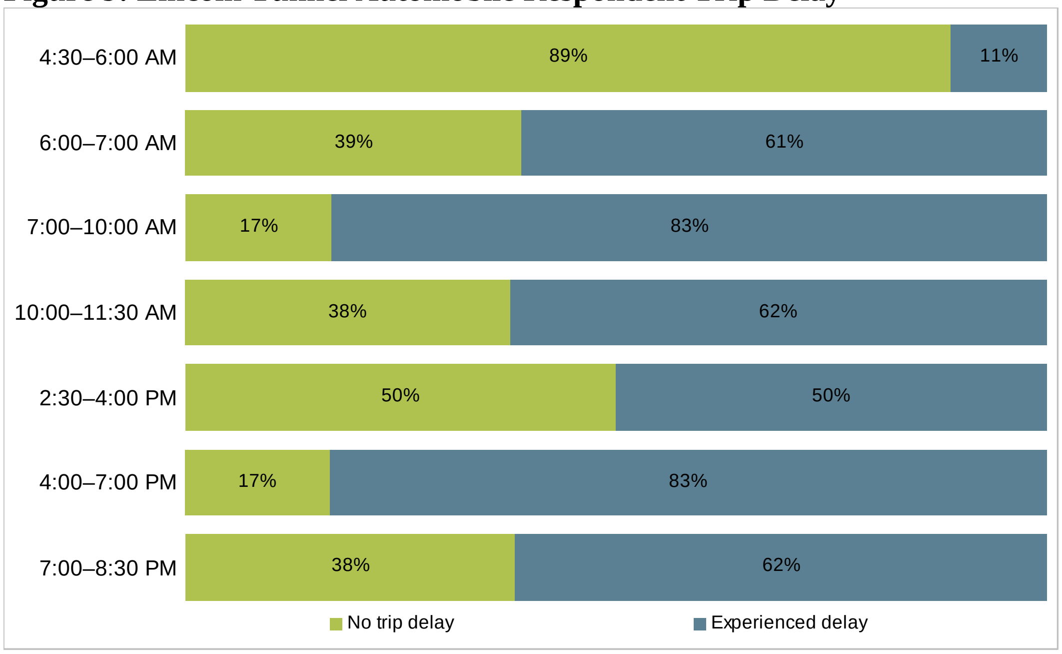
Carpooling - After reporting their trip time period and trip purpose, respondents indicated how they made their trip through the Lincoln Tunnel. Overall, 91 percent of respondents reported driving alone or with one other passenger, while 9 percent were in carpools of three-or-more occupants or vanpools. Both work commute trips (79 percent) and company business trips (81 percent) were primarily single-occupant trips, while more than half (57 percent) of other purpose trips were multiple-occupant trips.

Respondents who reported single-occupant vehicle trips were asked why they did not carpool. The primary reason cited (37 percent) was that respondents prefer the flexibility of traveling alone, while an additional 21 percent indicated that they do not know others to carpool with. Alternatively, respondents who carpooled were asked their primary reason for carpooling; 45 percent indicated that they carpooled to save money. Overall, 55 percent of those carpooling indicated that they carpool with family members, while 23 percent reported carpooling with co-workers, and 22 percent reported carpooling with friends.

Travel Time and Delay - A total of 21 percent of automobile respondents reported travel times of 30 minutes to 44 minutes with another 16 percent traveling for 45 to 59 minutes, 23 percent traveling for 60 to 74 minutes, and 15 percent traveling for 75 to 89 minutes. Respondents making work commute trips reported the shortest travel times, with 63 percent reporting travel times of less than 75 minutes. Only 39 percent of company business and 39 percent of other purpose trips were less than 75 minutes.

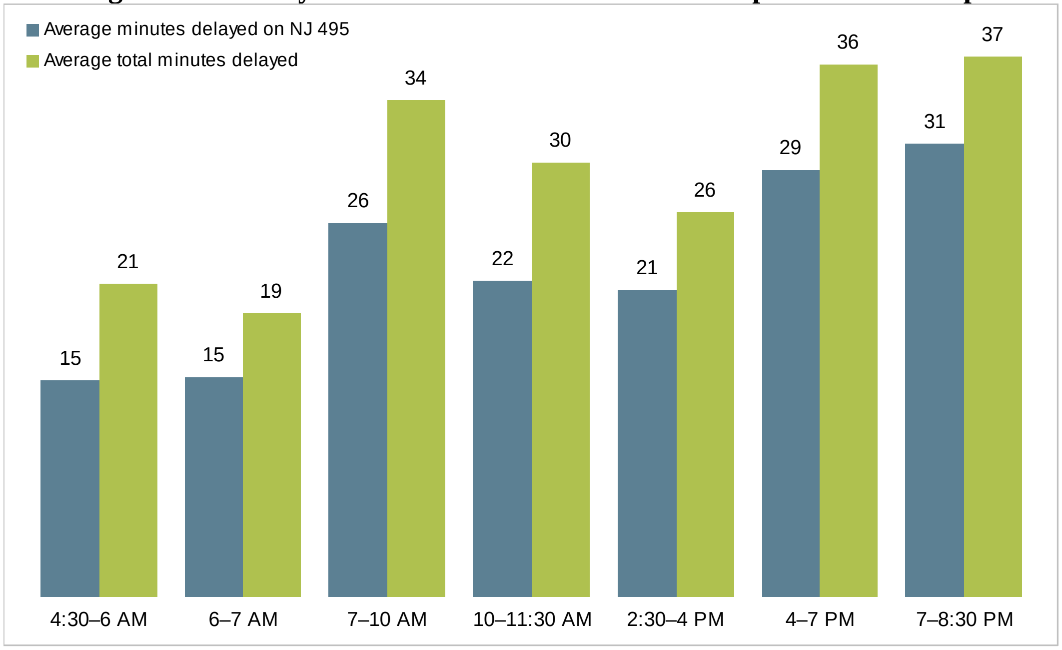
Overall, more than two-thirds of respondents (70 percent) reported that they experienced delay due to traffic or congestion during their trip. Figure 9 shows that the amount of delay varied according to the time period at the Lincoln Tunnel Toll Plaza. Travelers in the pre-peak time period experienced the least delay, with peak-period travelers experiencing the most delay. As travel conditions transition back to free-flow following the peak periods, travelers experienced some delay (62 percent from 10:00 a.m.-11:30 a.m. and 62 percent from 7:00 p.m.-8:30 p.m.).

Figure 9: Lincoln Tunnel Automobile Respondent Trip Delay



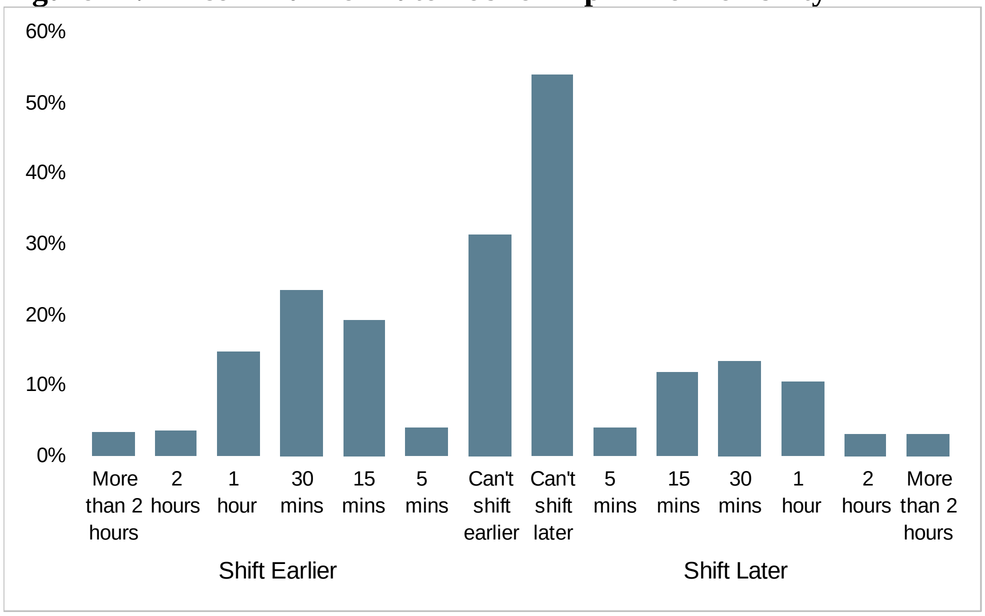
Lincoln Tunnel automobile respondents who experienced trip delays were asked to report the amount of time they were delayed on NJ 495 and the total amount of time they were delayed overall during their trip. Figure 10 shows the average minutes of eastbound trip delay during each survey time period for respondents who reported a delay. Again, peak-period eastbound travelers had the greatest delay, with AM peak period travelers reporting an average of 26 minutes delayed on NJ 495 and a total of 34 minutes delayed for their trip. Morning travelers experienced anywhere from 71 percent to 79 percent of their overall travel delays on NJ 495, with peak–period travelers experiencing more delay on NJ 495. Afternoon travelers generally reported higher average trip delays than morning travelers, with even higher percentages of the delay experienced on NJ 495 (i.e., 80 to 84 percent). This is most likely due to the reduced number of Manhattan-bound lanes at the Lincoln Tunnel in the afternoon peak hours in the tunnel. Afternoon peak travelers reported an average of 36 minutes delay on their trip and post-afternoon peak travelers reported an average of 37 minutes delay on their trip.

Figure 10: Average Minutes Delayed of Lincoln Tunnel Automobile Respondents Who Reported a Delay



Travel Time Flexibility - The final two questions of the trip characteristic section of the questionnaire asked respondents how much earlier and how much later they could have made their trip. Overall, almost a third (31 percent) of Lincoln Tunnel automobile respondents indicated that they couldn’t make their trip any earlier, while more than half (54 percent) indicated they couldn’t make their trip any later (see Figure 11). What is interesting to note about travelers’ travel time flexibility is that although the majority of respondents indicated little or no travel time flexibility in their travel times, a sizeable minority did suggest a significant amount of travel flexibility. Figure 11 shows that 45 percent of survey respondents indicated the ability to shift their travel time by 30 minutes earlier or more. Similarly, nearly 30 percent of the survey respondents indicated the flexibility to shift their travel times by 30 minutes later or more. If even a small portion of these travelers were able to be induced to shift their travel times, there could be a significant improvement in the delays experienced throughout the peak periods of travel.

Figure 11: Lincoln Tunnel Automobile Trip Time Flexibility



Demographics - To conclude the questionnaire, Lincoln Tunnel automobile respondents answered a series of demographic questions. Median household vehicle ownership was two vehicles, with 23 percent of respondents living in a single-vehicle household, 47 percent living in a 2-vehicle household, and 20 percent living in a 3-vehicle household.

Work commute trips had a slightly higher percentage of respondents (36 percent) in the management, business, and financial sectors and generally reflected the sample's overall occupation distribution. While 31 percent of company business respondents were also in the management, business, and financial sectors, an additional 23 percent reported their occupation as sales, office, and administrative support.

The last demographic question asked respondents their annual household income. Of those who answered the question, 32 percent reported an income of $200,000 or more. The higher the income bracket, the larger the proportion of respondents in the management, business, and financial operations sector; 52 percent of respondents with incomes of $200,000 or more, 27 percent of respondents with incomes of $100,000-$149,999, 16 percent of respondents with incomes of $50,000-$74,999, and 7 percent of respondents with incomes of less than $25,000. Lower income respondents had a higher percentage of individuals in the construction, maintenance, and repair sector; the service (food, retail, etc.) sector; and students. These results are consistent with other surveys of household income for PANYNJ interstate customers traveling on the bridges and tunnels. The Lincoln Tunnel corridor tends to be comprised of some of the highest income travelers in the New York-New Jersey region.

4.7 MODEL ESTIMATION FROM STATED PREFERENCE DATA

4.7.1 GENERAL APPROACH TO MODEL ESTIMATION AND SCALING

The stated-preference data collected as part of this study were used to estimate choice models to understand likely future travel behavior of current and potential Lincoln Tunnel HOT Lane users. Calibration of the choice models was then undertaken based on revealed preference information from other sources, including the 2006 Auto Trans-Hudson Crossings Origin-Destination study dataset and the report ***"Evaluation Study of Port Authority of New York and New Jersey's Time on Day Pricing Initiative"*** (Holguin-Veras et al, 2005).

A summary of model estimation methods results is included here. Full details are provided in Appendix B.

4.7.2 STATED PREFERENCE MODEL ESTIMATION APPROACH

Responses from the stated preference experiments from survey records deemed complete were expanded into a dataset containing up to eight observations for each of the respondents, yielding 27,233 observations. The data were used to support estimation of the coefficients of multinomial logit (MNL) choice models for several model segments, including automobile, truck, and bus segments, and within auto users, by trip purpose, payment type, crossing, and time of day.

4.7.3 STATED PREFERENCE EXPERIMENT ALTERNATIVES

As described in the Survey Questionnaire section of this report, several versions of the survey were created for the different traveler markets, including Lincoln Tunnel automobile drivers, drivers using adjacent crossings (i.e., the George Washington Bridge or Holland Tunnel), bus passengers traveling on buses in the XBL, and commercial vehicle drivers/operators. The choice set of alternatives presented in the stated preference experiments varied among the different markets.

Lincoln Tunnel automobile drivers were presented with six alternatives:

1. Current route driving on the proposed Lincoln Tunnel regular lanes
2. Driving on the proposed Lincoln Tunnel HOT Lane
3. Driving earlier or later on the proposed Lincoln Tunnel HOT Lane
4. Driving in a registered carpool (three or more occupants) on the proposed Lincoln Tunnel HOT Lane
5. Driving on the next best bridge or tunnel toward Manhattan
6. Riding a bus on the Lincoln Tunnel Exclusive Bus Lane (XBL)

Drivers using the adjacent crossings were presented with five alternatives:

1. Current route driving on the Holland Tunnel or George Washington Bridge
2. Driving on the proposed Lincoln Tunnel HOT Lane
3. Driving earlier or later on the proposed Lincoln Tunnel HOT Lane
4. Driving in a registered carpool (three or more occupants) on the proposed Lincoln Tunnel HOT Lane

5. Riding a bus on the proposed Lincoln Tunnel Exclusive Bus Lane (XBL)

Lincoln Tunnel bus passengers were presented with four alternatives:

1. Current bus on the Lincoln Tunnel Exclusive Bus Lane (XBL)
2. Drive on the proposed Lincoln Tunnel HOT Lane
3. Driving in a registered carpool (three or more occupants) on the proposed Lincoln Tunnel HOT Lane
4. Take a rail transit option to Manhattan

Commercial vehicle survey respondents were presented with four alternatives:

1. Current route driving on the Lincoln Tunnel regular lanes
2. Drive on the proposed Lincoln Tunnel HOT Lane
3. Drive earlier or later on the proposed Lincoln Tunnel HOT Lane
4. Driving on the next best bridge or tunnel toward Manhattan

4.7.4 Final Model Specifications

Several utility equation structures were tested using the variables included in the stated-preference experiments, as well as trip characteristic and socio-demographic variables. The variables that were retained in the final models were deemed to be statistically significant and easily applicable in forecasting. Details of the model specification for each traveler segment and the coefficients for the models are presented in the Appendix. For each model, coefficient values, standard errors, and t-statistics are presented. The statistics included for each model are number of observations, Log Likelihood at zero and at convergence, number of estimated parameters, and adjusted Rho-Squared (a model fit measure).

Automobile Models - The automobile model was determined to be the best fit when it included the following variables:

- Total travel time
- Total cost (toll plus HOT lane fee, if applicable, or bus fare) with an income effect
- Time and cost for 3+ occupant with an income effect
- Amount of time shift earlier
- Amount of time shift later
- Alternative specific constants

Other variables were tested, but were not statistically significant. Therefore, they were not included in the final model specification.

Bus Passenger Model - In the bus passenger model, coefficients were determined for total travel time and total cost (transit fare or toll plus HOT lane fee, if applicable) alternative specific constants. In reviewing the survey results, it was found that more than 75 percent of the bus passengers would never change their modes. Of the remaining 25 percent of passengers, some would switch to driving under only some of the hypothetical conditions presented. The relative lack of data did not allow for robust models and therefore, no diversion from bus to auto was assumed for this study.

Commercial Vehicle Model - The specification for the commercial vehicle models presented in this report included coefficients for time, cost, sensitivity to shifting departure time earlier or later, and alternative specific constants.

4.7.5 Values of Time and Other Willingness-to-Pay Indicators

Mean Values of Time - Mean values of time based on the MNL model results for each automobile segment are shown in Table 10. The values of time for each of the segments are estimated at a household income of $100,000.

Table 10
Mean Values of Time for Automobile Segments

Trip Segment	Time of Travel	Trip Purpose		
		Commuters	Business	Other
Alternate Crossing E-ZPass	All hours	$13.72	$16.73*	$12.10
Lincoln Tunnel Cash	All hours	$12.54	$4.73*	$6.09
Lincoln Tunnel E-ZPass	Before 6:00 a.m.	$20.99		
	6:00 a.m.-7:00 a.m.	$16.56	$13.15	$9.21
	7:00 a.m.-10:00 a.m.	$15.06		
	10:00 a.m.-11:30 a.m.	$12.33	$10.73	$10.57
	2:30 p.m.-4:00 p.m., after 7:00 p.m.	$9.12	$10.20	$8.43
	4:00 p.m.-7:00 p.m.	$19.20		$7.59

* Small sample size (less than 50 respondents)

In general, Table 10 shows that commuters have the highest values of time among the trip purpose segments, followed by business travelers, and lastly those traveling for other trip purposes. While it is typical that those traveling for non-work purposes demonstrate lower values of time than work commuters or business travelers, it is normally expected that business travelers have higher values of time than work commuters. The extremely low value-of-time for business travelers paying cash to use the Lincoln Tunnel shown in Table 10 could be the result of the relatively low sample size for this segment.

Even in other categories, however, commuters tended to have values of time that tended to be higher than that of business travelers. There are several reasons why commuters in this corridor may have higher values of time than business travelers. Most commuter trips are frequent (71 percent four or more times per week compared to only 14 percent of business trips), so commuters are in general much more familiar with the congested travel conditions on the approach to the Lincoln Tunnel at peak times. Business travelers are making slightly longer trips than commuters are and are traveling later than commuters (with a much larger proportion of business trips in the post-AM peak shoulder hours and very few before 7:00 a.m.).

Business travelers have slightly lower incomes than commuters, with 28 percent reporting incomes more than $200,000 compared to 35 percent of work commuters. Business travelers also have a slightly different employment type mix, with 22 percent working in a sales, office, and administrative jobs, compared to 9 percent of commuters and a smaller proportion (31 percent to 36 percent) working in the management, business, or financial sectors.

Since those making commute trips by auto through the Lincoln Tunnel have slightly higher incomes, they are more likely to be working in senior positions. These travelers have demonstrated their sensitivity to travel time savings by choosing to travel before congestion begins to build on the Lincoln Tunnel approach. The results show them to have higher values of time than business travelers.

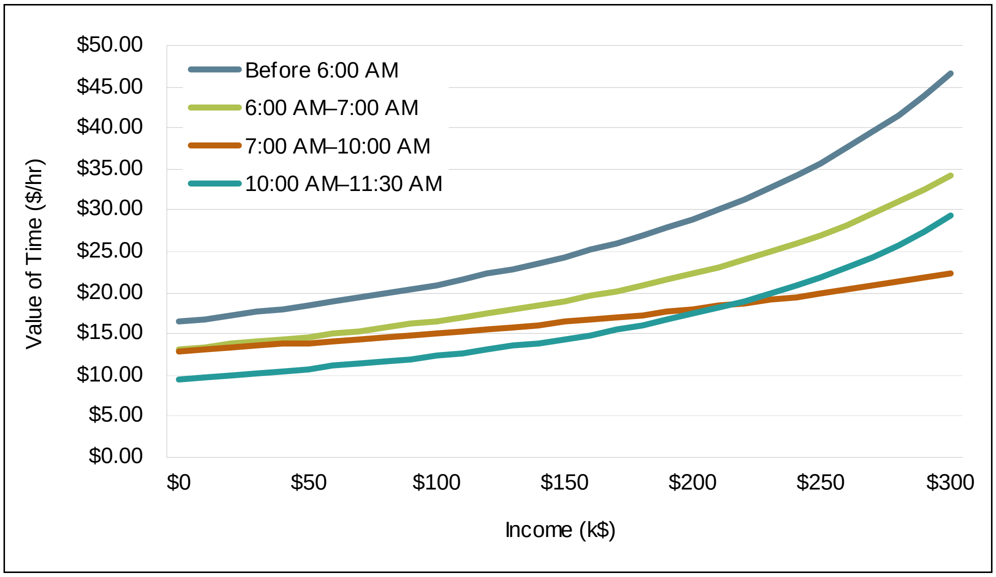
For bus passengers, a mean value of time of $8.80 was estimated from the MNL model.

For commercial vehicles, a mean value of time of $25.21 was estimated for the segment carrying time-sensitive goods, compared with $3.29 for the segment comprising those not carrying time-sensitive goods. The large difference in values of time between the two segments indicates two distinct types of commercial vehicle trips using the Lincoln Tunnel: a group with consistent time constraints because of the nature of their shipments (e.g., time-sensitive or perishable) that is willing to pay a higher toll to avoid congestion and a group without (or with relatively few) time constraints. The first group, consisting of just over 60 percent of commercial vehicle survey respondents, is more likely to be willing to pay a fee to avoid congestion, while the second group is willing to accept congestion and unwilling to pay a higher fee.

Interaction between Values of Time and Household Income - For automobile drivers, cost sensitivity and hence value of time was sensitive to household income. Since cost sensitivity reduces as income increases, value of time increases as income increases. The following series of figures present and compare the resulting value of time-income curves for the different automobile segments.

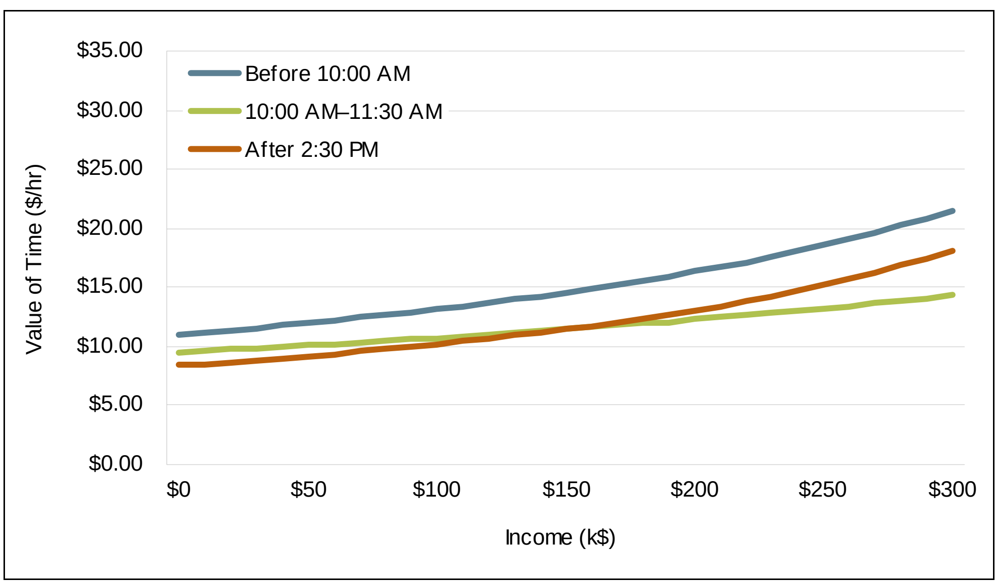
Work commuters paying by E-ZPass® and traveling through the Lincoln Tunnel in the AM peak and shoulder time periods were grouped into four time segments (Figure 12). Those traveling earliest (i.e., before 6 a.m.) were found to have the highest values of time, followed by the group traveling in the first hour of the AM peak, between 6 a.m. and 7 a.m. A possible explanation of this is that respondents who value their time most highly have already moved their departure time earlier to avoid the traffic congestion found later in the morning and therefore save time. Respondents traveling in the main part of the AM peak (i.e., from 7-10 a.m.) were found to have values of time less sensitive to income than those traveling at other times in the morning.

Figure 12: Lincoln Tunnel Automobile E-ZPass® Work Commuter Values of Time by Income for AM Time Period Segments



Morning peak period business travelers using the Lincoln Tunnel and paying by E-ZPass® were found to have slightly higher values of time than business travelers using the tunnel later in the day (Figure 13).

Figure 13: Lincoln Tunnel Automobile E-ZPass® Business Values of Time by Income for Time Period Segments



Chapter 5 MODELING APPROACH

This section presents an overview of the methodology used to develop estimates of traffic and revenue potential for each of the alternatives identified by the study team. The goal of the traffic forecast for this study was to answer the following questions:

- How much demand exists in the corridor?
- How much will the demand grow in the future?
- What share of traffic demand is eligible to use the proposed HOT lane and what will drivers be willing to pay under different operating scenarios?

Once traffic is assigned to either the proposed the HOT lane or the general purpose lanes, a traffic operations analysis is undertaken using the corridor micro-simulation to determine the operational impacts of each alternative to help identify the most promising alternatives.

Existing travel demand in the corridor was determined through traffic counts collected previously in the corridor, which were updated with new counts at key locations in the corridor. A detailed profile of current traffic demand was developed, with the new counts providing the ability to construct ramp-to-ramp matrices of demand. The data are key to identifying the potential market for demand for the proposed HOT lane, since only traffic traveling from end-to-end on NJ 495 are considered to be eligible to use the HOT lane based on its access configuration. These matrices became the foundation of the travel demand used in the operations analysis and travel behavior choice model developed for this study.

Total growth in all traffic in the NJ 495 corridor was estimated to develop estimates of global demand in the corridor. Global demand includes traffic eligible to use the proposed HOT lane as well as traffic that enters at intermediate interchanges and traffic that may not be destined for the Lincoln Tunnel. The total global demand on NJ 495 is used to project the overall levels of congestion and delay that can be avoided by using the proposed HOT lane.

The next step in the overall modeling approach used in this study required interaction between two different models: the micro-simulation traffic model (created in a VISSIM format) and a travel behavior choice model. The base year ramp-to-ramp matrices used to calibrate the VISSIM model were grown to future year levels using the growth rates detailed previously to estimate the future global demand in the corridor. These matrices are key inputs to both the micro-simulation and behavioral choice models.

5.1 MICRO-SIMULATION MODEL (VISSIM)

The micro-simulation traffic operations model was used to develop estimates of future delay under each of the alternatives considered in this study. It was used to test the maximum flow through the proposed HOT lane while maintaining free-flow speeds for each of the three physical configurations tested. For each configuration, the model was then run under a range of different loading levels in the proposed HOT lane, ranging from buses and carpools only to the maximum flow volume to observe the variations in travel time and delay in both the general purpose lanes and the proposed HOT lane.

The output from these runs of the micro-simulation model was used to develop equations that estimated the travel time in the general-purpose lanes based on the amount of traffic in the proposed HOT lane. This was necessary because a large portion of the delay in this corridor is due to queuing, which is not described well by speed/flow (demand) curves traditionally used in traffic engineering and transportation planning. These equations were then transferred into the travel behavior choice model, which will be described in the next section of this report.

This step of the analysis was also critical to the overall analysis since all the alternatives analyzed would have required the conversion of an existing general purpose lane to a HOT lane, which could potentially result in significant increases in delay in the corridor.

5.2 TRAVEL BEHAVIOR CHOICE MODEL

The travel behavior choice model developed for this study was used to estimate the amount of traffic that would want to use the proposed HOT lane under a set of travel and pricing conditions. The travel behavior choice model was based on the results of the stated-preference surveys. In each priced alternative, motorists have several options for travel:

1. Continue to drive in the fee-free general purpose lanes
2. Choose the proposed HOT lane
3. Choose to travel in the proposed HOT lane shifting travel during a shoulder hour
4. Choose to carpool and use the proposed HOT lane (with or without a discount)
5. Choose to take transit
6. Choose to use an alternative crossing

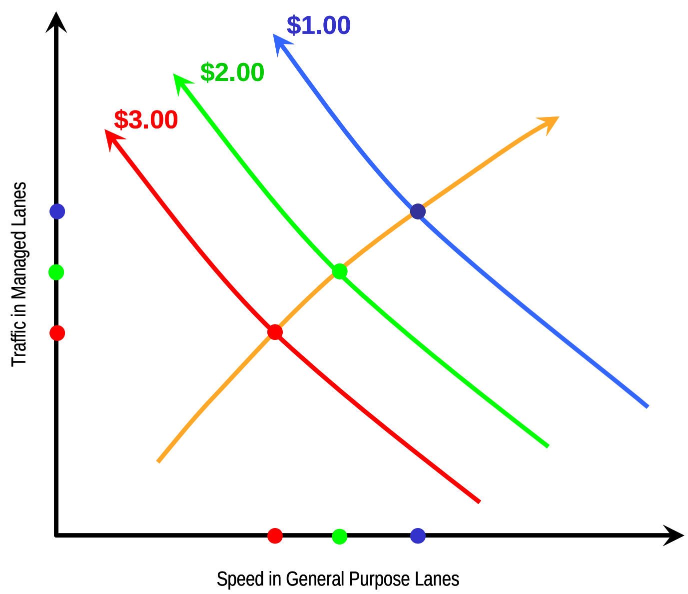
Key parameters that influence the choice of each of the travel options listed above are shown in Table 11. Of these parameters, time and cost are common to all travel options. The travel behavior choice model was developed using estimates of each of these parameters for travelers in the NJ 495 corridor, varying by movement and time of travel.

Table 11
Travel Choices Matrix

	GP Travel At Same Time	HOT Travel At Same Time	HOT Travel In Carpool	HOT Travel With Time Shift	Use Alternate Route	Use Transit
Travel Time	Current and Incremental Time (No-Build vs. Build)	GP Time - HOT Time Savings	Same As HOT Time +3 Min. / Passenger	Same As HOT Time	Current and Additional Alternate Route Time	Average Transit Time
Cost	Lincoln Tunnel Toll at New Arrival Time at Plaza	Lincoln Tunnel Toll and HOT Lane Fee at Time At Route 495 Approach	Discounted Lincoln Tunnel Toll and Discounted HOT Lane Fee At Time At Route 495 Approach	Lincoln Tunnel Toll and HOT Lane Fee At New Time At Route 495 Approach	Alternate Route Cost = Lincoln Tunnel Toll At Current Time	Average Transit Cost
Arrival Time At Route 495	Current	Current	Current	Current +/- Minutes Shifted	-----	-----

The travel behavior choice model is run in a series of iterations to identify the proposed HOT lane fees that achieve an equilibrium point between amount of vehicles in the HOT lane and the travel time savings associated with a specific HOT lane loading level. An example of this equilibrium relationship is shown in Figure 14. In this graphic, the orange line signifies the changes in general purpose lane speeds that occur at differing levels of HOT lane volume. As HOT lane volume increases, speeds in the general purpose lanes increase. The blue line indicates the amount of traffic desiring to use the HOT lane at a range of travel time savings for a sample HOT lane fee of $1.00 – when speeds in the general purpose lanes are low (travel time savings are high), the amount of traffic willing to pay the HOT lane fee is high. As speeds increase (travel time savings decrease), assuming the same price, the amount of traffic choosing the HOT lane decreases. The travel behavior choice model is designed to find the equilibrium point between these two curves. At higher levels of HOT lane fees, the pricing sensitivity curves move to the left, in that higher time savings would be required to maintain the same volumes in the HOT lane.

