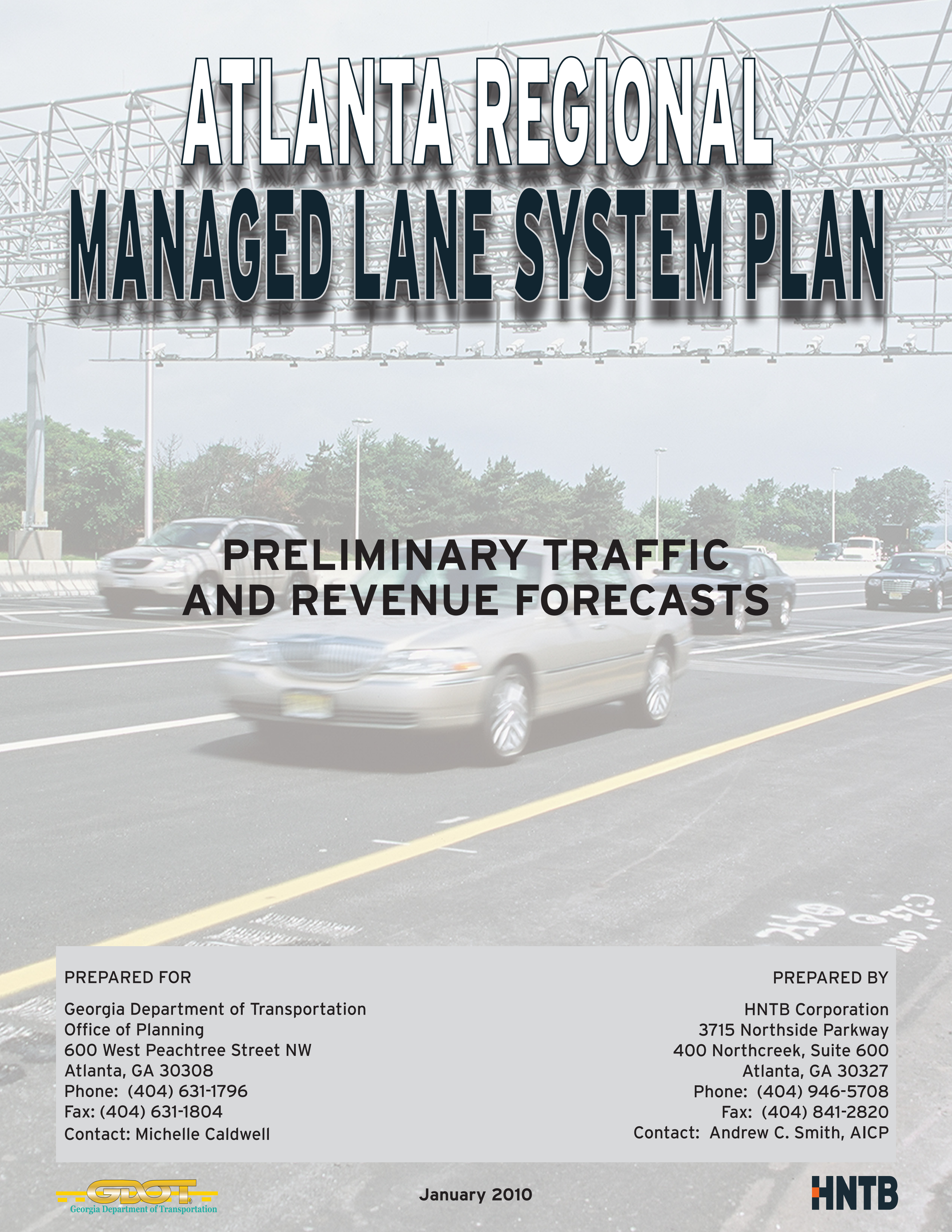

ATLANTA REGIONAL MANAGED LANE SYSTEM PLAN

PRELIMINARY TRAFFIC AND REVENUE FORECASTS

PREPARED FOR

Georgia Department of Transportation
Office of Planning
600 West Peachtree Street NW
Atlanta, GA 30308
Phone: (404) 631-1796
Fax: (404) 631-1804
Contact: Michelle Caldwell

PREPARED BY

HNTB Corporation
3715 Northside Parkway
400 Northcreek, Suite 600
Atlanta, GA 30327
Phone: (404) 946-5708
Fax: (404) 841-2820
Contact: Andrew C. Smith, AICP

Georgia Department of Transportation

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HNTB

Atlanta Regional Managed Lane System Plan

Technical Memorandum 7: Preliminary Traffic and Revenue Forecasts

Prepared for:

Georgia Department of Transportation
One Georgia Center
600 West Peachtree Street NW
Atlanta, Georgia 30308

Prepared by:

HNTB Corporation

PRELIMINARY TRAFFIC AND REVENUE FORECASTS

A. Introduction

Using the data framework established in the Mobilization and Data Collection task, in concert with the Global Demand Estimates, the planning team conducted an initial assessment of traffic and toll revenue for potential managed lane corridors. The objective of this effort is to evaluate the overall financial and operational feasibility of implementing various management techniques on highways throughout the Atlanta region. It is important to note that this is a preliminary traffic and revenue analysis, and is not intended for use in support of project financing.

This chapter presents a summary of the study corridors for traffic and revenue (T&R) analysis; a series of base policy alternatives; an overview of the methodology used in developing T&R forecasts; the preliminary traffic and revenue streams resulting from the various managed lane investments; and the results of system analysis and risk analysis.

Traffic and Revenue Analysis Corridor Identification

In 2003, the Georgia Department of Transportation (GDOT) adopted an HOV Strategic Implementation Plan for the Atlanta Region, a plan for implementing HOV projects in the Atlanta region over the next 20 years. All 17 corridors selected for HOV application in GDOT's HOV Strategic Implementation Plan were evaluated for potential managed lanes strategies as part of the Atlanta Regional Managed Lane System Plan (Figure 1).

To determine which corridors would be the best candidates for bi-directional managed lane strategies, HNTB developed a framework to screen these 17 initial candidate corridors based on the following three major factors - eligibility, access and system connectivity. Additionally, six policy scenarios (mobility, throughput, support transit investment, revenue maximization, truck movement and fast track implementation) were established to evaluate the sensitivity of the priority ranking. More detailed information regarding the framework, screening criteria and policy scenarios can be found in a companion technical memorandum, *Candidate System Screening Process*.

A three-tiered system was established to rank each candidate corridor based on the results of the candidate screening. The results of that ranking are listed below:

- **Tier 1 (Highest Priority)**
    - I-75 North from I-285 North to SR 20
    - I-85 North from I-285 North to SR 211

- I-20 East from I-285 East to SR 138
- I-285 North from I-85 North to I-75 North
- I-285 East from I-20 East to I-85 North
- SR 400 from I-85 to SR 20

- **Tier 2**
  - I-75 South from I-285 South to SR 16
  - I-20 West from I-285 West to Post Road
  - I-285 West from I-75 North to I-85 South
  - Inside I-285 (I-75, I-85, I-20)
  - I-575 from I-75 to SR 20
- **Tier 3 (Lowest Priority)**
  - I-85 South from I-285 South to US 29
  - I-285 South from I-85 South to I-20 East
  - I-675 from I-75 to I-285
  - I-985 from I-85 to SR 13
  - SR 316 from I-85 to SR 81
  - US 78 from N Druid Hills Road to Rockbridge Road

All Tier 1 (Highest Priority) and Tier 2 (Medium Priority) corridors were included in the preliminary traffic and revenue (T&R) analysis. Two corridors from the Tier 3 (Lowest Priority) list, I-285 South from I-85 South to I-20 East and SR 316 from I-85 to SR 81, were also included in the T&R analysis in order to provide system connectivity. The candidate bi-directional managed lane corridors for preliminary T&R analysis are presented in Figure 2.

Figure 1: Eighteen Initial Study Corridors for MLSP

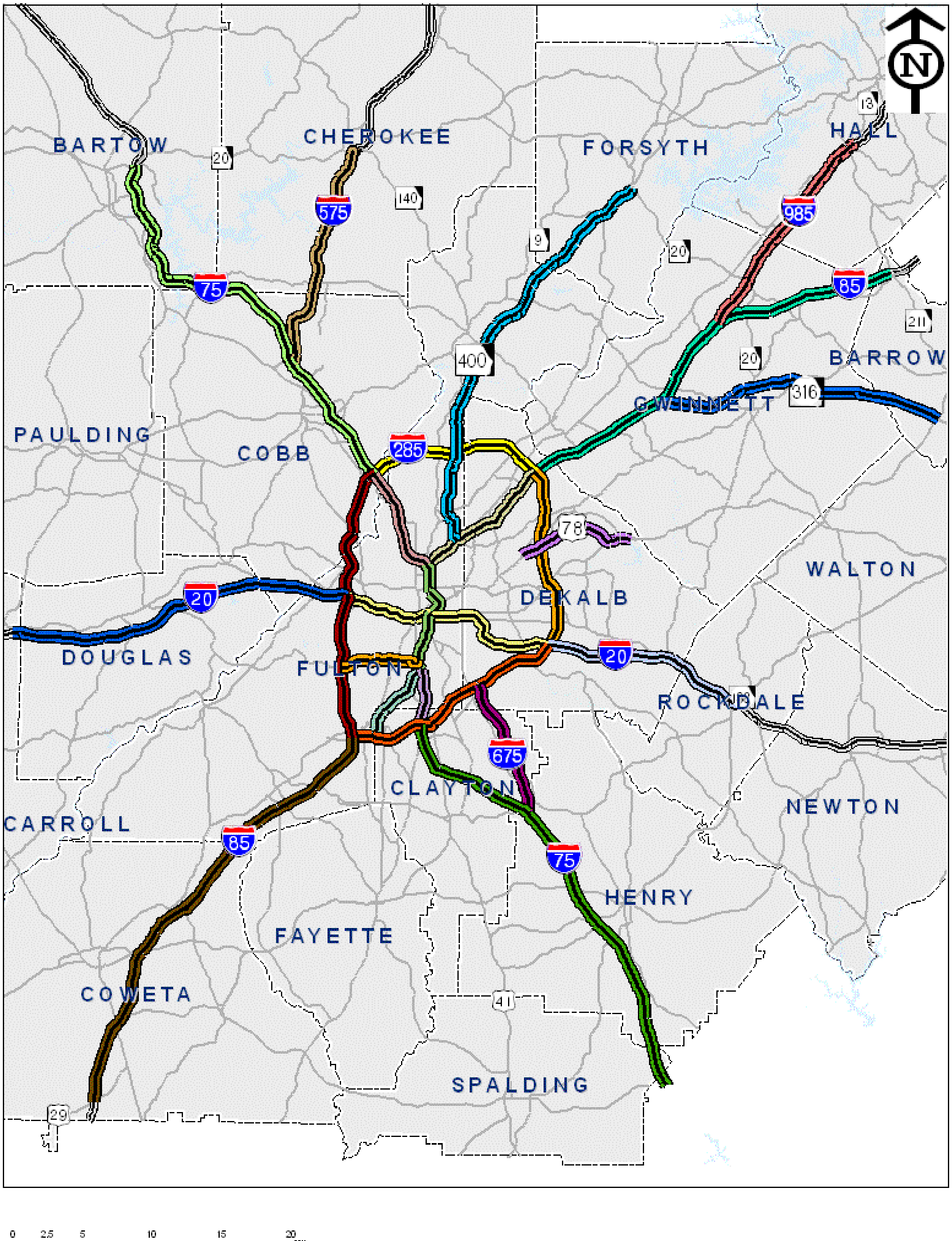
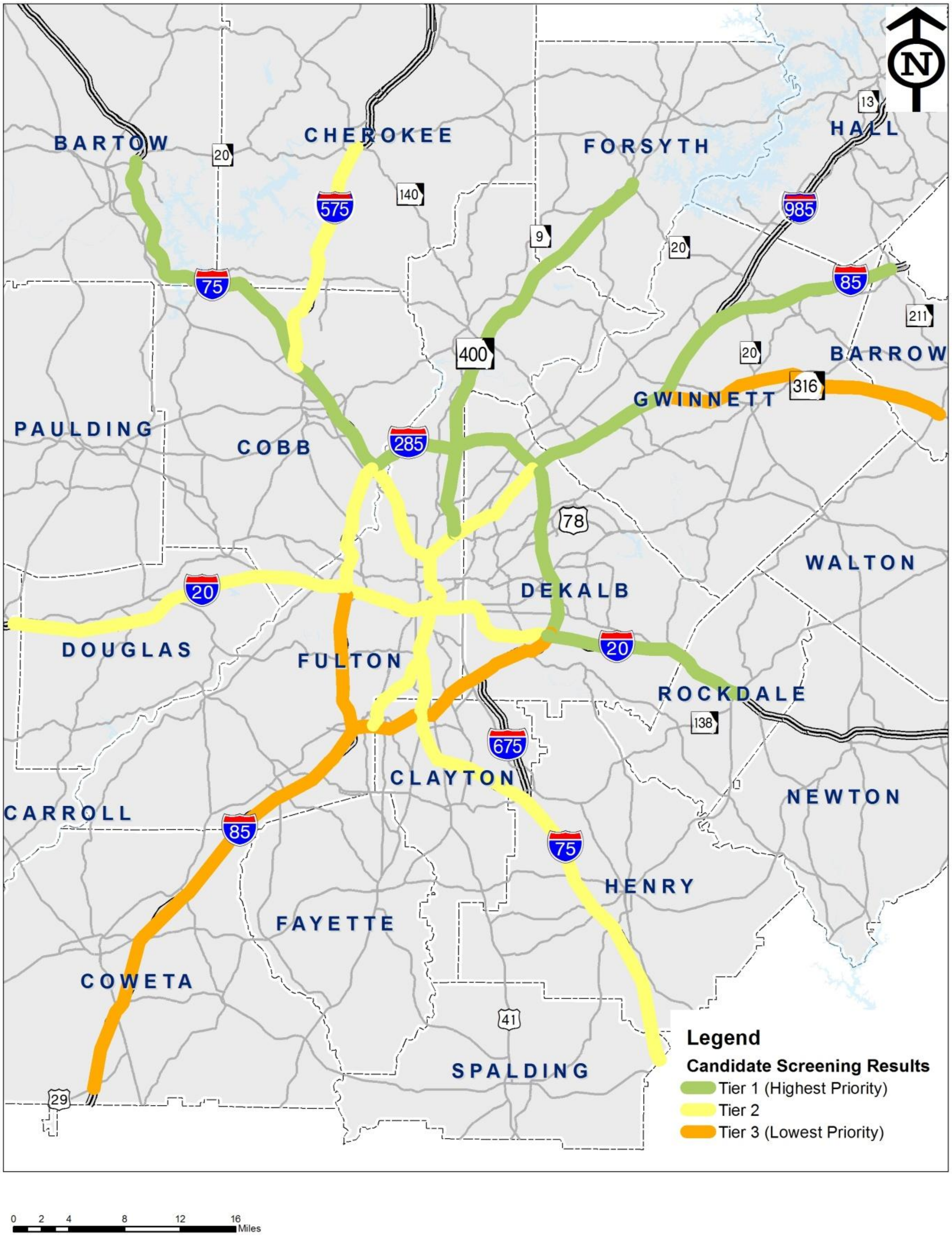


Figure 2: Study Corridors for Preliminary Traffic and Revenue Analysis



Base Managed Lane Investment Policies

Managed lane investment policies, including High Occupancy Toll (HOT) lanes, Express Toll Lanes (ETL)[1], Truck Only Toll lanes (TOT)[2], and Mixed Use Express Toll Lanes (Mixed ETL)[3], were included in the preliminary traffic and revenue analysis. The managed lane investment policies are described below.

High Occupancy Toll (HOT) Policy

High-Occupancy Toll refers to a managed lane policy that combines high occupancy vehicles (HOVs) and pricing strategies together to allow vehicles that don't meet passenger occupancy requirements to gain access to HOV lanes by paying a toll. Depending on different passenger occupancy requirements, HOT can be further defined as HOT2+[4], HOT3+[5] and HOT4+[6]. They are described in detail below.

- **HOT2+**
  - HOVs with two or more passengers are permitted to ride for free.
  - Transit vehicles, vanpools and emergency vehicles are permitted to use the lanes for free.
  - SOVs and Commercial Vehicles (CVs) (commercial autos, pick-up trucks, etc) are allowed to pay a toll to use the lanes when lane capacity is available.
  - Medium-Duty Trucks (FHWA classes 4-7) and Heavy-Duty Trucks (FHWA classes 8-13) are not eligible to use the lanes.
- **HOT3+**
  - Requires existing HOV occupancy policy change.
  - HOVs with three or more passengers are permitted to ride for free.
  - Transit vehicles, vanpools and emergency vehicles are permitted to use the lanes for free.

[1] ETL means that all vehicles in the managed lanes pay a toll. Trucks are not permitted in the managed lanes.

[2] TOT means the managed lanes are reserved for trucks willing to pay a toll.