Figure 14: HOT Lane Demand vs. General Purpose Lane Speeds Equilibrium



The travel behavior choice model was developed using the following steps and assumptions:

1. Use the individual survey records from the stated-preference surveys as observations of travel characteristics of drivers in the corridor, including vehicle occupancy, trip purpose, origins, destinations, approach road, method of payment, and total travel time, among others.
2. Expand the survey records to represent future traffic volumes based on the time of travel and approach route (NJ 3, NJ Turnpike Int. 16E, or NJ Turnpike Int. 17). Only trips

eligible to use the proposed HOT lane are included in the sample and subjected to the shifts in the travel behavior choice model. Trips that originate locally are assumed to remain in their current modes, times, and routes.

3. Duplicate survey records to distribute traffic oriented to Manhattan into four districts: upper, upper middle, lower middle, and lower Manhattan.
4. Assuming travel in the proposed HOT lane will be at its maximum throughput, estimates of travel time in the general purpose lanes for future conditions defined by the study alternatives were generated from regression equations developed from micro-simulation results.
5. Calculate the difference between the future conditions for study alternatives and base year existing conditions to estimate an increase in delay associated with the future condition. Add this increase to reported travel time for each survey record to estimate travel time in the general purpose lanes for each trip record.
6. Estimate costs for travel in the general purpose lane based on current method of payment and hour of travel.
7. Calculate the time savings from travel in the proposed HOT lane vs. travel in the general purpose lanes under future conditions for the study alternatives and subtract this time savings from the total travel time in the general purpose lanes estimated in Step 5. This time savings is only accrued from the point where the proposed HOT lane starts to the Lincoln Tunnel toll plaza.
8. Develop an initial table to establish HOT lane fees based on arrival time to NJ 495. Add these fees to the current Lincoln Tunnel tolls to estimate total cost for travel in the HOT lane.
9. Estimate travel time and cost for HOT lane travel during another less costly time interval and estimate the amount of shift in travel time needed to achieve this savings.
10. Estimate travel time and cost for HOT lane travel as carpool.
11. Estimate travel time and cost for travel using transit option. Use information provided by respondent for travel time where available; use estimate based on typical bus schedules where respondent did not provide information.
12. Estimate travel time and cost for travel using an alternative river crossing. Use information provided by respondent for travel time using alternative crossing where available; use estimate of incremental travel time based on origin and destination for records where the respondent did not provide information.
13. Using logit models developed from stated-preference surveys, estimate share of traffic choosing the time shift, carpool, transit, and alternate crossing choices.
14. For those that continue to drive in the corridor, apply a secondary analysis that considers only the travel time savings and the cost in the HOT lane. For each record, the proportion of motorists assigned to the HOT lane is a function of the computed time savings, the HOT lane fee, and the value of time for each individual record, which can vary based on trip purpose and income.
15. Test alternative HOT lane fees for each time period until the traffic in the HOT lane is maximized.
16. Loop HOT lane fees from Step 15 back through steps 13 through 15.
17. Estimate tolled and free traffic in the HOT lanes and calculate revenues based on fees and tolled transactions.

18. Estimate annual revenues based on expansion factor assuming 247 non-holiday weekdays.

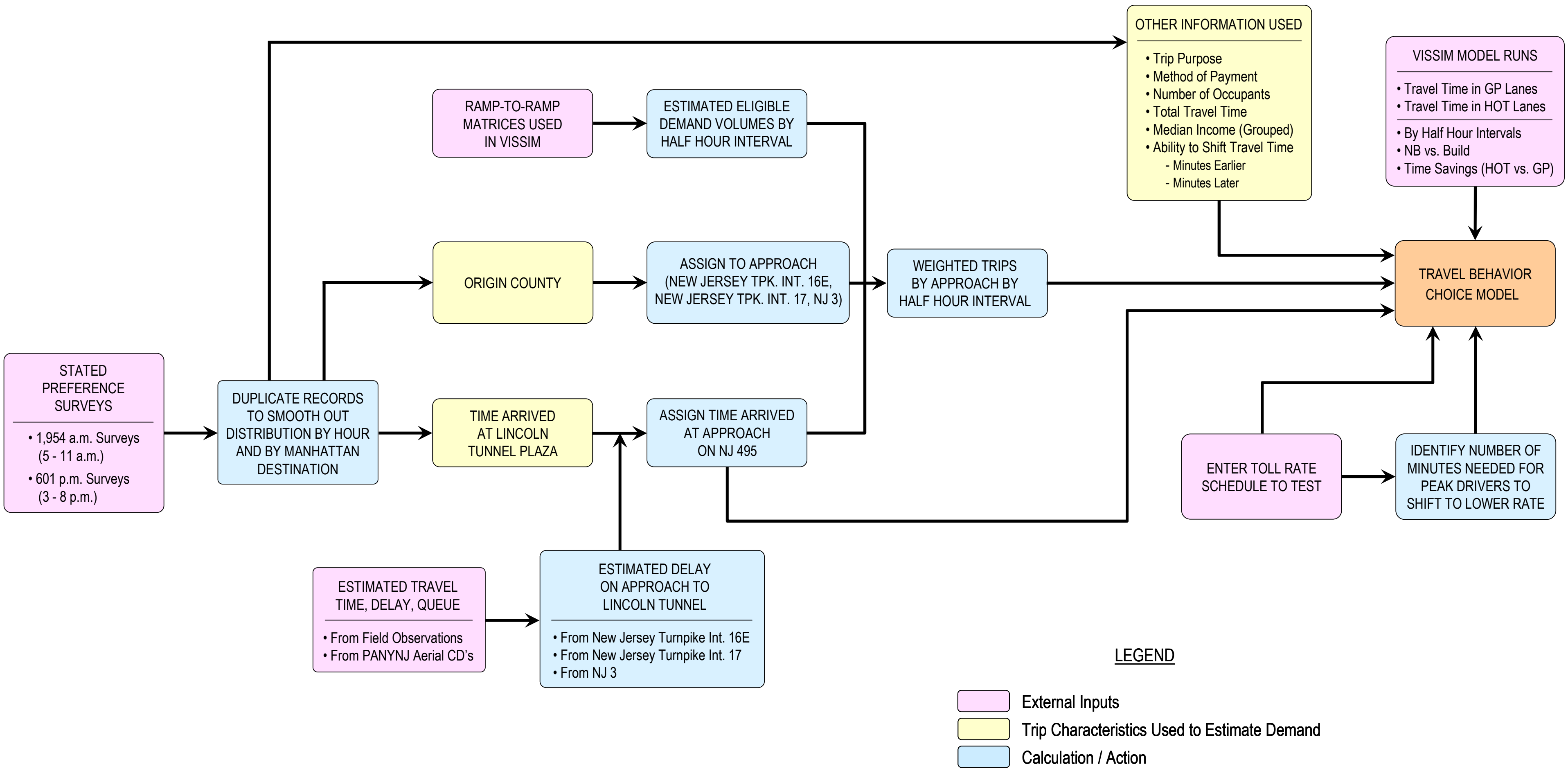
Figure 15 shows the development of some key inputs to the travel behavior choice model. To the extent possible, data collected from the stated preference surveys were used to provide travel time, trip purpose, occupancy, origin-destination, and other travel characteristic information to the behavior model.

5.3 OTHER MODEL INPUTS

Origin-Destination Survey - The origin-destination information from the stated-preference surveys conducted for this study was compared to the data collected from a formal trans-Hudson auto origin-destination survey that the PANYNJ completed about eight months prior to the stated preference survey. The trans-Hudson auto origin-destination survey was used to develop the distribution of trips to the four districts in Manhattan, since that survey collected zip code information for both ends of the trip. Other comparisons were limited since the stated-preference surveys had a higher sample than the origin-destination survey.

Regional Travel Demand Model - Trip tables, highway networks, other key inputs, and model documentation associated with the regional travel demand model developed by the New York Metropolitan Transportation Council (i.e., the Best Practices Model [BPM]) were obtained for use in developing potential traffic impacts of the HOT lane on a regional basis. While the model itself is an advanced model with features that allow it to be more sensitive to certain changes in transportation networks and congestion, the model has limited features to make it sensitive to the HOT lane-type pricing. All trans-Hudson and Staten Island crossings in the New York City metropolitan area are tolled and all PANYNJ parallel crossings are the same price. As a result, while tolls are used within the mode choice model to compare auto travel to transit travel, they are not a significant factor in the highway assignment/route choice part of the model since all routes crossing the rivers pay essentially a similar toll rate. Another limitation to using this model for HOT lane analysis was that only two analysis years were available – 2002 base year and 2035 horizon year; and the job stream is designed to develop trip tables for three-hour peak periods.

Impacts/Diversions - The proposed HOT lane was coded into the BPM's highway network for testing of potential diversionary shifts in traffic during the AM peak period. The capacity of the NJ 495 approach was reduced to reflect a Build condition, and a separate express link was added to replicate the proposed HOT lane. Traffic assignments were run using a range of alternative time penalties to test pricing in the proposed HOT lane. These tests indicated that the model was more sensitive to the time penalty assumptions than the capacity change assumptions. As such, it was determined that the model would be difficult to use to estimate the level of alternate route diversions without a significant level of additional calibration. For this study, the amount of diversion to alternative routes would be estimated from the travel behavior choice model. However, the BPM model was used to compare the likely alternate routes used by traffic that might shift out of the corridor against the results of the stated preference surveys.



WilburSmith ASSOCIATES

TRAVEL BEHAVIOR CHOICE MODEL DEVELOPMENT

FIGURE 15

From the BPM analysis, approximately 57 percent of the shifted traffic would be likely to use the George Washington Bridge, 14 percent would use the Holland Tunnel, 12 percent would use the Tappan Zee Bridge, and 18 percent would use the Goethals Bridge/Verrazano Narrows Bridge routing. From the stated preference surveys, approximately 55.6 percent of tunnel-bound automobile traffic originating from locations outside of the NJ 495 corridor stated that the George Washington Bridge would be their next best alternative, while 41 percent would use the Holland Tunnel. The remaining 3.4 percent were spread among the Goethals Bridge, the Tappan Zee Bridge, and the Outerbridge Crossing. The estimate of the share of traffic shifting to the George Washington Bridge is similar between the BPM model and the surveys. Given the difference in the sources, this conclusion is considered an appropriate estimate of the preferred alternative crossing.

Chapter 6 TRAFFIC OPERATIONS MODEL

A traffic operations model of the NJ 495 was developed using the VISSIM software and provided information to the travel behavior choice model in several ways in this study. After a base year re-calibration effort, the model was used to develop estimates of travel time savings for the HOT lane over travel in the general purpose lanes. The model was tested under a range of HOT lane traffic volumes to estimate the sensitivity of travel time in the general purpose lanes to HOT lane usage. This was a key input to the travel behavior choice model developed in this study. The travel behavior choice model was then used to estimate the traffic demand in the proposed HOT lane (based on the time savings noted above), shifts to other modes, travel time shifts, and shifts to other crossings. The resulting traffic volumes in the HOT lane and general purpose lanes were then input back into the operations model for review of final traffic operational impacts of each alternative.

6.1 MODEL OVERVIEW

The Lincoln Tunnel AM traffic operations simulation model was developed using VISSIM software. VISSIM is a micro-simulation traffic modeling software that uses car-following and lane-changing models in its algorithms. The study area network that was developed for this model included NJ 495 and its frontage roads from the NJ Turnpike's entry points to NJ 495 in the west to the Lincoln Tunnel New Jersey portals in the east. All intermediate interchanges were coded as entrance or exit ramps from NJ 495. Both directions are modeled, although the focus of calibration was on the eastbound direction. The contraflow XBL was modeled as a separate roadway from the "teardrop" area near the NJ Turnpike to the Lincoln Tunnel.

The model used for the previously completed ***"Exclusive Bus Lane Capacity Enhancement Feasibility Study"*** modeled only the 5-10 a.m. period. This model was a dynamic assignment model, which can be run in multiple iterations to allow the program to find multiple paths from an origin to a destination point based on traffic conditions at different times. The following vehicle types were included in the model:

1. Car 1&2 Manual – Single- or double-occupancy cars paying by cash
2. Car 1&2 E-ZPass® – Single- or double-occupancy cars using E-ZPass
3. Car 3+ Manual – 3-or-more-occupancy cars paying by cash
4. Car 3+ E-ZPass® – 3-or-more-occupancy cars using E-ZPass
5. Truck Manual – Trucks paying by cash
6. Truck E-ZPass® – Trucks using E-ZPass
7. Bus Manual – Buses paying by cash
8. Bus E-ZPass® – Buses using E-ZPass
9. XBL Bus – Buses using XBL Lane
10. Other – All vehicles not destined for the Lincoln Tunnel (local destinations and all westbound traffic)

Traffic was loaded into the dynamic model using 50 matrices, 10 for every hour of the simulation period. Each matrix was 48 x 48 with trips identified from an origin to a destination.

6.2 VISSIM MODEL REFINEMENTS

The following identifies a list of changes made by WSA to the VISSIM model for use in this study:

Update Traffic Volume Inputs - The original ramp-to-ramp matrices from the VISSIM model were used as seed matrices in a FRATAR matrix calibration process that used the ramp volumes in Figures 3 and 4 as control targets. The shares of traffic among cash vs. E-ZPass® and car vs. truck were also refined based on 2007 data.

Dynamic to Static - The VISSIM model was converted from a “dynamic” to a “static” assignment model to be able to model lane closures and restrictions occurring at the plaza during various time periods. The dynamic model cannot close specific lanes for only certain hours of the modeled period.

WSA used the ramp-to-ramp matrices used by the dynamic model to develop vehicle input volumes at the origin zones/ramps and to distribute traffic to destination zones/ramps. To minimize the number of routes that would need to be coded into the model, all routes to the tunnel from points west of John F. Kennedy Boulevard were consolidated to a point on NJ 495 and then distributed to toll lanes at the plaza. This avoided the need to code a separate route from each approach to each toll lane.

Network Coding – The following changes to links and link attributes were made to the highway network:

1. The toll plaza layout was refined to better align with the NJ 495 and local approaches from Hoboken. Specifically, WSA received additional input from PANYNJ as detailed in previous sections of this report about the traffic channelization activity and therefore, by refining the toll plaza layout, it was easier to model the traffic operations.

2. The link characteristic of NJ 495 was converted from an arterial to a freeway link type. However, the links on the toll plaza approaches from the Center Ramp (serving Willow Avenue traffic), the Helix, and the East Ramp (serving Willow Avenue and Boulevard East traffic) were kept as arterial links.

3. The links and connectors were reviewed for the network and minor changes made to improve the alignment of links and lane changing behavior between links for continuity in traffic flow on NJ 495 and at signalized intersections.

4. Lane change distances were altered during the calibration process near the toll plaza apron to minimize weaving activity.

5. The left lane of the Helix approach was coded as a separate link to allow traffic destined for Plaza Lane 4 to shift left in advance of the toll plaza.

6. Speed zones were created to slow traffic approaching from NJ 3 (express lanes) and in the "teardrop" area to slow buses to match observed speeds.

6.3 ASSUMPTIONS ON EXISTING LINCOLN TUNNEL OPERATIONS

Per discussion with PANYNJ and field observations, the following operating assumptions were reflected in the revised model:

5-7 a.m. and 9-11 a.m.

1. The toll plaza operates under normal conditions. No restrictions to open toll lanes.
2. Between 5:00 a.m. and 6:00 a.m., there is no traffic on the XBL.
3. All traffic from Willow Avenue/Hoboken can use the Center Ramp into the toll plaza (lanes 1 through 5) and can use the Center Tube.
4. All traffic from the Helix approach can use toll lanes 2 through 12 in the toll plaza and can choose the Center or South Tube based on which toll lane they use.
5. All traffic from Boulevard East/Weehawken and Willow Avenue/Hoboken can use the East Ramp into the toll plaza (toll lanes 11 through 23) and then use the South Tube.
6. Trucks are prohibited in the Center Tube.

6-10 a.m.

1. The XBL is open to bus-only traffic. This traffic proceeds non-stop to the tunnel. At the toll plaza, an E-ZPass® reader located over the XBL lane (outside of the toll plaza) records usage and charges bus tolls. The XBL feeds directly into the Center Tube of the Lincoln Tunnel and is often separated from toll plaza traffic with traffic cones.
2. Toll lanes 1 through 3 are restricted to usage by HOV-3+ traffic and local buses only. Lower- occupancy vehicles entering from Willow Avenue are directed to the East Ramp.
3. Trucks are prohibited in the Center Tube.

7-9 a.m.

1. Traffic cones are placed to the left of Toll Lane 4 and right of Toll Lane 9 to separate the Center Ramp, Helix, and East Ramp traffic.
2. Traffic cones are set up at the toll plaza to restrict what traffic from the Helix is able to enter into the Center Tube.
3. Traffic on the leftmost lane on the helix can use toll plaza lanes 4 and 5.

4. Toll Lane 4 is directed to the Center Tube. The remaining lanes (toll lanes 5 through 23) are directed to the South Tube.
5. All traffic from Hoboken can use the East Ramp into the toll plaza (toll lanes 11 through 23) and then use the South Tube.

Other

1. Plaza Lane 3 is closed between 8:00 a.m. and 10:00 a.m. (based on October 2008 data).

6.4 CALIBRATION PROCESS

The VISSIM model was extended by an hour to 11:00 a.m. and an additional set of matrices was developed for the 10-11 a.m. period. To replicate the traffic channelization observed in the field, the calibrated VISSIM model was converted to a static model. The primary reason for this conversion is that the dynamic assignment does not allow lane prohibitions at the plaza and changes to the use of the Center Tube by time period or vehicle type.

In the static model, new routing decisions or new paths were created to replicate the coning activity between 7:00 a.m. and 9:00 a.m. The lane choice was modified to match the new distributions obtained from October 2008 traffic counts at the toll plaza. The traffic demand volumes continue to be based on 2007 counts but with 2008 distributions by lane at the toll plaza. The updated traffic distribution was needed to better match the current channelization at the toll plaza. Due to the PANYNJ toll increase in early 2008 and recent economic conditions, it was decided that traffic in 2007 would be a better basis for the operational analysis for this study since it is likely to be higher than 2008 volumes.

6.5 VISSIM MODEL CALIBRATION RESULTS – 2007 EXISTING CONDITIONS

Tables 12 and 13 show a comparison of traffic throughput for the general toll lanes and the XBL toll lane, respectively. In these tables, the results of the VISSIM model are compared to control totals at the Lincoln Tunnel toll plaza for the 5-11 a.m. period. The control volumes were developed by applying lane usage information from October 2008 counts to 2007 control volumes. As noted earlier, the channelization patterns at the toll plaza were changed in 2008, after data collection was completed for this study. While it would be best to use more current traffic volumes as control targets, it was decided that 2007 volumes would be more appropriate for use in this study considering the lower traffic volumes in 2008 associated with a general toll increase, gas price spikes, and economic downturn. As shown, the modeled traffic volumes at the toll plaza are within 2 percent of the control volumes over the six-hour period. The distribution of traffic to the two different lane types (staffed vs. E-ZPass® only) is within 3 percent of the targets and the total throughput from the model replicates actual volumes to within 5 percent or better of the targets in any given hour.

Table 12
Comparison of Traffic Counts - Auto, Commercial, and Non-XBL Buses VISSIM vs. Actual

VISSIM Model (5 runs)															Percent Difference By Hour
Toll Lane Number[1]	1	2	3	4	5	6	7	8	9	10	11	12	23		
Lane Type	EZ	M	EZ	EZ	EZ	M	M	M	EZ	EZ	M	M	EZ	Total	
5-6 a.m.	29	0	153	482	297	68	194	353	154	335	177	69	290	2,601	-5%
6-7 a.m.	341	226	239	841	435	311	215	560	291	470	232	243	481	4,885	-4%
7-8 a.m.	277	259	28	820	383	328	306	376	273	349	279	261	266	4,205	1%
8-9 a.m.	252	188	0	776	414	343	319	339	271	177	188	197	413	3,877	3%
9-10 a.m.	281	300	0	856	517	256	252	269	307	259	186	162	279	3,924	0%
10-11 a.m.	43	33	47	688	678	367	373	312	475	270	141	151	373	3,951	0%
Total (VISSIM)	1,223	1,006	467	4,463	2,724	1,673	1,659	2,209	1,771	1,860	1,203	1,083	2,102	23,443	-1%

Control Volumes[2]														
Toll Lane Number[1]	1	2	3	4	5	6	7	8	9	10	11	12	23	
Lane Type	EZ	M	EZ	EZ	EZ	M	M	M	EZ	EZ	M	M	EZ	Total
5-6 a.m.	35	0	168	509	323	56	152	390	185	370	132	126	278	2,724
6-7 a.m.	330	233	256	921	446	294	201	611	340	517	227	236	477	5,089
7-8 a.m.	309	256	30	892	422	277	267	361	235	290	271	271	278	4,159
8-9 a.m.	293	156	1	811	387	293	276	318	196	237	233	259	290	3,750
9-10 a.m.	307	279	1	809	580	252	257	260	336	231	189	185	248	3,934
10-11 a.m.	33	31	51	720	701	241	226	292	477	339	232	242	379	3,964
Total (Control)	1,307	955	507	4,662	2,859	1,413	1,379	2,232	1,769	1,984	1,284	1,319	1,950	23,620

Difference	-84	51	-40	-199	-135	260	280	-23	2	-124	-81	-236	152	-177
Percent Difference	-6%	5%	-8%	-4%	-5%	18%	20%	-1%	0%	-6%	-6%	-18%	8%	-1%

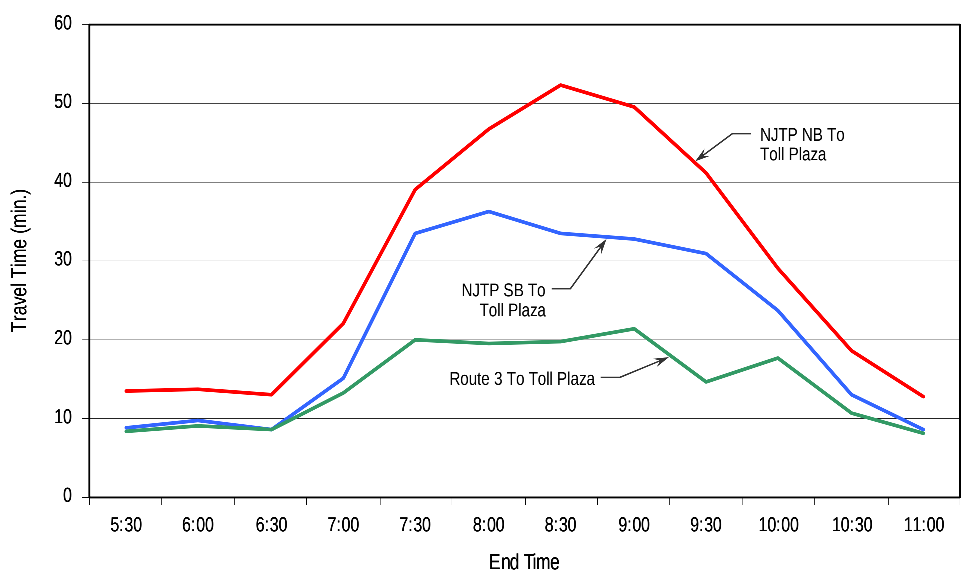
(1) Does not include XBL volumes, which use Lane 14.
(2) Estimated 2007 volumes adjusted to lane usage data from October 2008 to reflect new channelization patterns through tolllanes.
These figures represent the number of vehicles processed in each hour.

Table 13
Comparison of Traffic Counts - XBL Buses VISSIM vs. Actual

Hour	Toll Lane Number 14		
	VISSIM (5 runs)	Control	Difference
5-6 a.m.	0	0	0
6-7 a.m.	266	279	-13
7-8 a.m.	577	578	-1
8-9 a.m.	656	618	38
9-10 a.m.	333	351	-18
10-11 a.m.	39	12	27
Total (VISSIM)	1,871	1,838	33

Figure 16 shows the travel times obtained from the VISSIM model from the NJ Turnpike northbound (Exit 16E), NJ Turnpike southbound (Exit 17), and NJ 3 approaches. The travel time results show patterns similar to the travel times obtained in the field. The NJ Turnpike northbound approach shows the highest travel time, while NJ 3 shows the lowest. Travel times peak between 8-9 a.m. and generally recover after 10 a.m. The only significant variation from observations is the NJ 3 approach, for which the model estimates a slightly faster trip during the peak hour than is actually experienced.

Figure 16: VISSIM Existing Conditions Model Travel Time Profile – AM Peak Period



6.5.1 TRAFFIC OPERATIONS RESULTS – 2007 EXISTING CONDITIONS

In addition to the traffic volumes and travel times obtained during the calibration process, the following list of performance measures were calculated using the VISSIM model results:

- Number of vehicles
- Vehicle-miles traveled (VMT)
- Vehicle-hours traveled (VHT)
- Minutes per vehicle
- Average vehicle speed per vehicle
- Number of persons
- Person-miles traveled (PMT)
- Person-hours traveled (PHT)
- Minutes per person
- Average speed per person

The metrics listed above provide an understanding of the existing traffic operations and as well as a basis to assess future impacts in traffic operations with a priced managed lane on NJ 495. Table 14 provides a summary of the vehicle performance measures under existing conditions by approach (i.e., NJ Turnpike northbound, NJ Turnpike southbound, and NJ 3) and by lane use (general purpose and XBL) for the 7-9 a.m. peak hours. Table 15 presents the results for these performance measures based on person-travel for the six-hour 5-11 a.m. analysis period.

To estimate the number of persons traveling in the corridor, XBL buses were assumed to carry 45 passengers per bus and the non-XBL buses (buses that use the general purpose lanes for part of their trip) were assumed to carry 40 passengers per bus. The auto passengers per vehicle were based on a weighting of SOV (1.5 passengers per vehicle) and HOV (3.5 passengers per vehicle) vehicles. While these passenger loadings are slightly higher than current actual conditions, these assumptions were used to be consistent with previous studies for the corridor, and are used only for comparative purposes between scenarios in this report. These figures were assumed to remain constant throughout all the scenarios and years of analysis.

6.6 TRAFFIC OPERATIONS – FUTURE 2015 NO-BUILD

The base year 2007 ramp-to-ramp matrices used in VISSIM were factored to future 2015 conditions based on the growth forecasts described earlier. As discussed in Chapter 3, these growth rates were estimated from runs of regional travel demand models that reflect growth and allow for rebalancing of traffic according to delays in the regional highway network. Travel demand models are sensitive to congestion in terms of finding the best available path, but will continue to assign traffic even if the demand exceeds the roadway capacity.

Table 14
Existing (2007) Performance Measures By Approach (NJ Turnpike and NJ 3)
7:00-9:00 a.m.

Lane Type	Existing (2007)			
	NJTP 16E	NJTP 17	NJ 3	All Approaches
Number of Vehicles				
XBL	554	389	284	1,227
GP	1,243	962	2,193	4,398
HOT	-	-	-	-
All Lanes	**1,797**	**1,352**	**2,477**	**5,625**
Number of Persons				
XBL	24,921	17,523	12,771	55,215
GP	2,172	1,844	4,494	8,511
HOT	-	-	-	-
All Lanes	**27,093**	**19,367**	**17,265**	**63,726**
Persons Per Vehicle				
XBL	45.00	45.00	45.00	45.00
GP	1.75	1.92	2.05	1.94
HOT	-	-	-	-
All Lanes	**15.08**	**14.33**	**6.97**	**11.33**
Minutes Per Vehicle				
XBL	24.1	15.4	11.2	18.3
GP	46.3	33.9	20.1	30.5
HOT	-	-	-	-
All Lanes	**39.5**	**28.6**	**19.1**	**27.9**
Minutes Per Person				
XBL	24.1	15.4	11.2	18.3
GP	45.5	32.3	20.5	29.4
HOT	-	-	-	-
All Lanes	**25.8**	**17.0**	**13.6**	**19.8**

Table 15
Existing (2007) Performance Measures By Approach (NJ Turnpike and NJ 3)
5:00-11:00 a.m.

Lane Type	Existing (2007)			
	NJTP 16E	NJTP 17	NJ 3	All Approaches
Number of Vehicles				
XBL	803	569	412	1,784
GP	4,907	2,367	6,978	14,252
HOT	-	-	-	-
All Lanes	**5,710**	**2,936**	**7,391**	**16,037**
Number of Persons				
XBL	36,135	25,605	18,558	80,298
GP	12,049	5,516	17,266	34,831
HOT	-	-	-	-
All Lanes	**48,184**	**31,121**	**35,824**	**115,129**
Persons Per Vehicle				
XBL	45.00	45.00	45.00	45.00
GP	2.46	2.33	2.47	2.44
HOT	-	-	-	-
All Lanes	**8.44**	**10.60**	**4.85**	**7.18**
Minutes Per Vehicle				
XBL	22.0	14.4	11.1	17.1
GP	25.8	22.1	13.9	19.3
HOT	-	-	-	-
All Lanes	**25.2**	**20.6**	**13.7**	**19.1**
Minutes Per Person				
XBL	22.0	14.4	11.1	17.1
GP	21.9	18.8	13.2	17.1
HOT	-	-	-	-
All Lanes	**22.0**	**15.1**	**12.1**	**17.1**

The 2015 unconstrained No-Build traffic demand was input into the VISSIM model to identify future operating conditions. A detailed review of these results indicated a significant increase in corridor delay. As a consequence, it was determined that a constrained 2015 No-Build scenario would be more appropriate for comparison against the Study alternatives to be analyzed. The Study alternatives assume that traffic can choose other river crossings to avoid additional congestion in the NJ 495 Lincoln Tunnel corridor. A constrained 2015 No-Build scenario was developed to recognize that some demand can choose other river crossings or choose another way to make the trip.

Based on the results of the VISSIM model, it was evident that the traffic most likely to divert to an alternate crossing would be from the NJ Turnpike since the delay from those approaches increased by the highest amount. NJ 3 traffic was considered the least likely to divert because the travel time from that approach is not projected to increase significantly. Also, NJ 3 currently has somewhat of a favored approach to NJ 495 and to the Lincoln Tunnel, which would be forfeited by drivers diverting to an alternate crossing.

Therefore, the constrained 2015 No-Build volumes assume that the growth of traffic demand from the two NJ Turnpike approaches will be limited due to increased delays. This demand dataset is referred to as the Constrained No-Build scenario. The Unconstrained No-Build scenario reflects the growth rates from travel demand forecasting models.