[3] Mixed ETL means that all vehicles, trucks included, are permitted in the managed lanes if they pay a toll.

[4] HOT2+ is a managed lane designation where vehicles with 2 or more occupants are permitted in the lanes at no charge, while single-occupant vehicles can access the lanes only by paying a toll. Trucks are not permitted in the managed lanes.

[5] HOT3+ means that vehicles with just 1 or 2 occupants are required to pay a toll. Vehicles with 3 or more occupants are permitted at no charge. Trucks are not permitted in the managed lanes.

[6] HOT4+ means that vehicles with 1, 2 or 3 occupants are required to pay a toll. Vehicles with 4 or more occupants are permitted at no charge. Trucks are not permitted in the managed lanes.

  - SOVs and Commercial Vehicles (CVs) (commercial autos, pick-up trucks, etc) are allowed to pay a toll to use the lanes when lane capacity is available.
  - Medium-Duty Trucks (FHWA classes 4-7) and Heavy-Duty Trucks (FHWA classes 8-13) are not eligible to use the lanes.
- **HOT4+**
  - Requires existing HOV occupancy policy change.
  - HOVs with four or more passengers are permitted to ride in the lanes for free.
  - Transit vehicles, vanpools and emergency vehicles are permitted to use the lanes for free.
  - SOVs and Commercial Vehicles (CVs) (commercial autos, pick-up trucks, etc) are allowed to pay a toll to use the lanes when lane capacity is available.
  - Medium-Duty Trucks (FHWA classes 4-7) and Heavy-Duty Trucks (FHWA classes 8-13) are not eligible to use the lanes.

The corridors that passed the managed lane candidate screening stage were included in the traffic and revenue analysis for these three HOT policies: HOT2+, HOT3+ and HOT4+. Figure 3 shows the HOT candidate corridors. The HOT policy base alternative assumed that four new HOT lanes (two lanes in each direction) would be constructed for the corridors without existing HOV lanes. For the corridors with existing HOV lanes, two new HOT lanes (one lane in each direction) would be constructed and the existing HOV lanes (one lane in each direction) would be converted to HOT lanes. In total, approximately 1,140 new freeway lane miles would be added into the interstate highway system under the HOT policy base alternative.

<u>Express Toll Lanes (ETL) Policy</u>

Express Toll Lane refers to a managed lane policy that allows all passenger-car traffic including SOVs, HOVs, and CVs to use the ETL by paying a toll. Transit vehicles, vanpools and emergency vehicles are permitted to use the ETL for free. Medium-duty and heavy-duty trucks are not eligible to utilize the ETL.

Identical to the HOT policy, the ETL policy includes all corridors that passed the managed lane candidate screening stage (shown in Figure 3) for preliminary traffic and revenue assessment. In terms of managed lane configuration, the ETL policy assumed that four new ETL lanes (two lanes in each direction) would be constructed for the corridors without existing HOV lanes. For the corridors with existing HOV lanes, two new ETL lanes (one lane in each direction) would be constructed and the existing HOV lanes (one lane in each direction) would be converted to ETLs. In total, approximately 1,140 new freeway lane miles would be added into the interstate highway system under the ETL base policy.

<u>Voluntary Truck Only Toll (TOT) Policy</u>

Truck Only Toll refers to a tolling policy that allows medium-duty trucks (FHWA classes 4-7) and heavy-duty trucks (FHWA classes 8-13) to use the TOT lanes by paying a toll. All passenger-car traffic including SOVs, HOVs, and CVs are not eligible to utilize the TOT lanes. In this study, TOT lanes are assumed to be voluntary.

The candidate corridors for Voluntary TOT policy are based on the recommendations from the Statewide Truck Lane Needs Identification Study conducted by GDOT in 2006-2007. This study explored the feasibility of implementing Truck Only Lanes on sections of interstate and other limited-access highways across the state. Using a series of performance thresholds that focus primarily on potential truck mobility needs, utilization, and benefit/cost, the study identified the following Metro Atlanta corridors for potential truck-only lanes (in no particular order):

- I-75 North from I-285 to just north of Red Top Mountain Road (Exit 285)
- I-20 West from just west of Thornton Road to I-285
- I-75 South from just south of High Falls Road (Exit 198) to I-285
- I-85 North from I-285 to just north of SR 20 / Buford Drive (Exit 115)
- I-285 entire corridor.

Figure 4 shows the Voluntary TOT candidate corridors. The base voluntary TOT lane alternative in the Managed Lane System Plan assumed that four new voluntary TOT lanes (two lanes in each direction) would be constructed on those candidate TOT corridors. In total, approximately 620 new freeway lane miles would be added into the interstate highway system under the voluntary TOT policy base alternative.

Mixed Express Toll Lanes (METL) Policy

Mixed Express Toll Lanes (METL)[7] refers to a managed lane policy that allows all vehicles including SOVs, HOVs, CVs, medium-duty and heavy-duty trucks to use the METL by paying a toll. Transit vehicles, vanpools and emergency vehicles are permitted to use the METL for free.

The candidate corridors for the METL alternative are the same as the ones in voluntary TOT alternative with the exception of I-20 west corridor from just west of Thornton Road to I-285. This portion of I-20 West was not included. Figure 5 shows the METL candidate corridors.

Due to the mixture of cars and trucks in the same managed lane system, ideally METL would include 6 lanes (three lanes in each direction) along the corridor to provide flexibility and operational safety. Another important consideration is lane balance between general purpose (GP) lanes and METLs. Providing the same number of lanes for METL as GP lanes could result in diminishing return on investment. Therefore, the base METL alternative assumed that six new METLs (three lanes in each direction) would be constructed on the corridors with eight or more general purpose lanes (four or more lanes in each direction); and four new METLs (two lanes in each direction) would be constructed on the corridors with less than eight general purpose lanes (four lanes in each direction). In total, approximately 900 new freeway lane miles would be added into the interstate highway system under the METL policy base alternative.

[7] METL or Mixed ETL means that all vehicles, trucks included, are permitted in the managed lanes if they pay a toll.

ETL + Voluntary TOT Policy

The ETL + Voluntary TOT[8] policy includes a set of ETL lanes and a separate set of TOT lanes in the same corridor. The ETL lanes permit transit vehicles, vanpools and emergency vehicles to use these lanes for free; and it also allows passenger-car traffic (SOVs, HOVs, and CVs) to use these lanes by paying a toll. Voluntary TOT lanes allow medium-duty and heavy-duty trucks to use the TOT lanes by paying a toll.

The candidate corridors for ETL + Voluntary TOT alternative are identical to the ones under a voluntary TOT policy. Figure 6 shows the ETL + Voluntary TOT corridors.

The ETL + Voluntary TOT policy assumed four new ETLs (two lanes in each direction) and four new voluntary TOT lanes (two lanes in each direction) would be constructed. In total, approximately 1,200 new freeway lane miles would be added into the interstate highway system under the ETL + Voluntary TOT policy base alternative. Eight lanes were added to all of the managed lane corridors regardless of the number of existing general purpose lanes. This was done to test the impact of two complete, independent systems of managed lanes on the regional highway infrastructure.

[8] ETL + TOT means parallel systems of managed lanes, one with tolled passenger cars and the other with tolled trucks.

Figure 3: HOT and ETL Candidate Corridors – Bi-Directional

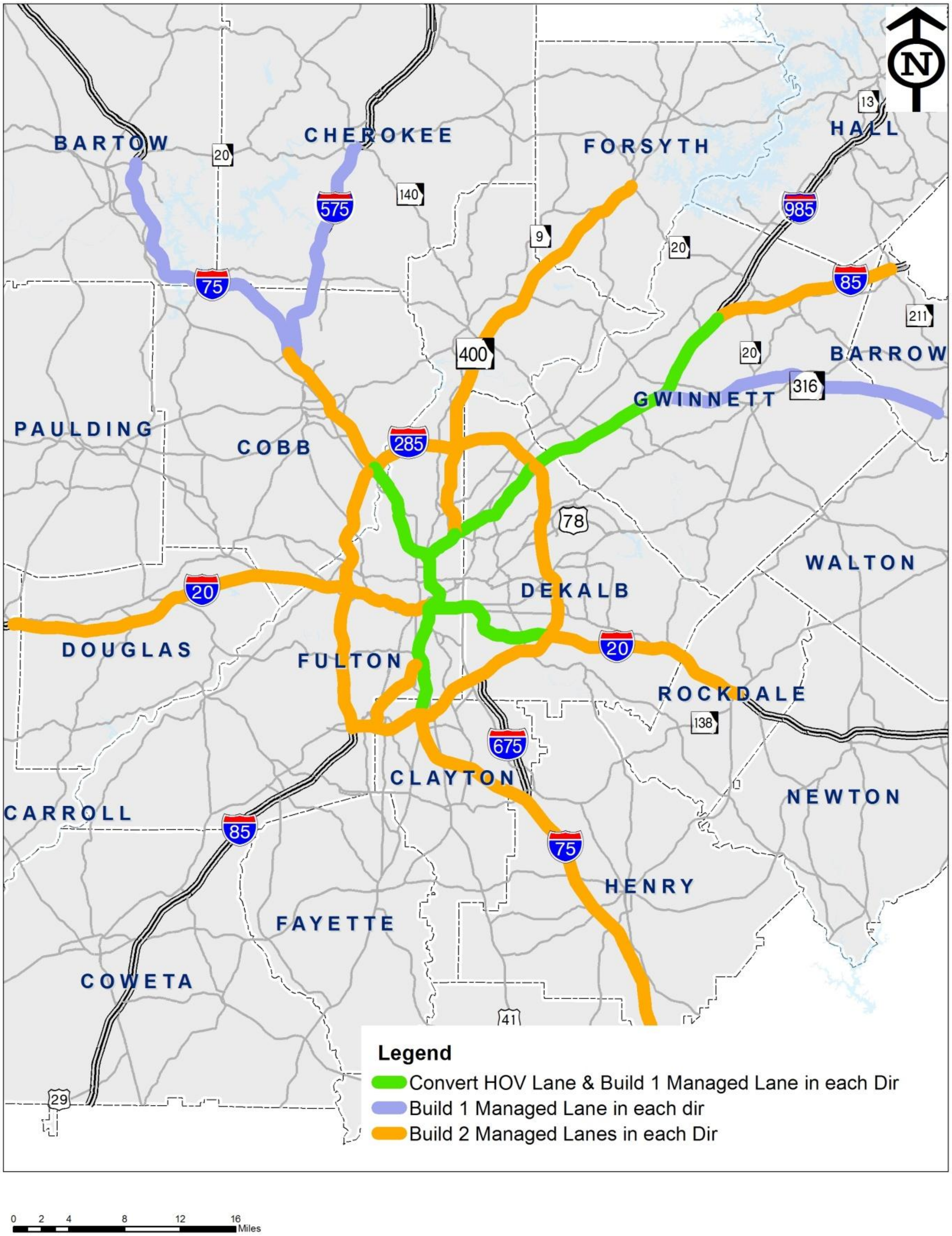


Figure 4: TOT Candidate Corridors

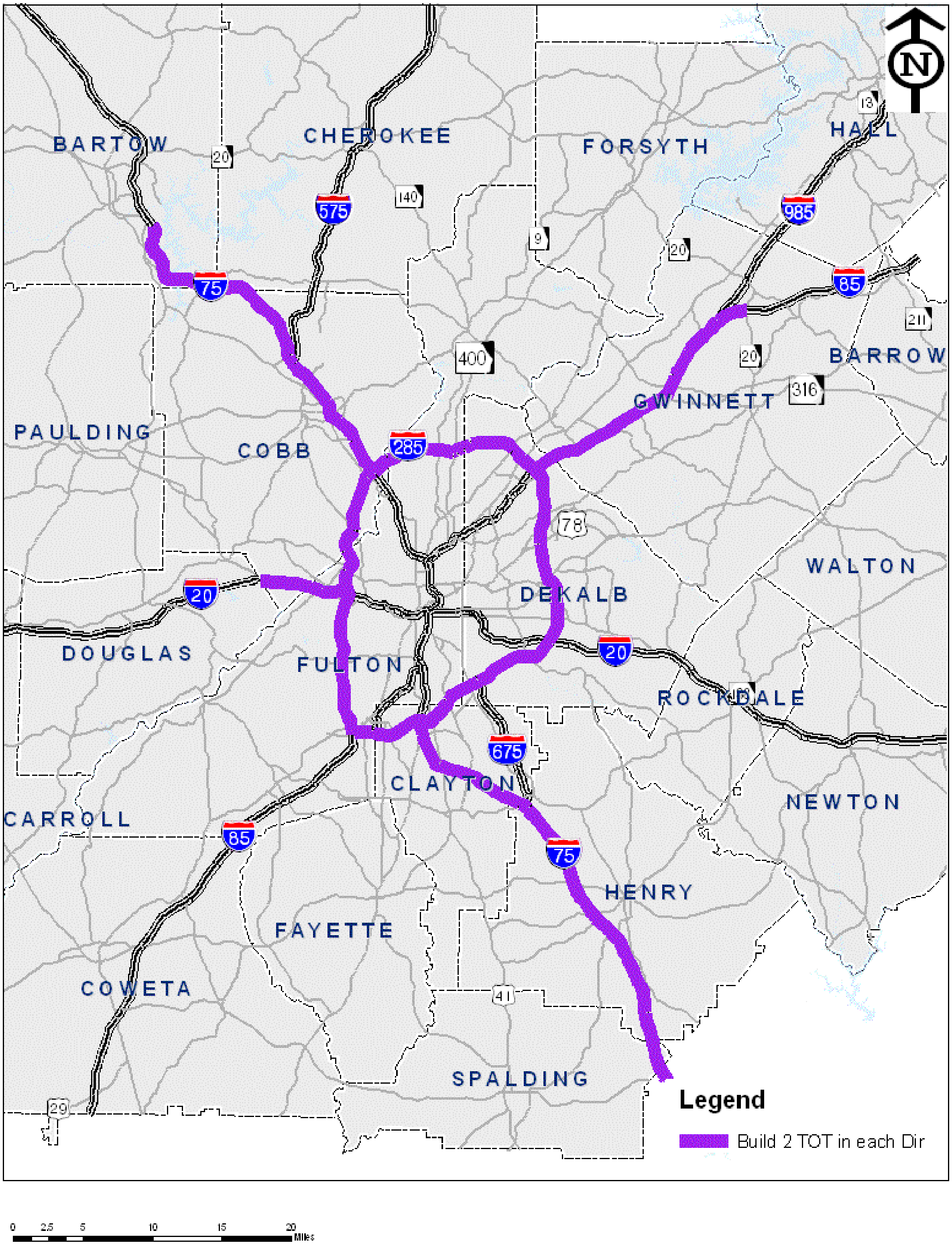


Figure 5: Mixed ETL Candidate Corridors

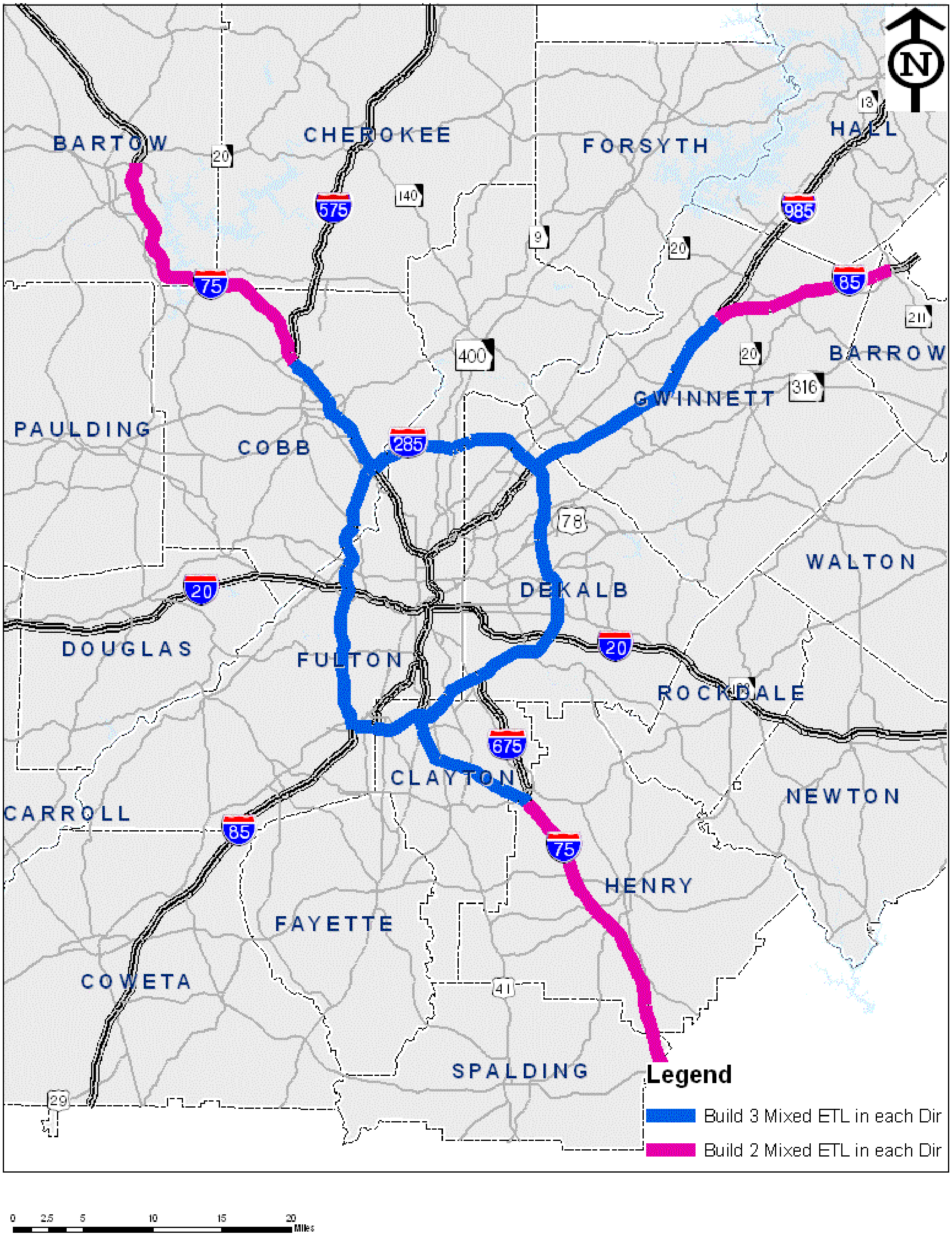
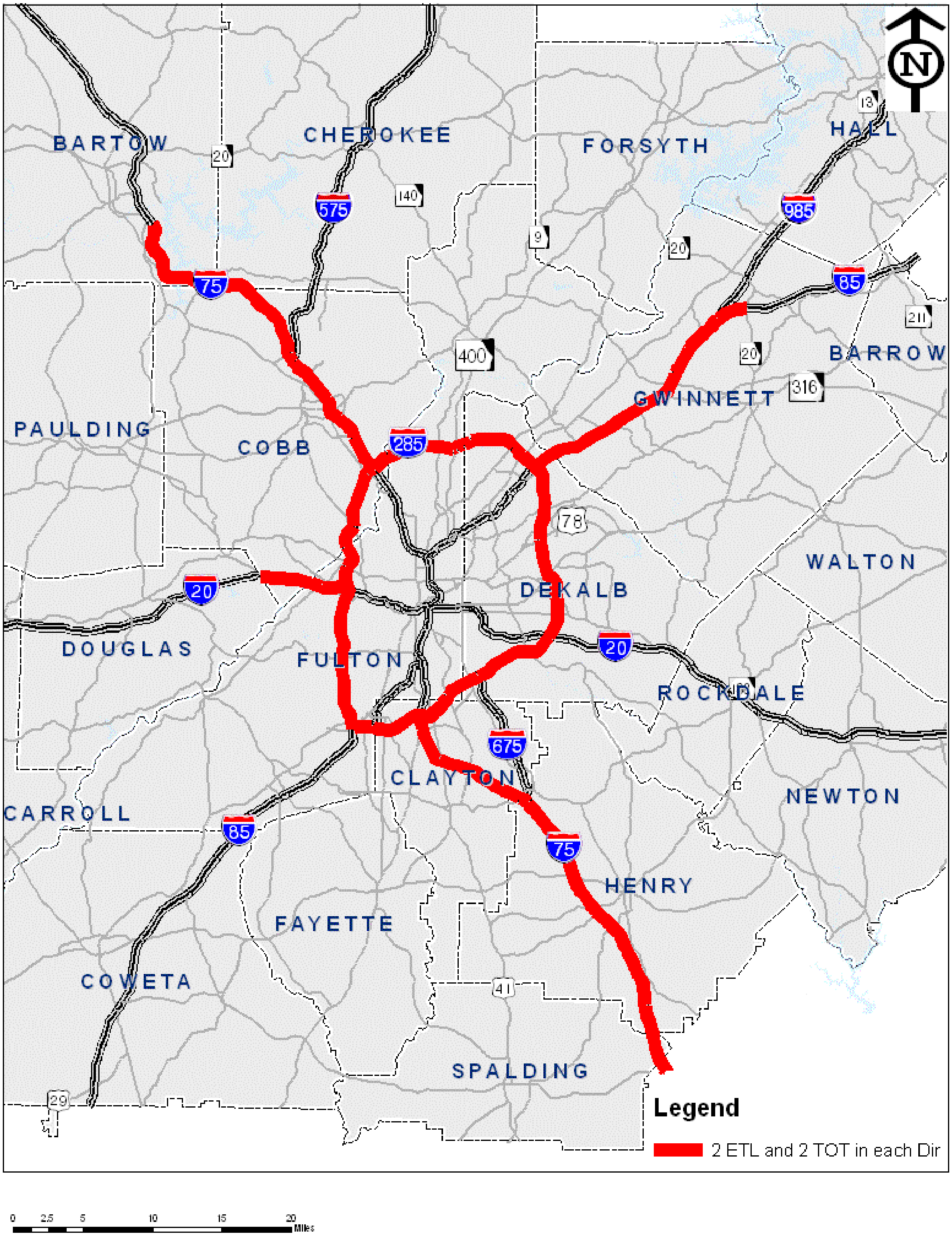


Figure 6: ETL and TOT Candidate Corridors



B. Preliminary Traffic and Revenue Forecasting Methodology

Atlanta Regional Commission Travel Demand Model

The primary tool used to quantify the traffic impacts and forecast revenue is the Atlanta Regional Commission's (ARC) travel demand model. The ARC's travel demand model follows the traditional four-step process: trip generation; trip distribution; mode choice; and trip assignment. The model also includes other sub-models, such as commercial vehicles and truck model, air passenger travel model, etc to estimate travel on both highway and transit facilities throughout the region.

This study employed the latest version of ARC's travel demand model, which was released in 2007 and is based on the most recent regional transportation plan, Envision 6. Hence, the travel model stream reflects the most up-to-date short-term and long-term transportation projects in the Atlanta region, as well as the most recent population and employment forecasts from the ARC.

Model Inputs

<u>Roadway Network Update</u>

The roadway network in the ARC travel demand model includes all regionally and locally important roadways. The candidate managed lane corridors discussed in the previous section were validated against aerial photography and coded into the roadway network with proposed access locations.

<u>Trip Tables</u>

The development of trip tables, which defines the number of roadway and transit trips between various traffic analysis zone pairs, is another major step in the modeling process. As managed lane strategies expand from HOT lanes to ETL lanes by different occupancy levels and to TOT lanes by truck type, it is essential to develop trip tables that accurately represent the demand of all vehicle types including SOVs, HOVs for different occupancy levels, commercial vehicles, medium-duty trucks and heavy-duty trucks. Two revisions were made to the ARC original travel demand model trip tables: splitting the HOV demand tables and revising truck trip tables:

- Splitting the HOV demand tables into HOV2+, HOV3+ and HOV4+

  The ARC travel demand model splits auto volume into two occupancy categories: SOV and HOV2+. Other auto occupancy classes, HOV3+ and HOV4+ for example, are grouped together in the traffic assignment procedures. To fully evaluate HOV global demand by occupancy, the MLSP analysis disaggregated HOV trips into three classifications of HOV: HOV2+, HOV3+, and HOV4+. The HOV2+, HOV3+ and HOV4+ trip tables were then recalibrated using field auto occupancy data collected by corridor and by time period. It was observed that the ARC travel demand model is fairly accurate in replicating the percentage split of total volume into SOVs and HOVs. However the percentage of HOV3+ vehicles in the model is much higher than observed field data. Based on the comparisons of model output vs. field data, the three individual HOV trips tables were adjusted by shifting a portion of HOV3+'s and HOV4+'s into HOV2+'s.

- Revising truck trip tables (medium-duty truck and heavy-duty truck)

The future medium-duty truck trip table and heavy-duty truck trip table employed in the MLSP analysis was revised from ARC's original forecast. The revised medium-duty truck trip table and heavy-duty truck trip table reflect the latest truck growth forecast in the GDOT's Statewide Truck Lanes Needs Identification Study. This study updated future daily commodity truck tables in the Statewide Travel Demand Model using the 2004 TRANSEARCH database in combination with the annual growth rate developed in the Statewide Transportation Plan (SWTP) from the FHWA's Freight Analysis Framework. The revised 20-county medium-duty truck trip table and heavy-duty truck trip table were used for MLSP analysis.

Analysis Years and Time Periods

The years selected for the MLSP analysis are 2020 and 2030. These two analysis years are not representative of the opening year and design year for the managed lane investments. Rather they served as two individual timeline points for revenue estimation. The travel demand models for year 2020 and 2030 are based on assumptions of future land use, population and employment forecasts and roadway investments developed by ARC.

For each forecast year, the following five separate time periods were modeled:

- A morning peak period from 6:00 AM to 10:00 AM,
- A mid-day period from 10:00 AM to 3:00 PM,
- A afternoon peak period from 3:00 PM to 7:00 PM,
- A late evening period from 7:00 PM to 10:00 PM, and
- A night period from 10:00 PM to 6:00 AM.

Stated Preference Surveys and Willingness-to-Pay Methodology

Since there is only one tolled facility in the Atlanta area, a simple toll diversion modeling methodology has historically been employed to forecast demand on tolled facilities in the region. This methodology uses a fixed value of time ($15/hour for autos and $60/hour for trucks) and assigns either 100 or 0 percent to tolled and toll-free routes during each iteration of the highway assignment. Hence, it does not account for potential variation in value of time by trip characteristics (like trip purpose and trip length) and trips maker's characteristics (like income and gender).

To accurately forecast managed lane usage within the regional transportation network, the ARC travel demand model was enhanced by incorporating willingness-to-pay (WTP) methodology into the standard equilibrium highway assignment process. The WTP methodology helps determine a driver's probability of using the managed lanes and/or truck only toll lanes based on the various tradeoffs regarding travel time savings, toll cost, and other trip characteristics.

The data used to establish the WTP at varying levels of travel time savings and toll rates were developed based on the stated preference surveys conducted in May and June, 2007 by GDOT. The surveys targeted two different user markets: passenger cars and trucks.

Passenger Car Stated Preference (SP) Survey

A computer-assisted self-interview (CASI) technique was developed and used to administer stated preference surveys. The surveys included a random sampling of passenger car drivers who made a weekday trip within the past week of 15 minutes or more that used any of the study routes[9]. The survey data was collected by intercepting residents at activity sites and through online completion by residents and employees of local businesses, organizations, and colleges in the greater Atlanta area. In total, over 4,000 responses were collected for the passenger car SP survey.

Each of these respondents was presented with eight separate trade-off scenarios with three travel options. These three travel options included information about travel time, toll cost, and vehicle occupancy. Figure 7 shows an example of a set of travel options presented in the survey.

Figure 7: Example Trade-Off Scenario

Using the results of this survey, a series of willingness-to-pay diversion curves were developed for different time periods (AM Peak, PM Peak, and Off-Peak) and for different managed lane study corridors, recognizing the fact that willingness-to-pay varies by different times-of-day and by different corridor. These WTP diversion curves were then ultimately incorporated into the ARC's model assignment process for subsequent toll sensitivity analyses and revenue estimation.

Figure 8 shows an example of passenger car willingness-to-pay curves for the I-285 corridor during the PM peak period, with the ratio of the toll rate to amount of travel time saving on the x-axis and percentage of willingness-to-pay on the y-axis. The figure shows that for the

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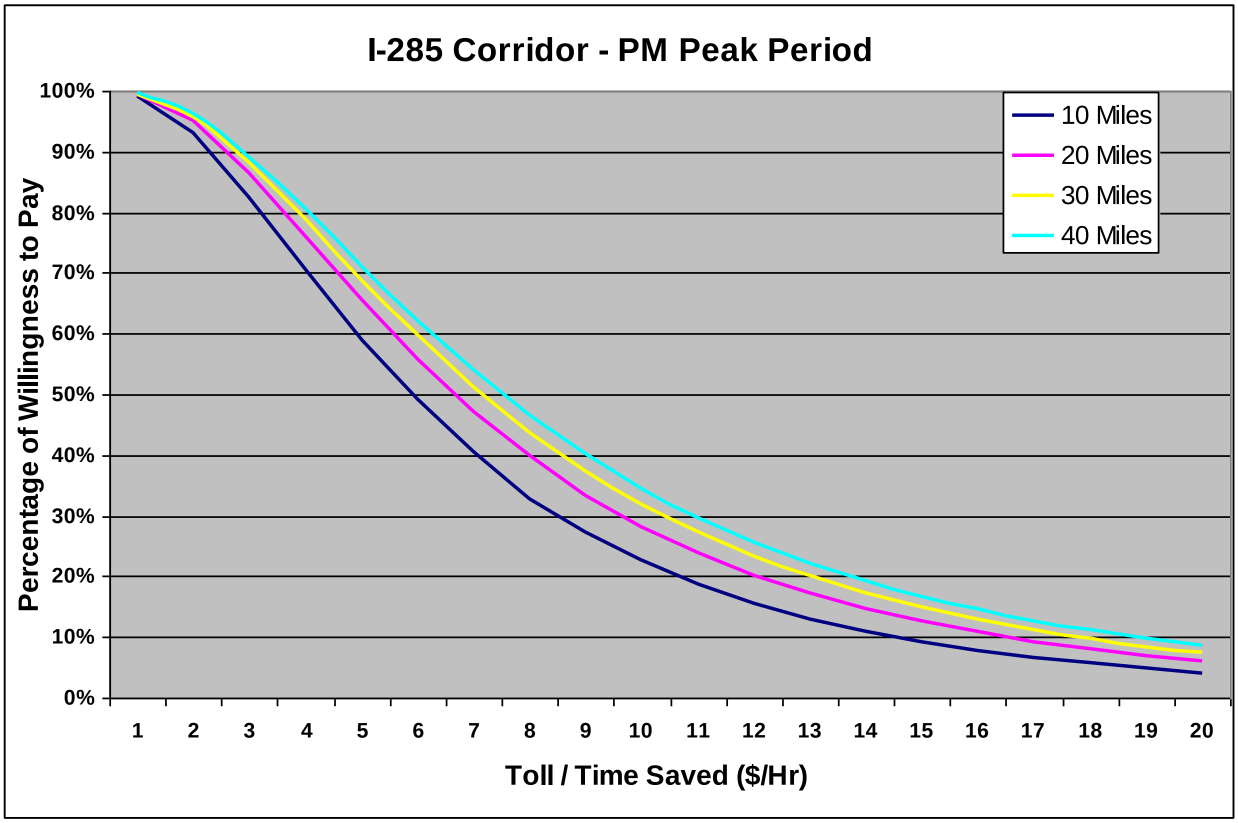
[9] The study routes include I-85, I-20, and I-75 inside of the I-285, I-20 to the west and east of I-285, I-85 to the north of I-285, and all of I-285.

same amount of travel time savings, more users are willing to pay small amounts, but fewer users are willing to pay larger amounts. For example, about 50% of auto users are willing to pay $6.00 in order to save an hour on their 10-mile trip while only 16% of auto users are willing to pay $12.00 in order to save an hour on their 10-mile trip.

The figure also illustrates the relationship between the willingness-to-pay and the total trip distance. Under the condition with same ratio of toll rates to amount of travel time savings, less people are willing to pay for the short distance trip than for the long distance trip. For example, about 23% of auto users are willing to pay $5.00 in order to save 30 minutes on their 10-mile trip while about 35% of auto users are willing to pay $20.00 in order to save two hours on their 40-mile trip.

Figure 8: I-285 Passenger Car Willingness-to-Pay Curves – PM Peak Periods



Truck Stated Preference (SP) Survey

A similar technique and survey approach was used to administer truck stated preference surveys to a random sampling of truck drivers, fleet managers or dispatchers who drove or managed drivers making weekday trips that used any of the truck lane study routes[10]. The survey data were collected by intercepting truck drivers at sites and through online completion by fleet managers or dispatchers in the greater Atlanta area. In total, over 400 responses were collected for truck SP survey. The sample consisted of 56% of drivers for trucking companies with more than one vehicle and 42% owner-operated drivers.