6.6.1 TRAFFIC OPERATIONS RESULTS – 2015 NO-BUILD

Peak Hours (7-9 a.m.)

Table 16 provides a summary of the performance measures under future 2015 No-Build unconstrained and constrained demand conditions for the 7-9 a.m. peak period. Table 16 provides a summary of performance measures for the three NJ 495 approaches individually and for the all the approaches combined. Similar to existing conditions, NJ 3 is forecasted to experience the lowest vehicle and person travel time in the corridor compared to the two NJ Turnpike approaches. The increased demand results in increased queuing that can eventually prevent buses from accessing the XBL. Additionally, there is limited capacity for bus growth in the peak hour.

The difference in travel time between the XBL and the general purpose lanes remains consistent between the unconstrained and constrained conditions. From the two NJ Turnpike approaches, the XBL is forecasted to save approximately 21-24 minutes of travel time, depending on scenario and approach. From the NJ 3 approach, in 2015, the XBL is forecasted to save about 9 minutes over travel in the general purpose lanes. A similar comparison using weighted travel times for all approaches combined seems to indicate that the XBL does not save any travel time; but this is misleading since the travel times for general purpose lane travel for the combination of the three approaches are also influenced by the differences in travel time and distance from each approach.

Table 16
Future (2015) No-Build Performance Measures By Approach (NJ Turnpike and NJ 3)
7:00-9:00 a.m.

Lane Type	NJTP 16E		NJTP 17		NJ 3		All Approaches	
	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained	Constrained
Number of Vehicles								
XBL	582	582	408	408	298	295	1,287	1,286
GP	1,325	1,254	1,002	969	2,361	2,353	4,687	4,576
HOT	-	-	-	-	-	-	-	-
All Lanes	**1,907**	**1,835**	**1,410**	**1,378**	**2,659**	**2,648**	**5,975**	**5,861**
Number of Persons								
XBL	26,190	26,181	18,351	18,378	13,392	13,293	57,933	57,852
GP	2,289	2,151	2,072	1,846	4,777	4,781	9,138	8,778
HOT	-	-	-	-	-	-	-	-
All Lanes	**28,479**	**28,332**	**20,423**	**20,224**	**18,169**	**18,074**	**67,071**	**66,630**
Persons Per Vehicle								
XBL	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
GP	1.73	1.72	2.07	1.90	2.02	2.03	1.95	1.92
HOT	-	-	-	-	-	-	-	-
All Lanes	**14.94**	**15.44**	**14.49**	**14.68**	**6.83**	**6.83**	**11.23**	**11.37**
Minutes Per Vehicle								
XBL	61.7	53.1	42.2	37.6	12.2	12.6	44.1	38.9
GP	83.0	74.7	65.8	59.8	21.0	21.2	48.1	44.0
HOT	-	-	-	-	-	-	-	-
All Lanes	**76.5**	**67.8**	**58.9**	**53.2**	**20.0**	**20.2**	**47.2**	**42.9**
Minutes Per Person								
XBL	61.7	53.1	42.2	37.6	12.2	12.6	44.1	38.9
GP	80.8	72.1	64.1	56.5	22.0	22.3	46.3	41.7
HOT	-	-	-	-	-	-	-	-
All Lanes	**63.2**	**54.5**	**44.4**	**39.3**	**14.8**	**15.2**	**44.4**	**39.2**

As indicated by the results in the table, the average vehicle and person travel times experienced in the corridor with an unconstrained demand in 2015 are 47.2 minutes and 44.4 minutes, respectively. Under the constrained demand condition, the average vehicle and person travel times experienced are 42.9 minutes and 39.2 minutes, respectively. The reduction in vehicle and person travel times from the NJ Turnpike is about five minutes due to traffic diverting to an alternate crossing.

NJ Turnpike Int. 16E – As shown in Table 16, the vehicle and person travel times from this approach under an unconstrained demand are 76.5 minutes and 63.2 minutes, respectively. With a constrained demand, the vehicle and person times reduce to 67.8 minutes and 54.5 minutes, respectively. Therefore, there is a reduction of about nine minutes in travel time.

NJ Turnpike Int. 17 – As shown in Table 16, the vehicle and person travel times under an unconstrained demand are 58.9 minutes and 44.4 minutes, respectively. With a constrained demand, the vehicle and person times reduce to 53.2 minutes and 39.3 minutes, respectively. Therefore, there is a reduction of about five minutes in travel time.

NJ 3 – As shown in Table 16, the vehicle and person travel times under an unconstrained demand are 20.0 minutes and 14.8 minutes, respectively. Since NJ 3 volume did not change between the unconstrained and constrained conditions, travel time from this approach is about the same. NJ 3 will not show a reduction in travel demand between the unconstrained and constrained No-Build conditions because the growth in delays for the NJ 3 approach is not anticipated to be great enough to cause traffic to divert to an alternate crossing.

It is also important to note that the difference in XBL and GP vehicle and person travel times from the NJ Turnpike (more than 20 minutes) is higher than NJ 3 (about 9 minutes) due to the time savings experienced on the XBL lane for a longer distance. When the vehicle and person travel times are aggregated for all three approaches, the difference between the XBL and the general purpose lanes appear to be smaller because of the difference in distance to the Lincoln Tunnel from each of the different approaches. Additionally, the share of traffic from NJ 3 is different when comparing the XBL and the general purpose lanes, which affects how the lower travel times from NJ 3 are weighted in the average.

Morning Analysis Period (5-11 a.m.)

Table 17 provides a summary of the performance measures under 2015 No-Build unconstrained and constrained demand conditions for the 5-11 a.m. period for each of the three NJ 495 approaches separately, as well as for the three approaches combined.

As indicated by the results in the table, the average vehicle and person travel times experienced in the corridor with an unconstrained demand in 2015 are 32.6 minutes and 36.1 minutes, respectively. Under the constrained demand condition, the average vehicle and person travel times experienced are 29.1 minutes and 31.5 minutes, respectively. The reduction in vehicle and person travel times from the two NJ Turnpike approaches associated with the constrained condition is approximately 3.5 to four minutes.

Table 17
Future (2015) No-Build Performance Measures By Approach (NJ Turnpike and NJ 3)
5:00-11:00 a.m.

Lane Type	NJTP 16E		NJTP 17		NJ 3		All Approaches	
	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained	Constrained	Unconstrained	Constrained
Number of Vehicles								
XBL	843	843	596	596	434	434	1,873	1,873
GP	5,214	5,119	2,491	2,438	7,468	7,432	15,172	14,989
HOT	-	-	-	-	-	-	-	-
All Lanes	**6,057**	**5,962**	**3,087**	**3,034**	**7,902**	**7,866**	**17,045**	**16,862**
Number of Persons								
XBL	37,935	37,935	26,820	26,820	19,521	19,530	84,276	84,285
GP	13,091	12,541	5,831	5,543	18,455	18,254	37,377	36,339
HOT	-	-	-	-	-	-	-	-
All Lanes	**51,026**	**50,476**	**32,651**	**32,363**	**37,976**	**37,784**	**121,653**	**120,624**
Persons Per Vehicle								
XBL	45.00	45.00	45.00	45.00	45.00	45.00	45.00	45.00
GP	2.51	2.45	2.34	2.27	2.47	2.46	2.46	2.42
HOT	-	-	-	-	-	-	-	-
All Lanes	**8.42**	**8.47**	**10.58**	**10.67**	**4.81**	**4.80**	**7.14**	**7.15**
Minutes Per Vehicle								
XBL	53.3	45.7	38.8	33.3	12.3	12.6	39.2	34.1
GP	48.7	42.4	44.6	38.4	15.7	15.8	31.8	28.5
HOT	-	-	-	-	-	-	-	-
All Lanes	**49.3**	**42.8**	**43.5**	**37.4**	**15.6**	**15.6**	**32.6**	**29.1**
Minutes Per Person								
XBL	53.3	45.7	38.8	33.3	12.3	12.6	39.2	34.1
GP	43.1	36.9	40.0	32.7	15.6	15.2	29.1	25.4
HOT	-	-	-	-	-	-	-	-
All Lanes	**50.7**	**43.5**	**39.0**	**33.2**	**13.9**	**13.9**	**36.1**	**31.5**

NJ Turnpike Int. 16E – As shown in Table 17, the vehicle and person travel times under an unconstrained demand are 49.3 minutes and 50.7 minutes, respectively. With a constrained demand, the vehicle and person times reduce to 42.8 minutes and 43.5 minutes, respectively, resulting in a reduction of about seven minutes in travel time.

NJ Turnpike Int. 17 – The vehicle and person travel times under an unconstrained demand are 43.5 minutes and 39.0 minutes, respectively. With a constrained demand, the vehicle and person times reduce to 37.4 minutes and 33.2 minutes, respectively, reflecting a reduction of about six minutes in travel time.

NJ 3 – As shown in Table 17, the vehicle and person travel times under an unconstrained demand are 15.6 minutes and 13.9 minutes, respectively. With a constrained demand, the vehicle and person times will be about the same, since NJ 3 demand was not affected by constraint process.

Chapter 7 ANALYSIS OF ALTERNATIVES

This section describes the study alternatives that were identified for comparative evaluation in this study and the results of this evaluation process.

7.1 DESCRIPTION OF ALTERNATIVES

A total of eight alternatives were developed for analysis in this study. The alternatives developed recognized the relatively short distance of NJ 495, which is 2.5 miles at its maximum from the western end at the NJ Turnpike to the Lincoln Tunnel's New Jersey portals in the east. Given the background growth in travel demand expected in the corridor by 2015 and 2030, access constraints to the proposed managed lane are a critical issue in considering the viability of a potential HOT lane in the corridor. This is less of a concern from NJ 3, which has good direct access to the left lane of NJ 3 (i.e., the general purpose lane that would be converted to a priced managed lane). However, the multiple-lane merge required for NJ Turnpike traffic to access the proposed HOT lane creates considerable congestion at the access point for NJ Turnpike vehicles that would like to use the proposed HOT lane. This congestion adds a significant travel time penalty for NJ Turnpike vehicles. As a consequence, two physical alternatives were developed that address improved access for NJ Turnpike vehicles to the proposed HOT lane.

Other alternatives consider variations on how carpools will be priced (i.e., free access vs. paid access to the proposed HOT lane), and whether small trucks will be allowed into the HOT lane during non-peak commuting hours.

In all configurations, the following assumptions apply:

1. The proposed HOT lane would operate as an express connection from the western end of NJ 495 to the Lincoln Tunnel.
2. Traffic entering NJ 495 from local streets would not be allowed access to the proposed HOT lane.
3. The left lane of the eastbound roadway would be converted into the proposed HOT lane without widening of the main portion of NJ 495.
4. The left lane of NJ 495 would be separated from the center and right lanes using double solid lines and plastic posts to separate the proposed HOT lane from the general purpose lanes.
5. The existing NJ 3 express connector ramp would be modified to allow the HOT lane to start on the ramp as it separates from the lane carrying southbound through traffic on NJ 3. The three express lanes on NJ 3 currently merge to two lanes on the connector ramp shortly after the separation from the through lane (see Figure 17).

Figure 17: NJ 3 Access to HOT Lane

6. At the eastern end of NJ 495, the proposed HOT lane would be channelized through Toll Lane 4 of the toll plaza. Traffic in the proposed HOT lane would be required to merge with high-occupancy traffic entering from the Center Ramp carrying Willow Avenue traffic. Both traffic streams would use the right lane of the Center Tube of the Lincoln Tunnel.
7. It was assumed that the existing toll plaza would remain in place and would continue to operate as it currently does, with E-ZPass® and cash toll collection. While the PANYNJ is advancing an all-electronic tolling option in its current toll system replacement plans, this change to the toll plaza operation was not modeled in the proposed HOT lane operations plan.
8. All buses from NJ 3 destined for the Lincoln Tunnel would be diverted to the proposed HOT lane and would no longer use the XBL. The buses remaining on the XBL would originate from the NJ Turnpike and would continue to use the XBL and the left lane of the Center Tube.
9. All traffic using the proposed HOT lane would be required to have an E-ZPass® transponder.
10. The HOT lane would be posted for 35 mph, similar to the current XBL, due to the presence of buses in the lane.

11. The fees for using the HOT lane will be varied dynamically to maintain free-flow travel in the proposed HOT lane.
12. The fees for using the proposed HOT lane will be varied dynamically to keep total traffic in the HOT lane at its maximum desired level, reflecting the capacity at the toll plaza merges and tunnel portals.

The Study alternatives are briefly described below

7.1.1 ALTERNATIVE 1

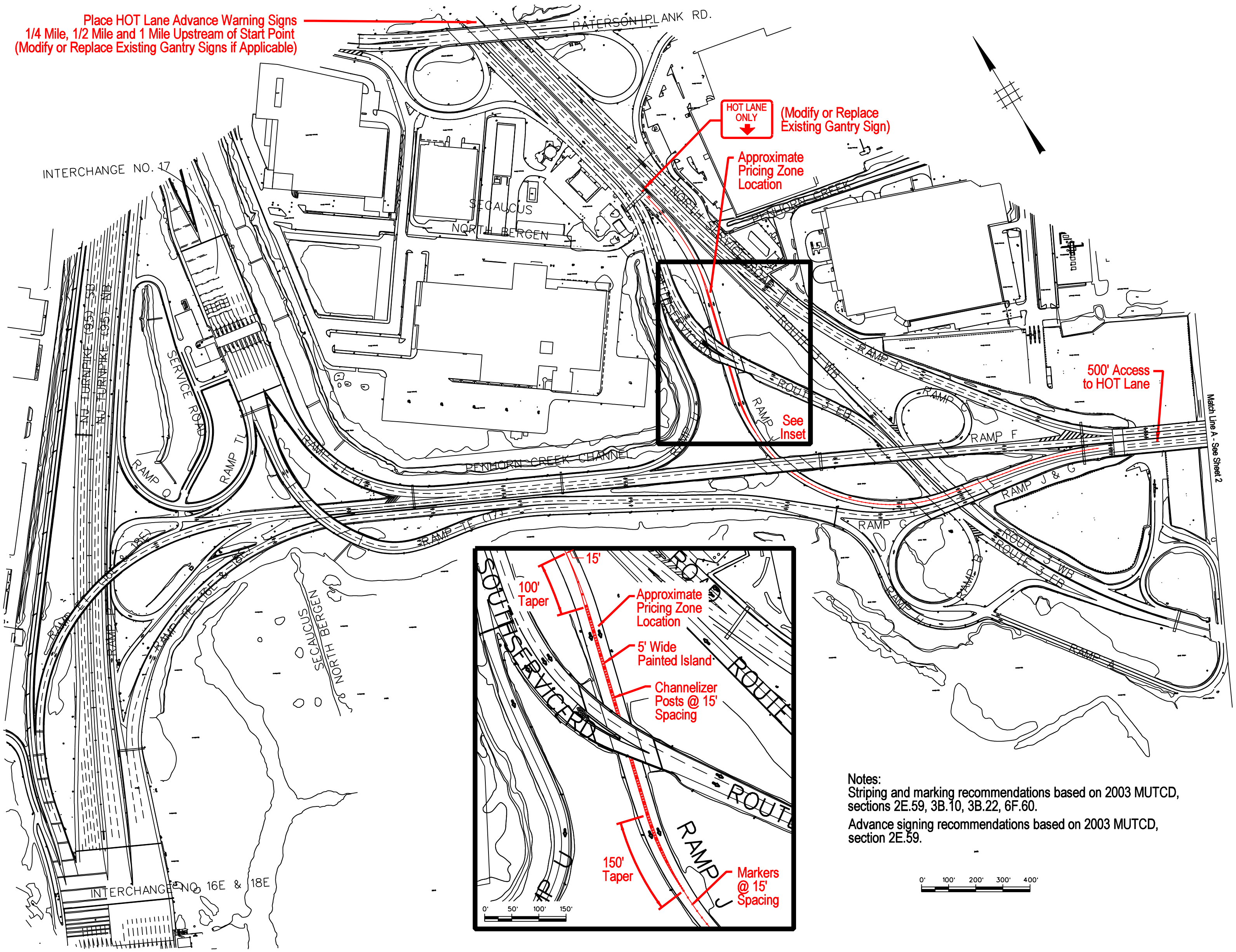
This alternative is essentially a "no construction" option, in that there are no western access improvements for NJ Turnpike traffic to access the proposed HOT lane. Access to the proposed HOT lane would be allowed from NJ 3 through the existing NJ 3 express lane connector. With no change to the western portion of NJ 495 in this alternative, NJ Turnpike traffic would have to merge over to the far left lane in the section of NJ 495 along the North Bergen Viaduct. In this central section (shown in Figure 18), there would be a break in the striping to allow traffic from the NJ Turnpike approaches to enter the proposed HOT lane just east of the NJ 3 merge with NJ 495. Figures 18 through 20 show the anticipated configuration of NJ 495 and the proposed HOT lane under Alternative 1 for the western, central, and eastern portions of the highway, respectively.

The connector ramp from the express lanes on NJ 3 currently narrows from three to two lanes on the ramp, with two lanes continuing onto NJ 495. These two lanes are added to NJ 495 on the left side of the roadway. The conversion of the left lane of NJ 495 to the proposed HOT lane would allow traffic eligible to use this new managed lane to enter from the NJ 3 express left approach lane and the center and right lane would merge to allow access to the general purpose lanes. In this alternative, the traffic from the NJ Turnpike would be required to weave across the right lane of the NJ 3 approaches to enter the HOT lane.

Alternative 1 has two variants that were evaluated distinguishing the eligibility rules for HOV-3+ vehicles in the managed lane. Alternative 1A assumes HOV-3+ use the proposed managed lane for free, while Alternative 1B assumes that the managed lane would be free for buses, but HOV-3+ vehicles would be required to pay a fee.

Alternative 1A – Alternative 1A assumes that registered carpools with three or more occupants can use the HOT lane for free. It is assumed that the discount registration requirements for the proposed HOT lane would be similar to that currently used by PANYNJ for its existing E-ZPass® carpool discount program. To participate in the current program, vehicles must use E-ZPass® to pay tolls, vehicles must have three or more occupants, and drivers must pre-register their E-ZPass® account as a carpool account. To qualify for the carpool toll discount at the toll plaza, the vehicle must drive through a staffed toll lane and allow the toll collector to verify the number of occupants in the vehicle. The toll collector registers the transaction as a carpool transaction and the discount is applied to the transaction.

Alternative 1B – This alternative assumes that no discount will be applied to HOV-3+ traffic when they use the proposed HOT lane. This alternative was established to evaluate the policy



Notes:
Striping and marking recommendations based on 2003 MUTCD, sections 2E.59, 3B.10, 3B.22, 6F.60.
Advance signing recommendations based on 2003 MUTCD, section 2E.59.

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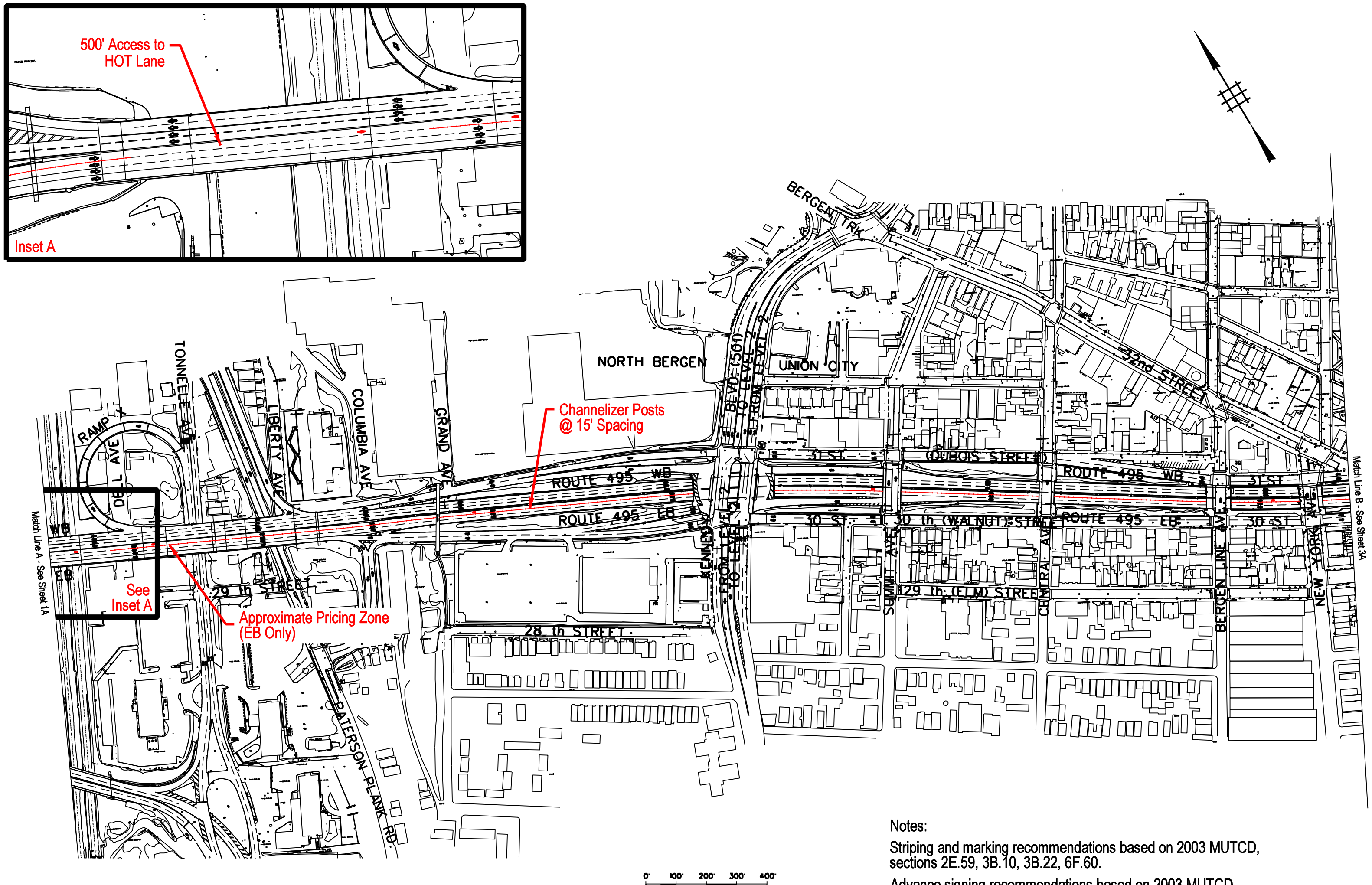
ALTERNATIVE 1 - NJ 3 WITH WEAVE (WESTERN SECTION)

FIGURE 18



Notes:

Striping and marking recommendations based on 2003 MUTCD, sections 2E.59, 3B.10, 3B.22, 6F.60.

Advance signing recommendations based on 2003 MUTCD, section 2E.59.

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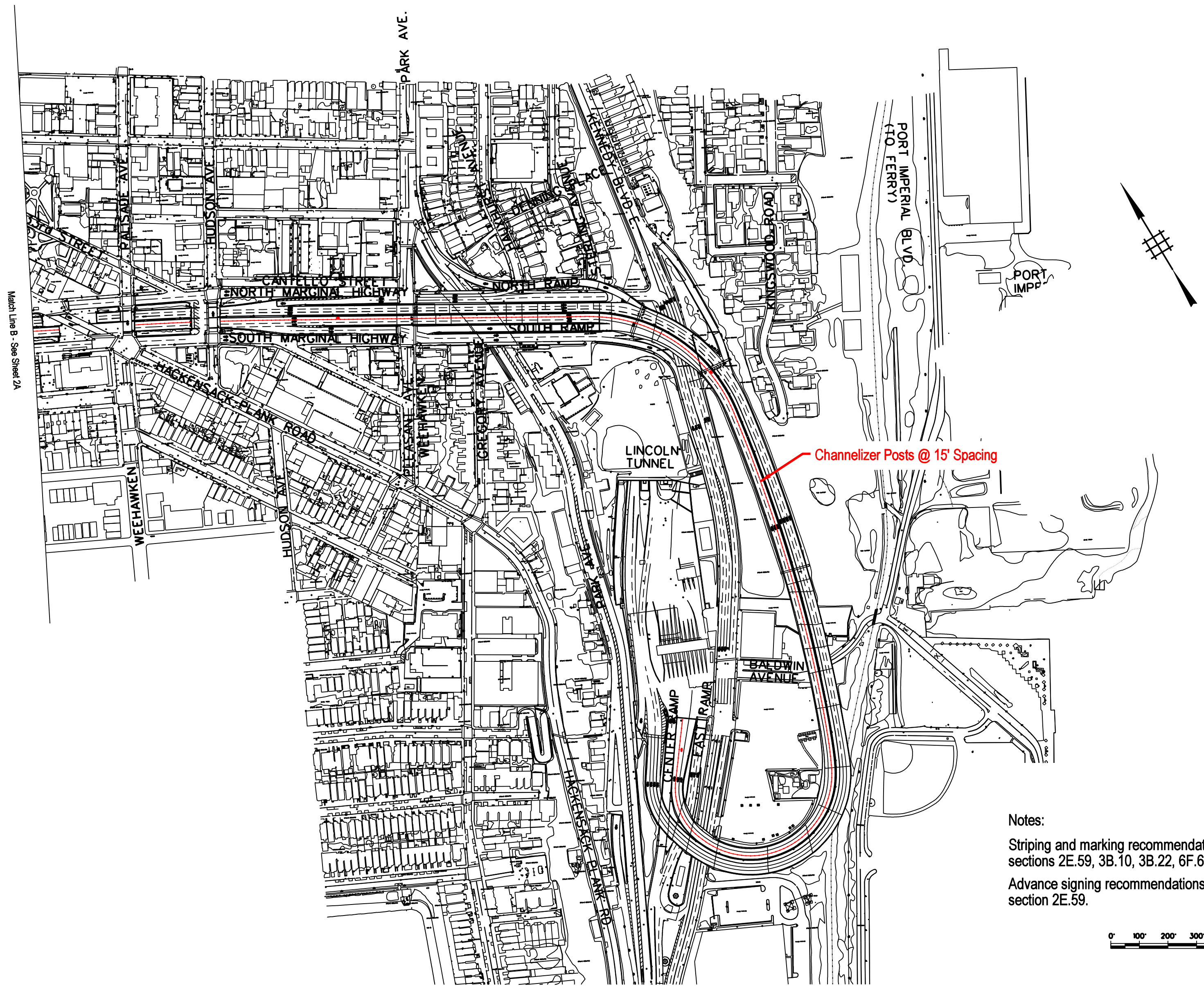
ALTERNATIVE 1 - NJ 3 WITH WEAVE (CENTRAL SECTION)

FIGURE 19



Notes:

Striping and marking recommendations based on 2003 MUTCD, sections 2E.59, 3B.10, 3B.22, 6F.60.

Advance signing recommendations based on 2003 MUTCD, section 2E.59.

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ALTERNATIVES 1, 3 AND 4 (EASTERN SECTION)

FIGURE 20

decision of HOT lane discounts, as well as to offer options to the onerous enforcement requirements that would need to be adopted to verify vehicle occupancy of HOV-3+ vehicles using the proposed HOT lane with a discount.

7.1.2 ALTERNATIVE 2A

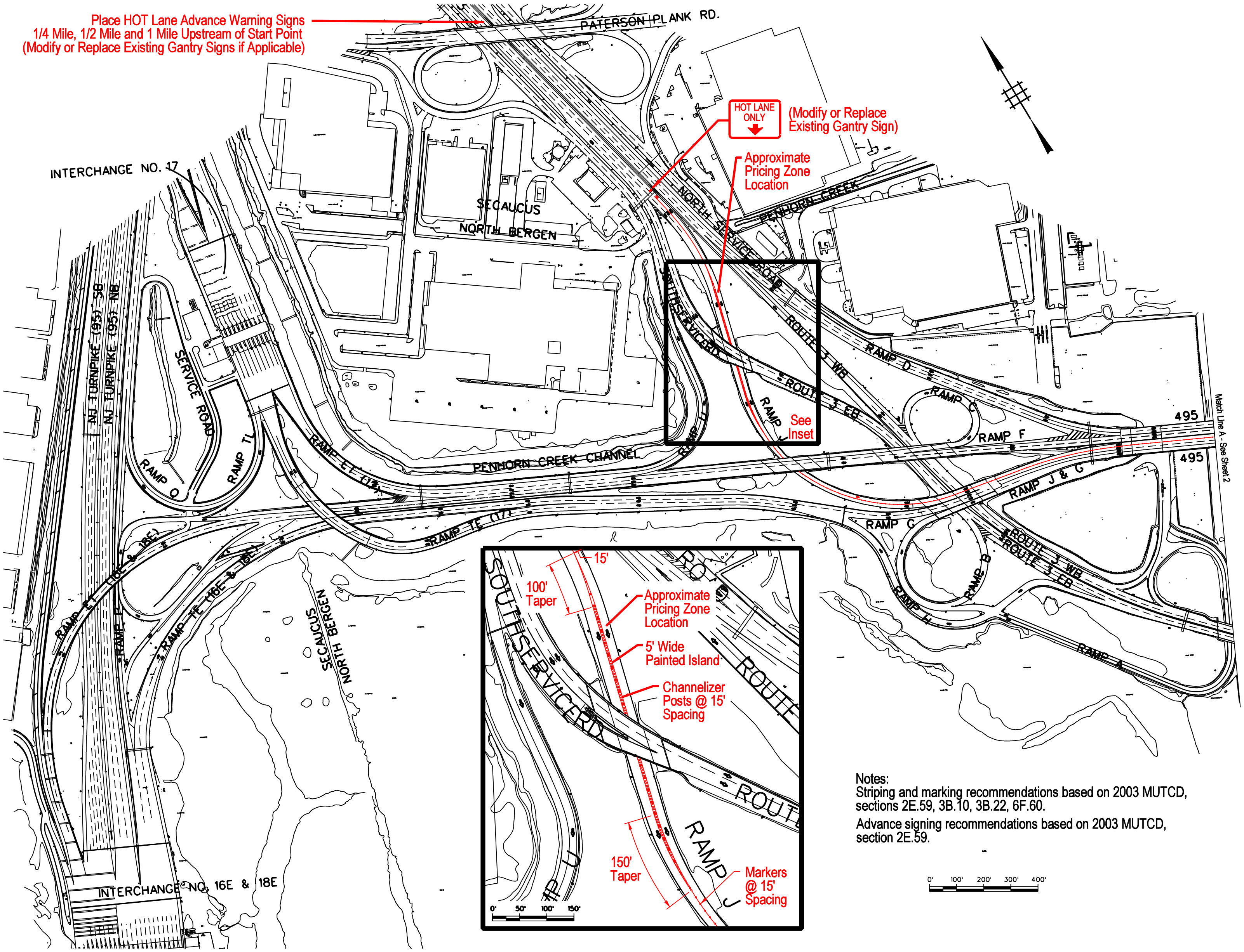
Alternative 2A is physically the same as Alternative 1A, but in this scenario, Class 2 and Class 3 trucks (i.e., two- and three-axle commercial vehicles) would be allowed to use the proposed HOT lane during the shoulder hours from 5-6 a.m. and 10-11 a.m.