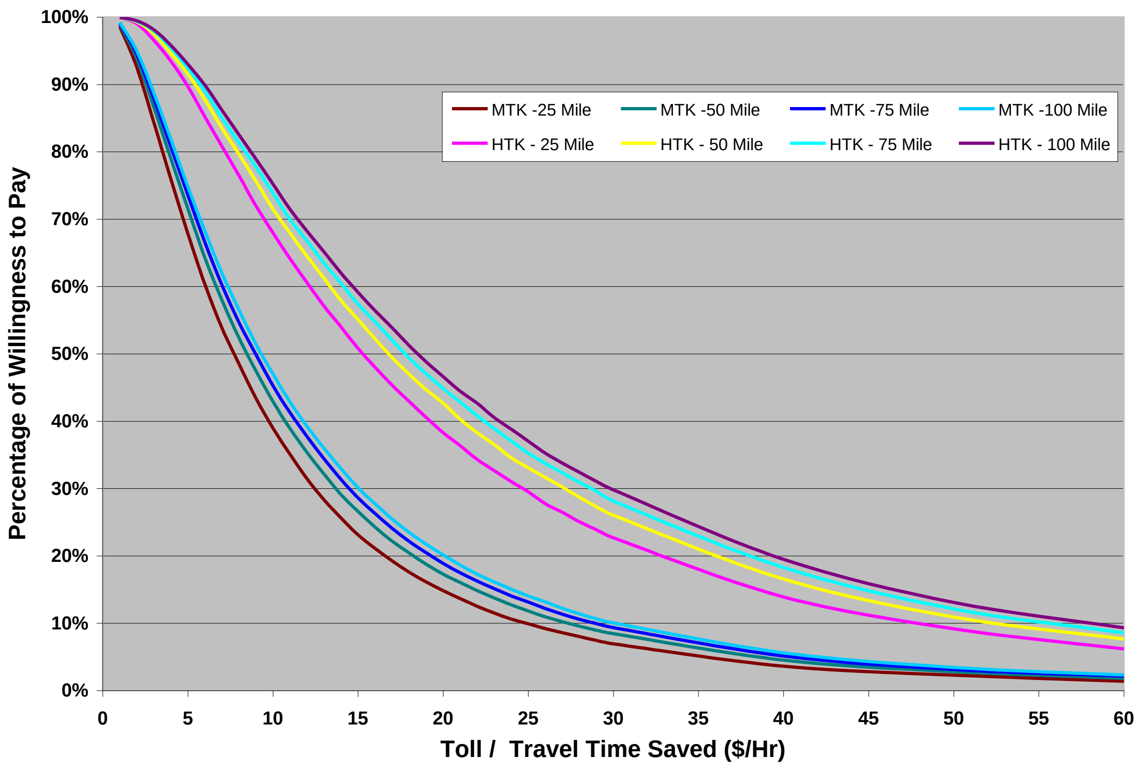
[10] The study routes include I-85, I-75, I-20 and all of I-285.

Each of these respondents was presented with eight separate trade-off scenarios with two travel options - travel time and toll cost. Using the results of this survey, WTP diversion curves were developed for medium-duty trucks and heavy-duty trucks by the total trip distance recognizing the fact that willingness-to-pay varies by truck type and by distance traveled. These WTP diversion curves were then ultimately incorporated into the ARC's model assignment process for subsequent toll sensitivity analyses and revenue estimations.

Figure 9 shows an example of willingness-to-pay curves for medium-duty trucks and heavy-duty trucks respectively. Similar trends are observed for the medium-duty truck and heavy-duty truck WTP curve as the passenger car WTP curve. More truck users are willing to pay small amounts, but fewer users are willing to pay larger amounts for the same amount of travel time savings. And under a condition with the same ratio of toll rates to amount of travel time savings, less truck users are willing to pay for the short distance trip than for the long distance trip.

Results of the truck SP survey show that the overall willingness-to-pay for heavy-duty trucks is higher than that for medium-duty trucks.

Figure 9: Medium-Duty Trucks and Heavy-Duty Trucks Willingness-to-Pay Curves



More detailed information regarding the survey approach and results are included in Technical Memorandum 1B *Greater Atlanta Stated Preference Survey Documentation.*

The willingness-to-pay curves for passenger cars, medium-duty trucks and heavy-duty trucks were incorporated into the equilibrium highway assignment process to estimate the percentage of travelers who could choose a tolled travel option given a certain value of travel time savings. After the determination of willingness to pay, the individual trip table for each vehicle type is split in two: one table for those willing to pay tolls (under certain travel circumstances) and one for those who are not willing to pay tolls (under any circumstances). Then the standard TP+ equilibrium assignment methodologies were applied. Those who are not willing to pay are all assigned to paths without tolls. Those who are willing to pay become eligible for tolled facilities and are assigned to both tolled and untolled roads based on congestion levels. It is important to note that the various vehicle types (i.e., SOV, HOV2+, HOV3+, HOV4+, CV, medium-duty trucks and heavy-duty truck) were handled separately in the TP+ assignment process to recognize different restrictions on specific lane uses (HOT lane, TOT lane, ETL lane, etc.) and toll charges. For example, medium-duty truck and heavy-duty truck traffic were not permitted to use the HOT lanes. SOV, HOV, CV and medium-duty truck traffic were not allowed to use the TOT lanes.

C. Traffic and Revenue Analysis

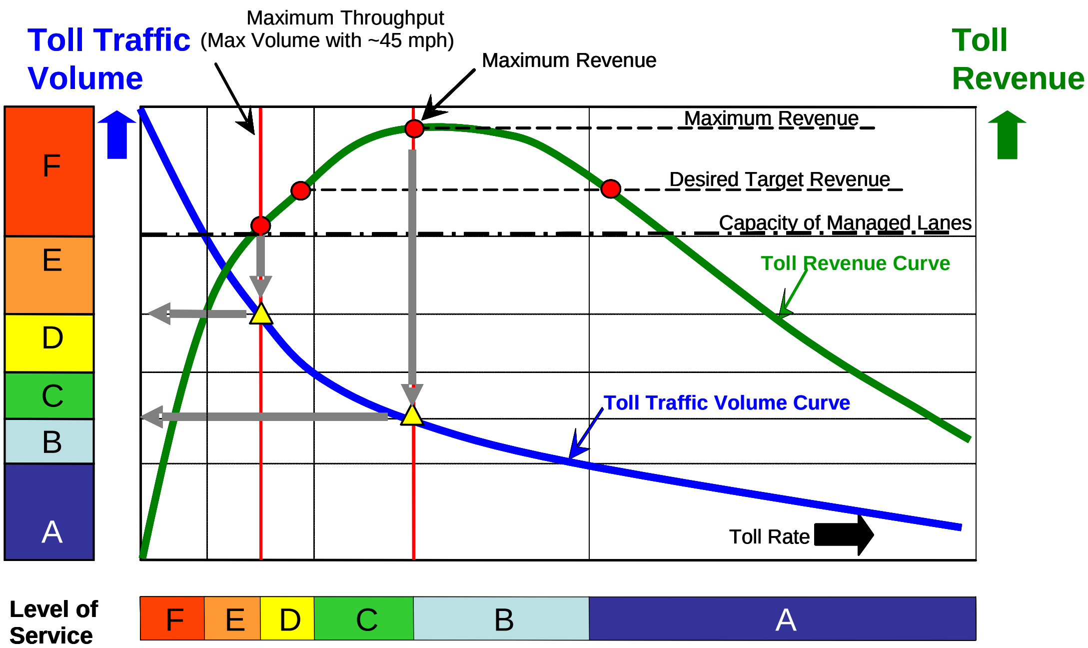
Toll Sensitivity Analysis

The traffic and revenue methodology described in the previous section was used to conduct a toll sensitivity test for each managed lane candidate corridor under different policy alternatives, separately by time-of-day and direction. The goal of performing a toll sensitivity analysis is to provide an understanding of the relationship between toll rates, traffic impacts and revenue levels.

Figure 10 shows an example of toll sensitivity curve (in green) and associated toll traffic volume curve (in blue), with toll rate on the x-axis and revenue/toll traffic volume on the y-axis. As seen from the toll traffic volume curve, lower toll rates in the managed lanes result in higher usage (higher traffic volume) while higher toll rates result in lower usage (lower traffic volumes). The toll sensitivity curve shows different trends. As the x-axis values (toll rates) increase from left to right, revenue increases to a high point and then begins to decline. With a higher percent of the corridor's global demand in the managed lanes, demand, and more specifically operating speeds, in the general purpose lanes improve leading to an overall reduction in congestion. Consequently, improving the conditions in the general purpose lanes erodes the value of the managed lane to paying traffic. Constantly changing conditions results in a delicate balance between the operating conditions in the managed lanes and the general purpose lanes and the price associated with the managed lanes.

The resulting toll sensitivity curves illustrate the relative levels of potential toll revenue and the traffic associated with each hypothetical toll charge.

Figure 10: Toll Sensitivity Curve



A series of toll sensitivity curves were created by time period, travel direction, analysis year and segment to illustrate the relationships between the toll rates and revenue collected for each segment. Based on these toll sensitivity curves, toll rates are set to target specific levels of service (traffic conditions) and revenue objectives. In this study, toll rates were established for the following two scenarios:

- **A throughput maximization scenario**
  This scenario refers to a tolling scheme designed to price managed lane capacity such that the maximum number of vehicles use the managed lane while still maintaining a minimum operating speed of 45 mph.

- **A revenue maximization scenario**
  This scenario refers to a tolling scheme designed to generate the highest level of total revenue and maintain a minimum operating speed of 45 mph.

  These two scenarios were used to frame the initial traffic and revenue forecasts for the managed lane investment strategy. The results of the toll sensitivity analysis for each corridor are presented in their respective *Corridor Resources Guide Documentation*.

Traffic and Revenue Analysis Results

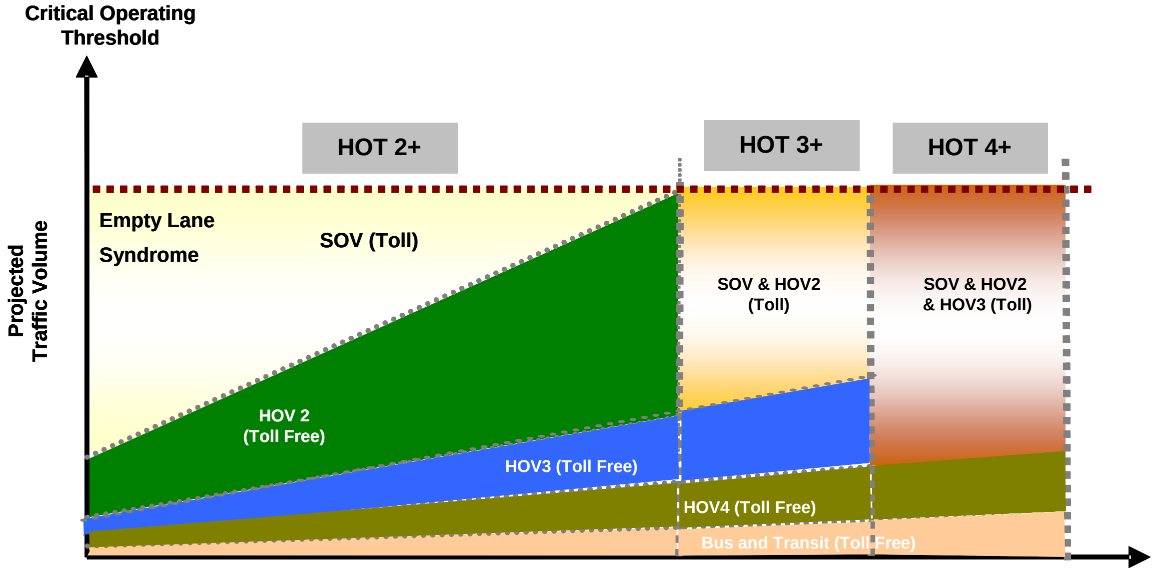
This section presents the traffic and revenue analysis results for managed lane candidate corridors under each of the managed lane policies evaluated for year 2020 and 2030.

High Occupancy Toll Policies

- **HOT2+**

Figure 11 illustrates the life cycle of an HOV facility and depicts the stage at which various strategies can be enacted over the life of an HOV facility so that free flow or desirable conditions can always be maintained.

Figure 11: Life Cycle of an HOV and HOT Facility



For instance, whenever an HOV lane is established or the occupancy requirements increase, there is typically a time period when the volume to capacity ratio is low, which leads to “empty lane syndrome”. By allowing vehicles that don't meet passenger occupancy or vehicle eligibility requirements to gain access to HOV lanes by paying a toll, it provides the opportunity to fill unused capacity and also provides transportation choice for those willing to pay. Through the use of variable pricing, which sets the toll according to the level of congestion, the number of SOVs that use the facility is never allowed to exceed the "critical operating threshold," or the traffic volume at which operations become congested.

As time goes on and HOV volumes grow, the region’s HOV lanes with 2+ occupancy requirements might become increasingly crowded on certain corridors and will eventually jeopardize their ability to serve their very purpose – providing travel time advantages and reliable trips for carpools and express buses. To evaluate when HOV2+ demand will reach the critical operating threshold for each corridor, the planning team conducted a time-series analysis. This analysis assumed that two HOV Lanes in each direction will be constructed along all managed lane candidate corridors with HOV2+ free policy. The same access points were assumed in this analysis as proposed for the Managed Lane investments. To identify the HOV demand threshold time range for each corridor, the planning team used the speed of 45 mph as the critical operating threshold (based on FHWA policy). Based on the analysis results, segments on I-75 North corridor (North of I-285) and I-285 North corridor are forecasted to exceed the critical operating threshold prior to 2020 under the HOV2+ free policy; for these corridors, since there is no capacity available to sell to SOVs prior to 2020, no revenue will be estimated for the HOT2+ policy. The I-285 East corridor, Downtown Connector (I-75/I-85) and segments on the I-85 North corridor and I-285 West corridor are forecasted to reach the critical operating threshold between the years 2020 and 2030. Other corridors, such as I-575, I-75 North (inside I-285) and I-85 North (inside of I-285) are forecasted to reach the critical operating threshold between the years 2030 and 2050. I-285 South corridor and I-20 inside of I-285 is forecasted to reach the critical operating threshold after the year 2050.

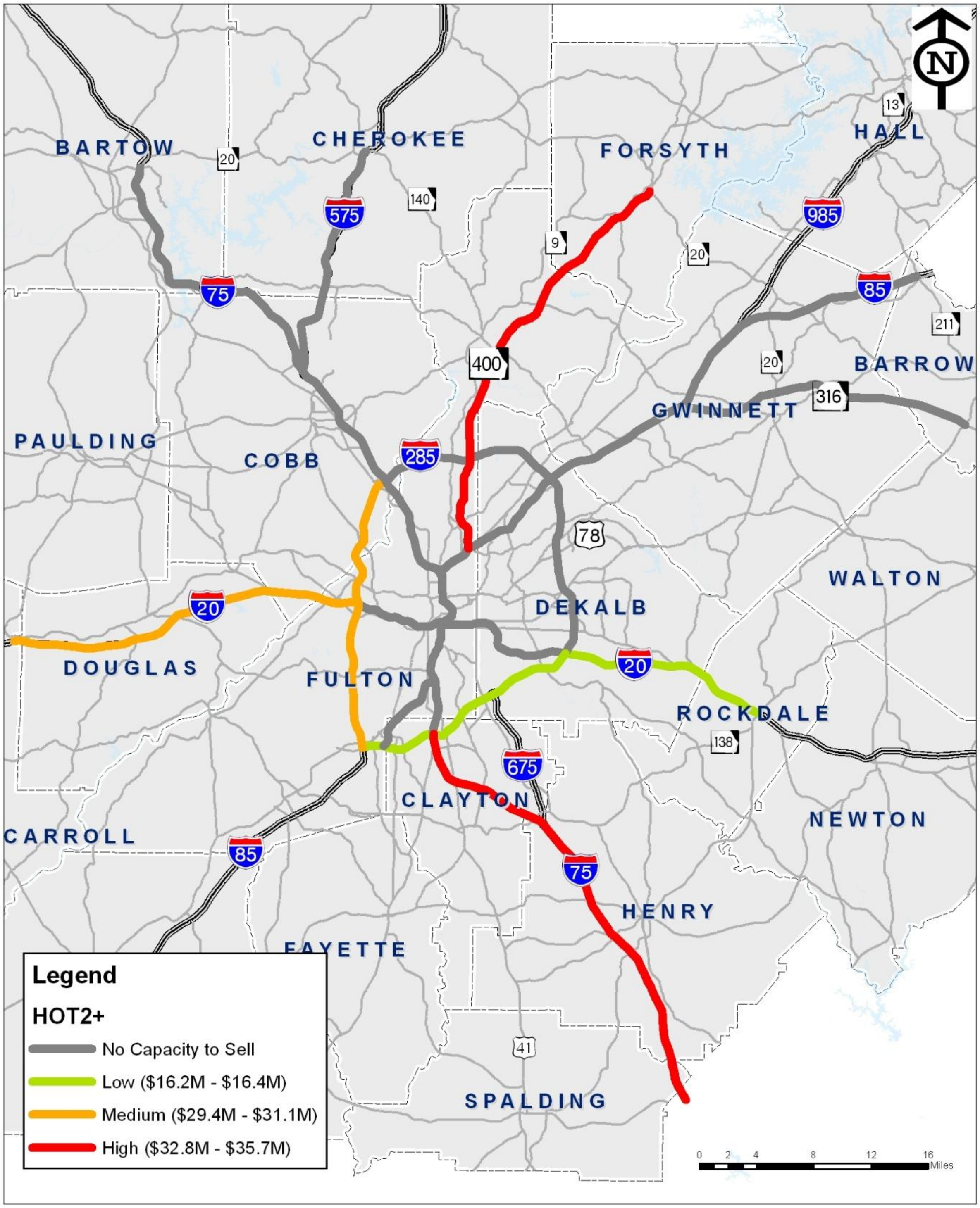
Year 2020 and 2030 traffic and revenue forecasts for all managed lane candidate corridors with HOT2+ investment policies are presented in the following table. Both the revenue and traffic numbers are presented for the maximum efficiency policy, a policy that prices managed lanes such that the maximum number of vehicles use the managed lanes while still providing a minimum operating speed of 45 mph. Using the maximum efficiency threshold, I-75 North Corridor (North of I-285), I-285 North Corridor, and I-575 Corridor were identified as having no capacity to sell in the year 2020. By 2030, additional corridors, including I-85 North Corridor, SR 316, I-285 East Corridor, Downtown Connector and all corridors inside of I-285 were identified as having no capacity to sell. Therefore no revenue is estimated on these corridors. Note that some corridors with relatively higher vehicle demand do not generate higher revenue because the toll rates, vehicle miles traveled, and transportation performance are unique on each corridor.

Table 1: Traffic and Revenue – All Managed Lane Candidate Corridors with HOT2+ Policy

Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	No Capacity to Sell			
I-75 South	21.0	185,490	35.7	210,328
I-85 North	26.6	201,673	No Capacity to Sell	
I-20 East	8.1	150,575	16.2	173,806
I-20 West	14.9	162,778	31.1	191,327
I-285 South	10.4	180,924	16.4	201,993
I-285 East	17.7	220,858	No Capacity to Sell	
I-285 North	No Capacity to Sell			
I-285 West	17.7	195,232	29.4	213,483
I-575	No Capacity to Sell			
SR 400	20.2	171,771	32.8	190,358
Downtown Connector	18.7	370,224	No Capacity to Sell	
I-85 North (Inside I-285)	10.8	228,801		
I-85 South (Inside I-285)	3.6	127,110		
I-75 North (Inside I-285)	7.0	214,096		
I-75 South (Inside I-285)	5.3	194,559		
I-20 East (Inside I-285)	6.8	174,500		
I-20 West (Inside I-285)	2.8	191,340		
SR 316	4.8	90,733		

The 2030 estimated revenue numbers were then ranked and grouped into three categories using a geometric distribution. This method was utilized because it produces nearly equal numbers of corridors within each ranking. The three categories are high revenue, medium revenue and low revenue. Figure 12 illustrates 2030 annual revenue ranking for all HOT2+ managed lane corridor. The gray-colored routes represent those corridors that were identified with no capacity to sell in 2030 and beyond. The red-colored corridors, SR 400 and I-75 South were identified as high HOT2+ revenue generating corridors with estimated revenue ranges from $32.8M to $35.7M. The orange-colored corridors, I-20 West and I-285 West, were identified as medium HOT2+ revenue generating corridors with estimated revenue ranges from $29.4M to $31.1M. The green-colored corridors, I-20 East and I-285 South were identified as low HOT2+ revenue generating corridors with estimated revenue ranges from $16.2M to $16.4M.

Figure 12: 2030 HOT2+ Corridor Revenue Ranking - Maximum Efficiency Policy



- **HOT3+**

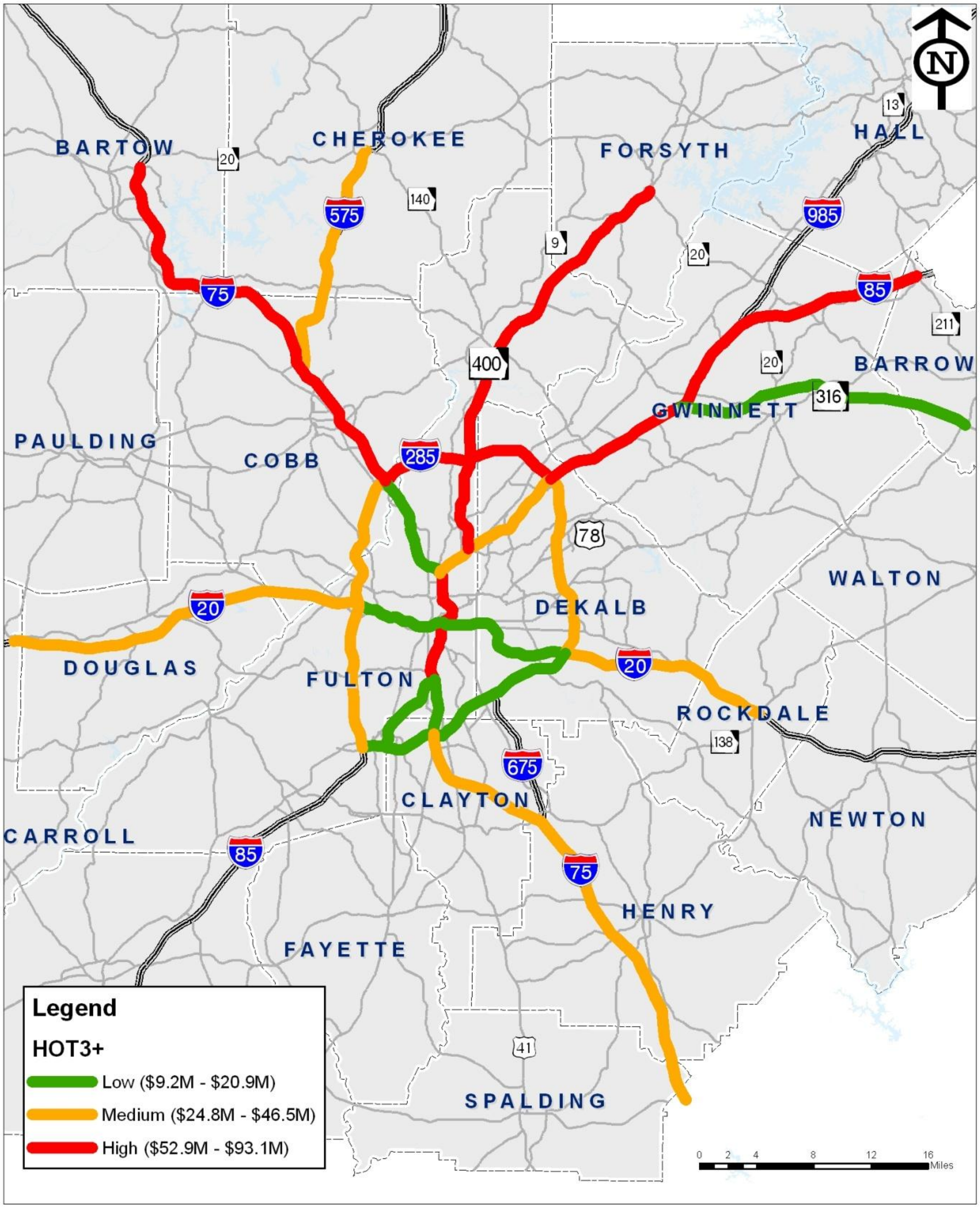
Year 2020 and 2030 traffic and revenue forecasts for HOT3+ under the maximum efficiency scenario are presented in the following table.

Table 2: Demand and Revenue - All Managed Lane Candidate Corridors with HOT3+ Policy

Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	54.0	202,207	93.1	217,879
I-75 South	23.8	183,609	42.5	208,390
I-85 North	42.4	198,516	66.9	217,455
I-20 East	11.0	147,663	25.0	170,110
I-20 West	20.3	160,577	46.5	187,251
I-285 South	12.7	177,576	20.9	197,816
I-285 East	28.0	214,474	46.5	233,606
I-285 North	34.6	272,646	58.2	277,958
I-285 West	22.6	190,849	40.2	205,011
I-575	9.7	104,160	24.8	134,513
SR 400	31.2	168,760	55.1	186,647
Downtown Connector	32.6	361,182	52.9	395,934
I-85 North (Inside I-285)	18.7	222,855	31.9	244,657
I-85 South (Inside I-285)	5.6	124,423	9.8	142,978
I-75 North (Inside I-285)	11.1	211,231	18.3	228,606
I-75 South (Inside I-285)	9.2	194,226	14.6	212,832
I-20 East (Inside I-285)	10.8	171,388	18.2	189,653
I-20 West (Inside I-285)	4.4	189,593	9.2	212,447
SR 316	7.6	89,313	16.5	97,467

Figure 13 is the map of 2030 annual revenue ranking for HOT3+ managed lane corridors. I-75 North, SR 400, I-85 North, I-285 North and the Downtown Connector were identified as high HOT3+ revenue generating corridors with estimated revenue ranges from $52.9M to $93.1M. I-575, I-20 East, I-20 West, I-85 North Inside, I-285 East, I-285 West and I-75 South were identified as medium HOT3+ revenue generating corridors with estimated revenue ranges from $24.8M to $46.5M. The corridors inside of I-285 (I-75 North, I-20 East, I-20 West, I-85 South, I-75 South) , I-285 South, and SR 316 were identified as low HOT3+ revenue generating corridors with estimated revenue ranges from $9.2M to $20.9M.

Figure 13: 2030 HOT3+ Corridor Revenue Ranking - Maximum Efficiency Policy



- **HOT4+**

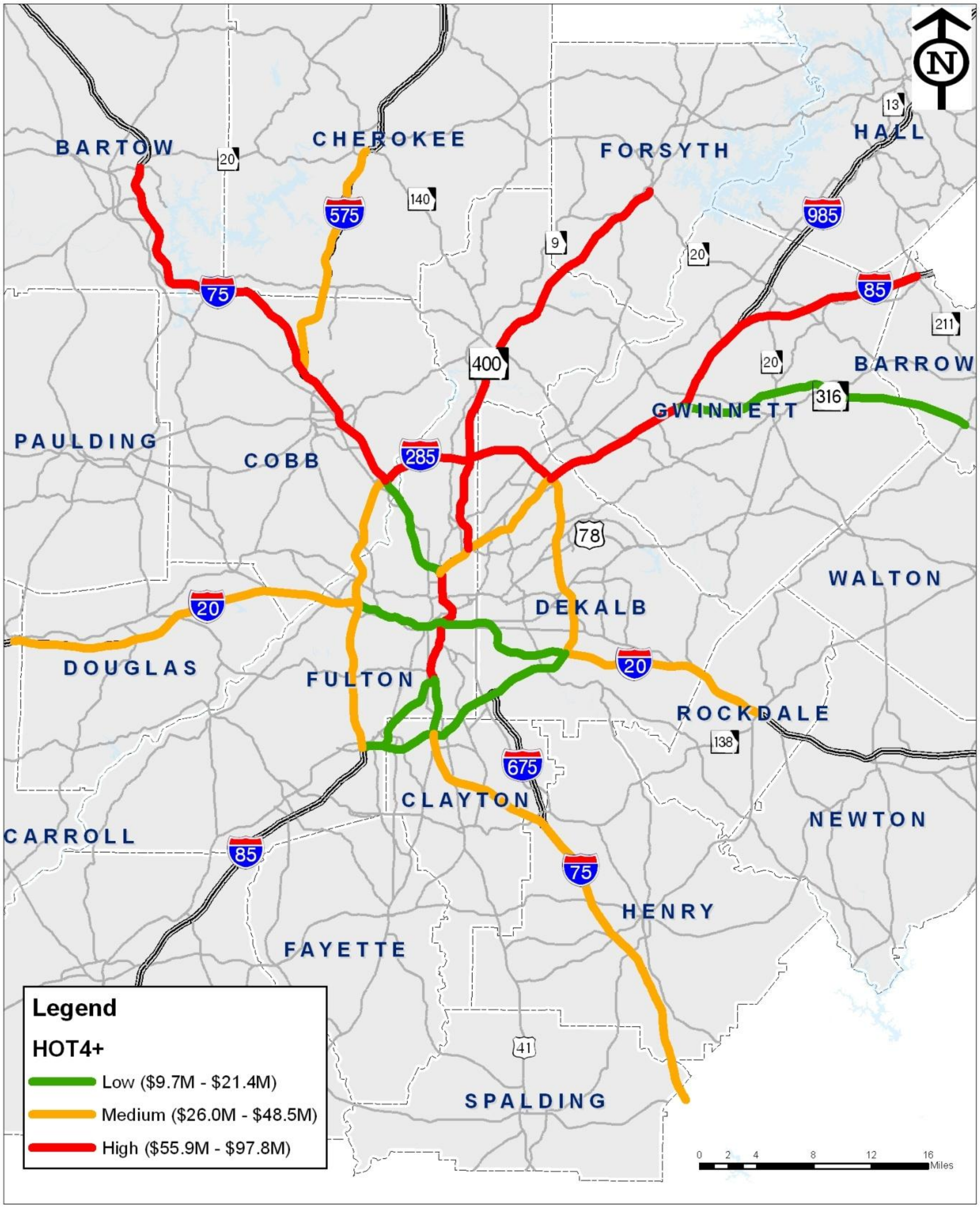
Year 2020 and 2030 traffic and revenue forecasts for all managed lane candidate corridors with HOT4+ eligibility policy under maximum efficiency scenario are presented in the following table.

Table 3: Demand and Revenue – All Managed Lane Candidate Corridors with HOT4+ Policy

Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	56.2	201,720	97.8	217,673
I-75 South	24.1	183,460	43.5	208,400
I-85 North	44.3	198,135	70.6	217,010
I-20 East	11.3	147,005	26.0	169,455
I-20 West	20.9	160,044	48.1	186,643
I-285 South	12.8	177,872	21.4	197,601
I-285 East	29.0	214,901	48.5	232,563
I-285 North	36.7	272,676	62.3	277,458
I-285 West	23.1	189,834	41.4	204,809
I-575	10.3	103,805	26.4	134,015
SR 400	32.5	168,421	57.8	186,304
Downtown Connector	34.3	359,441	55.9	394,929
I-85 North (Inside I-285)	19.6	221,852	33.5	243,972
I-85 South (Inside I-285)	5.8	123,099	10.5	142,413
I-75 North (Inside I-285)	11.7	211,281	19.4	228,082
I-75 South (Inside I-285)	9.6	194,808	15.6	213,239
I-20 East (Inside I-285)	11.4	171,228	18.9	189,219
I-20 West (Inside I-285)	4.6	189,025	9.7	211,090
SR 316	8.0	89,141	17.4	97,262

Figure 14 shows the map of 2030 annual revenue ranking for all HOT4+ managed lane corridors. I-75 North, SR 400, I-85 North, I-285 North and the Downtown Connector were identified as high HOT4+ revenue generating corridors with estimated revenue ranging from $55.9M to $97.8M. I-575, I-20 East, I-20 West, I-85 North Inside, I-285 East, I-285 West and I-75 South were identified as medium HOT4+ revenue generating corridors with estimated revenue ranging from $26.0M to $48.5M. I-75 North Inside, I-20 East Inside, I-20 West Inside, I-85 South Inside, I-75 South Inside, I-285 South, and SR 316 were identified as low HOT4+ revenue generating corridors with estimated revenue ranging from $9.7M to $21.4M.