7.1.3 ALTERNATIVE 3

Alternative 3 was established to address the difficulty of NJ Turnpike traffic to access the proposed HOT lane with a challenging weave to the left on NJ 495. This alternative allows access to the proposed HOT lane from NJ 3 only and the weaving area from Alternative 1 is eliminated. To accommodate NJ Turnpike traffic in the proposed HOT lane, this alternative envisions directing northbound NJ Turnpike traffic to travel along the existing service road that runs north of the Interchange 16E toll plaza to a new drop ramp that would be constructed from Harmon Meadow Boulevard in Secaucus to allow access to NJ 3. Harmon Meadow Boulevard crosses over NJ 3 approximately 0.5 miles north of NJ 495. This routing would add approximately 0.6 miles of travel for northbound NJ Turnpike traffic, and require this traffic to cross a signalized intersection at Paterson Plank Road, representing a travel time penalty for vehicles electing to use the proposed HOT lane. For traffic traveling southbound on the NJ Turnpike, this alternative assumes that traffic desiring to use the proposed HOT lane could either reroute to the western spur and use Interchange 16W to access NJ 3 or exit at Interchange 17 and also use the drop ramp from Harmon Meadow Boulevard to NJ 3. Alternative 3 was devised as a low-cost construction alternative to eliminate the weave on NJ 495 for NJ Turnpike vehicles seeking to access the proposed HOT lane, which is a concern for traffic safety and the congestion impacts in the peak hours. Figures 21 and 22 show the western and central sections of NJ 495 for Alternative 3. The drop ramp at Harmon Meadow Boulevard is outside the area depicted in Figure 21 but is shown overlaid on an aerial background in Figure 23. The eastern section of NJ 495 for Alternative 3 is represented by Figure 20.

Alternative 3A – Alternative 3A assumes that registered carpools can use the HOT lane for free.

Alternative 3B – Alternative 3B assumes that all vehicles except buses pay to use the HOT lane.



Notes:
Striping and marking recommendations based on 2003 MUTCD, sections 2E.59, 3B.10, 3B.22, 6F.60.
Advance signing recommendations based on 2003 MUTCD, section 2E.59.

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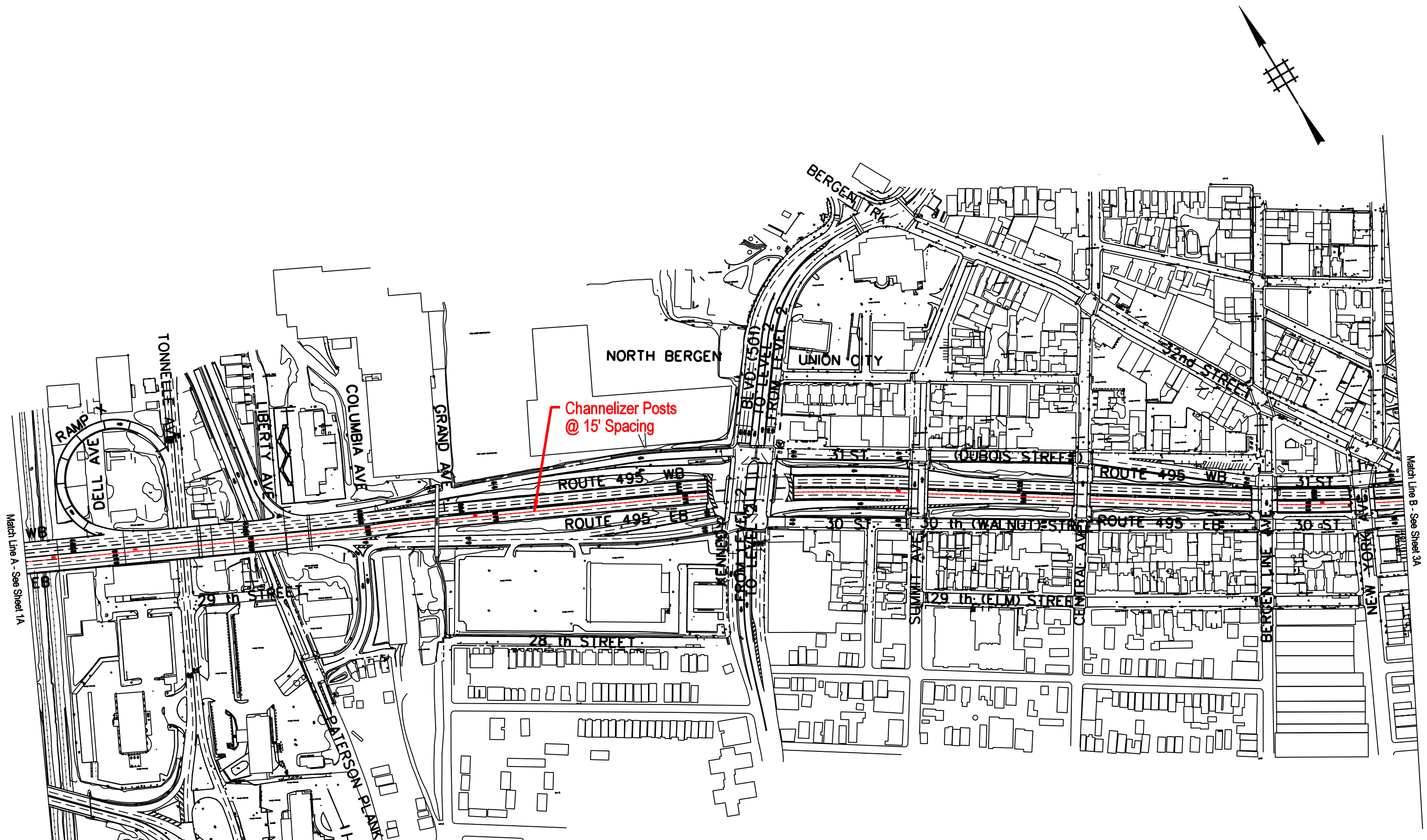
ALTERNATIVE 3 - NJ 3 WITH DROP RAMP (WESTERN SECTION)

FIGURE 21



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Notes:
Striping and marking recommendations based on 2003 MUTCD, sections 2E.59, 3B.10, 3B.22, 6F.60.

Advance signing recommendations based on 2003 MUTCD, section 2E.59.

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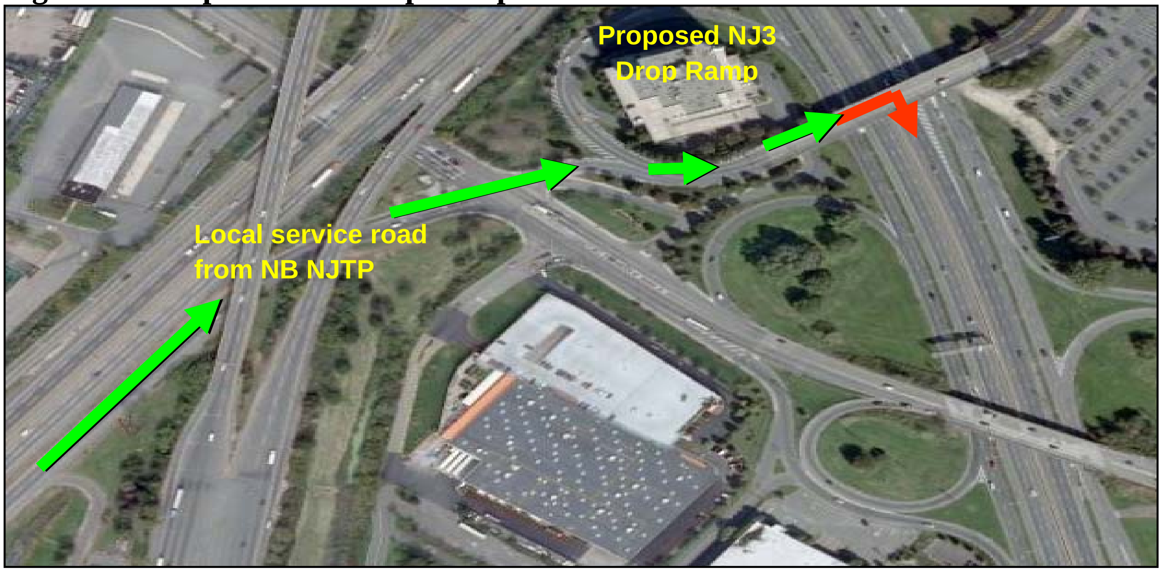
ALTERNATIVES 3 AND 4 (CENTRAL SECTION)

FIGURE 22

Figure 23: Proposed NJ3 Drop Ramp



7.1.4 ALTERNATIVE 3 MODIFIED

A variation on Alternative 3 was evaluated following the initial analysis of Alternative 3. The modified Alternative 3 assumes that the drop ramp to NJ 3 is not constructed and northbound NJ Turnpike would not be able to easily access the HOT lane. Southbound NJ Turnpike traffic would be able access the proposed HOT by diverting to Interchange 16W to approach the corridor from NJ 3, with an increase of 2.5 miles of travel.. All traffic from NJ 3 would have the choice to either access the HOT lane or use the general purpose lanes on NJ 495.

Alternative 3A-Modified – Alternative 3A-Modified assumes that registered carpools can use the HOT lane for free.

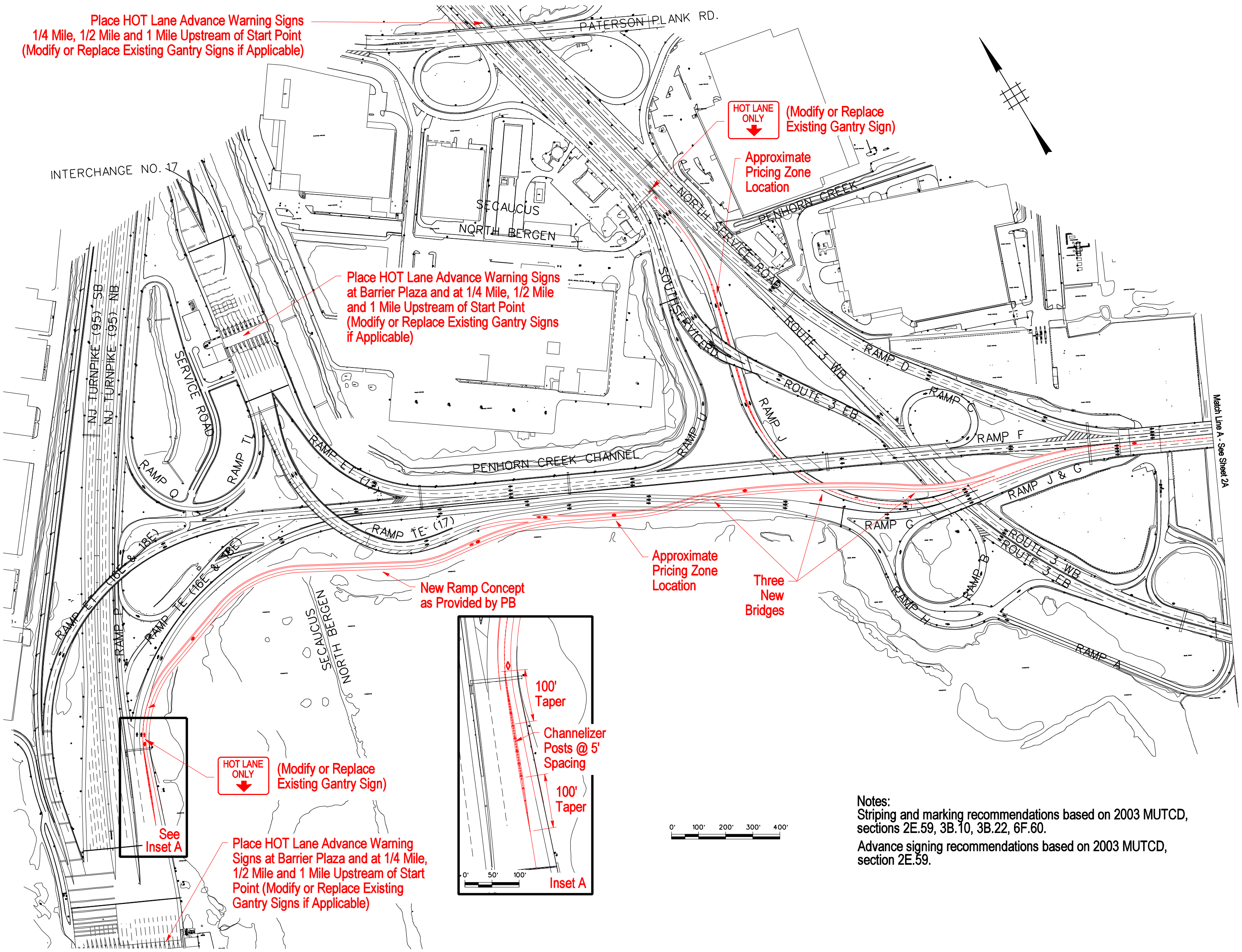
7.1.5 ALTERNATIVE 4

Alternative 4 addresses the NJ Turnpike access to the proposed HOT lane through a more extensive construction project that would allow direct access without the need to weave across NJ 495. This alternative envisions the construction of a new roadway and three bridges to allow direct access to the proposed HOT lane from the NJ Turnpike approaches. The bridges would cross over the NJ495 and NJ 3 connector ramp before dropping to merge with the HOT lane that would be on the left side of NJ 495. This alternative provides a dedicated travel lane from the NJ Turnpike toll plazas to the HOT lane, offering better service level for NJ Turnpike traffic and less congestion for traffic on the remaining general purpose lanes. Alternative 4 is shown in Figures 24 and 22 for the western and central sections, respectively. The eastern section would be as shown in Figure 20.

Alternative 4A – Alternative 4A assumes that registered carpools can use the HOT lane for free.

Alternative 4B – Alternative 4B assumes that all vehicles except buses pay to use the HOT lane.

The alternatives, along with key parameters and assumptions, are summarized in Table 18.



Notes:
Striping and marking recommendations based on 2003 MUTCD, sections 2E.59, 3B.10, 3B.22, 6F.60.
Advance signing recommendations based on 2003 MUTCD, section 2E.59.

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ALTERNATIVE 4 - NJ 3 WITH NEW BRIDGE (WESTERN SECTION)

FIGURE 24

Table 18
Study Scenarios

Forecast Scenario	West End Access Assumptions: from NJ 3	West End Access Assumptions: from NJTP	Period of Operation	HOV Discount	Allow Class 2,3 trucks?
No-Build	--	--	--	--	--
1a	Existing Connector	Weave betw. NJ 3 & JFK	5-11 a.m.	HOV3+ free	No
1b	Existing Connector	Weave betw. NJ 3 & JFK	5-11 a.m.	HOV3+ No discount	No
2a	Existing Connector	Weave betw. NJ 3 & JFK	5-11 a.m.	HOV3+ free	Trucks 5-6, 10-11
3a	Existing Connector	Divert to new drop ramp from Harmon Meadows Blvd. and/or NJ 3	5-11 a.m.	HOV3+ free	No
3b	Existing Connector	Divert to new drop ramp from Harmon Meadows Blvd. and/or NJ 3	5-11 a.m.	HOV3+ No discount	No
3a-Modified	Existing Connector	Divert to NJ 3	5-11 a.m.	HOV3+ free	No
4a	Existing Connector	New Bridge on NJ 495	5-11 a.m.	HOV3+ free	No
4b	Existing Connector	New Bridge on NJ 495	5-11 a.m.	HOV3+ No discount	No

7.2 ANALYSIS RESULTS

The eight study alternatives were analyzed separately in the travel behavior choice model. The analyses indicated relatively small differences between the alternatives in the amount of traffic reductions that might take place from shifts to transit, creation of new carpools, and diversions to alternative routes. The results of the alternatives analyses are shown graphically in Figure 25 and Figure 26 in a manner that allows for easy comparison between alternatives.

7.2.1 OVERVIEW OF TRIP-MAKING RESULTS

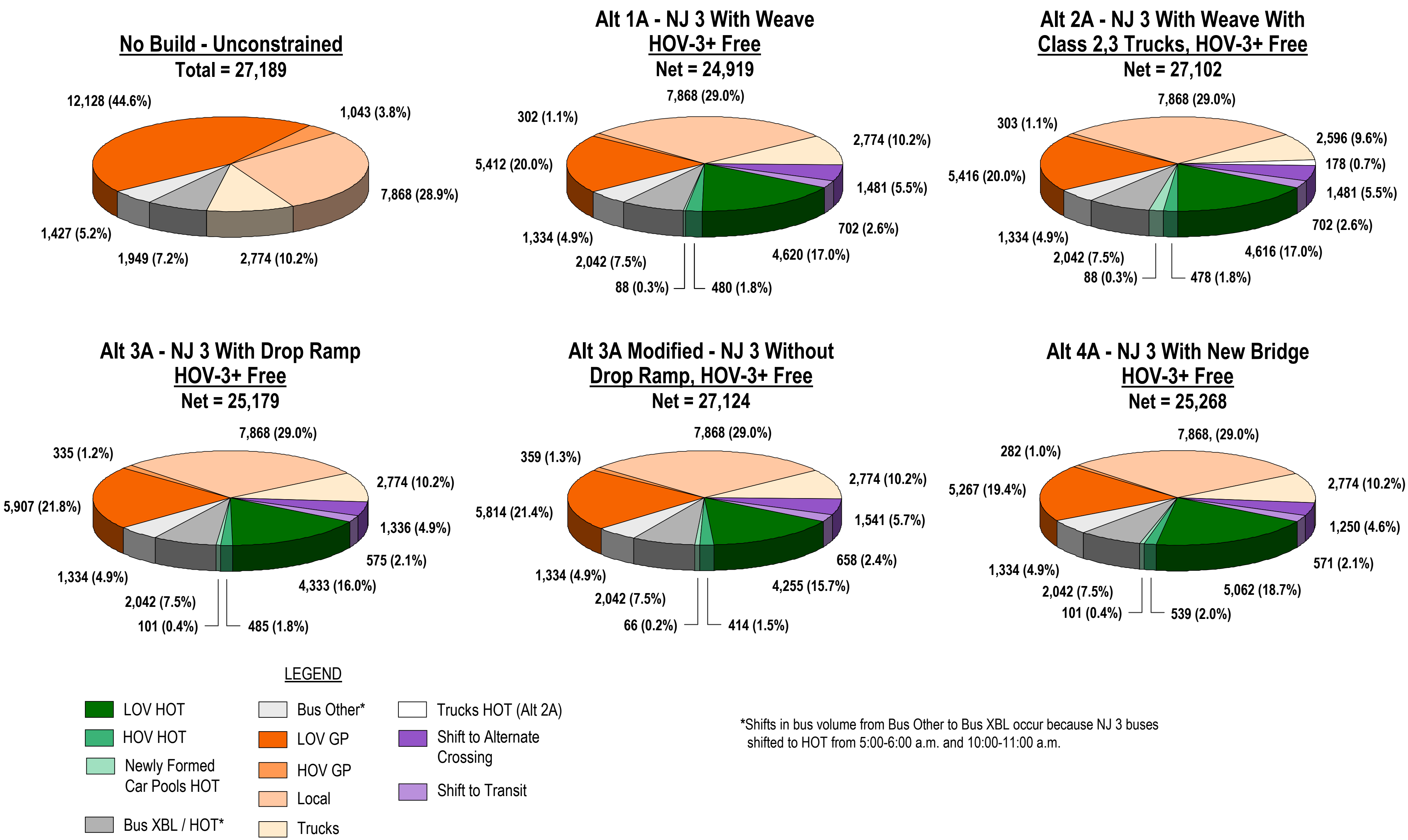
The results of the analyses of the alternatives that allow for free of HOV-3+ vehicles (i.e., Alternatives 1A, 2A, 3A, 3A-Modified, and 4A) are shown in Figures 25 and 26 for the entire 5-11 a.m. analysis period. Figure 25 shows the impacts of the alternatives stated in terms of vehicular demand and Figure 26 states the impacts in terms of person-trip demand. These charts summarize the impacts by vehicle type and show the amount of traffic shifted to the proposed HOT lane, alternate routes, and transit. The traffic depicted in these graphics represents vehicles destined for the Lincoln Tunnel only. Traffic that is destined for local destinations is assumed to remain constant in all the scenarios. The volumes for the No-Build condition shown in these charts represent the unconstrained condition. The unconstrained condition represents the starting point against which traffic is diverted to the proposed HOT lane and the total demand shown in all the pie charts is the same.

In the pie chart for the No-Build condition in Figure 25, low-occupancy vehicular traffic constitutes 44.6 percent of the total demand for the Lincoln Tunnel during the 5-11 a.m. period. Locally originating traffic from Union City, Weehawken, and Hoboken accounts for 28.9 percent of Lincoln Tunnel traffic. Buses on both the XBL and local approaches account for a combined 12.4 percent of total traffic, and carpools with three or more occupants account for 3.8 percent of total tunnel-bound traffic.

The pie charts for the study alternatives have the following color scheme: slices colored with shades of orange are components of traffic that remain in the general purpose lanes, slices colored with shades of green are traffic components that shift to the proposed HOT lane, and slices in shades of purple represent vehicles that are removed from the NJ 495 corridor. As with the No-Build case, the two gray-colored slices represent bus volumes going to the Lincoln Tunnel. The truck, bus, and local components of traffic are assumed to be essentially unchanged between scenarios since many have limited options for alternative routes. Trucks using the HOT lane are unique to Alternative 2A and are presented in white.

7.2.2 VEHICLE TRIP IMPACTS

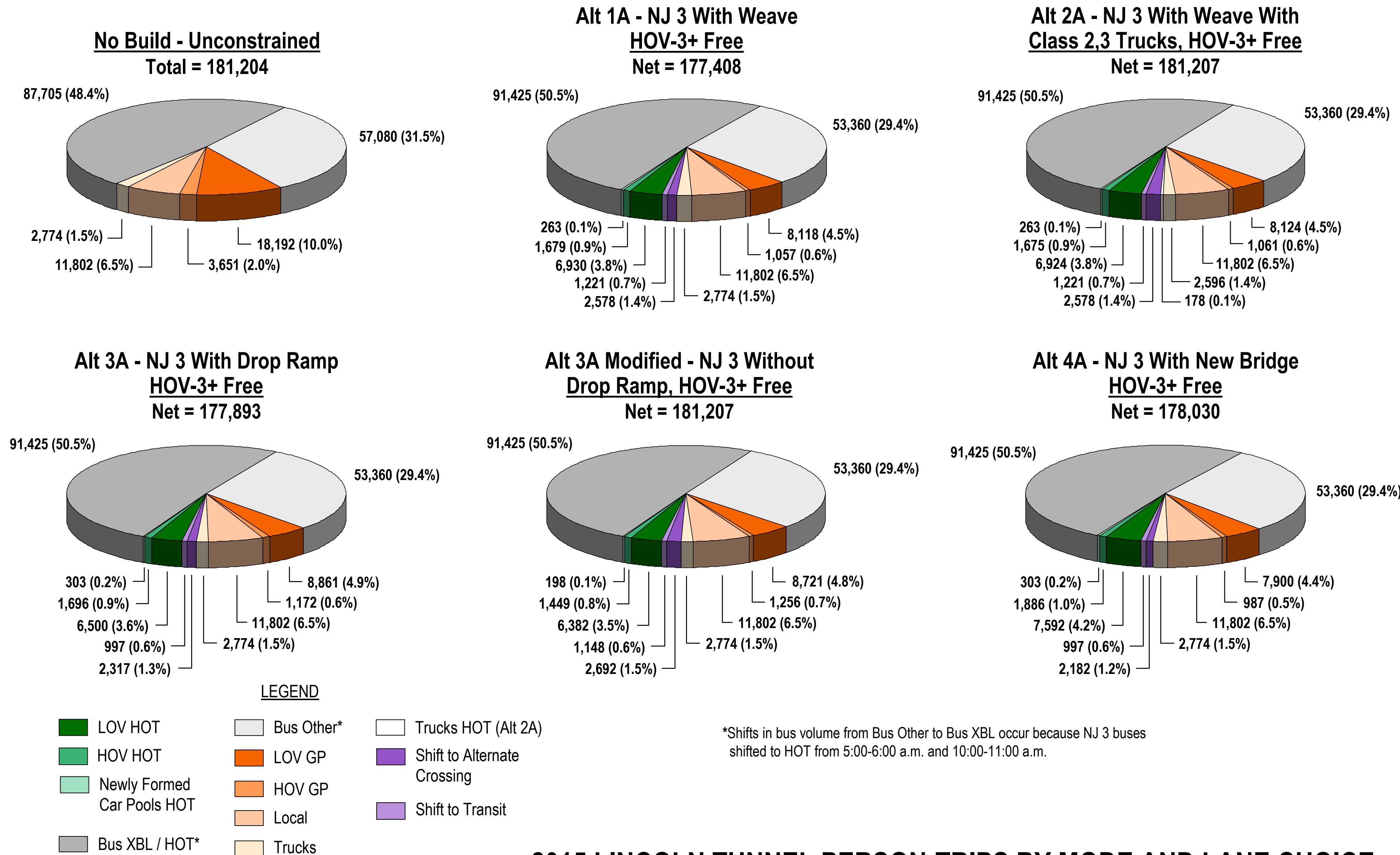
A comparison of some of the key metrics for vehicular trips in Figure 25 is instructive. All the alternatives achieve a net lower amount of traffic in the NJ 495 corridor as compared with the No-Build case. It is interesting to note that Alternative 3A-Modified (i.e., NJ 3 only access to the HOT lane and no access ramp from the NJ Turnpike) achieves a very modest traffic



2015 LINCOLN TUNNEL TRAFFIC BY MODE AND LANE CHOICE
5:00-11:00 A.M. - COMPARISON OF ALTERNATIVES

WilburSmith ASSOCIATES

FIGURE 25



2015 LINCOLN TUNNEL PERSON-TRIPS BY MODE AND LANE CHOICE 5:00-11:00 A.M. - COMPARISON OF ALTERNATIVES

FIGURE 26

reduction in the corridor reflecting the limited improvement that is made in this alternative. Similarly, Alternative 2A also has a modest corridor traffic reduction as trucks consume HOT lane capacity in the shoulder hours and congest access to the lane by buses and autos. Alternatives 1A, 3A and 4A all perform rather similarly in terms of net traffic remaining in the corridor in the presence of the proposed HOT lane.

However, traffic reduction in the corridor needs to be evaluated against where the diverted traffic actually goes. Traffic reductions in the corridor as a result of transit shift and carpool formation are objectives of the proposed HOT lane, but vehicular traffic diversion to other congested corridors is not a desirable outcome. Comparing the two purple slices of the pies in Figure 25, along with the light green slice provides an indication of traffic diversion to other corridors, transit shift and new carpool formation in each of the alternatives. A comparison of the alternatives indicates a disappointing rate of new carpool formation in all scenarios, with the best alternatives achieving only a 0.4 percent conversion of vehicle trips and a 0.2 percent conversion of passenger trips. Transit shift is a bit higher but is still disappointing, ranging from 2.1 percent to 2.6 percent of the vehicular trips and 1.2 percent to 1.5 percent of passenger trips. The largest share of net corridor traffic reduction in all scenarios comes from traffic diversion to other corridors, which ranges from 4.6 percent to 5.7 percent of all vehicular trips (i.e., 1,250 to 1,540 vehicles during the 5-11 a.m. period). Overall, the results indicate very little shifting of traffic, either positively or negatively. Alternative 3A-Modified did not perform well, with high traffic diversion to other corridors and low carpool formation and only modest transit shift. Alternative 4A achieved the lowest traffic diversion to other corridors and the highest carpool formation rates.

The share of corridor vehicular traffic drawn to the proposed HOT lane is decidedly low-occupancy vehicles, ranging from 15.7 percent to 18.7 percent of all vehicular trips (i.e., 4,255 vehicles to 5,062 vehicles over the 5-11 a.m. period). Consistent with the findings of new carpool formation, the share of HOV traffic in the HOT lane ranges from 1.5 percent to 2.0 percent of the vehicular traffic (i.e., 414 to 539 vehicles from 5-11 a.m.). This finding would indicate that the traffic balance from paying LOVs will be important and have some revenue generating benefits, but that the proposed HOT lane will serve its purpose of moving more people by providing capacity and reliability for buses, rather than attracting new HOV autos.

7.2.3 PERSON-TRIP IMPACTS

Figure 26 shows the impacts of the study alternatives in terms of person trips for the 5-11 a.m. period. For this analysis, vehicle occupancy data from today's existing conditions were used to establish the assumptions for the future years' vehicle occupancy levels in the corridor. For the 2015 analysis depicted in Figure 26, it was assumed that low-occupancy vehicles carry 1.5 persons/vehicle, current carpool traffic carries 3.5 persons/vehicle (newly formed carpools carry 3.0 persons), buses in the XBL carry 45 persons, and other buses carry 40 persons/vehicle. As shown, although buses account for only 12.4 percent of base traffic, they carry 79.9 percent of the people using the Lincoln Tunnel in the 5-11 a.m. period.

In all of the study alternatives, there is a shift of bus riders from the other bus category to the XBL/HOT category, indicating that more future bus riders will enjoy the advantages of a prioritized managed lane in all the Study alternatives. The benefit arises largely from that fact that 90 percent of the buses on the NJ 3 approach to NJ 495 are assumed to use the proposed HOT lane from 5-6 a.m. and 10-11 a.m. The net loss in person-trips in the corridor includes 1.8 percent to 2.1 percent of people shifting to alternate crossings and to transit. The automobiles using the HOT lane attract 4.7 percent to 5.4 percent of persons, depending on the alternative. Figure 26 serves to reinforce the low carpool formation outcomes of the analysis indicating that approximately 200-300 person trips are shifted to new carpools from 5-11 a.m., representing 0.1 percent to 0.2 percent of the total trips made during the period.

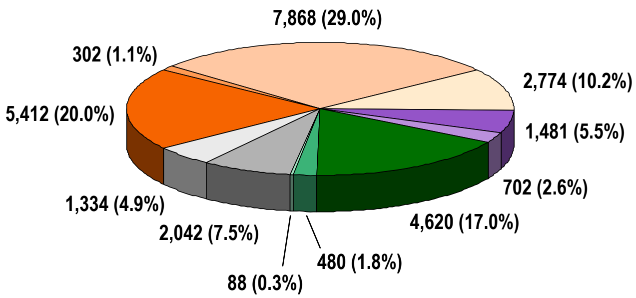
When viewed in terms of total person trips in the 5-10 a.m. period, Alternative 4A appears to produces more positive results. This alternative attracts the highest HOT lane use, while showing the lowest shit of person trips to other corridors. The consequence is that Alternative 4A enjoys the lowest remaining LOV share of traffic remaining in the general-purpose lanes.