Figure 14: 2030 HOT4+ Corridor Revenue Ranking - Maximum Efficiency Policy



- **Express Toll Lanes (ETL) Policy**

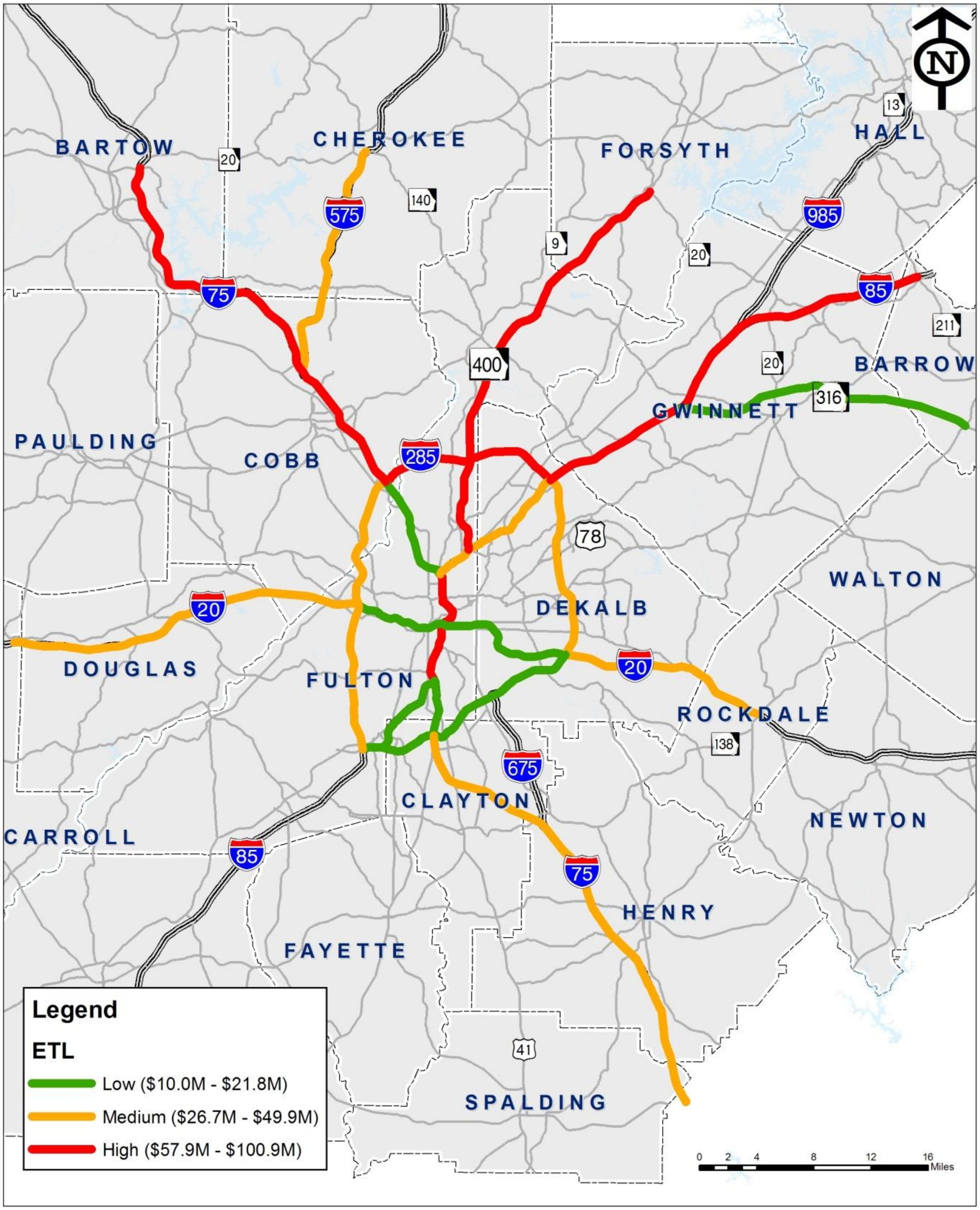
  Year 2020 and 2030 traffic and revenue forecasts under the maximum efficiency scenario are presented in the following table for all managed lane candidate corridors with the ETL eligibility policy.

Table 4: Traffic and Revenue – All Managed Lane Candidate Corridors with ETL Policy

Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	57.7	201,396	100.9	217,536
I-75 South	24.2	183,360	44.2	208,406
I-85 North	45.6	197,881	73.0	216,713
I-20 East	11.5	146,567	26.7	169,019
I-20 West	21.3	159,688	49.2	186,238
I-285 South	12.9	178,069	21.8	197,457
I-285 East	29.7	215,185	49.9	231,867
I-285 North	38.1	272,696	65.0	277,125
I-285 West	23.4	189,158	42.2	204,675
I-575	10.6	103,568	27.5	133,683
SR 400	33.4	168,195	59.6	186,076
Downtown Connector	35.4	358,280	57.9	394,259
I-85 North (Inside I-285)	20.2	221,184	34.6	243,515
I-85 South (Inside I-285)	5.9	122,217	10.9	142,037
I-75 North (Inside I-285)	12.0	211,315	20.1	227,733
I-75 South (Inside I-285)	9.8	195,196	16.3	213,511
I-20 East (Inside I-285)	11.8	171,122	19.4	188,929
I-20 West (Inside I-285)	4.7	188,646	10.0	210,185
SR 316	8.2	89,027	18.0	97,129

Figure 15 shows a map of 2030 annual revenue ranking for all ETL managed lane corridors. I-75 North, SR 400, I-85 North, I-285 North and the Downtown Connector were identified as high ETL revenue generating corridors with estimated revenue ranging from $57.9M to $100.9M. I-575, I-20 East, I-20 West, I-85 North Inside, I-285 East, I-285 West, and I-75 South were identified as medium ETL revenue generating corridors with estimated revenue ranging from $26.7M to $49.9M. I-75 North Inside, I-20 East Inside, I-20 West Inside, I-85 South Inside, I-75 South Inside, I-285 South, and SR 316 were identified as low ETL revenue generating corridors with estimated revenue ranging from $10.0M to $21.8M.

Figure 15: 2030 ETL Corridor Revenue Ranking - Maximum Efficiency Policy



- **Voluntary Truck Only Toll (TOT) Policy**

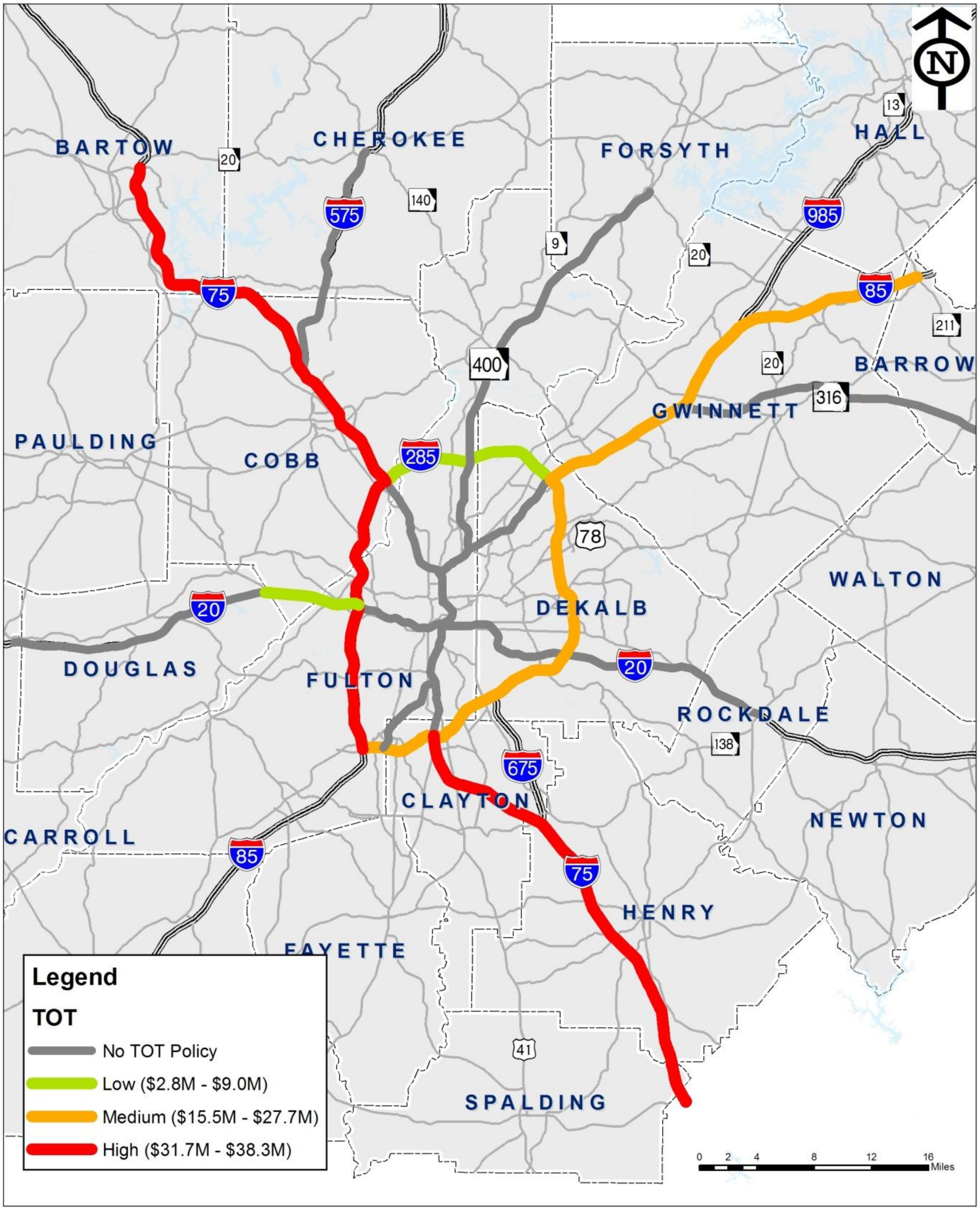
  Year 2020 and 2030 traffic and revenue forecasts under the maximum efficiency scenario are presented in the following table for all managed lane candidate corridors with the TOT eligibility policy. Corridor I-575, I-20 East, SR 400, I-20 West from SR 6 to Post Rd, and all corridors inside of I-285 were identified not eligible for potential truck-only-lanes.

Table 5: Traffic and Revenue - All Managed Lane Candidate Corridors with TOT Policy

Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	20.7	197,762	33.1	215,561
I-75 South	26.3	175,814	31.7	204,508
I-85 North	16.8	181,327	25.1	202,242
I-20 West (from I-285 West to SR 6)	2.4	39,895	2.8	46,942
I-285 South	12.9	175,134	27.7	195,059
I-285 East	9.8	201,015	15.5	221,914
I-285 North	7.0	247,836	9.0	258,747
I-285 West	23.0	192,524	38.3	213,271

Figure 16 shows a map of 2030 annual revenue ranking for all TOT managed lane corridors. I-75 North, I-285 West and I-75 South were identified as high TOT revenue generating corridors with revenue ranging from $31.7M to $38.3M. I-85 North, I-285 East and I-285 South were identified as medium TOT revenue generating corridors with revenue ranging from $15.5M to $27.7M. I-285 North and I-20 West from I-285 West to SR 6 were identified as low TOT revenue generating corridors with revenue ranging from $2.8 to $9.0M.

Figure 16: 2030 TOT Corridor Revenue Ranking - Maximum Efficiency Policy



- **Mixed Express Toll Lanes (METL) Policy**

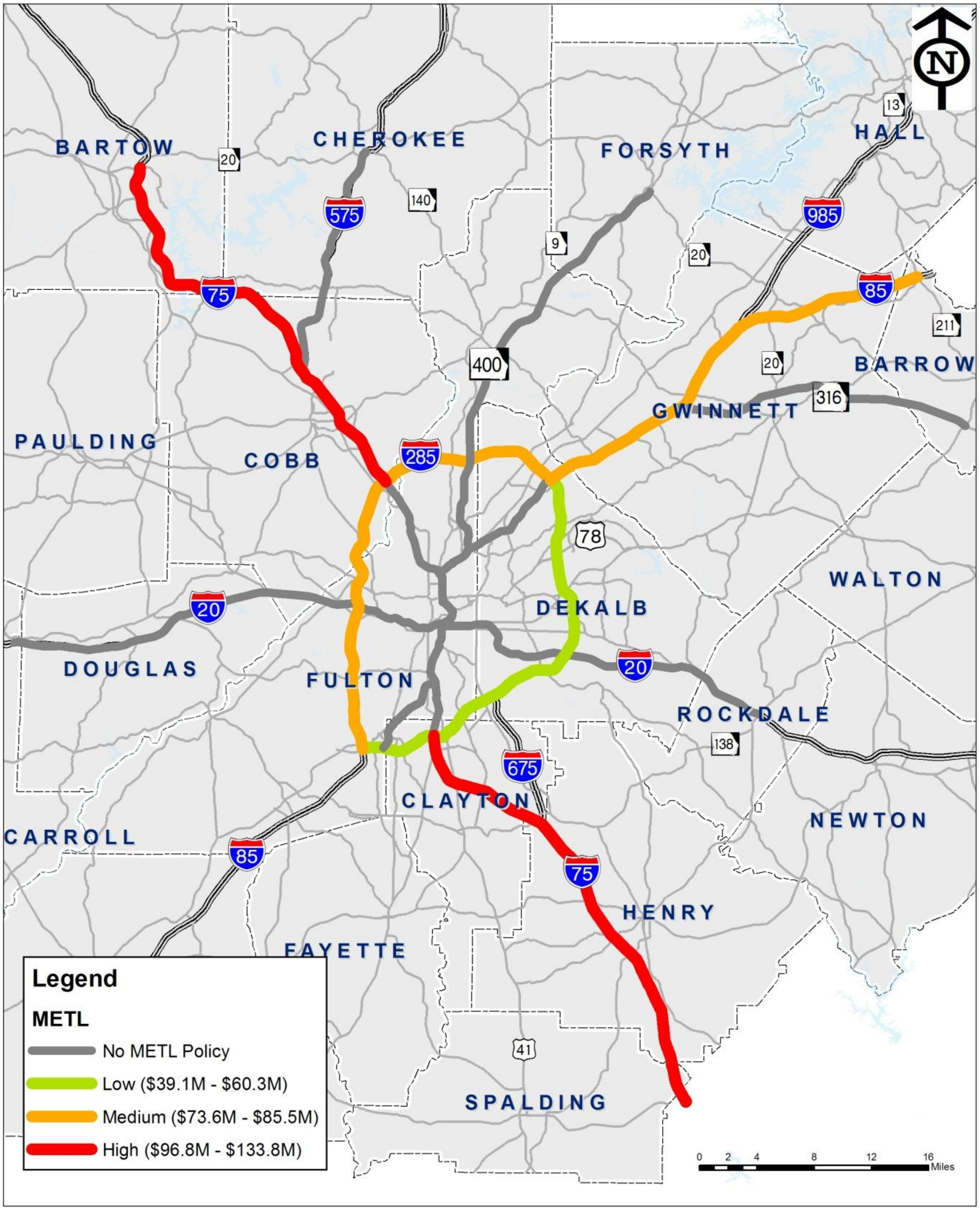
  Year 2020 and 2030 traffic and revenue forecasts under the maximum efficiency scenario are presented in the following table for all managed lane candidate corridors with the METL eligibility policy. Corridor I-575, SR 400, I-20 East, I-20 West, and all corridors inside I-285 were identified as not eligible for the METL policy.

Table 6: Traffic and Revenue - All Managed Lane Candidate Corridors with METL Policy

Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	84.3	208,751	133.8	228,575
I-75 South	47.8	185,434	96.8	208,649
I-85 North	49.9	207,024	85.5	228,934
I-285 South	19.1	185,333	39.1	207,145
I-285 East	35.2	226,690	60.3	242,423
I-285 North	41.3	284,983	73.6	291,025
I-285 West	41.3	199,126	79.0	212,939

Figure 17 shows a map of 2030 annual corridor revenue ranking for all METL managed lane corridors. I-75 North and I-75 South were identified as high METL revenue generating corridors with estimated revenue ranging from $96.8M to $133.8M. I-285 North and I-285 West were identified as medium METL revenue generating corridors with estimated revenue ranging from $73.6M to $85.5M. I-85 North, I-285 South and I-285 East were identified as low METL revenue generating corridors with estimated revenue ranging from $39.1M to $60.3M.

Figure 17: 2030 METL Corridor Revenue Ranking - Maximum Efficiency Policy



- **ETL + Voluntary TOT (2+2) Policy**

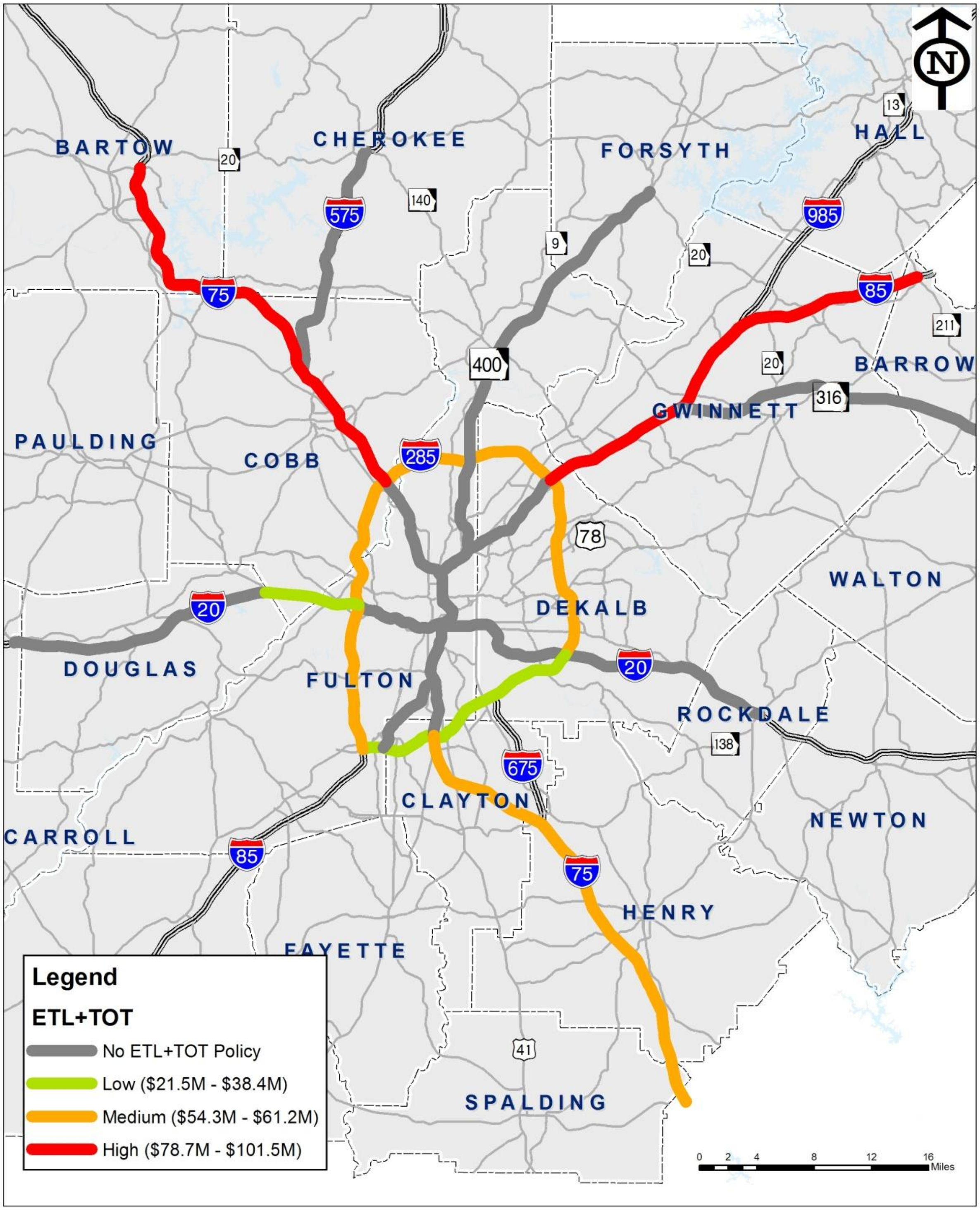
Year 2020 and 2030 traffic and revenue forecasts under the maximum efficiency scenario are presented in the following table for all managed lane candidate corridors with the 2+2 eligibility policy. Corridor I-575, I-20 East, SR 400, I-20 West from SR 6 to Post Rd, and all corridors inside of I-285 were identified as not eligible for 2+2 policy.

Table 7: 2030 Demand and Revenue - All Managed Lane Candidate Corridors with 2+2 Policy

Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	60.1	218,831	101.5	239,556
I-75 South	38.8	192,419	54.3	221,898
I-85 North	49.9	209,290	78.7	233,787
I-20 West (from I-285 West to SR 6)	14.2	200,564	21.5	242,023
I-285 South	22.4	194,663	38.4	224,712
I-285 East	34.0	230,412	54.9	260,462
I-285 North	38.2	284,148	59.8	297,998
I-285 West	41.1	210,378	61.2	239,962

Figure 18 shows a map of 2030 annual corridor revenue ranking for ETL + Voluntary TOT corridors. I-75 North and I-85 North were identified as high revenue generating corridors with estimated revenue ranging from $78.7M to $101.5M. I-285 North, I-285 West, I-285 East and I-75 South were identified as medium revenue generating corridors with estimated revenue ranging from $54.3M to $61.2M. I-285 South and I-20 West from I-285 West to SR6 were identified as low revenue generating corridors with estimated revenue ranging from $21.5M to $38.4M.

Figure 18: 2030 ETL+TOT Corridor Revenue Ranking - Maximum Efficiency Policy



Reversible Managed Lanes

In additional to bi-directional managed lanes, the MLSP also evaluated the feasibility of implementing reversible managed lanes (either at-grade or elevated) on identified metro Atlanta interstate corridors.

A framework was developed to screen all candidate managed lane corridors and identify which of these corridors could be enhanced through the implementation of reversible managed lane alternatives. The screening process was based on the following four criteria: (1) Travel Demand and Operational Performance; (2) Activity Center and Regional Growth Trends; (3) Market for Reversible Managed Lanes; and (4) Presence of Existing HOV Lanes.

More detailed information regarding the framework, screening criteria and screening results can be found in a companion technical memorandum, *Identification of Candidate Corridors for Reversible Managed Lane.*

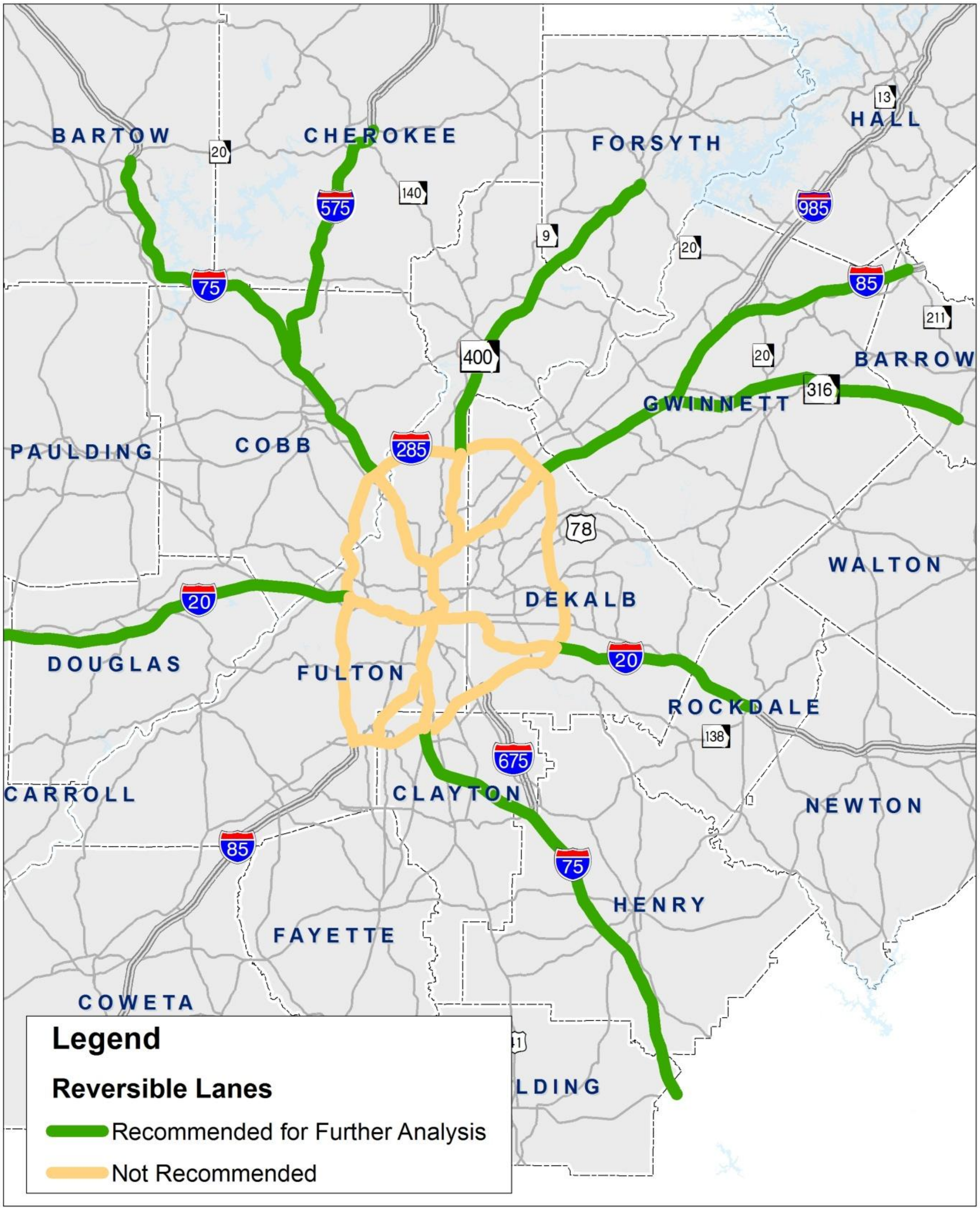
Based on the results of the reversible lane screening analysis, the corridors recommended for further analysis of reversible managed lanes are listed below and illustrated in Figure 19.

- Recommended for further analysis of reversible managed lanes
    - I-75 North from I-285 North to SR 20
    - I-75 South from I-285 South to SR 16
    - I-85 North from I-285 North to SR 211
    - I-20 East from I-285 East to SR 138
    - I-20 West from I-285 West to Post Road
    - SR 400 from I-85 to SR 20
    - I-575 from I-75 to SR 20
    - SR 316 from I-85 North to SR 81

There are major issues with directionality on I-285 and the corridors inside of I-285. In addition, the potential directional market share for managed lanes is more balance on I-285 and the corridors inside of I-285. Therefore, the following corridors are not recommended for further analysis of reversible managed lanes.

- Entire I-285 Corridor
- Corridors inside I-285 (I-75, I-85, I-20, SR 400)

Figure 19: Recommended Candidate Corridors for Reversible Managed Lanes



Managed Lane Investment Policies for Reversible Lanes

Investment policies, including HOT lanes, ETL, and Mixed Use Express Toll Lanes (Mixed ETL), were included in the preliminary traffic and revenue analysis for reversible managed lanes. Reversible TOT lanes and combined system (reversible ETL+TOT) were not included in the analysis because the reversible lanes operate on the premise that there is a large directional market between flows during peak periods of the day. Since trucks typically do not follow the peak directional patterns as passenger cars, a reversible concept is the least efficient for a truck-only system; therefore they were not included in the analysis.

The following sections summarize the reversible managed lane corridors under HOT, ETL and Mixed ETL eligibility policies.

High Occupancy Toll (HOT) Policy - Reversible

The corridors that passed the reversible managed lane screening were included in the traffic and revenue analysis for the HOT policy. For bi-directional managed lanes, the HOT policy alternative assumed four HOT lanes (two lanes in each direction) along the corridor. Under the reversible managed lane investment scenario, 2-lane reversible and 3-lane reversible options were evaluated.

The HOT policy 2-lane reversible option assumed that 2 new HOT lanes would be constructed for corridors without existing HOV lanes. For corridors with existing HOV lanes (I-85 from I-285 to Pleasant Hill Road), the existing HOV lanes (one lane in each direction) would be converted to 2 reversible HOT lanes. In total, approximately 350 new reversible lane miles would be added into the interstate highway system under the 2-lane reversible scenario with HOT policy.

Figure 20 shows 2-lane reversible managed lane corridors with HOT policy.

Under the 3-lane reversible option, for corridors without existing HOV lanes and with four or more general purpose lanes in each direction, it assumed that three HOT lanes would be constructed; and two HOT lanes would be constructed in corridors with less than four general purpose lanes in each direction. For corridors with existing HOV lanes (I-85 from I-285 to Pleasant Hill Road), one new reversible HOT lane would be constructed and the existing HOV lanes (one lane in each direction) would be converted to 2 reversible HOT lanes. In total, approximately 420 new reversible lane miles would be added into the interstate highway system under the 3-lane reversible scenario with HOT policy.

Figure 21 shows 3-lane reversible managed lane corridors with HOT policy.

Express Toll Lanes (ETL) Policy- Reversible

Identical to the HOT policy, the ETL policy includes all corridors that passed the reversible managed lane screening for preliminary traffic and revenue assessment. In terms of lane configuration, both 2-lane reversible (shown in Figure 20) and 3-lane reversible options (shown in Figure 21) were evaluated with the ETL policy.

The ETL policy 2-lane reversible option assumed that 2 new ETL lanes would be constructed for the corridors without existing HOV lanes. For corridors with existing HOV lanes (I-85 from I-285 to Pleasant Hill Road), the existing HOV lanes (one lane in each direction) would be converted to 2 reversible ETL lanes. In total, approximately 350 new reversible lane miles would be added into the interstate highway system under the 2-lane reversible scenario.

Under the 3-lane reversible option, for corridors without existing HOV lanes and with four or more general purpose lanes in each direction, it assumed that three new express toll lanes would be constructed; and two new express toll lanes would be constructed in corridors with less than four general purpose lanes in each direction. For corridors with existing HOV lanes (I-85 from I-285 to Pleasant Hill Road), one new reversible express toll lane would be constructed and the existing HOV lanes (one lane in each direction) would be converted to 2 reversible express toll lanes. In total, approximately 420 new reversible lane miles would be added into the interstate highway system under the 3-lane reversible scenario with ETL policy.

Mixed Express Toll Lanes (METL) Policy - Reversible

The corridors that passed the reversible managed lane screening were included in the traffic and revenue analysis under METL policy with the exception of SR 400, I-575, I-20 East and I-20 West. These four corridors are not heavy truck-traveled corridors based on the recommendations from the Statewide Trucks Lane Needs Identification Study conducted by GDOT in 2006-2007. Figure 22 shows reversible candidate corridors with METL policy.

The reversible candidate corridors with METL policy assumed that, for corridors with four or more general purpose lanes in each direction, three new reversible METLs would be constructed; and two new reversible METLs would be constructed for corridors with less than four general purpose lanes in each direction. For corridors with existing HOV lanes (I-85 from I-285 to Pleasant Hill Road), one new reversible mixed express toll lane would be constructed and the existing HOV lanes (one lane in each direction) would be converted to 2 reversible mixed express toll lanes. In total, approximately 420 new reversible lane miles would be added into the interstate highway system under the METL policy.