Figures 27 and 28 compare vehicular traffic and person trips from 5-11 a.m. for two payment options for HOV-3+ vehicles: (1) if HOV-3+ are allowed to access the proposed HOT lane for free, and (2) if HOV-3+ pay to access the proposed managed lane. The results shown in Figures 27 and 28 illustrate that is very little reaction to changes in the pricing of the proposed HOT lane for carpools, due mostly to the relatively low numbers of vehicles that would be affected by this policy difference. While there is less carpool formation under a scenario where HOV-3+ vehicles are charged to enter the proposed HOT lane, the differential is so small (i.e., 41 vehicles during the 5-11 a.m. period), the difference is negligible. The priced access for HOV-3+ vehicles to the proposed HOT lane encourages slightly more traffic to shift to alternative crossings and modest transit shifts as well, but once again these shifts are negligible over the six-hour period. Finally, as one would expect, the number of HOV-3+ vehicles in the proposed HOT lane decreases when HOV-3+ vehicles are charged to use the proposed managed lane, but only slightly.

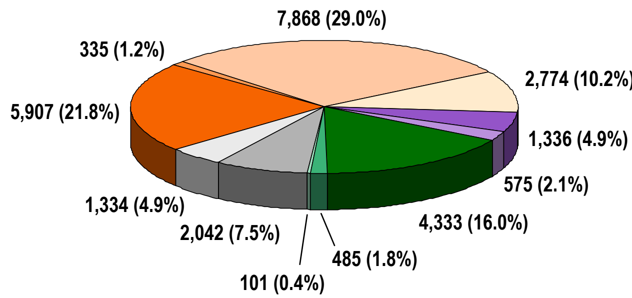
7.2.4 PROPOSED HOT LANE FEES

The average fees required to be charged in the proposed HOT lane in order to manage demand in a manner that allows the new managed lane to flow at a minimum of 35 mph are shown in Table 19 for all the Study alternatives. To maximize the usage of the proposed HOT lane and maintain a reasonable balance of traffic in all lanes of the NJ 495 corridor, proposed HOT lane fees are kept lower during periods of lower demand and lower congestion. However, for the purpose of this analysis, a minimum HOT lane fee of $1.00 was assumed.

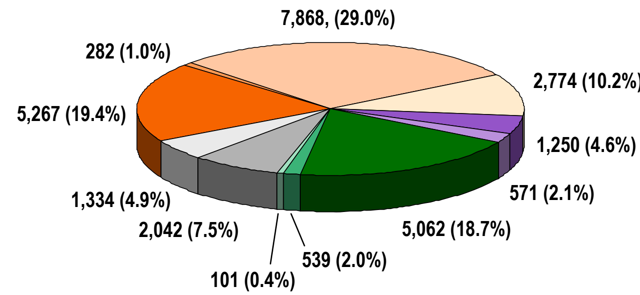
Alt 1A - NJ 3 With Weave, HOV-3+ Free
Net = 24,919



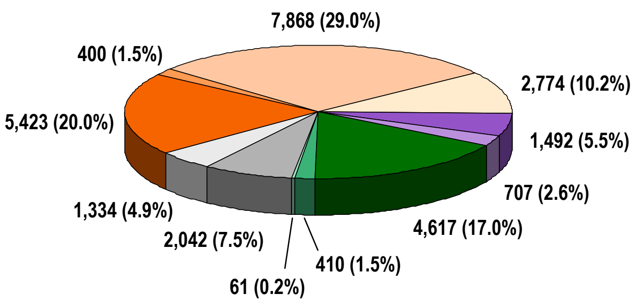
Alt 3A - NJ 3 With Drop Ramp, HOV-3+ Free
Net = 25,179



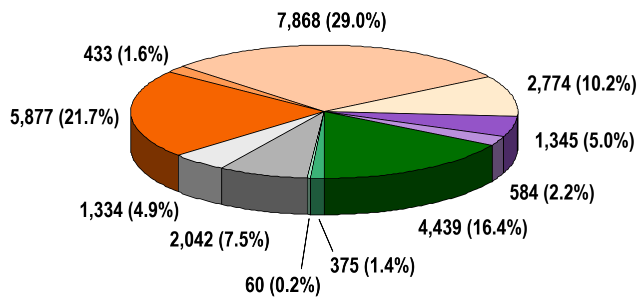
Alt 4A - NJ 3 With New Bridge, HOV-3+ Free
Net = 25,268



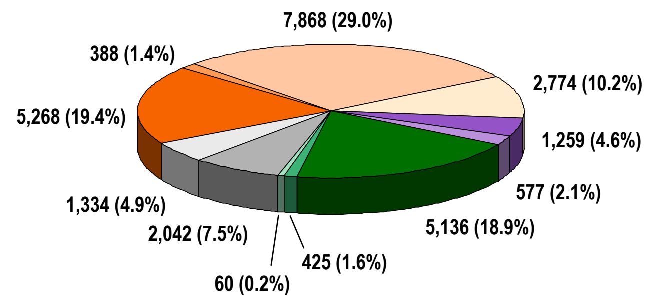
Alt 1B - NJ 3 With Weave, HOV-3+ Charged
Net = 24,930



Alt 3B - NJ 3 With Drop Ramp, HOV-3+ Charged
Net = 25,201



Alt 4B - NJ 3 With New Bridge, HOV-3+ Charged
Net = 25,294



LEGEND

- LOV HOT
- HOV HOT
- Newly Formed Car Pools HOT
- Bus XBL / HOT*
- Bus Other*
- LOV GP
- HOV GP
- Local
- Trucks
- Shift to Alternate Crossing
- Shift to Transit

*Shifts in bus volume from Bus Other to Bus XBL occur because NJ 3 buses shifted to HOT from 5:00-6:00 a.m. and 10:00-11:00 a.m.

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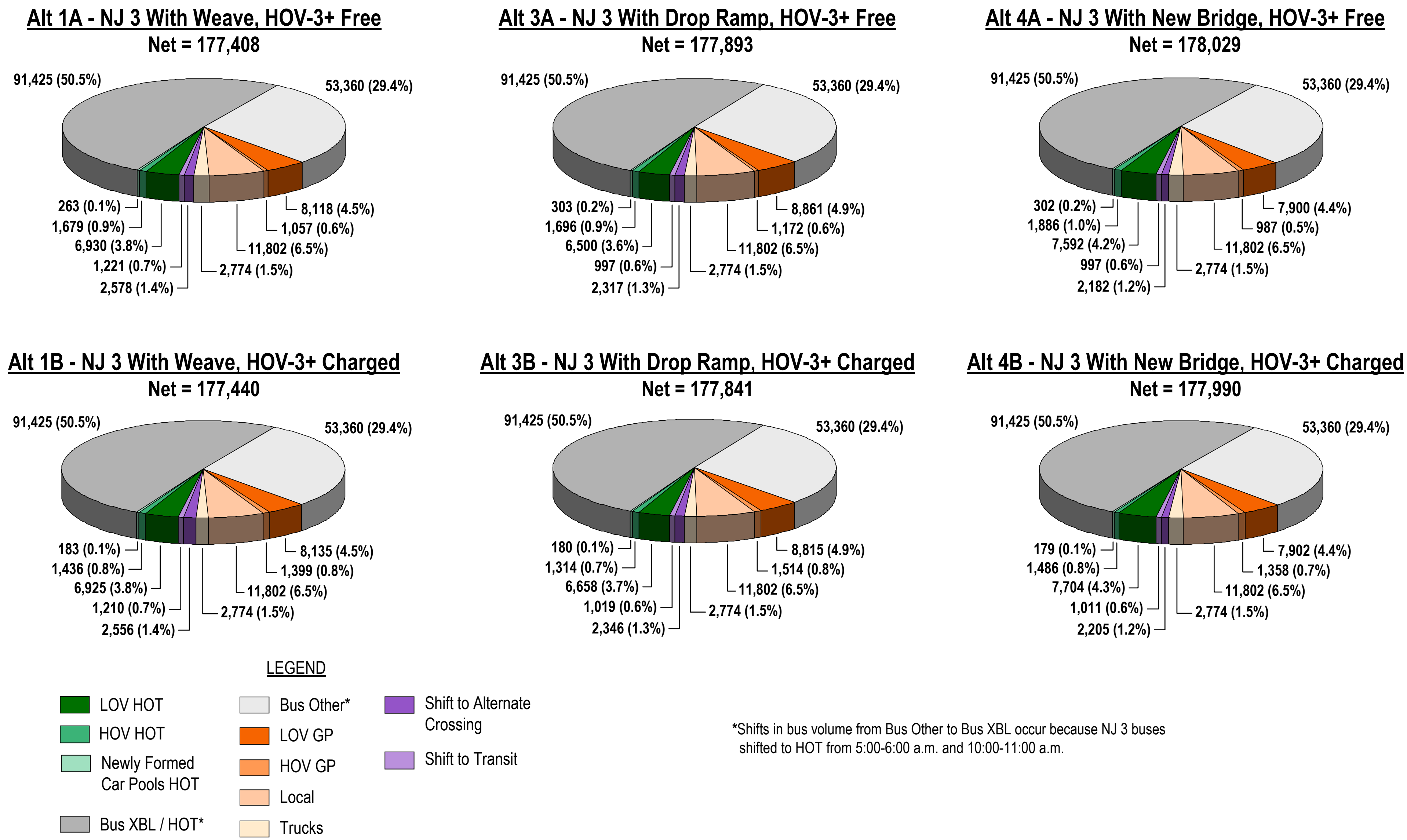
2015 LINCOLN TUNNEL TRAFFIC BY MODE AND LANE CHOICE 5:00-11:00 A.M. - IMPACT OF HOV DISCOUNT

FIGURE 27



*Shifts in bus volume from Bus Other to Bus XBL occur because NJ 3 buses shifted to HOT from 5:00-6:00 a.m. and 10:00-11:00 a.m.

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2015 LINCOLN TUNNEL PERSON-TRIPS BY MODE AND LANE CHOICE
5:00-11:00 A.M. - IMPACT OF HOV DISCOUNT

FIGURE 28

Table 19

2015 Passenger Car HOT Lane Fee Summary by Alternative

Time	Alternative							
	1A	1B	2A	3A	3B	3A-Mod.	4A	4B
5:00 - 5:30 a.m.	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00
5:30 - 6:00 a.m.	1.50	1.50	1.50	2.50	2.50	2.50	2.00	2.00
6:00 - 6:30 a.m.	2.50	2.50	2.50	3.50	3.25	2.50	3.50	3.50
6:30 - 7:00 a.m.	4.50	4.25	4.50	6.50	6.25	4.50	7.25	7.00
7:00 - 7:30 a.m.	5.00	5.00	5.00	6.75	6.75	4.75	7.25	7.00
7:30 - 8:00 a.m.	3.25	3.25	3.25	5.25	5.25	3.50	5.00	5.00
8:00 - 8:30 a.m.	2.50	2.50	2.50	4.50	4.50	2.75	3.50	3.50
8:30 - 9:00 a.m.	2.75	2.75	2.75	4.00	4.00	1.75	4.75	4.75
9:00 - 9:30 a.m.	1.75	1.75	1.75	3.25	3.25	1.25	3.00	3.00
9:30 - 10:00 a.m.	2.00	2.00	2.00	2.50	2.50	1.25	2.75	2.75
10:00 - 10:30 a.m.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

The proposed HOT lane fees needed to manage low-occupancy vehicle demand are highest in the alternatives where HOV-3+ traffic is allowed free access to the managed lane. The proposed HOT lane fees also tend to be higher in the alternatives where the demand is highest, which corresponds to alternatives with the highest level of accessibility to the new lane by the different roadway approaches. For example, the highest charge needed to manage demand for Alternative 3A-Modified is $4.75, while the highest fee for Alternative 3A is $6.75. Because Alternative 3A-Modified effectively eliminates access to the proposed HOT lane for NJ Turnpike northbound traffic, total potential demand for the proposed HOT lane is lower, and therefore lower fees are needed to keep the lane full with NJ 3 and NJ Turnpike southbound traffic. In fact, in this scenario, there is the possibility that the proposed HOT lane may be underutilized outside the peak hours.

The alternative with the highest proposed HOT lane fee is Alternative 4A, where new approach roadways and new bridge structures are constructed to provide more direct access to the proposed HOT lane from the NJ Turnpike. This scenario is the most attractive to NJ Turnpike traffic because it can potentially save them the greatest amount of time over travel in the general-purpose lanes. As a consequence, the demand for the new lane tends to be the highest, requiring a higher price to maintain favorable travel times for the managed lane.

A traffic analysis was performed using vehicular volumes at half-hour intervals and the proposed HOT lane fees shown in Table 19 are shown in half-hour intervals. These are intended to be planning-level estimates of typical prices that would be required to maintain favorable travel times and speeds in the managed lane for the intervals shown. In practice, the proposed HOT lane prices would need to be changed dynamically in order to maintain free-flow conditions in the HOT lane. A pricing system for access the proposed HOT lane would need to consider a dynamic pricing algorithm that could be used to adjust rates as needed to attract as much traffic as possible while maintaining desired operating conditions and travel times. While a system of fixed incrementally stepped prices could be designed to match the typical daily traffic patterns, the dynamic pricing algorithm would cause the actual rates charged to vary from day to day, depending on actual operating conditions each day. The dynamically priced approach would better manage corridor demand in a manner that adapts to the daily variations of traffic demand and travel conditions

7.2.5 ESTIMATED 2015 TRANSACTIONS AND REVENUE

Tables 20 through 27 show the estimated charged and free transactions in the proposed HOT lane for each half-hour interval for the eight study alternatives analyzed. Total transactions were used to estimate annual operating costs. Transactions and revenues were annualized assuming 247 weekdays per year after holidays are considered. All prices and revenues are shown in 2007 dollars.

Alternative 4B is estimated to generate the most revenue, at $4.8 million per year. Alternatives 4A and 3B would have slightly lower revenues, with $4.6 million each. Alternative 3A would generate approximately $4.3 million per year. Alternative 3A-Modified would generate the least amount of revenue, at $2.8 million per year. Alternatives 1A, 1B, and 2A are estimated to generate approximately $3.0 million to $3.2 million per year. In general, pricing of carpools would add about 5 percent to 6 percent in revenue to a HOV-free alternative.

Table 20
2015 Estimated Weekday A.M. Peak Transactions and Revenue by Hour
Alternative 1A - NJ 3 with Weave

	HOT	HOT Lane				Total	Projected
	Lane	Passenger Cars				HOT Lane	Revenue
Time	Fee	Paying Fee	Free	Buses	Trucks	Vehicles	Revenue
5:00 - 5:30 a.m.	$1.00	273	17	23	-	313	$273
5:30 - 6:00 a.m.	$1.50	388	21	28	-	437	582
6:00 - 6:30 a.m.	$2.50	550	43	28	-	621	1,375
6:30 - 7:00 a.m.	$4.50	497	55	39	-	591	2,237
7:00 - 7:30 a.m.	$5.00	411	45	60	-	516	2,055
7:30 - 8:00 a.m.	$3.25	427	36	72	-	535	1,388
8:00 - 8:30 a.m.	$2.50	432	19	85	-	536	1,080
8:30 - 9:00 a.m.	$2.75	373	18	85	-	476	1,026
9:00 - 9:30 a.m.	$1.75	433	9	42	-	484	758
9:30 - 10:00 a.m.	$2.00	383	9	26	-	418	766
10:00 - 10:30 a.m.	$1.00	417	25	22	-	464	417
10:30 - 11:00 a.m.	$1.00	283	25	22	-	330	283
Total		4,867	322	532	-	5,721	$12,239
					Average Fee		$2.14
					Annual Total	1,413,087	$3,022,971

NOTES: All prices and revenue are shown in 2007 dollars.
Transactions and revenue are annualized at 247 weekdays per year.

Table 21
2015 Estimated Weekday A.M. Peak Transactions and Revenue by Hour
Alternative 1B - NJ 3 with Weave

Time	HOT Lane Fee	HOT Lane: Passenger Cars: Paying Fee	HOT Lane: Passenger Cars: Free	HOT Lane: Buses	HOT Lane: Trucks	Total HOT Lane Vehicles	Projected Revenue Revenue
5:00 - 5:30 a.m.	$1.00	285	-	23	-	308	$285
5:30 - 6:00 a.m.	$1.50	413	-	28	-	441	620
6:00 - 6:30 a.m.	$2.50	508	-	28	-	536	1,270
6:30 - 7:00 a.m.	$4.25	573	-	39	-	612	2,435
7:00 - 7:30 a.m.	$5.00	447	-	60	-	507	2,235
7:30 - 8:00 a.m.	$3.25	458	-	72	-	530	1,489
8:00 - 8:30 a.m.	$2.50	448	-	85	-	533	1,120
8:30 - 9:00 a.m.	$2.75	387	-	85	-	472	1,064
9:00 - 9:30 a.m.	$1.75	443	-	42	-	485	775
9:30 - 10:00 a.m.	$2.00	392	-	26	-	418	784
10:00 - 10:30 a.m.	$1.00	436	-	22	-	458	436
10:30 - 11:00 a.m.	$1.00	300	-	22	-	322	300
Total		5,090	0	532	-	5,622	$12,813
					Average Fee		$2.28
					Annual Total	1,388,634	$3,164,749

NOTES: All prices and revenue are shown in 2007 dollars.
Transactions and revenue are annualized at 247 weekdays per year.

Table 22
2015 Estimated Weekday A.M. Peak Transactions and Revenue by Hour
Alternative 2A - NJ 3 with Weave with Class 2,3 trucks

Time	HOT Lane Fee	HOT Lane: Passenger Cars: Paying Fee	HOT Lane: Passenger Cars: Free	HOT Lane: Buses	HOT Lane: Trucks	Total HOT Lane Vehicles	Projected Revenue Revenue
5:00 - 5:30 a.m.	$1.00	279	17	23	1	320	$282
5:30 - 6:00 a.m.	$1.50	360	21	28	131	540	936
6:00 - 6:30 a.m.	$2.50	550	43	28	-	621	1,375
6:30 - 7:00 a.m.	$4.50	497	55	39	-	591	2,238
7:00 - 7:30 a.m.	$5.00	411	45	60	-	516	2,056
7:30 - 8:00 a.m.	$3.25	427	36	72	-	535	1,386
8:00 - 8:30 a.m.	$2.50	432	19	85	-	536	1,080
8:30 - 9:00 a.m.	$2.75	373	18	85	-	476	1,025
9:00 - 9:30 a.m.	$1.75	433	9	42	-	484	758
9:30 - 10:00 a.m.	$2.00	383	9	26	-	418	766
10:00 - 10:30 a.m.	$1.00	427	25	22	40	514	528
10:30 - 11:00 a.m.	$1.00	289	25	22	6	342	305
Total		4,861	322	532	178	5,893	$12,735
					Average Fee		$2.16
					Annual Total	1,455,582	$3,145,655

NOTES: All prices and revenue are shown in 2007 dollars.
Transactions and revenue are annualized at 247 weekdays per year.

Table 23
2015 Estimated Weekday A.M. Peak Transactions and Revenue by Hour
Alternative 3A - NJ 3 with Drop Ramp

Time	HOT Lane Fee	HOT Lane: Passenger Cars: Paying Fee	HOT Lane: Passenger Cars: Free	HOT Lane: Buses	HOT Lane: Trucks	Total HOT Lane Vehicles	Projected Revenue Revenue
5:00 - 5:30 a.m.	$1.00	198	16	23	-	237	$198
5:30 - 6:00 a.m.	$2.50	297	20	28	-	345	743
6:00 - 6:30 a.m.	$3.50	548	44	28	-	620	1,918
6:30 - 7:00 a.m.	$6.50	506	57	39	-	602	3,289
7:00 - 7:30 a.m.	$6.75	409	52	60	-	521	2,761
7:30 - 8:00 a.m.	$5.25	414	50	72	-	536	2,174
8:00 - 8:30 a.m.	$4.50	428	28	85	-	541	1,926
8:30 - 9:00 a.m.	$4.00	415	26	85	-	526	1,660
9:00 - 9:30 a.m.	$3.25	371	12	42	-	425	1,206
9:30 - 10:00 a.m.	$2.50	366	13	26	-	405	915
10:00 - 10:30 a.m.	$1.00	334	25	22	-	381	334
10:30 - 11:00 a.m.	$1.00	266	25	22	-	313	266
Total		4,552	368	532	-	5,452	$17,389
					Average Fee		$3.19
					Annual Total	1,346,644	$4,294,960

NOTES: All prices and revenue are shown in 2007 dollars.
Transactions and revenue are annualized at 247 weekdays per year.

Table 24
2015 Estimated Weekday A.M. Peak Transactions and Revenue by Hour
Alternative 3B - NJ 3 with Drop Ramp

Time	HOT Lane Fee	HOT Lane: Passenger Cars: Paying Fee	HOT Lane: Passenger Cars: Free	HOT Lane: Buses	HOT Lane: Trucks	Total HOT Lane Vehicles	Projected Revenue Revenue
5:00 - 5:30 a.m.	$1.00	208	-	23	-	231	$208
5:30 - 6:00 a.m.	$2.50	312	-	28	-	340	780
6:00 - 6:30 a.m.	$3.25	618	-	28	-	646	2,009
6:30 - 7:00 a.m.	$6.25	552	-	39	-	591	3,450
7:00 - 7:30 a.m.	$6.75	446	-	60	-	506	3,011
7:30 - 8:00 a.m.	$5.25	453	-	72	-	525	2,378
8:00 - 8:30 a.m.	$4.50	449	-	85	-	534	2,021
8:30 - 9:00 a.m.	$4.00	437	-	85	-	522	1,748
9:00 - 9:30 a.m.	$3.25	382	-	42	-	424	1,242
9:30 - 10:00 a.m.	$2.50	378	-	26	-	404	945
10:00 - 10:30 a.m.	$1.00	354	-	22	-	376	354
10:30 - 11:00 a.m.	$1.00	286	-	22	-	308	286
Total		4,875	0	532	-	5,407	$18,430
					Average Fee		$3.41
					Annual Total	1,335,529	$4,552,272

NOTES: All prices and revenue are shown in 2007 dollars.
Transactions and revenue are annualized at 247 weekdays per year.

Table 25
2015 Estimated Weekday A.M. Peak Transactions and Revenue by Hour
Alternative 3A Modified - NJ 3 Without Drop Ramp

	HOT	HOT Lane				Total	Projected
	Lane	Passenger Cars				HOT Lane	Revenue
Time	Fee	Paying Fee	Free	Buses	Trucks	Vehicles	Revenue
5:00 - 5:30 a.m.	$1.00	186	14	23	-	223	$186
5:30 - 6:00 a.m.	$2.50	294	17	28	-	339	735
6:00 - 6:30 a.m.	$2.50	530	36	28	-	594	1,325
6:30 - 7:00 a.m.	$4.50	534	47	39	-	620	2,403
7:00 - 7:30 a.m.	$4.75	414	46	60	-	520	1,967
7:30 - 8:00 a.m.	$3.50	407	43	72	-	522	1,425
8:00 - 8:30 a.m.	$2.75	403	23	85	-	511	1,108
8:30 - 9:00 a.m.	$1.75	413	20	85	-	518	723
9:00 - 9:30 a.m.	$1.25	363	9	42	-	414	454
9:30 - 10:00 a.m.	$1.25	353	10	26	-	389	441
10:00 - 10:30 a.m.	$1.00	270	19	22	-	311	270
10:30 - 11:00 a.m.	$1.00	266	19	22	-	307	266
Total		4,433	303	532	-	5,268	$11,302
					Average Fee		$2.15
					Annual Total	1,301,196	$2,791,594

NOTES: All prices and revenue are shown in 2007 dollars.
Transactions and revenue are annualized at 247 weekdays per year.

Table 26
2015 Estimated Weekday A.M. Peak Transactions and Revenue by Hour
Alternative 4A - NJ 3 with New Bridge

	HOT	HOT Lane				Total	Projected
	Lane	Passenger Cars				HOT Lane	Revenue
Time	Fee	Paying Fee	Free	Buses	Trucks	Vehicles	Revenue
5:00 - 5:30 a.m.	$1.00	345	17	23	-	385	$345
5:30 - 6:00 a.m.	$2.00	415	21	28	-	464	830
6:00 - 6:30 a.m.	$3.50	531	45	28	-	604	1,859
6:30 - 7:00 a.m.	$7.25	527	61	39	-	627	3,821
7:00 - 7:30 a.m.	$7.25	381	52	60	-	493	2,762
7:30 - 8:00 a.m.	$5.00	448	46	72	-	566	2,240
8:00 - 8:30 a.m.	$3.50	440	25	85	-	550	1,540
8:30 - 9:00 a.m.	$4.75	359	23	85	-	467	1,705
9:00 - 9:30 a.m.	$3.00	407	11	42	-	460	1,221
9:30 - 10:00 a.m.	$2.75	384	11	26	-	421	1,056
10:00 - 10:30 a.m.	$1.00	602	25	22	-	649	602
10:30 - 11:00 a.m.	$1.00	503	25	22	-	550	503
Total		5,342	362	532	-	6,236	$18,484
					Average Fee		$2.96
					Annual Total	1,540,292	$4,565,486

NOTES: All prices and revenue are shown in 2007 dollars.
Transactions and revenue are annualized at 247 weekdays per year.

Table 27
2015 Estimated Weekday A.M. Peak Transactions and Revenue by Hour
Alternative 4B - NJ 3 with New Bridge

	HOT	HOT Lane				Total	Projected
	Lane	Passenger Cars				HOT Lane	Revenue
Time	Fee	Paying Fee	Free	Buses	Trucks	Vehicles	Revenue
5:00 - 5:30 a.m.	$1.00	357	-	23	-	380	$357
5:30 - 6:00 a.m.	$2.00	428	-	28	-	456	856
6:00 - 6:30 a.m.	$3.50	560	-	28	-	588	1,960
6:30 - 7:00 a.m.	$7.00	567	-	39	-	606	3,969
7:00 - 7:30 a.m.	$7.00	431	-	60	-	491	3,017
7:30 - 8:00 a.m.	$5.00	484	-	72	-	556	2,420
8:00 - 8:30 a.m.	$3.50	460	-	85	-	545	1,610
8:30 - 9:00 a.m.	$4.75	376	-	85	-	461	1,786
9:00 - 9:30 a.m.	$3.00	417	-	42	-	459	1,251
9:30 - 10:00 a.m.	$2.75	394	-	26	-	420	1,084
10:00 - 10:30 a.m.	$1.00	623	-	22	-	645	623
10:30 - 11:00 a.m.	$1.00	523	-	22	-	545	523
Total		5,620	0	532	-	6,152	$19,456
					Average Fee		$3.16
					Annual Total	1,519,544	$4,805,509

NOTES: All prices and revenue are shown in 2007 dollars.
Transactions and revenue are annualized at 247 weekdays per year.

7.3 TRAFFIC OPERATIONS SUMMARY – 2015 CONDITIONS

Future traffic volumes for each study Alternative (i.e., Alternatives 1, 2, 3, and 4) were input into the VISSIM traffic simulation model to derive operational performance measures for each alternative. A comparative analysis of the corridor performance outputs from the traffic simulation model for each Study alternative helped to weigh the relative merits of each option studied. For each study alternative, the traffic simulation model was employed for the option "A" variant of each study alternative since options "A" and "B" are very similar in nature from the standpoint of traffic operations and demand.

As noted earlier, under all the study alternatives, the existing XBL bus traffic originating from NJ 3 was diverted into the proposed HOT lane; buses from the NJ Turnpike were assumed to stay on the existing contra-flow XBL. The travel behavior demand model allowed traffic to choose an alternative crossing, as well as for exiting person trips to shift to a transit mode or form a carpool. As a consequence, the study alternatives generally result in a modest level of trip reduction in the NJ 495 corridor. In this section, the constrained No-Build demand, which is slightly lower than the unconstrained scenario, is used to compare changes in the operational performance measures with the study alternatives.

In all study alternatives, it is noted that travel times in the XBL are improved by 10-25 minutes over the No-Build alternative at 2015 traffic levels. In Alternatives 1, 2, and 3, express buses from the NJ 3 approach would be improved over their current travel times. In Alternative 4, the travel time advantage over No-Build could be minimal due additional queuing on NJ 3 since more NJ Turnpike traffic would be attracted to the HOT lane.

7.3.1 TRAVEL TIME AND QUEUES - PEAK HOURS (7-9 A.M.)

All Approaches - Table 28 provides a summary of the corridor performance measures used to compare the constrained 2015 No-Build alternative, with study Alternatives 1A, 2A, 3A, 3A-Modified, and 4A during the peak operating hours of 7-9 a.m. This two-hour period represents the heaviest traffic volumes for the corridor. The values in Table 28 reflect the combined performance of three roadway approaches to NJ 495 (i.e., NJ Turnpike Int. 16E, NJ Turnpike Int. 17, and NJ 3). In some alternatives, improved travel time for one approach is offset by increased delays for another approach. The metrics in Table 28 reflect the weighted combination of these effects to provide an overall cumulative corridor impact. This table, along with the tables that follow, presents the travel times for traffic that arrived at NJ 495 between the hours of 7:00 a.m. and 9:00 a.m., no matter what time they were ultimately processed at the toll plaza.

Minutes per Vehicle – Alternative 2A shows the lowest minutes per vehicle (22.5 minutes per vehicle) compared to other options, resulting in a savings of 20.4 minutes over the No-Build condition, followed by Alternative 3A-Modified, with an average travel time of 25.9 minutes per vehicle, and a net improvement of 17.0 minutes per vehicle. This is logical since Alternative 2A shifts additional small truck traffic from peak hours into the shoulder hour before delays are high, resulting in the net impact being felt primarily in the peak hours. It should be noted that the XBL vehicle and person travel times are shorter in each of the alternatives compared to the No Build condition as shown in Table 28.

In this table, which shows the weighted average travel times by approach, the XBL vehicle and person travel times do not seem to show significant time savings over the general purpose lanes. As was the case with Table 16, the XBL travel times for the No-Build condition does show a range in time savings of approximately 9-24 minutes when comparing each approach individually. However, because each approach has a different length and travel time within the system, when travel from all three approaches are weighted and averaged, the XBL vehicle and person travel times appear to be almost equal to the general purpose lane travel times.

Minutes per Person – Alternative 2A shows the lowest minutes per person (18.7 minutes per person) compared to other options, followed closely by Alternative 4A. Alternative 4A, which provides a new connector ramp to allow the NJ Turnpike traffic to enter the HOT lane, provides the highest level of travel time improvement for traffic from the NJ Turnpike approaches. The result of this improvement for this approach is reduced delays for buses on the existing XBL, with a savings of 20.1 minutes over the No-Build condition.

Table 28
2015 Performance Measures by All Approaches (NJ Turnpike and NJ 3)
7:00-9:00 a.m.

Lane Type	No-Build (Constrained)	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Number of Vehicles											
XBL	1,286	990	-295	991	-295	991	-295	991	-295	990	-295
GP	4,576	1,855	-2,721	1,837	-2,738	2,111	-2,464	2,106	-2,469	2,100	-2,475
HOT	-	2,083	-	2,073	-	2,122	-	2,070	-	2,073	-
All Lanes	**5,861**	**4,928**	**-933**	**4,901**	**-960**	**5,224**	**-637**	**5,166**	**-695**	**5,164**	**-697**
Number of Persons											
XBL	57,852	44,568	-13,284	44,577	-13,275	44,577	-13,275	44,577	-13,275	44,568	-13,284
GP	8,778	4,020	-4,758	3,837	-4,942	4,270	-4,508	4,285	-4,493	4,336	-4,442
HOT	-	15,033	-	15,490	-	15,522	-	15,449	-	15,532	-
All Lanes	**66,630**	**63,622**	**-3,009**	**63,904**	**-2,726**	**64,369**	**-2,261**	**64,311**	**-2,319**	**64,436**	**-2,194**
Persons Per Vehicle											
XBL	45.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00
GP	1.92	2.17	0.25	2.09	0.17	2.02	0.10	2.03	0.12	2.06	0.15
HOT	-	7.22	-	7.47	-	7.31	-	7.46	-	7.49	-
All Lanes	**11.37**	**12.91**	**1.54**	**13.04**	**1.67**	**12.32**	**0.95**	**12.45**	**1.08**	**12.48**	**1.11**
Minutes Per Vehicle											
XBL	38.9	24.3	-14.6	20.2	-18.7	22.4	-16.5	28.0	-10.8	18.8	-20.1
GP	44.0	36.5	-7.5	30.7	-13.3	40.4	-3.6	39.7	-4.3	41.4	-2.6
HOT	-	20.7	-	16.3	-	30.7	-	10.8	-	23.0	-
All Lanes	**42.9**	**27.3**	**-15.5**	**22.5**	**-20.4**	**33.0**	**-9.8**	**25.9**	**-17.0**	**29.7**	**-13.2**
Minutes Per Person											
XBL	38.9	24.3	-14.6	20.2	-18.7	22.4	-16.5	28.0	-10.8	18.8	-20.1
GP	41.7	34.1	-7.6	28.3	-13.4	38.9	-2.8	36.2	-5.5	40.9	-0.8
HOT	-	15.5	-	11.9	-	21.4	-	10.4	-	25.3	-
All Lanes	**39.2**	**22.8**	**-16.4**	**18.7**	**-20.6**	**23.2**	**-16.0**	**24.3**	**-14.9**	**21.8**	**-17.4**
Maximum Queue Length (miles)	**6.1**	**4.2**	**-1.9**	**4.3**	**-1.8**	**4.1**	**-2.0**	**4.6**	**-1.5**	**4.2**	**-1.9**

Persons per Vehicle – Alternative 2A shows the highest persons per vehicle (13.04) compared to other options, followed closely by Alternative 1A. The number of persons per vehicle in the general purpose lanes tends to decline for the Build alternatives because a higher share of the HOV traffic is in shifted to the HOT lane in the Build alternatives.

Tables 29 through 31 provide the same information as Table 28, but shown by individual approach.

NJ Turnpike Int. 16E – Table 29 shows the operational results for the NJ Turnpike Int. 16E approach.

Minutes per Vehicle – As expected, Alternative 4A shows the greatest improvement in travel times for this approach, with an average peak hour travel time of 23.7 minutes per vehicle, representing a time savings of 44.1 minutes over the No-Build case. From this approach, Alternative 3A-Modified provides the worst travel time, averaging 46.6 minutes per vehicle. This is logical since traffic from this approach cannot use the HOT lane in this alternative.

Minutes per Person – For the NJ Turnpike Int. 16E approach, the rankings of the alternatives in terms of minutes of travel are roughly the same as the rankings for minutes per vehicle. Alternative 4A shows the lowest travel time in minutes per person (17.8 minutes per person) compared to other options and Alternative 3-Modified shows the highest.

Persons per Vehicle – Alternative 1A shows the highest persons per vehicle (18.72) compared to other options.

Maximum Queue Length (miles) – Alternative 4A shows the highest reduction in maximum queue length (2.5 miles) over the No-Build condition.

NJ Turnpike Int. 17 – Table 30 shows the operational results for the NJ Turnpike Int. 17 approach.

Table 29
2015 Performance Measures for NJ Turnpike Int. 16E Approach
7:00-9:00 a.m.

Lane Type	No-Build (Constrained)	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Number of Vehicles											
XBL	582	582	0	582	0	582	0	582	0	582	0
GP	1,254	534	-720	529	-725	597	-657	963	-290	433	-821
HOT	0	365	365	368	368	456	456	0	0	614	614
All Lanes	**1,835**	**1,480**	**-355**	**1,479**	**-357**	**1,635**	**-201**	**1,545**	**-290**	**1,629**	**-207**
Number of Persons											
XBL	26,181	26,190	9	26,181	0	26,181	0	26,181	0	26,181	0
GP	2,151	934	-1,217	874	-1,276	969	-1,181	1,581	-570	702	-1,449
HOT	0	594	594	602	602	740	740	0	0	1,033	1,033
All Lanes	**28,332**	**27,718**	**-613**	**27,657**	**-674**	**27,890**	**-441**	**27,762**	**-570**	**27,916**	**-416**
Persons Per Vehicle											
XBL	45.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00
GP	1.72	1.75	0.03	1.65	-0.06	1.62	-0.09	1.64	-0.07	1.62	-0.09
HOT	-	1.63	-	1.64	-	1.62	-	-	-	1.68	-
All Lanes	**15.44**	**18.72**	**3.29**	**18.71**	**3.27**	**17.06**	**1.63**	**17.97**	**2.53**	**17.14**	**1.70**
Minutes Per Vehicle											
XBL	53.1	26.9	-26.1	21.9	-31.2	22.8	-30.3	33.9	-19.2	17.2	-35.9
GP	74.7	48.8	-25.9	41.7	-33.0	48.2	-26.5	54.3	-20.3	42.9	-31.8
HOT	-	39.5	-	32.4	-	20.2	-	-	-	16.4	-
All Lanes	**67.8**	**37.9**	**-29.9**	**31.6**	**-36.2**	**31.4**	**-36.5**	**46.6**	**-21.2**	**23.7**	**-44.1**
Minutes Per Person											
XBL	53.1	26.9	-26.1	21.9	-31.2	22.8	-30.3	33.9	-19.2	17.2	-35.9
GP	72.1	45.3	-26.8	39.4	-32.7	45.7	-26.5	52.9	-19.2	40.0	-32.2
HOT	-	39.6	-	32.6	-	20.2	-	-	-	16.4	-
All Lanes	**54.5**	**27.8**	**-26.7**	**22.7**	**-31.8**	**23.5**	**-31.0**	**35.0**	**-19.5**	**17.8**	**-36.8**
Maximum Queue Length (miles)	**6.1**	**4.2**	**-1.9**	**4.3**	**-1.8**	**3.8**	**-2.3**	**4.6**	**-1.5**	**3.6**	**-2.5**

Table 30
2015 Performance Measures for NJ Turnpike Int. 17 Approach
7:00-9:00 a.m.

Lane Type	No-Build (Constrained)	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Number of Vehicles											
XBL	408	408	0	409	0	409	0	409	0	409	0
GP	969	430	-540	423	-546	341	-628	316	-653	399	-570
HOT	0	268	268	254	254	489	489	0	0	395	395
All Lanes	**1,378**	**1,106**	**-272**	**1,086**	**-292**	**1,239**	**-139**	**725**	**-653**	**1,203**	**-175**
Number of Persons											
XBL	18,378	18,378	0	18,396	18	18,396	18	18,396	18	18,387	9
GP	1,846	1,091	-755	1,056	-790	856	-990	837	-1,009	893	-953
HOT	0	457	457	433	433	780	780	0	0	662	662
All Lanes	**20,224**	**19,926**	**-298**	**19,886**	**-338**	**20,032**	**-192**	**19,233**	**-991**	**19,942**	**-282**
Persons Per Vehicle											
XBL	45.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00
GP	1.90	2.54	0.63	2.50	0.59	2.51	0.60	2.65	0.74	2.24	0.33
HOT	-	1.71	-	1.71	-	1.59	-	-	-	1.68	-
All Lanes	**14.68**	**18.01**	**3.33**	**18.31**	**3.63**	**16.17**	**1.49**	**26.54**	**11.86**	**16.58**	**1.90**
Minutes Per Vehicle											
XBL	37.6	20.6	-17.1	17.8	-19.8	21.8	-15.8	19.7	-17.9	20.9	-16.7
GP	59.8	39.8	-20.0	34.3	-25.5	43.4	-16.4	37.9	-21.9	42.4	-17.4
HOT	-	26.5	-	22.5	-	20.3	-	-	-	24.5	-
All Lanes	**53.2**	**29.5**	**-23.7**	**25.3**	**-27.9**	**27.2**	**-26.0**	**27.6**	**-25.6**	**29.2**	**-24.0**
Minutes Per Person											
XBL	37.6	20.6	-17.1	17.8	-19.8	21.8	-15.8	19.7	-17.9	20.9	-16.7
GP	56.5	36.4	-20.1	31.0	-25.4	38.6	-17.9	32.5	-23.9	37.8	-18.7
HOT	-	26.6	-	22.6	-	20.4	-	-	-	24.4	-
All Lanes	**39.3**	**21.6**	**-17.8**	**18.6**	**-20.8**	**22.5**	**-16.9**	**20.2**	**-19.1**	**21.8**	**-17.5**
Maximum Queue Length (miles)	**4.3**	**3.5**	**-0.8**	**3.6**	**-0.7**	**3.3**	**-1.0**	**3.4**	**-0.9**	**3.3**	**-1.0**

Table 31
2015 Performance Measures for NJ 3 Approach
7:00-9:00 a.m.

Lane Type	No-Build (Constrained)	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Number of Vehicles											
XBL	295	0	-295	0	-295	0	-295	0	-295	0	-295
GP	2,353	891	-1,461	885	-1,468	1,173	-1,180	827	-1,526	1,268	-1,085
HOT	0	1,450	1,450	1,451	1,451	2,122	2,122	2,070	2,070	1,064	1,064
All Lanes	**2,648**	**2,341**	**-307**	**2,336**	**-312**	**3,295**	**647**	**2,896**	**248**	**2,332**	**-316**
Number of Persons											
XBL	13,293	0	-13,293	0	-13,293	0	-13,293	0	-13,293	0	-13,293
GP	4,781	1,995	-2,786	1,906	-2,875	2,445	-2,337	1,867	-2,915	2,742	-2,040
HOT	0	13,982	13,982	14,455	14,455	15,522	15,522	15,449	15,449	13,837	13,837
All Lanes	**18,074**	**15,977**	**-2,097**	**16,361**	**-1,714**	**17,966**	**-108**	**17,316**	**-759**	**16,578**	**-1,496**
Persons Per Vehicle											
XBL	45.00	-	-	-	-	-	-	-	-	-	-
GP	2.03	2.24	0.21	2.15	0.12	2.08	0.05	2.26	0.23	2.16	0.13
HOT	-	9.64	-	9.96	-	7.31	-	7.46	-	13.00	-
All Lanes	**6.83**	**6.82**	**0.00**	**7.00**	**0.18**	**5.45**	**-1.37**	**5.98**	**-0.85**	**7.11**	**0.28**
Minutes Per Vehicle											
XBL	12.6	-	-	-	-	-	-	-	-	-	-
GP	21.2	27.5	6.3	22.5	1.3	35.5	14.4	23.5	2.3	40.6	19.5
HOT	-	14.9	-	11.1	-	21.6	-	10.8	-	26.2	-
All Lanes	**20.2**	**19.7**	**-0.5**	**15.4**	**-4.8**	**26.6**	**6.4**	**14.4**	**-5.8**	**34.0**	**13.8**
Minutes Per Person											
XBL	12.6	-	-	-	-	-	-	-	-	-	-
GP	22.3	27.7	5.4	21.7	-0.6	36.3	14.0	23.6	1.3	42.2	19.9
HOT	-	14.1	-	10.7	-	21.4	-	10.4	-	26.0	-
All Lanes	**15.2**	**15.8**	**0.6**	**12.0**	**-3.2**	**23.4**	**8.2**	**11.8**	**-3.3**	**28.6**	**13.5**
Maximum Queue Length (miles)	**3.2**	**3.5**	**0.3**	**3.3**	**0.1**	**4.1**	**0.9**	**3.2**	**0.0**	**4.2**	**1.0**

Minutes per Vehicle **–** From this approach, Alternative 2A shows the lowest minutes per vehicle (25.3 minutes per vehicle) and the greatest reduction in total travel time compared to other options. Travel times for XBL buses from this approach are also the best under Alternative 2A, followed by Alternative 3A-Modified.

Minutes per Person **–** Alternative 2A shows the lowest minutes per person (18.6 minutes per person) compared to other options.

Persons per Vehicle – Alternative 3A-Modified shows the highest persons per vehicle (26.54) compared to other options.

Maximum Queue Length (miles) – Alternatives 3A and 4A show the highest reduction in maximum queue length (1.0 miles) over the No-Build condition.

NJ 3 – Table 31 shows the operational results for NJ 3. Under all the alternatives analyzed, the NJ 3 XBL buses are diverted into the HOT lane. As expected, the alternatives that favor access for NJ 3 traffic tend to result in the best HOT lane travel times for this approach. Under all the alternatives, the traffic destined for the general purpose lanes from NJ 3 is limited to one lane. This reduction in capacity on NJ 3 can create higher delays and longer travel times for general purpose traffic. For the alternatives where there may be less traffic choosing the HOT lane and more traffic in the general purpose lanes from NJ 3, (Alternatives 3 and 4), total delays on NJ 3 may increase.

Minutes per Vehicle **–** Alternative 3A-Modified shows the lowest minutes per vehicle (14.4 minutes per vehicle) compared to other options. This results in an improvement of 5.8 minutes in travel time from the No-Build case.

Under Alternative 1A, NJ 3 XBL buses in the HOT lane experience a travel time of 14.1 minutes per vehicle as compared to the XBL No-Build travel time of 12.6 minutes. Under Alternatives 2A and 3A-Modified, the NJ 3 XBL buses also experience a travel time lower than the No-Build condition (10.7 and 10.4 minutes per vehicle respectively).

In Alternatives 3A and 4A, the travel time from NJ 3 increases from the No-Build condition. This happens in Alternative 3A because all HOT lane traffic is diverted to the NJ 3 approach, thereby increasing the total amount of traffic approaching the corridor from NJ 3. Under Alternative 4, traffic from the NJ Turnpike stands to benefit the most from the new connector ramp. Therefore, more traffic from the NJ Turnpike uses the HOT lane in Alternative 4A than the other alternatives. Less traffic from NJ 3 uses the HOT lane in Alternative 4 than in other alternatives and the general purpose lanes from NJ 3 do not improve as much as other alternatives. This increase in delay for general purpose lane traffic spills over into the NJ 3 approach, resulting in higher travel times for NJ 3 XBL buses of 21.4 and 26.0 minutes per vehicle for Alternatives 3A and 4A, respectively, when traveling in the HOT lane, as compared to XBL No-Build travel time of 12.6 minutes.

Minutes per Person **–** Alternative 3A-Modified shows the lowest minutes per person (11.8 minutes per person) compared to other options. In this scenario, the only access to the HOT lane is from NJ 3. The travel time benefits for the XBL buses that have been shifted to the HOT lane are reflected in this measurement. As with vehicle travel time, some alternatives show an increase over the No-Build condition.

Persons per Vehicle **–** Alternative 4A shows the highest persons per vehicle (7.11) compared to other options.

Maximum Queue Length (miles) **–** Alternative 3A-Modified does not show any change in the maximum queue length over the No-Build condition. This is because NJ 3 traffic is not affected under this alternative.

7.3.2 TRAVEL TIME AND QUEUES - MORNING ANALYSIS PERIOD (5-11 A.M.)

Tables 32 through 35 provide a summary comparing the operational performance of each of the alternatives for the entire morning analysis period from 5-11 a.m. Table 32 shows the results for the combination of three approaches, while Tables 32 through 34 show the results for the NJ Turnpike Int. 16E, NJ Turnpike Int. 17, and NJ 3 approaches, respectively.

All Approaches – Table 32 provides a summary of performance measures for the combination of three approaches. As with the earlier tables, degradation in travel times for one approach can sometimes offset improvements for a different approach. Similarly, negative impacts in travel time in some hours can offset improvements in the peak hours. This table reflects the net impacts for all hours from all approaches.

Minutes per Vehicle **–** Alternative 2A shows the lowest minutes per vehicle (15.5 minutes per vehicle) compared to other options, followed by Alternatives 1A and 3A-Modified. The XBL travel times are most improved under Alternative 4A.

Minutes per Person **–** Alternative 2A shows the lowest minutes per person (15.3 minutes per person) compared to other options, followed by Alternatives 1A and 4A.

Persons per Vehicle **–** Alternative 2A shows the highest persons per vehicle (7.81) compared to other options.

NJ Turnpike Int. 16E – Table 33 shows the operational results for the NJ Turnpike Int. 16E approach for the entire morning analysis period.

Table 32
2015 Performance Measures by All Approaches (NJ Turnpike and NJ 3)
5:00-11:00 a.m.

Lane Type	No-Build (Constrained)	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	. 3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Number of Vehicles											
XBL	1,873	1,439	-434	1,439	-434	1,439	-434	1,439	-434	1,439	-434
GP	14,989	7,734	-7,255	7,593	-7,397	8,266	-6,723	8,202	-6,788	7,602	-7,387
HOT	0	5,701	5,701	5,873	5,873	5,446	5,446	5,262	5,262	6,223	6,223
All Lanes	**16,862**	**14,875**	**-1,988**	**14,905**	**-1,957**	**15,151**	**-1,711**	**14,903**	**-1,960**	**15,264**	**-1,598**
Number of Persons											
XBL	84,285	64,755	-19,530	64,755	-19,530	64,755	-19,530	64,755	-19,530	64,755	-19,530
GP	36,339	20,598	-15,741	20,965	-15,374	21,593	-14,746	21,634	-14,705	20,515	-15,824
HOT	0	30,414	30,414	30,659	30,659	29,809	29,809	29,660	29,660	31,139	31,139
All Lanes	**120,624**	**115,767**	**-4,857**	**116,379**	**-4,245**	**116,157**	**-4,467**	**116,048**	**-4,575**	**116,409**	**-4,215**
Persons Per Vehicle											
XBL	45.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00
GP	2.42	2.66	0.24	2.76	0.34	2.61	0.19	2.64	0.21	2.70	0.27
HOT	-	5.33	-	5.22	-	5.47	-	5.64	-	5.00	-
All Lanes	**7.15**	**7.78**	**0.63**	**7.81**	**0.65**	**7.67**	**0.51**	**7.79**	**0.63**	**7.63**	**0.47**
Minutes Per Vehicle											
XBL	34.1	20.5	-13.6	17.7	-16.4	19.6	-14.5	23.6	-10.5	17.0	-17.1
GP	28.5	19.8	-8.7	17.7	-10.8	24.2	-4.3	24.0	-4.5	24.1	-4.5
HOT	-	13.9	-	12.1	-	23.5	-	9.1	-	15.8	-
All Lanes	**29.1**	**17.6**	**-11.5**	**15.5**	**-13.7**	**23.5**	**-5.6**	**18.7**	**-10.5**	**20.0**	**-9.1**
Minutes Per Person											
XBL	34.1	20.5	-13.6	17.7	-16.4	19.6	-14.5	23.6	-10.5	17.0	-17.1
GP	25.4	17.1	-8.2	15.4	-10.0	21.3	-4.1	20.3	-5.1	21.0	-4.3
HOT	-	12.1	-	10.3	-	16.3	-	9.2	-	18.9	-
All Lanes	**31.5**	**17.7**	**-13.7**	**15.3**	**-16.1**	**19.1**	**-12.4**	**19.3**	**-12.2**	**18.2**	**-13.2**
Maximum Queue Length (miles)	**7.1**	**4.2**	**-2.9**	**4.3**	**-2.8**	**4.1**	**-3.0**	**4.6**	**-2.5**	**4.3**	**-2.8**

Table 33
2015 Performance Measures for NJ Turnpike Int. 16E Approach
5:00-11:00 a.m.

Lane Type	No-Build (Constrained)	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Number of Vehicles											
XBL	843	843	0	843	0	843	0	843	0	843	0
GP	5,119	2,946	-2,173	2,895	-2,224	3,302	-1,817	4,156	-962	2,158	-2,961
HOT	0	1,323	1,323	1,424	1,424	1,151	1,151	0	0	2,440	2,440
All Lanes	**5,962**	**5,112**	**-850**	**5,162**	**-800**	**5,296**	**-666**	**4,999**	**-962**	**5,441**	**-521**
Number of Persons											
XBL	37,935	37,935	0	37,935	0	37,935	0	37,935	0	37,935	0
GP	12,541	8,726	-3,815	9,069	-3,472	9,508	-3,033	10,984	-1,557	7,676	-4,865
HOT	0	2,267	2,267	2,355	2,355	1,819	1,819	0	0	3,955	3,955
All Lanes	**50,476**	**48,928**	**-1,548**	**49,359**	**-1,118**	**49,262**	**-1,215**	**48,919**	**-1,557**	**49,566**	**-910**
Persons Per Vehicle											
XBL	45.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00
GP	2.45	2.96	0.51	3.13	0.68	2.88	0.43	2.64	0.19	3.56	1.11
HOT	-	1.71	-	1.65	-	1.58	-	-	-	1.62	-
All Lanes	**8.47**	**9.57**	**1.10**	**9.56**	**1.10**	**9.30**	**0.84**	**9.79**	**1.32**	**9.11**	**0.64**
Minutes Per Vehicle											
XBL	45.7	22.8	-22.9	19.3	-26.5	19.9	-25.8	28.4	-17.3	15.9	-29.8
GP	42.4	22.6	-19.7	20.7	-21.7	25.1	-17.3	29.7	-12.6	22.9	-19.5
HOT	-	21.6	-	18.9	-	20.3	-	-	-	13.3	-
All Lanes	**42.8**	**22.4**	**-20.5**	**19.9**	**-22.9**	**23.2**	**-19.6**	**29.5**	**-13.3**	**17.5**	**-25.3**
Minutes Per Person											
XBL	45.7	22.8	-22.9	19.3	-26.5	19.9	-25.8	28.4	-17.3	15.9	-29.8
GP	36.9	18.1	-18.8	16.8	-20.1	20.8	-16.1	24.1	-12.8	17.5	-19.4
HOT	-	21.3	-	18.8	-	20.3	-	-	-	13.4	-
All Lanes	**43.5**	**21.9**	**-21.7**	**18.8**	**-24.8**	**20.1**	**-23.4**	**27.5**	**-16.1**	**15.9**	**-27.6**
Maximum Queue Length (miles)	**7.1**	**4.2**	**-2.9**	**4.3**	**-2.8**	**3.8**	**-3.3**	**4.6**	**-2.5**	**3.6**	**-3.5**

Table 34
2015 Performance Measures for NJ Turnpike Int. 17 Approach
5:00-11:00 a.m.

Lane Type	No-Build (Constrained)	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	. 3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Number of Vehicles											
XBL	596	596	0	596	0	596	0	596	0	596	0
GP	2,438	1,370	-1,068	1,324	-1,114	1,010	-1,428	926	-1,512	1,085	-1,353
HOT	0	651	651	680	680	1,121	1,121	0	0	1,030	1,030
All Lanes	**3,034**	**2,617**	**-417**	**2,600**	**-435**	**2,727**	**-307**	**1,522**	**-1,512**	**2,711**	**-323**
Number of Persons											
XBL	26,820	26,820	0	26,820	0	26,820	0	26,820	0	26,820	0
GP	5,543	3,772	-1,771	3,812	-1,731	3,197	-2,346	3,062	-2,481	3,174	-2,370
HOT	0	1,149	1,149	1,136	1,136	1,790	1,790	0	0	1,674	1,674
All Lanes	**32,363**	**31,741**	**-622**	**31,768**	**-596**	**31,806**	**-557**	**29,882**	**-2,481**	**31,667**	**-696**
Persons Per Vehicle											
XBL	45.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00	45.00	0.00
GP	2.27	2.75	0.48	2.88	0.61	3.16	0.89	3.31	1.03	2.92	0.65
HOT	-	1.76	-	1.67	-	1.60	-	-	-	1.63	-
All Lanes	**10.67**	**12.13**	**1.46**	**12.22**	**1.55**	**11.66**	**1.00**	**19.63**	**8.97**	**11.68**	**1.02**
Minutes Per Vehicle											
XBL	33.3	17.3	-16.0	15.4	-17.8	19.1	-14.2	16.7	-16.5	18.6	-14.7
GP	38.4	20.9	-17.5	18.8	-19.6	26.3	-12.1	23.3	-15.1	25.1	-13.3
HOT	-	16.3	-	14.0	-	20.2	-	-	-	15.6	-
All Lanes	**37.4**	**18.9**	**-18.4**	**16.8**	**-20.6**	**22.2**	**-15.2**	**20.7**	**-16.6**	**20.0**	**-17.4**
Minutes Per Person											
XBL	33.3	17.3	-16.0	15.4	-17.8	19.1	-14.2	16.7	-16.5	18.6	-14.7
GP	32.7	17.9	-14.7	15.9	-16.8	20.7	-12.0	17.8	-14.9	19.3	-13.3
HOT	-	16.1	-	14.2	-	20.2	-	-	-	15.7	-
All Lanes	**33.2**	**17.4**	**-15.8**	**15.4**	**-17.7**	**19.3**	**-13.8**	**16.9**	**-16.3**	**18.5**	**-14.7**
Maximum Queue Length (miles)	**4.3**	**3.5**	**-0.8**	**3.6**	**-0.7**	**3.3**	**-1.0**	**3.4**	**-0.9**	**3.3**	**-1.0**

Table 35
2015 Performance Measures for NJ 3 Approach
5:00-11:00 a.m.

Lane Type	No-Build (Constrained)	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	. 3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Number of Vehicles											
XBL	434	0	-434	0	-434	0	-434	0	-434	0	-434
GP	7,432	891	-6,541	885	-6,547	1,173	-6,259	827	-6,605	1,268	-6,164
HOT	0	3,727	3,727	3,769	3,769	5,446	5,446	5,262	5,262	2,753	2,753
All Lanes	**7,866**	**4,619**	**-3,248**	**4,654**	**-3,212**	**6,619**	**-1,247**	**6,089**	**-1,777**	**4,021**	**-3,845**
Number of Persons											
XBL	19,530	0	-19,530	0	-19,530	0	-19,530	0	-19,530	0	-19,530
GP	18,254	8,099	-10,155	8,084	-10,170	8,888	-9,367	7,587	-10,667	9,665	-8,589
HOT	0	26,999	26,999	27,169	27,169	29,809	29,809	29,660	29,660	25,510	25,510
All Lanes	**37,784**	**35,098**	**-2,686**	**35,253**	**-2,532**	**38,697**	**913**	**37,247**	**-537**	**35,175**	**-2,609**
Persons Per Vehicle											
XBL	45.00	-	-	-	-	-	-	-	-	-	-
GP	2.46	9.09	6.63	9.13	6.68	7.58	5.12	9.18	6.72	7.62	5.17
HOT	-	7.24	-	7.21	-	5.47	-	5.64	-	9.26	-
All Lanes	**4.80**	**7.60**	**2.80**	**7.57**	**2.77**	**5.85**	**1.04**	**6.12**	**1.31**	**8.75**	**3.94**
Minutes Per Vehicle											
XBL	12.6	-	-	-	-	-	-	-	-	-	-
GP	15.8	65.1	49.3	56.1	40.4	77.3	61.5	62.4	46.6	83.8	68.1
HOT	-	10.8	-	9.2	-	15.0	-	9.1	-	18.0	-
All Lanes	**15.6**	**21.3**	**5.7**	**18.1**	**2.6**	**26.1**	**10.5**	**16.3**	**0.7**	**38.7**	**23.2**
Minutes Per Person											
XBL	12.6	-	-	-	-	-	-	-	-	-	-
GP	15.2	15.7	0.5	13.5	-1.7	22.0	6.8	15.7	0.5	24.4	9.2
HOT	-	11.2	-	9.4	-	16.3	-	9.2	-	20.0	-
All Lanes	**13.9**	**12.2**	**-1.6**	**10.3**	**-3.5**	**17.7**	**3.8**	**10.5**	**-3.3**	**21.2**	**7.4**
Maximum Queue Length (miles)	**4.1**	**3.5**	**-0.6**	**3.3**	**-0.8**	**4.1**	**0.0**	**3.2**	**-0.9**	**4.3**	**0.2**

Minutes per Vehicle – As expected, Alternative 4A shows the best travel time for the NJ Turnpike Int. 16E approach, with 17.5 minutes per vehicle, representing an improvement of 25.3 minutes over the No-Build. Travel times for buses using XBL are also the most improved, with travel times of 15.9 minutes, or 30 minutes less than the No-Build. Alternatives 2A and 1A are the next best improved.

Minutes per Person –Similar to the minutes per vehicle measurement, Alternative 4A shows the lowest minutes per person (15.9 minutes per person) compared to other options, with alternatives 2A and 1A following.

Persons per Vehicle – Alternative 3A-Modified shows the highest persons per vehicle (9.79) compared to other options.

Maximum Queue Length (miles) – Alternative 4A shows the highest reduction in maximum queue length (3.5 miles) over the No-Build condition.

As noted earlier, Alternative 4A most benefits the NJ Turnpike Int. 16E traffic due to the improved access to the HOT lane. The higher rate of diversion to the HOT lane reduces general purpose lane travel times from this approach.

NJ Turnpike Int. 17 – Table 34 shows the operational results for the NJ Turnpike Int. 17 approach for the entire morning analysis period. In general, patterns are similar to those found in Table 32 for the northbound approach.

Minutes per Vehicle – Alternative 2A shows the lowest minutes per vehicle (16.8 minutes per vehicle) compared to other options, followed by Alternative 1A.

Minutes per Person – Alternative 2A shows the lowest minutes per person (15.4 minutes per person) compared to other options, followed by Alternative 3A-Modified.

Persons per Vehicle – Alternative 3A-Modified shows the highest persons per vehicle (19.63) compared to other options.

Maximum Queue Length (miles) – Alternatives 3A and 4A show the highest reduction in maximum queue length (1.0 miles) over the No-Build condition.

NJ 3 – Table 35 shows the operational results for the NJ 3 approach for the entire morning analysis period.

Minutes per Vehicle – For all scenarios, the average travel time for the entire morning analysis period is slightly higher than under the No-build condition. This could be due to the lane usage restrictions on the express connector ramp that must be applied to implement the HOT lane. Under current conditions, traffic can spread between the two lanes as needed. During less congested times of the morning, traffic from NJ 3 can avoid turbulence from NJ 495 by staying in the left lane. With a HOT lane, the left lane will be designated as a HOT lane and may not be as fully utilized as it would under the No-Build condition.

Of the Build alternatives, Alternative 3A-Modified shows the lowest travel time (16.3 minutes per vehicle) compared to other options, since this scenario would have the greatest number of vehicles from NJ 3 in the HOT lane. Alternative 4A performs the worst for NJ 3 for the same reasons that it did for the peak hours; increased HOT lane usage by NJ Turnpike traffic results in fewer NJ 3 vehicles and sub-optimal usage of the lanes on the connector ramp.

Travel times for XBL buses improve from 12.6 minutes under No-Build conditions to just over 9 minutes under Alternatives 3A-Modified and 2A (XBL buses from NJ 3 will be in the HOT lane).

Minutes per Person – Alternatives 2A and 3A-Modified show the lowest minutes per person (10.3 minutes and 10.5 minutes, respectively) compared to other options, with a savings of 3.3 minutes to 3.5 minutes from No-Build. Travel time per person for NJ 3 traffic increases by 7.4 minutes per person under Alternative 4A compared to No-Build.

Persons per Vehicle – Alternative 4A shows the highest persons per vehicle (8.75) compared to other options.

Maximum Queue Length (miles) – Alternative 3A does not show any change in the maximum queue length over the No-Build condition.

7.3.3 VEHICLE THROUGHPUT - PEAK HOURS (7-9 A.M.)

The amount of vehicles processed, or vehicle throughput levels, was extracted from the VISSIM model at two locations in the corridor – at the Lincoln Tunnel toll plaza and at a point on the mainline between the JFK Boulevard on-ramp and the Pleasant Avenue off-ramp.

Table 36 shows the vehicle throughputs during the peak hours from 7-9 a.m.

Lincoln Tunnel Plaza – As shown in the table, Toll Lane 4 at the Lincoln Tunnel toll plaza processes the highest amount of traffic under Alternative 3A followed by Alternative 4A. This is similar to today's operating conditions. It should be noted that under the No-Build condition, Toll Lane 4 of the plaza is used by E-ZPass® traffic and under the Build condition, Toll Lane 4 is converted into a HOT lane.

The number of XBL buses processed at the plaza is consistent across each alternative. As stated earlier, NJ 3 XBL traffic is routed into the HOT lane for each alternative; therefore, the XBL traffic processed under each alternative is lower than the No-Build condition.

Table 36
Vehicle Throughput at Lincoln Tunnel Toll Plaza and on NJ 495 East of JFK Boulevard
7:00-9:00 A.M.

Location	Lane	No-Build*	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	Alt. 3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Lincoln Tunnel Toll Plaza	Lane 4	1,618	2,037	419	2,069	451	2,147	529	2,098	480	2,127	509
	All other lanes	6,702	6,380	-322	6,441	-260	6,433	-269	6,410	-292	6,403	-298
	Total	**8,320**	**8,417**	**97**	**8,510**	**190**	**8,580**	**261**	**8,508**	**189**	**8,530**	**210**
	XBL	1,273	988	-285	995	-278	995	-278	995	-278	996	-277
NJ 495 Between JFK Blvd. and Pleasant Ave.	GP	7,125	5,508	-1,617	5,560	-1,565	5,225	-1,900	5,398	-1,727	5,133	-1,992
	HOT	0	2,044	2,044	2,070	2,070	2,136	2,136	2,087	2,087	2,108	2,108
	Total	**7,125**	**7,552**	**427**	**7,630**	**505**	**7,361**	**236**	**7,485**	**360**	**7,241**	**116**
	GP (per lane)	2,375	2,754	379	2,780	405	2,613	238	2,699	324	2,567	192

*No-Build is the constrained demand

JFK Boulevard and Pleasant Avenue – Alternative 2A processes the highest amount of traffic on NJ 495 between JFK Boulevard and the Pleasant Avenue off-ramp. Under this alternative, the corridor processes a total of 7,630 vehicles across all three lanes over the two-hour period. It should be noted that all of the Build alternatives process a higher amount of traffic on the general purpose lanes than the No-Build case.

7.3.4 VEHICLE THROUGHPUT - MORNING ANALYSIS PERIOD 5-11 A.M.

Table 37 shows the vehicle throughputs at two locations during the 5-11 a.m. period.

Lincoln Tunnel Plaza – As shown in Table 37, Toll Lane 4 at the Lincoln Tunnel toll plaza processes the highest amount of traffic under Alternative 4A compared to other alternatives. Overall, however, the throughput at the toll plaza under each alternative is lower than the No-Build case. The main reason is that the traffic from the helix approach is allowed to use the outer lanes of the Lincoln Tunnel toll plaza during lower-volume shoulder hours (5-7 a.m. and 9-11 a.m.) under the No-Build condition. Under each of the Build conditions, those booths would not be available to the traffic from the general purpose lanes from the helix. This condition may be improved through a different set of lane usage assumptions during non-peak hours. The XBL traffic processed at the plaza is the same under each alternative.

JFK Boulevard and Pleasant Avenue – For the entire six-hour analysis period, Alternative 4A processes the highest amount of traffic on NJ 495 between JFK Boulevard and the Pleasant Avenue off-ramp. Similar to the observations for peak hours, each alternative processes a higher amount of corridor traffic than the No-Build condition.

Table 37
Vehicle Throughput at Lincoln Tunnel Toll Plaza and on NJ 495 East of JFK Boulevard
(5:00-11:00 A.M.)

Location	Lane	No-Build*	Alt. 1A	Difference from No-Build	Alt. 2A	Difference from No-Build	Alt. 3A	Difference from No-Build	Alt. 3A-Mod.	Difference from No-Build	Alt. 4A	Difference from No-Build
Lincoln Tunnel Toll Plaza	Lane 4	4,583	5,685	1,102	5,869	1,286	5,429	846	5,255	671	6,158	1,574
	All other lanes	19,690	17,424	-2,265	17,409	-2,281	18,027	-1,663	17,998	-1,692	17,387	-2,303
	Total	**24,273**	**23,110**	**-1,163**	**23,278**	**-995**	**23,456**	**-817**	**23,253**	**-1,021**	**23,545**	**-729**
	XBL	1,942	1,508	-434	1,508	-434	1,508	-434	1,508	-434	1,508	-434
NJ 495 Between JFK Blvd. and Pleasant Ave.	GP	23,242	16,434	-6,807	16,320	-6,922	16,937	-6,305	16,910	-6,332	16,296	-6,946
	HOT	0	5,689	5,689	5,866	5,866	5,434	5,434	5,255	5,255	6,182	6,182
	Total	**23,242**	**22,123**	**-1,118**	**22,186**	**-1,056**	**22,371**	**-871**	**22,165**	**-1,077**	**22,478**	**-764**
	GP (per lane)	7,747	8,217	470	8,160	413	8,468	721	8,455	708	8,148	401

*No-Build is the constrained demand

Chapter 8 SCREENING OF ALTERNATIVES

A series of screening criteria was developed to help compare the study alternatives and assess the relative benefits of each option. The resulting comparative analysis was used to develop a ranking of each alternative. Weights were applied to each criterion to help develop a priority ranking of alternatives, with the goal of selecting two alternatives for further consideration and implementation planning.

8.1 SCREENING CRITERIA

Several criteria were identified for screening and determining the feasible alternatives. These criteria were established based on discussions with the representatives from the NJ Department of Transportation and NJ Turnpike Authority who served as an oversight committee with Port Authority staff for this study. The criteria employed in this analysis are detailed in the remainder of Section 8.1.

8.1.1 MOBILITY

Mobility is defined by the corridor throughput that can be achieved. Throughput is measured in terms of the number of vehicles and number people that can be moved within the corridor during the peak period. Mobility is evaluated using three criteria:

- Vehicle Trips
- Person Trips
- Persons per Vehicle

8.1.2 CORRIDOR EFFICIENCY

Corridor efficiency is defined as the ability for vehicles and people to move through the corridor with minimal travel times and delay. Corridor efficiency is evaluated using four criteria:

- Minutes per Vehicle - Travel time experienced by each vehicle within the corridor. Lower vehicle travel times result in higher corridor efficiency.
- Minutes per Person - Travel time experienced by each person within the corridor. Lower person travel time results in higher corridor efficiency. Travel time for buses in the XBL and the proposed HOT lane are important factors for this criterion.
- Maximum Queue Lengths - Queue length is measured by the total distance that vehicles are queued from the Lincoln Tunnel toll plaza during the entire analysis period.
- Diversions to Other Corridors - The amount of traffic that diverts to alternate crossings due to increases in congestion and delay within the NJ 495 corridor. Higher diversions indicate poor corridor efficiency.

8.1.3 OPERATIONAL CONSIDERATIONS

Operational issues play a key role in the feasibility of any alternative. The operational considerations addressed in the ranking of alternatives employed three criteria:

- Safety - A critical aspect of corridor operations involving the protection of drivers and travelers, and the non-recurring delays caused by incidents in the corridor. Safety concerns on the mainline segment include merging, diverging, and weaving areas, and also consider the mix of large and small vehicles that must converge to enter the confined tunnel portals and traverse the substandard lane widths on portions of the NJ 495 corridor. A comparison of the Study alternatives indicates that some alternatives conform to operational and design guidelines better than others.

- Facility Operations - The relative ease of operating the proposed HOT lane facility is considered qualitatively for this criterion. Specific items considered for this criterion include how traffic will be monitored or verified to allow HOV discounts, what will be required to open and close the new managed lane each day, and how complex and clear the signage and restrictions for the HOT lane may be.

- Enforcement - Enforcement must address the requirement that all vehicles using the proposed HOT lane have a valid E-ZPass® transponder, as well as vehicle occupancy enforcement for alternatives that allow free access for HOV-3+ in the proposed HOT lane. The allowance of certain commercial vehicle classes at specified hours also adds to enforcement complexity when the system needs to ensure that only the proper vehicle types use the managed lane and only during permissible hours.

8.1.4 IMPLEMENTATION CONSIDERATIONS

Implementation issues generally address the ease of moving from the feasibility assessments and planning to an operational managed lane in the corridor. Key considerations include agency financial requirements, impacts on local constituencies, and the benefits and impacts to specific groups of users. Each study alternative in this corridor possess one or more implementation challenges. The criteria used to consider implementation issues are:

- Capital Cost - A qualitative estimate of the relative investment requirements to build a capital improvement including roadways, structures, and other physical improvements, was considered for each alternative. Lower capital costs resulted in a higher rating for ease of implementation.

- Local Impacts - The local impacts of most alternatives include the implications for the removal of a general purpose lane from the highway mainline on the bordering communities, coupled with the fact that residents and businesses along the corridor have no easy access to the new managed lane. The relative local impacts of the study alternatives have a primary focus on the likelihood for traffic diversions to the parallel local street system. This criterion assigns lower ranks to alternatives that have a higher impact on local streets.

- Equitable Access to the Proposed HOT Lane Access - This criterion evaluated the availability and ease of access to the proposed HOT lane for each of the three main user groups that enter the NJ 495 corridor at its western end – NJ Turnpike Int. 16E, NJ Turnpike Int. 17, and NJ 3. If the proposed HOT lane can be accessed by each of the three approach roads, the equity access is rated higher.

- Construction Impacts - This qualitative criterion is rated based on the anticipated impacts during construction such as maintenance and protection of traffic, lane closures, etc. The highest rating is associated with the lowest construction impact.

8.2 FEASIBILITY MATRIX

Based on the operational performance of the corridor and discussions with the Port Authority's operations and planning staff, regional agencies that compromised the project oversight committee and the consultant team, each alternative was rated using the screening criteria using ratings from 1 to 3, representing low, medium and high ratings. A score of 1 is the lowest value and a score of 3 representing the best rating. Each of the screening criteria was rated for the 7-9 a.m. peak period and also over the six-hour 5-11 a.m. period. Tables 38 and 39 show the feasibility matrices, which include the rating for each criterion during the 7-9 a.m. and 5-11 a.m. time periods respectively.

8.2.1 WEIGHTING

Each of the screening criteria was weighted to derive a rating for each alternative. Tables 38 and 39 list the weights associated with each screening criteria.

As indicated in the tables, the mobility and corridor efficiency groups were given a higher weight (i.e., a total of 57 percent) indicating the importance of corridor performance as a prime rationale for accepting any of the study alternatives. Among the remaining criteria, safety was weighed highly (12 percent). Equitable access, an important implementation issue for this project, was weighted equal to or higher than some of the mobility and corridor efficiency criteria.

Table 38
Lincoln Tunnel HOT Lane Rating
Total Traffic (HOT Lane, XBL, and General Purpose Lanes Combined)
7:00-9:00 A.M.

		NJ 495 w/ Weave Section				NJ 3 Approach				New Parallel Roadway	
Measures of Effectiveness	**Weight**	**Alternative 1A (Weave)**	**Weighted Rating**	**Alternative 2A (w/trucks)**	**Weighted Rating**	**Alternative 3A (Drop Rp)**	**Weighted Rating**	**Alternative 3A-Mod. (No Drop Rp)**	**Weighted Rating**	**Alternative 4A (New Bridge)**	**Weighted Rating**
Mobility											
Vehicle Demand	5%	1	0.05	1	0.05	3	0.15	3	0.15	3	0.15
Person Demand	12%	2	0.24	2	0.24	2	0.24	2	0.24	2	0.24
Persons-per-Vehicle	10%	3	0.30	3	0.30	2	0.20	2	0.20	2	0.20
Corridor Efficiency (1)											
Minutes-per-Vehicle	5%	2	0.10	3	0.15	1	0.05	2	0.10	2	0.10
Minutes-per-Person	10%	2	0.20	3	0.30	1	0.10	1	0.10	2	0.20
Max Queue Lengths	6%	2	0.12	2	0.12	2	0.12	1	0.06	2	0.12
Diversions to Other Corridors	6%	1	0.06	1	0.06	2	0.12	2	0.12	2	0.12
Operational Issues (2)											
Safety Issues	12%	1	0.12	1	0.12	2	0.24	3	0.36	3	0.36
Facility Operations	5%	2	0.10	1	0.05	1	0.05	3	0.15	3	0.15
Enforcement	5%	2	0.10	1	0.05	2	0.10	3	0.15	3	0.15
Implementation											
Capital Cost	7%	3	0.21	2	0.14	1	0.07	2	0.14	1	0.07
Local Impacts(3)	4%	1	0.04	2	0.08	2	0.08	1	0.04	3	0.12
Equity Access(4)	10%	3	0.30	3	0.30	2	0.20	1	0.10	3	0.30
Construction Impacts	3%	3	0.09	3	0.09	2	0.06	3	0.09	1	0.03
Total Points	**100%**		**2.03**		**2.05**		**1.78**		**2.00**		**2.31**

(1) Corridor Efficiency is defined as to how the new scenario will improve the overall movement of people and vehicles within the corridor.
(2) Operational Issues represent the specific day-to-day requirements and conditions needed to make the lane operationally variable.
(3) Local Impacts is a combination of Vehicle Demand, Min-per-veh, max queue, and diversions to other corridors.
(4) Equity Access - is a combination of the availability of the HOT lane to all approaches AND how direct the approach entry is.

Items are rated from 1 to 3 with 3=highest/best value, 2=good or secondary, and 1=lowest ranking
The alternatives with the highest overall rating are preferred.

Table 39
Lincoln Tunnel HOT Lane Rating
Total Traffic (HOT Lane, XBL, and General Purpose Lanes Combined)
5:00-11:00 A.M.

Measures of Effectiveness	Weight	NJ 495 w/ Weave Section				NJ 3 Approach				New Parallel Roadway	
		Alternative 1A (Weave)	Weighted Rating	Alternative 2A (w/trucks)	Weighted Rating	Alternative 3A (Drop Rp)	Weighted Rating	Alternative 3A-Mod. (No Drop Rp)	Weighted Rating	Alternative 4A (New Bridge)	Weighted Rating
Mobility											
Vehicle Demand	5%	2	0.10	2	0.10	3	0.15	2	0.10	3	0.15
Person Demand	12%	2	0.24	2	0.24	2	0.24	2	0.24	2	0.24
Persons-per-Vehicle	10%	2	0.20	2	0.20	2	0.20	2	0.20	2	0.20
Corridor Efficiency (1)											
Minutes-per-Vehicle	5%	2	0.10	3	0.15	1	0.05	2	0.10	1	0.05
Minutes-per-Person	10%	2	0.20	3	0.30	1	0.10	1	0.10	2	0.20
Max Queue Lengths	6%	2	0.12	2	0.12	2	0.12	1	0.06	2	0.12
Diversions to Other Corridors	6%	2	0.12	2	0.12	2	0.12	2	0.12	2	0.12
Operational Issues (2)											
Safety Issues	12%	1	0.12	1	0.12	2	0.24	3	0.36	3	0.36
Facility Operations	5%	2	0.10	1	0.05	1	0.05	3	0.15	3	0.15
Enforcement	5%	2	0.10	1	0.05	2	0.10	3	0.15	3	0.15
Implementation											
Capital Cost	7%	3	0.21	2	0.14	1	0.07	2	0.14	1	0.07
Local Impacts (3)	4%	1	0.04	2	0.08	2	0.08	1	0.04	3	0.12
Equity Access (4)	10%	3	0.30	3	0.30	2	0.20	1	0.10	3	0.30
Construction Impacts	3%	3	0.09	3	0.09	2	0.06	3	0.09	1	0.03
Total Points	**100%**		**2.04**		**2.06**		**1.78**		**1.95**		**2.26**

(1) Corridor Efficiency is defined as to how the new scenario will improve the overall movement of people and vehicles within the corridor.
(2) Operational Issues represent the specific day-to-day requirements and conditions needed to make the lane operationally variable.
(3) Local Impacts is a combination of Vehicle Demand, Min-per-veh, max queue, and diversions to other corridors.
(4) Equity Access - is a combination of the availability of the HOT lane to all approaches AND how direct the approach entry is.

Items are rated from 1 to 3 with 3=highest/best value, 2=good or secondary, and 1=lowest ranking
The alternatives with the highest overall rating are preferred.

8.2.2 MOBILITY CRITERIA

During the 7-9 a.m. peak period, total vehicle trips is highest under Alternatives 3A, 3A-M, and 4A, while Alternatives 1A and 2A indicate a lower number of vehicle trips by about 6 percent. During the 5-11 a.m. period, Alternatives 3A and 4A accommodate the highest number of vehicle trips, while Alternatives 1A, 2A, and 3A-M are lower by about 3 percent. The number of person trips for both the 7-9 a.m. period and the 5-11 a.m. period were very similar in all alternatives. Finally, Alternatives 1A and 2A showed a slightly higher ratio of persons per vehicle in the corridor during the peak 7-9 a.m. period, while the persons per vehicle ratio was similar in each alternative over the full 5-11 a.m. period.

8.2.3 CORRIDOR EFFICIENCY CRITERIA

In terms of travel time measures, Alternative 2A performed well during the peak hours and the entire morning commute period, for both vehicle travel time and person travel time. Alternatives 1A and 4A also perform well, particularly emerging as strong alternatives in person travel time in the corridor. While Alternative 3A-M performs satisfactorily in terms of vehicular travel time, it does not perform as well in person travel time. Alternative 3A-M also showed the longest queues because the NJ Turnpike traffic does not have access to the proposed HOT lane. Finally, in terms of traffic diversion to other corridors, Alternatives 1A and 2A showed the most traffic diversion in the 7-9 a.m. period. The remaining alternatives diverted 35 percent less traffic to alternate crossings.

8.2.4 OPERATIONAL CRITERIA

8.2.4.1 Safety

Alternatives 1A and 2A feature a weave entrance to the proposed HOT lane to serve NJ Turnpike traffic. While this type of access design is used for HOV and HOT lanes in other parts of the country, recent studies by the Texas Transportation Institute have found that an excessive difference in speeds between entering vehicles and vehicles in the HOT lane may result in an increase in traffic accidents at a weave access location. This may be offset by a potential reduction in incidents due to less weaving on the rest of the corridor due to a smoother flow of traffic through the proposed HOT lane. In addition, while the weave access point would create a complex weave situation at this location, traffic from the NJ Turnpike would be required to weave across general purpose lane traffic that is in the right lane of the NJ 3 connector before they could enter the proposed HOT lane. While the simulation model shows that this maneuver does not cause additional delay, this location would require more specific operational analysis should these scenarios be advanced.

Alternative 2A considers allowing commercial vehicles with two and three axles into the proposed HOT lane for two hours of the day (i.e., 5-6 a.m. and 10-11 a.m.). Given that the proposed HOT lane is designated for the left lane of eastbound NJ 495, left-lane restrictions would need to be lifted during these hours, but remain in place during the rest of the day. At the Lincoln Tunnel, two- and three-axle vehicles are also prohibited from using the Center Tube when the South Tube is open. Allowing these vehicles into the proposed HOT lane would need to weigh either allowing them to use the Center Tube for the two hours of the commercial HOT lane operation, or requiring a difficult left hand merge in crowded conditions after the toll plaza to access the left lane of the South Tube.

Alternative 3A would direct traffic from the NJ Turnpike northbound approach to the frontage road toward the Paterson Plank Road/Harmon Meadow Boulevard intersection. Traffic would then be directed to use a new drop ramp that is added on the bridge from Harmon Meadow Boulevard to the left side of NJ 3. This design has been used elsewhere the U.S. in HOV facilities with limited points of access, although in those cases, there is more lateral clearance available for breakdown lanes and acceleration lanes. This scenario would direct additional traffic to the Paterson Plank Road/Harmon Meadow Boulevard intersection, which already experiences queues and delay during peak hours. Alternative 3A-Modified is the same as Alternative 3A, but removes the drop ramp. This alternative represents the smallest amount of change to the existing roadway system of all the Study alternatives, but represents a trade-off of access, equity, and potentially effectiveness.

Alternative 4A involves the construction of a new bridge and access ramps to provide access to the proposed HOT lane from the NJ Turnpike. While this alternative is considered to have the highest design requirements in that all the approaches to the proposed HOT lanes would be through free-flow/high-speed connections, the design challenges presented by the already-complicated roadway geometries in this area require that traffic merge from the left to join the main stream of traffic. Specifically, NJ Turnpike southbound traffic joins the northbound stream of traffic from the left side. Together, this traffic proceeds to join the HOT lane coming from NJ 3 on the left side from a higher elevation, which potentially constrains sight distance. While general highway design principles desire to avoid the number of left hand entrance and exits, the traffic volumes performing these maneuvers are expected to flow well, which should ease their ability to merge.

Alternatives 1A and 2A pose the highest concern relative to safety. Under these alternatives, traffic from the NJ Turnpike is allowed to access the proposed HOT lane via a two-lane shift over to the left. While shifting two lanes, NJ Turnpike traffic has to watch for oncoming traffic from the NJ 3 general purpose and HOT lanes. This creates a challenging and difficult situation for drivers wanting to use the proposed HOT lane from the NJ Turnpike. Under Alternative 3A, the location of the drop ramp and its merge with NJ 3 traffic creates a safety concern under this alternative.

8.2.4.2 Facility Operations

Some alternatives, such as the HOV discount options, require additional planning and, potentially, equipment to implement. The alternative with commercial vehicles in the proposed HOT lane presents operational challenges for signage and how commercial vehicles should be directed to the south tube would be difficult to address fully. The ability for traffic to enter the proposed HOT lane in an intermediate section may cause operational problems due to weaving in the general-purpose lanes. Placement of posts to channelize traffic becomes critical to ensure that they are in place correctly at times when the proposed HOT lane would be operational. Installation and removal of these posts will represent increased resources to manage in a timely and safe manner. For the alternative where a drop ramp is proposed to NJ 3, signage would have to be provided for NJ Turnpike traffic.

Alternative 2A creates a major concern relative to management at the toll plaza facility since trucks are allowed in the proposed HOT lane. Placement of posts to demarcate the proposed HOT lane may be more critical in this alternative as trucks require additional time to merge and accelerate than automobiles. Alternative 3A raises the concern of identifying a location for placement of pricing management devices and signs for motorists prior to entering the proposed HOT lane. Since this option uses a drop ramp from Harmon Meadow Boulevard onto NJ 3, the operation of the traffic signal on Harmon Meadow Boulevard would have to be monitored periodically. The monitoring would include updating signal timing and coordination parameters on the local streets leading up to the drop ramp.

Alternative 1A is a concern relative to management of NJ Turnpike traffic entering the proposed HOT lane and providing appropriate signage and collection points for the HOT lane fee. However, this is not as significant as Alternatives 2A and 3A.

8.2.4.3 Enforcement

Allowing commercial vehicles into the HOT lane would not necessarily be an enforcement concern during the hours they are allowed in there for a fee. However, it may complicate enforcement of commercial vehicle restrictions during other hours of the day and require additional enforcement during other hours of the day. Decisions will need to be made as to where police officers will be able to pull vehicles over to issue citations.

As a consequence, Alternative 2A would create significant enforcement challenges and cost issues relative to truck access, management at the toll plaza, and allowing trucks into the tunnel. Relatively, Alternatives 1A and 3A create minor enforcement issues arising from lane and HOT lane fee violations, HOV verifications, etc. These are minor enforcement issues in comparison to Alternative 2A.

8.2.5 IMPLEMENTATION CRITERIA

8.2.5.1 Capital Cost

Alternatives 3A and 4A have the highest capital cost involved due to significant roadway and bridge construction designed to accommodate access to the proposed HOT lane. Alternatives 2A and 3A-M would have capital cost associated with signage and equipment placement. Alternative 1A is relatively easy to implement and therefore, the capital cost would be least significant of the study alternatives.

8.2.5.2 Local Impacts

The local impact criterion considers the fact that some Study alternatives divert NJ 495 onto the local street system, and that alternatives with excessive delay or indirect access may cause drivers to divert to local streets. Based on these measures, Alternative 4A is rated the highest, Alternatives 2A and 3A followed by Alternatives 1A and 3A-Modified. While Alternative 3A would divert traffic to the local street system, Alternative 3A-Modified was ranked lower since the access restrictions may cause additional diversions to local streets.

8.2.5.3 Equitable Access

Under Alternative 3A-M, NJ Turnpike does not have access into the proposed HOT lane. Alternative 3A does provide some circuitous access to both NJ 3 and NJ Turnpike traffic into the proposed HOT lane. However, NJ Turnpike traffic has to divert to a local roadway (Harmon Meadow Boulevard) to enter the proposed HOT lane in this alternative making it less attractive than the remaining alternatives.

8.2.5.4 Construction Impacts

Impacts during construction are anticipated where a significant amount of roadway and bridge work is involved. This is the case under Alternative 4A involving the most amount of construction followed by Alternative 3A. Alternatives 1A, 2A, and 3A-M do not require construction of new roads and have minimal impact on traffic during implementation.

8.3 TOP-RANKED ALTERNATIVES

Alternative 4, with construction of new roadway approaches and new bridge structures, is shown as the highest ranked alternative. Alternatives 1A and 2A, with a weave access area to the proposed HOT lane, are very similar, and are ranked second. Alternative 3A-Modified, with access via NJ 3 only, is ranked next, indicating that the simplicity of operations may offset some mobility and access deficiencies. Alternative 3A, NJ 3 access only with a new drop ramp, is ranked last.

Alternatives 1A and 2A have almost identical ranking. The operational improvements associated with shifting some traffic from peak to shoulder hours in Alternative 2A would be offset by the operational difficulties and safety concerns of allowing commercial vehicles into the proposed HOT lane, which is the left lane. After discussion with the Study team and external agency advisors, Alternative 1A is favored over Alternative 2A.

Since Alternative 4A involves a much higher capital investment than Alternatives 1A or 3A, the oversight committee agreed that it would be reasonable to consider Alternative 1A as a short-term implementation project to test the ability of a HOT lane to improve corridor operations and express bus operations while longer-term planning takes place to implement Alternative 4.

8.3.1 HOV Discount Options

As part of this Study, an initial review was made to identify ways in which HOV occupancy requirements could be verified and rules could be enforced. While the toll plaza is in place, HOV verification can be accomplished by directing HOV traffic to Lane 3 at the toll plaza.

Procedures for allowing a Toll Collector to monitor vehicle occupancy and verify the number of occupants would be as they are practiced today at the Lincoln Tunnel for the Port Authority's Carpool Discount plan. If the vehicles do not have sufficient people, no carpool discount violation is needed; the vehicle can simply be charged the full rate.

When the toll plaza is removed in the future, new vehicle-occupancy verification locations and procedures would need to be developed or the discount policy could be eliminated. Under procedures commonly used by other managed lane facilities, where carpool vehicles cannot stop to be verified, carpool traffic would still be directed to a separate declaration lane in which PANYNJ Police could visually observe the number of occupants within the vehicle. Under this program, a violation will occur when a vehicle uses the declaration lane with less than three occupants or when a valid E-ZPass® carpool account is not detected by the roadside equipment. Violators will be cited for violating the minimum three-occupant carpool discount policy and fined according to a policy established for this purpose.

The decision on whether or not to offer a discount to HOV traffic was not included as part of the alternatives ranking process to select between the physical alternatives, but through consideration of the operational needs of a discount program and the overall direction in which PANYNJ is moving towards all-electronic cashless tolling (AET) procedures in its toll system replacement project. While it is possible to perform HOV enforcement for the HOT lane in a way that is similar to today's operating conditions, removal of the toll plaza after AET is in place will make verification of occupancy difficult and expensive. In addition, the right-of-way required to establish HOV declaration lanes at the three approach roadways to NJ 495 represents a significant hurdle in implementing HOV discount policies for the proposed HOT lane. As a consequence, it was decided to advance the HOT lane evaluation without a discount for carpools.

Based on this these rankings, the study oversight committee agreed that Alternatives 4B and 1B are best suited for implementation planning. Considering the amount of construction needed, Alternative 4B is considered a long-term solution while Alternative 1B is considered a near-term solution.

Chapter 9 IMPLEMENTATION NEEDS FOR SELECTED ALTERNATIVES

The concept of operations of the proposed Lincoln Tunnel HOT Lane is presented in this section. Operational parameters of the top-ranked alternatives (i.e., Alternative 1B and Alternative 4B) will be reviewed, followed by tolling system needs. The section will conclude with a summary of some steps and decisions that will need to be made as planning for the proposed HOT lane progresses.

9.1 LINCOLN TUNNEL HOT LANE OPERATIONAL PARAMETERS

9.1.1 ACCESS POINTS

Given the limited distance of the NJ 495 corridor from the NJ Turnpike to the Lincoln Tunnel, the number of access points into the proposed Lincoln Tunnel HOT Lane will need to be limited in order to ensure the effectiveness of the operation. For Alternative 1, the Lincoln Tunnel HOT Lane will be provided with two access points: one will be on the NJ 3 entrance ramp to eastbound NJ 495 and the other will be just east of the NJ 3 ramp for NJ Turnpike traffic. Alternative 4 assumes a new roadway and bridge structures will be constructed to provide traffic from the NJ Turnpike direct access into the proposed HOT lane.

9.1.2 FACILITY CONFIGURATION

The access points will be clearly signed and striped to indicate that each is an entrance into the proposed HOT lane. The HOT lane will also be separated from the general purpose lanes with removable delineator posts for the entire length of the proposed HOT lane. It is expected that this approach will improve operations and safety by discouraging vehicle weaving in and out of the proposed managed lane. Limiting the number of access points also reduces the number of tolling zones required, simplifying enforcement and reducing deployment costs.

9.1.3 OPERATIONS

The current concept is to operate the proposed HOT lane from 5-11 a.m. However, no formal decision has been made as to whether the posts would be removed after 11:00 a.m. or whether they would remain in place with a $0.00 fee posted on the variable message signs for the remainder of the day. This option would reduce the operating cost of the managed lane by eliminating the need for resources to set up and deconstruct the HOT lane delineators each morning. Additionally, the PANYNJ has expressed interest in examining the possibility of using the proposed HOT lane in the afternoon peak period as a way to get eastbound buses to the tunnel more reliably in the congested afternoon period. If the posts were to remain in place, there may be the opportunity to shorten the charging period of the proposed HOT lane in the morning to allow more swift recovery after restrictions are lifted at the toll plaza at 10:00 a.m.

9.1.4 COLLECTION OF HOT LANE FEES

To effectively manage usage and collect HOT lane fees, all vehicles using the HOT lane will be required to have an E-ZPass® account and transponder in good standing. E-ZPass® accounts that are not maintained in good standing will be treated as a violator. For HOT lane scenarios that provide a discount for registered HOV traffic, the current PANYNJ Carpool Discount registration process could be used.

It is anticipated that the toll plaza will remain in place for several years after the proposed HOT lane would open. It is envisioned that a carpool verification procedure similar to what is used today could be used for the HOT lane operation. When a registered carpool uses the HOT lane and wants to receive the discount, the driver must use a staffed toll lane at the toll plaza and stop to allow the toll collector to verify vehicle occupancy. The HOT lane is envisioned to use Toll Lane 4. Carpool traffic approaching the plaza could be directed to use Toll Lane 3 for vehicle occupancy checks. Toll Lane 3 is currently closed for several hours during the morning peak period.

9.2 INTERACTION WITH ALL-ELECTRONIC TOLLING PLANS

The PANYNJ is currently planning to replace it toll collection system with the capability of non-stop, all-electronic toll collection. As part of this study, the current striping and channelization plans for the short- and long-term implementation of all-electronic tolling (AET) were reviewed for their potential effects on operations of the HOT lane.

As long as the current toll plaza is in place, the HOT lane would be able to operate as it would with cash toll collection. The traffic would be channelized to Lane 4 of the toll plaza and would merge with high-occupancy traffic from the Willow Avenue approach.

If the toll plaza is removed at some point in the future, traffic channelization patterns would remain essentially the same as they are with the toll plaza. A main difference would be that a new tolling zone would be required upstream along NJ 495. The cost of an additional tolling zone for the proposed HOT lane was not included in the toll system cost estimates presented later in this chapter.

9.3 LINCOLN TUNNEL HOT LANE TECHNOLOGY CONFIGURATION

As previously presented in Figures 18 through 24, the preliminary roadway system configuration will encompass the eastbound NJ 495 travel corridor from the NJ Turnpike to the existing Lincoln Tunnel toll plaza. The proposed points of access are also depicted.

Additionally, the schematic shows the preliminary locations for proposed HOT lane pricing zones, dynamic message signs (DMS), and static signs. In all scenarios, there would be a pricing zone located on the NJ 3 express entrance ramp to NJ 495, and the system would use the existing tolling equipment installed in Toll Lane 4 at the Lincoln Tunnel toll plaza.

For Alternative 1, an additional pricing zone will be located just east of the weave access point into the proposed HOT lane, shown in Figure 19. The schematic also shows the preliminary locations for the DMS and HOT lane static designation signs that are located in advance of the Lincoln Tunnel HOT lane access points.

For Alternative 4, a second HOT lane pricing zone would be located at a point after the two entrances from the NJ Turnpike, before the merge with NJ 3. This is shown in Figure 24.

9.3.1 LINCOLN TUNNEL HOT LANE TECHNOLOGY SYSTEMS

This section provides a functional overview of the proposed Lincoln Tunnel HOT Lane technology that may be deployed. The basic system would consist of the following subsystems:

- HOT lane pricing zone subsystems
- HOT lane transaction processing
- Price determination and display tracking
- HOT lane enforcement

HOT lane Pricing Zone Subsystems – All of the roadside equipment, including the ETC antennas, ETC readers, controller units, enforcement beacons, electrical and lightning protection equipment, communication equipment, enclosure/cabinets, and cantilever structures will be located at the roadside pricing zones. The primary activities that will occur at the pricing zone are typically the detection and identification of E-ZPass® transponders, generation of E-ZPass® transactions, collection of violation enforcement subsystem (VES) data, storage of the transaction data, activation of the enforcement beacon, and communication with the E-ZPass® Customer Service Center (CSC) to transmit transactions and receive tag status file updates and access files and configuration data.

HOT Lane Transaction Processing Subsystem (TPS) – This element of the HOT lane system will consist of the microprocessor subsystem components that receive transaction information from the pricing zone controllers. The transactional data are typically used in other managed lane facilities to perform trip building where multiple transponder reads are reconstructed based on time stamps to determine a vehicle's trip. In the case of the Lincoln Tunnel HOT Lane, this information could be used to ensure that a vehicle's transponder was detected at all pricing zones, which would indicate that the vehicle did not enter or exit the HOT lane illegally. This information is also used to determine the appropriate rate to charge. This E-ZPass® transaction is then sent from the TPS to the CSC for account posting and revenue recognition.

Price Determination and Display Tracking Subsystem – This subsystem continuously receives and processes HOT lane and general purpose lane vehicle detection system data from roadside devices; operates a dynamic pricing module; writes to a pricing table that relates location, time and date, and price at established price update intervals; downloads price data to HOT lane DMS; and receives display acknowledgement.

HOT Lane Violation Enforcement Subsystem (VES) – This subsystem includes VES equipment as a means of enforcing the HOT lane and also overhead tolling zone transaction indicator beacons (activated by the pricing zone subsystem when there is no transponder read) and cameras mounted on the gantry, which will capture license plate images of all vehicles traveling in the HOT lane.

All HOT lane vehicles will be required to have an E-ZPass® transponder. In the event that a vehicle traverses a pricing zone without a transponder, or with an invalid one, the pricing zone will record the transaction as a violation. The pricing zone subsystem will subsequently capture an image of the vehicle license plate. Using the violation images, the TPS will first recreate the trip and then process it as a violation transaction to be sent to the CSC for processing per PANYNJ's violation business rules and procedures.

9.4 TOLL SYSTEM DESIGN CONSIDERATIONS

9.4.1 DYNAMIC PRICING PROCESS

The proposed Lincoln HOT Lane will provide a way for the unused capacity of the proposed second bus lane to be used by automobiles. Under this program, vehicles with one or two occupants will be allowed to use the HOT lane for a fee. Several alternatives were tested with pricing for buses and carpools of three or more occupants. Eligible vehicles are those that are classified as Class 1 in the PANYNJ tolling system, which are generally any vehicles with two axles and four tires, or motorcycles.

As a primary operational guideline of the proposed HOT lane program, traffic speeds within the HOT lane must remain at or above a minimum desired speed. This minimum speed level is a policy decision that would be set by the PANYNJ. The automobile demand must be regulated in order to be sure that the system is able to maintain the minimum speed. HOT lane fees will rise as traffic increases in the HOT lane. The validity of these increases will be confirmed by traffic density measurements in the general-purpose lanes, to be collected by roadside traffic sensors.

Increasing HOT lane fees will deter patrons from usage of the HOT lane. The dynamic pricing system may also post "bus only" for a short period of time to close the lane to autos. As the lane empties out (resulting in an increase in speed and reduction in density), HOT lane rates will be reduced to attract usage. Since the project is using an existing lane, it is critical that maximum traffic flow in the lane be maintained to minimize the negative impacts associated with the reduced capacity for the general-purpose lanes.

The approach to use the HOT lane traffic speed and density data in conjunction with data from the general purpose lanes will provide a more accurate means to determine and assess the impacts of changing HOT lane fees. This all-lane traffic monitoring approach to HOT lane fee setting will ensure that low-occupancy users of the HOT lane will be charged an amount commensurate with perceived time savings, which will entice use of the HOT lane facility when excess capacity is available.

As the LOV motorist approaches an entry point to the HOT lane, a DMS will display the current HOT lane fee for use of the managed lane. At each HOT lane entry point, specific rates will be displayed on the DMS to inform the motorist what fee is being charged. Since the facility is an express facility, only one price will be posted. It is recommended that the amount posted include the current toll to use the Lincoln Tunnel, to minimize confusion. If the LOV motorist chooses to enter the HOT lane, the toll amount observed on the sign at the time of entry to the HOT lane will be the maximum amount actually charged to the motorist regardless of any rate changes that might occur while the motorist is in the HOT lane.

Figures 29 and 30 show the typical placement for the DMS signs in relation to the pricing zones for Alternatives 1 and 4, respectively. The DMS sign showing the combined total of HOT lane fee and Lincoln Tunnel toll will be placed prior to the pricing zone. The amount of time it takes a vehicle to travel from the DMS to the pricing zone would be determined and applied as an offset to the actual time that is assigned to the transaction at the pricing zone. This would allow the pricing system to charge the patron what was on the DMS when they last saw it. The speed in the general purpose lanes between the sign and the pricing zone will need to be monitored to calculate the offset correctly. Additionally, the frequency of the rate change also plays a factor in accurately determining what the price the patron is likely to have seen. A longer interval between rate changes, such as 15 minutes, would minimize the likelihood of errors.

9.4.2 USING GENERAL-PURPOSE LANE TRAFFIC VOLUMES TO ADJUST HOT LANE FEES

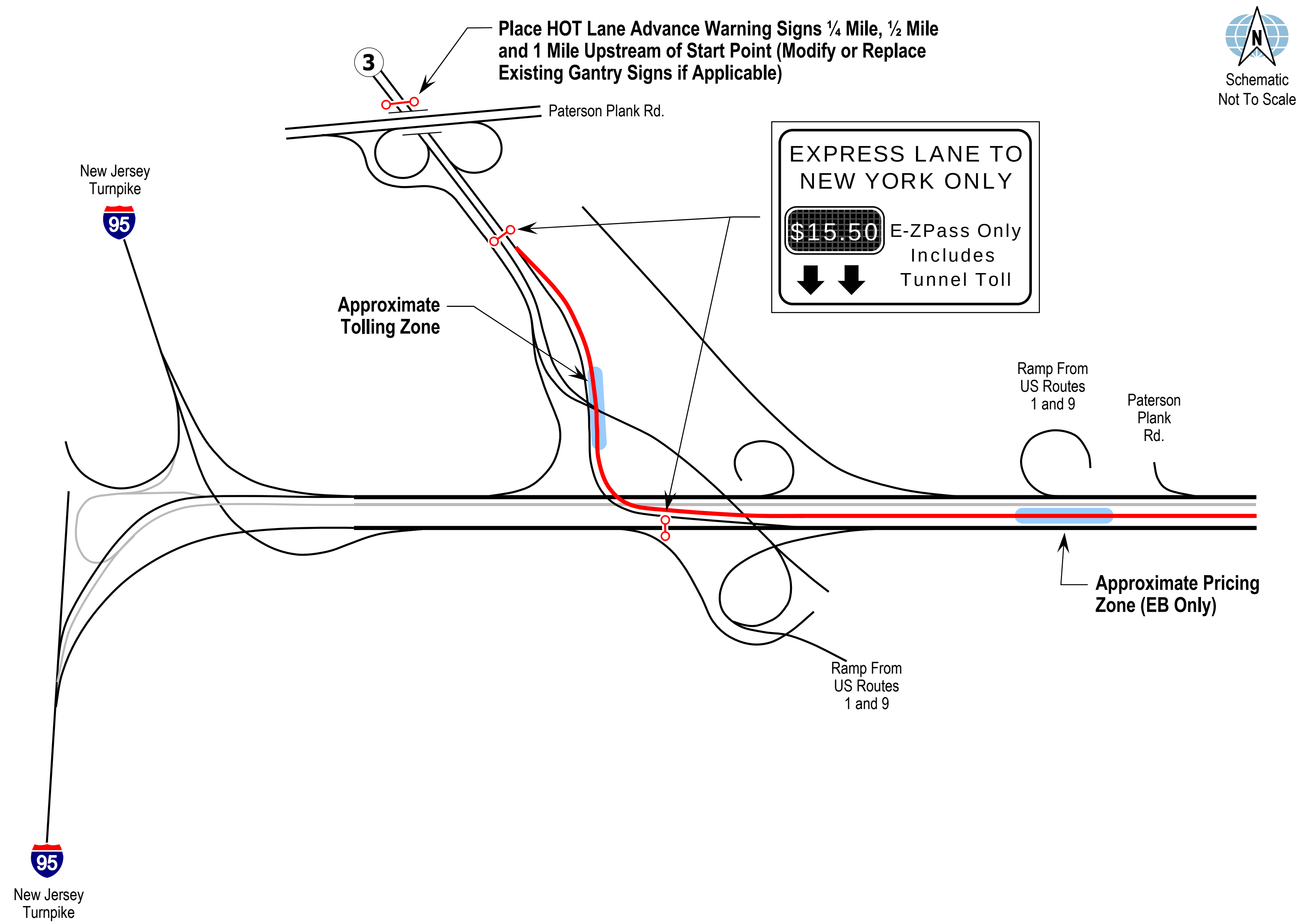
HOT lane fee collection can be enhanced by designing into the TPS the ability to react quickly to changes in TD and travel speed in the general purpose lanes and to adjust the HOT lane fees to reflect HOT lane demand and available capacity in these lanes.

The inherent advantages of a motorist using the HOT lane are time savings and the elimination of frustration in having to drive in slower-moving general purpose lane traffic. The travel time in the HOT lane, barring an incident in that lane, should be consistent during peak and shoulder hours. The density and speed in the general purpose lanes will be measured and compared to the density and speed calculations in the HOT lane. A fee or rate table can then be established to price trips.

9.4.3 ROADSIDE HOT LANE PRICING ZONE SITES

Each of the pricing zone sites will consist of two antennas and a roadside cabinet that houses an ETC reader, VES communication gear, a pricing zone controller, electronics, lightning protection, and a power supply with battery backup. The antennas will communicate with each transponder mounted in vehicles while traveling through the pricing zone. Two antennas will be installed, one mounted above the centerline of the HOT lane and one above the centerline of the leftmost general purpose lane. The antenna mounted over the general purpose lane immediately next to the HOT lane will be used to ensure that vehicles traveling in the general purpose lane with a transponder are not charged the HOT lane fee.

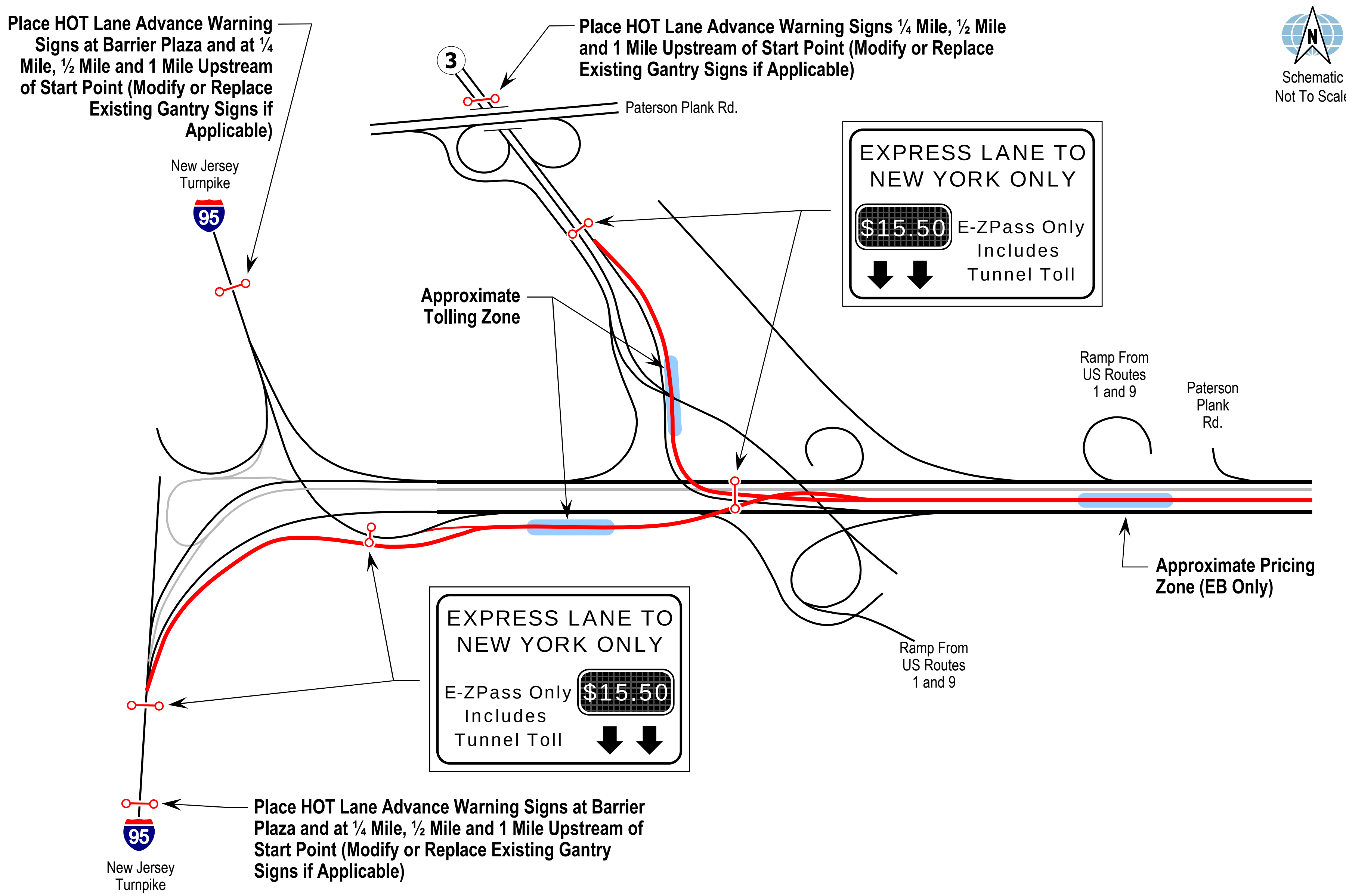
The ETC reader is connected to a combined antenna and transceiver, which will be mounted over the HOT lane. The reader will be capable of reading radio frequency signals received from transponders in the HOT lanes and sending the decoded data to the pricing zone controller. The controller writes this data to a transaction record along with other data and a unique ID. An



WilburSmith ASSOCIATES

HOT LANE PRICING SYSTEM SIGN ELEMENTS - ALTERNATIVE 1

FIGURE 29



HOT LANE PRICING SYSTEM SIGN ELEMENTS - ALTERNATIVE 4

FIGURE 30

uninterruptable power supply (UPS) will ensure that clean and reliable power is provided to the HOT lane equipment in the event of a power outage of at least 30 minutes.

All the components of the roadside system will connect either directly to the communications network or indirectly through an interconnection to the pricing zone controller.

9.4.4 VEHICLE DETECTION STATIONS

It is current anticipated that there will be six vehicle detection stations (VDS) installed within the HOT lane corridor and another six roadside VDS just off the outside shoulder of the roadway to monitor the general purpose lanes. The VDS will consist of equipment and devices embedded in the pavement and/or along the NJ 495 eastbound corridor to measure vehicle volume, density, and speed in the HOT and general purpose lanes. Vehicle detectors will connect directly to a roadside controller that communicates using landline or wireless communication with the TPS. Because of limitations on the separation of vehicle detectors and controllers, HOT and general purpose lane VDS equipment will be installed at approximately the same HOT lane station to reduce the number of roadside controller cabinets and the associated communication and electrical costs incurred to make each site operational.

Traffic densities at any single VDS may be impacted by environmental or geometric conditions. They can potentially misrepresent the real-time traffic condition within the entire NJ 495 corridor. To mitigate any potential misrepresentation, a coefficient, or range of coefficients, can be used to augment the affected VDS location and corresponding calculated TD.

The traffic density measurements are used in the HOT lane rate setting function, so that the HOT lane fee will be adjusted upward or downward based on the change in the HOT lane traffic density. Small deviations in HOT lane TD might result in a small or no change to the HOT lane fees. Large deviations will typically result in large changes to the fees.

9.4.5 DYNAMIC MESSAGE SIGNS (DMSS)

Each pricing zone will have one DMS installed just upstream from the access point into the HOT lane. It is anticipated that the DMS will be LED-based display modules imbedded in a static flat panel sign and capable of displaying up to nine alphanumeric characters. The static portion will display general information about access to the HOT lane. The DMS will display the dollar amount of the HOT lane fee in effect during a given time period. This dollar amount will change automatically based on user-configurable settings in the dynamic pricing algorithm. The length of the price change interval will need to be set by the operator. Allowing the algorithm to post new HOT lane fees at shorter intervals would tend to make it more difficult for the system to correctly charge the patron what they last saw on the DMS due to assumptions that are needed to estimate the time the patron last saw the DMS sign and the time the transponder was detected in the pricing zone. Using shorter intervals, however, would help ensure that the HOT lane remains freeflow, since the system could react to sudden changes in speeds quicker. Current operating HOT lanes use intervals of 3, 5, and 6 minutes.

9.4.6 CLOSED-CIRCUIT TELEVISION CAMERAS (CCTV)

CCTV cameras will be installed at each of the pricing zone sites for the primary purpose of viewing the traffic conditions along the portions of the HOT and general purpose lanes within the camera's range. The CCTV cameras will be standard freeway surveillance cameras. These cameras will provide security at each pricing zone and will allow observation of any physical problems that might occur at these locations, including potential traffic incidents and lane blockages. The CCTV system will be configured to allow pan/tilt/zoom capabilities.

9.4.7 HOT LANE PRICING ZONE CONTROLLER

The pricing zone controller is the primary roadside equipment (computer) that is responsible for a variety of tasks such as communication and management of the E-ZPass® ETC subsystem, VES subsystem, transaction establishment and processing, and communication with the TPS and CSC. Communication with the CSC and TPS supports receiving tag status files and updates, configuration data, access privileges table, and time synchronization, and sending transaction records and status messages. A redundant design may be needed to meet subsystem availability requirements so the pricing operation can continue despite a failure within the pricing zone subsystem.

9.4.8 TRANSACTION PROCESSOR AND TRIP FORMATION

As ETC or VES transactions are received from the pricing zone controllers, the TPS will write each of these independent records to a database. The TPS is then responsible for the reconstruction, or 'trip-building' of individual records into full trip records to confirm whether a vehicle violated the striping and post delineation, and for carpool discount processing, to develop revenue transactions which are formatted properly for posting at the CSC.

The TPS will invoke pre-defined business rules to ensure the HOT lane fee assigned to the trip has a high probability of being equal to or lower than the price displayed and viewed by the user prior to entering the HOT lane facility. An example of such a rule is the need for consecutive transactions for a particular user occurrence within a configurable time interval to qualify for inclusion in a trip. The design could be based upon calculation of a variable time interval between consecutive transactions based on measured speeds and known distances.

9.5 HOT LANE ENFORCEMENT

It is assumed that enforcement of the proposed HOT lane will be solely conducted by PANYNJ Police. Since the selected alternatives do not offer an HOV discount, no occupancy verification is required. This greatly simplifies the enforcement process.

Due to geometric roadway constraints along the corridor, there are no feasible locations for enforcement areas on the corridor that would assist officers in the enforcement of the proposed HOT lane. The delineator posts will deter potential violators from entering and exiting the HOT lane along the corridor, but at the same time, will inhibit police enforcement. Due to the geometric constraints of the corridor, an officer will not have the ability to pursue and make contact with a potential violator until the vehicle reaches the existing Lincoln Tunnel toll plaza apron area. At that point, the officer could determine if the patron is a violator. Therefore, the only safe and effective enforcement area may be at the existing toll plaza.

Due to these geometric limitations, the toll system costs presented in this chapter include costs for an automated violation enforcement system. Since the selected alternatives will not offer an HOV discount, no occupancy verification is required. This greatly simplifies the enforcement process, and almost all enforcement can take place electronically, because all vehicles in the HOT lane are required to have a valid transponder. If a transponder is not detected, the license plate of the vehicle will be photographed and submitted for violations processing through predetermined business rules. Furthermore, the HOT lane pricing system will look for redundancy in transponder reads to verify that a vehicle did not break through the posts to enter or exit the HOT lane. A transponder must be detected at a minimum of two locations to be considered a valid transaction.

9.5.1 HANDHELD ENFORCEMENT UNITS

As a supporting tool to aid in the HOT lane enforcement process, handheld enforcement units will be provided to PANYNJ enforcement officers. These portable handheld units will operate as a wireless device that will allow officers to easily transfer from one patrol vehicle to another. The handheld unit will be designed to read the E-ZPass® ID number from a transponder when it is passed within the unit's read zone. Once the transponder ID number is read, the software program that is resident on the handheld device will attempt to match the ID number to an active E-ZPass® account number, which is also resident in active memory in the unit, to determine whether the account is in good standing.

Updated versions of the E-ZPass® tag status file will be automatically downloaded from the CSC or TPS to the handheld device at least once each day. It is envisioned that an incremental tag status file will also be transmitted periodically throughout the course of the day. This operation, however, is dependent upon the capability and business rules that are in place at the time of HOT lane commissioning. The information obtained via the handheld device will allow the officer to issue a violation citation to the vehicle operator if the transponder (or account) is not valid.

9.5.2 HOT LANE EQUIPMENT MAINTENANCE

Maintenance of all components of the HOT lane fee system deployed to support the operation of the HOT lane will be the responsibility of PANYNJ, or the HOT lane operator. The HOT lane equipment that is required for the operations will require periodic, remedial, and ongoing preventive maintenance.

Overhead equipment that is installed either above the HOT lane pavement or left general-purpose lane pavement, or just off the right shoulder, will be accessed from the right shoulder, or after closure of the HOT lane during nights and during low traffic demand periods.

9.6 ESTIMATED HOT LANE COSTS

9.6.1 ESTIMATED ELECTRONIC HOT LANE PRICING SYSTEM CAPITAL COSTS

A summary of the estimated NJ 495 HOT Lane electronic pricing system capital costs are presented in Table 40. Equipment capital costs are included for the roadside systems, the E-ZPass® subsystems, common equipment, and spare components. The estimated capital cost of pricing system-related civil-related work, including the procurement and installation of the pricing zone gantries, are included in the total costs shown. The total estimated equipment capital cost is about $1.4 million.

Other capital costs that are included in Table 40 are for the various project services that are typically required by the systems integrator. These services would include, at a minimum, project management, software development of the roadside subsystem and interface to the Host subsystem, procurement of a maintenance online management system (MOMS), pricing system equipment installation, documentation development, system integration factory and field testing, and warranty support. The estimated capital cost of these services is about $2.5 million. The total estimated equipment and services capital cost for the NJ 495 HOT Lane Project is $3.9 million.

All of the estimated capital costs are shown in 2009 dollars. A 20 percent contingency factor was applied to each of the estimated capital cost categories. These costs do not include costs for pavement striping or delineator posts.

9.6.2 ESTIMATED ELECTRONIC PRICING SYSTEM MAINTENANCE AND OPERATING COSTS

Also presented in Table 40 is a summary of the estimated annual operations and system maintenance costs for the each of the two selected NJ 495 HOT Lane alternatives. The estimated HOT lane operating and maintenance costs were developed based upon several assumptions, including the assumption that this operation would be integrated into the existing Lincoln Tunnel toll plaza and E-ZPass® system. As one would expect, the cost for E-ZPass® transaction processing is the only difference between the operating costs for the alternatives. The estimated operating costs include the labor costs associated with staffing for the NJ 495 HOT Lane with one additional customer service representative, the cost to process the NJ 495 HOT Lane transactions by the CSC, additional utilities, and all required maintenance costs (both services and hardware). System enforcement and communication costs are not included in this estimate. The estimated total annual operating costs to effectively support the NJ 495 HOT Lane is $379,400 for Alternative1B, and $403,100 for Alternative 4B, in 2009 dollars. No contingency factor was applied. At this time, the actual operating plan for the HOT lane has not been decided. Therefore, personnel costs associated with installing and removing the delineator posts have not been included in these M&O cost estimates.

Table 40
Summary of Estimated HOT Lane Pricing System
Capital and M&O Costs

Capital Costs		
	Alt. 1B	**Alt. 4B**
Equipment/Communications		
ORT Lane Equipment	$151,400	$151,400
ETC Equipment	56,000	56,000
VES Equipment	74,000	74,000
TDC Equipment	29,000	29,000
Dynamic Message Signs	100,000	100,000
Common Equipment	433,000	433,000
Spare Equipment	129,000	129,000
Static Signs	5,000	5,000
Gantries (includes installation)	184,000	184,000
DMS/CCTV Poles (includes installation)	240,000	240,000
Communications	0	0
Subtotal	$1,401,400	$1,401,400
System Development/Deployment		
Software	$1,245,000	$1,245,000
Documentation	250,000	250,000
Warranty	300,000	300,000
Project Management	500,000	500,000
Training	100,000	$ 100,000
Equipment Installation	60,000	$ 60,000
Subtotal	$2,455,000	$2,455,000
Total Capital Cost	**$3,856,400**	**$3,856,400**

9.7 IMPLEMENTATION ISSUES/DECISIONS NEEDED

Should the PANYNJ decide to move forward with development of the HOT lane project, the following are some of the issues that need to be addressed:

1. Timeframe for implementation
2. Operating agency
    a. Who will operate the lane?
    b. Who will maintain the lane?
    c. Who will collect the revenue?
    d. Who will fund capital costs?
3. HOT lane operation
    a. If 5-11 a.m. only
        i. Will delineator posts be removed and how?
        ii. When will posts be installed and removed?
        iii. How will lane be striped (solid vs. dashed)
    b. If posts are not removed
        i. Potential for pricing during all times of day
            1. Use $0.00-$0.25 HOT lane fee
            2. Can consider pricing in other hours as needed
        ii. What message to post on advance warning signs if $0.00 fee?
        iii. Leaving posts in place may not allow optimum distribution of traffic flow between lanes during non-peak hours, particularly near the toll plaza
        iv. Leavings posts in place will force traffic using the HOT lane to enter the lane in one spot only, which may unnecessarily concentrate weaving/entering volume rather than allow it to take place as needed, which may increase incidents of vehicle conflict
        v. Allowing traffic in the HOT lane in the afternoon will result in buses approaching the toll plaza and South Tube from the left side the roadway rather than the right side
4. Operating goals of project
    a. What should minimum desired speeds, which govern when the lane is closed to priced vehicles and open to buses only, be set at?
5. HOT lane fee system elements
    a. Is there a need to monitor density/flow in general purpose lanes?
6. Enforcement procedures
    a. Will electronic enforcement through VES be sufficient?
7. Detailed plans for striping and equipment location