Figure 20: HOT and ETL Candidate Corridors – Reversible 2-Lane

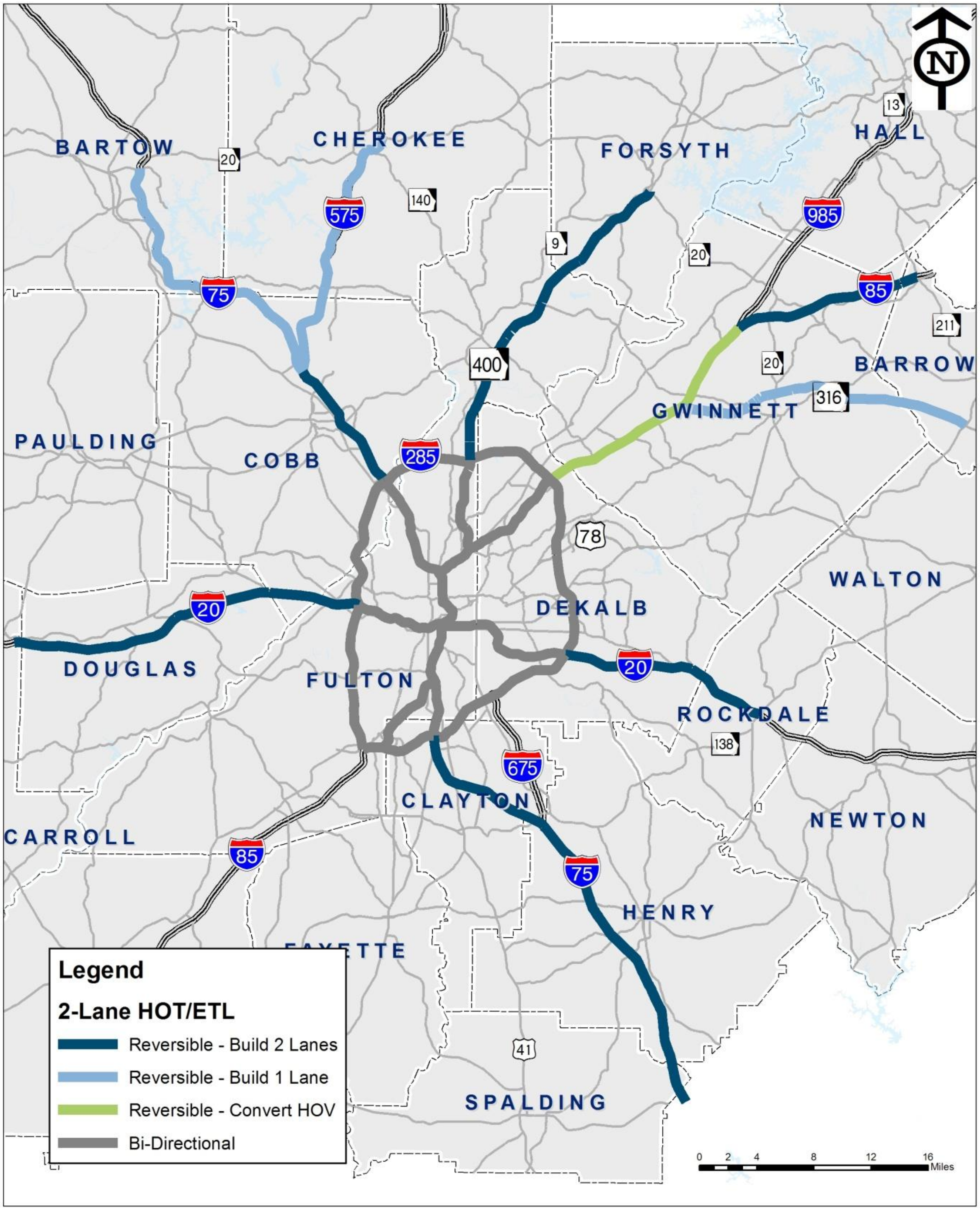


Figure 21: HOT and ETL Candidate Corridors – Reversible 3-Lane

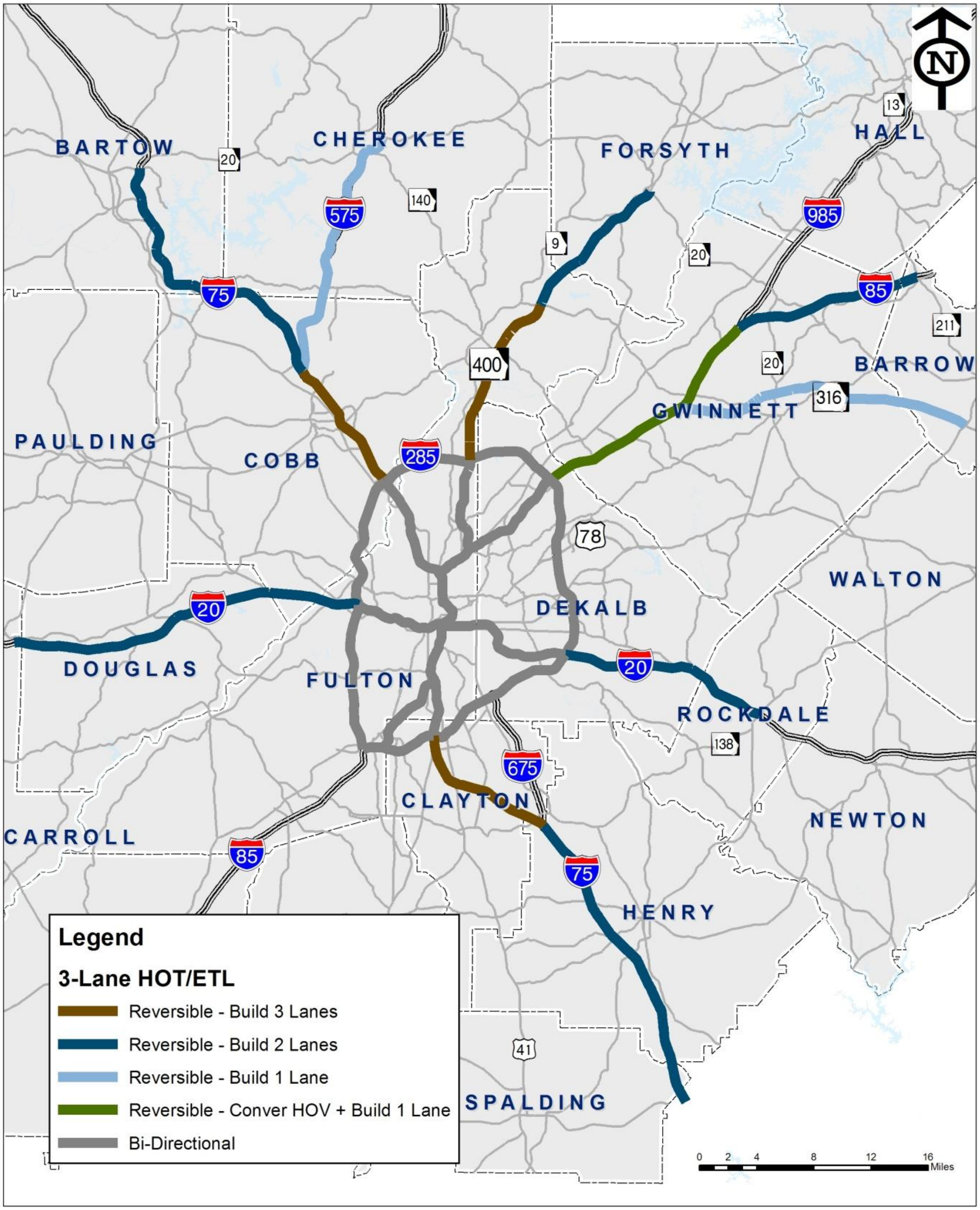
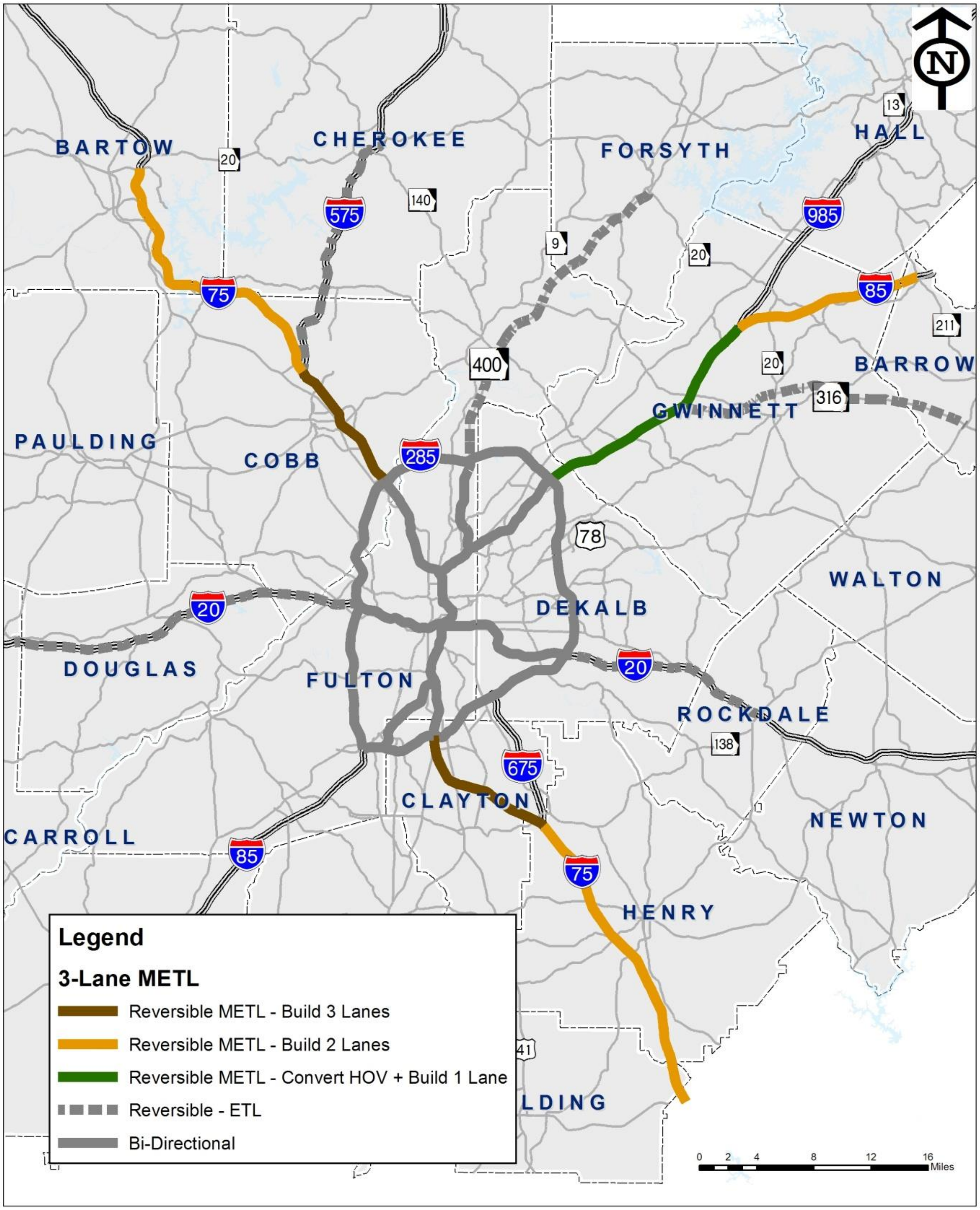


Figure 22: METL Candidate Corridors – Reversible



Reversible Managed Lane Traffic and Revenue Analysis Results

This section presents the traffic and revenue analysis results for reversible managed lane candidate corridors under each of the managed lane policies evaluated for year 2020 and 2030.

High Occupancy Toll Policies

- **HOT2+**

The analysis results for 2-lane bi-directional managed lanes showed that many corridors, including I-75 North, I-85 North and I-575 are forecasted to approach and exceed the critical operating threshold (speed of 45 mph) in peak direction prior to 2030 under the HOV2+ free policy. Clearly, HOT2+ with two lanes in peak direction will not meet the stated objectives of a managed lane system. Therefore, no revenue estimates were generated for 2-lane reversible system with HOT2+ policy.

An evaluation of traffic and revenue analysis was performed for 3-lane reversible managed lanes with HOT2+ policy to understand whether providing three reversible lanes in the peak direction meets the goals of managed lane investments. Year 2020 and 2030 traffic and revenue forecasts for 3-lane reversible managed lanes with a HOT2+ eligibility policy are presented in Table 8. Both the traffic and revenue numbers are based on the maximum efficiency policy - a management policy that prices the managed lanes such that the maximum number of vehicles uses the managed lanes while still providing a minimum operating speed of 45 mph.

Table 8: Demand and Revenue
- 3-lane Reversible Managed Lane Candidate Corridors with HOT2+ Policy

Reversible Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	No Capacity to Sell			
I-75 South	11.5	125,657	25.7	140,104
I-85 North	22.0	139,463	34.4	151,632
SR 400	9.6	127,684	17.6	140,856

The 2030 estimated revenue numbers were ranked into three categories (High, Medium and Low) using the same methodology discussed previously. Figure 23 illustrates 2030 annual revenue ranking for HOT2+ reversible managed lane corridors. I-75 North is forecasted to have capacity exhausted by free vehicles (i.e. HOV2+) with three managed lanes in the peak direction. Therefore, no revenue estimation were generated for I-75 North corridor and I-575 corridor.

Among other corridors, I-85 North, highlighted in red was identified as the highest HOT2+ revenue generating corridor with estimated revenue of $34.4M in 2030. The orange-colored corridors, I-20 West and I-75 South, were identified as medium HOT2+ revenue generating corridors with estimated revenue in 2030 around $25M. The green-colored corridors, I-20 East, SR 400 and SR 316 were identified as low HOT2+ revenue generating corridors with estimated revenue ranges from $12M to $17.6M in 2030.

Figure 23: 2030 HOT2+ Reversible Managed Lane Revenue Ranking - 3-Lane with Maximum Efficiency Policy

- **HOT3+**

Year 2020 and 2030 traffic and revenue forecasts for 2-lane reversible managed lanes and 3-lane reversible managed with a HOT3+ policy under the maximum efficiency scenario are presented in Tables 9 and 10 respectively.

Table 9: Demand and Revenue
- 2 Lane Reversible Managed Lane Candidate Corridors with HOT3+ Policy

Reversible Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	41.3	141,421	70.6	150,878
I-75 South	12.8	124,892	28.2	134,992
I-85 North	28.8	135,040	46.6	146,223
I-20 East	7.1	104,814	19.1	117,222
I-20 West	14.7	108,527	37.9	123,928
I-575	7.7	78,346	20.4	102,132
SR 400	12.4	127,233	24.0	138,543
SR 316	5.3	86,951	13.3	89,403

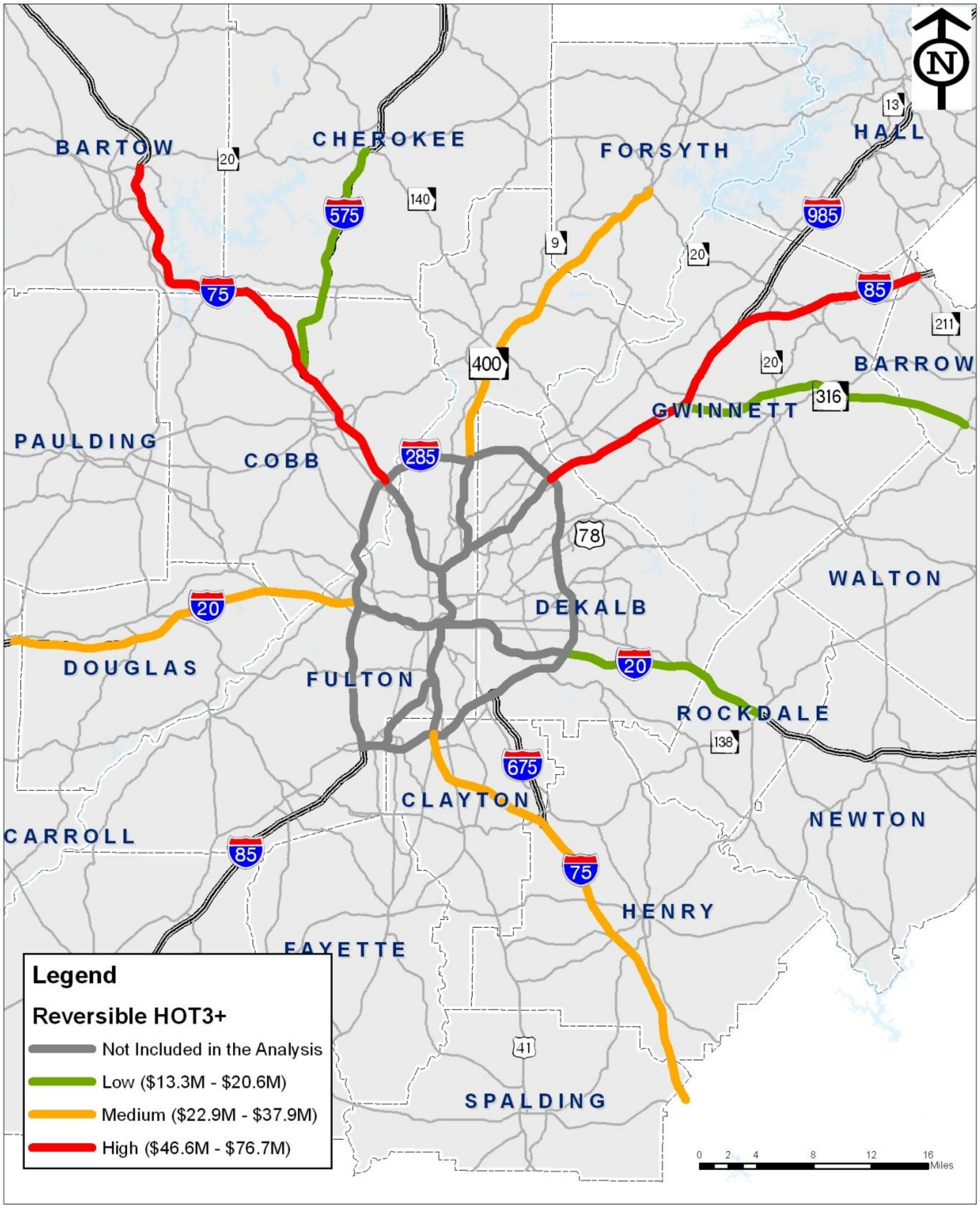
Table 10: Demand and Revenue
- 3 Lane Reversible Managed Lane Candidate Corridors with HOT3+ Policy

Reversible Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	43.9	143,452	76.7	151,040
I-75 South	13.2	125,607	26.5	139,141
I-85 North	30.7	135,991	48.2	147,668
SR 400	12.8	127,510	22.9	139,047

As seen in the tables above, under the maximum efficiency scenario, the reversible managed lanes only realize approximately 5% increase in daily demand with the additional lane in each direction (i.e. from 2-lane to 3-lane reversible system). Since the capacity increase far exceeds the demand increase on managed lanes, only a slight change in annual revenue was observed. Among all the corridors, I-75 North has the highest revenue increase from 41.3M to 43.9M (6% increase) and from 70.6M to 76.7M (9% increase), in 2020 and 2030, respectively. Clearly, the benefits of adding additional capacity in reversible managed lanes, in terms of vehicles served and annual revenue generated diminish as the number of managed lanes increase from two to three in each direction.

Figure 24 displays the 2030 annual revenue ranking for HOT3+ 2-lane and 3-lane reversible managed lane corridors. I-75 North and I-85 North were identified as high HOT3+ revenue generating corridors with estimated revenue ranges from $46.6M to $76.7M in 2030. SR 400, I-75 South and I-20 West were identified as medium HOT3+ revenue generating corridors with estimated revenue ranges from $22.9M to $37.9M in 2030. I-575, I-20 East and SR 316 were identified as low HOT3+ revenue generating corridors with estimated revenue from $13.7M to $20.6M in 2030.

Figure 24: 2030 HOT3+ Reversible Managed Lane Revenue Ranking - 2-lane and 3-lane with Maximum Efficiency Policy



- **HOT4+**

Year 2020 and 2030 traffic and revenue forecasts for 2-lane reversible managed lanes and 3-lane reversible managed lanes with a HOT4+ policy under the maximum efficiency scenario are presented in Tables 11 and 12 respectively.

Table 11: Demand and Revenue
- 2 Lane Reversible Managed Lane Candidate Corridors with HOT4+ Policy

Reversible Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	43.1	140,997	74.2	150,426
I-75 South	13.0	124,518	28.9	134,587
I-85 North	30.2	134,635	49.1	145,784
I-20 East	7.3	104,500	19.8	116,870
I-20 West	15.1	108,201	39.2	123,556
I-575	8.1	78,111	21.7	101,825
SR 400	13.0	126,851	25.1	138,127
SR 316	5.6	86,690	14.0	89,135

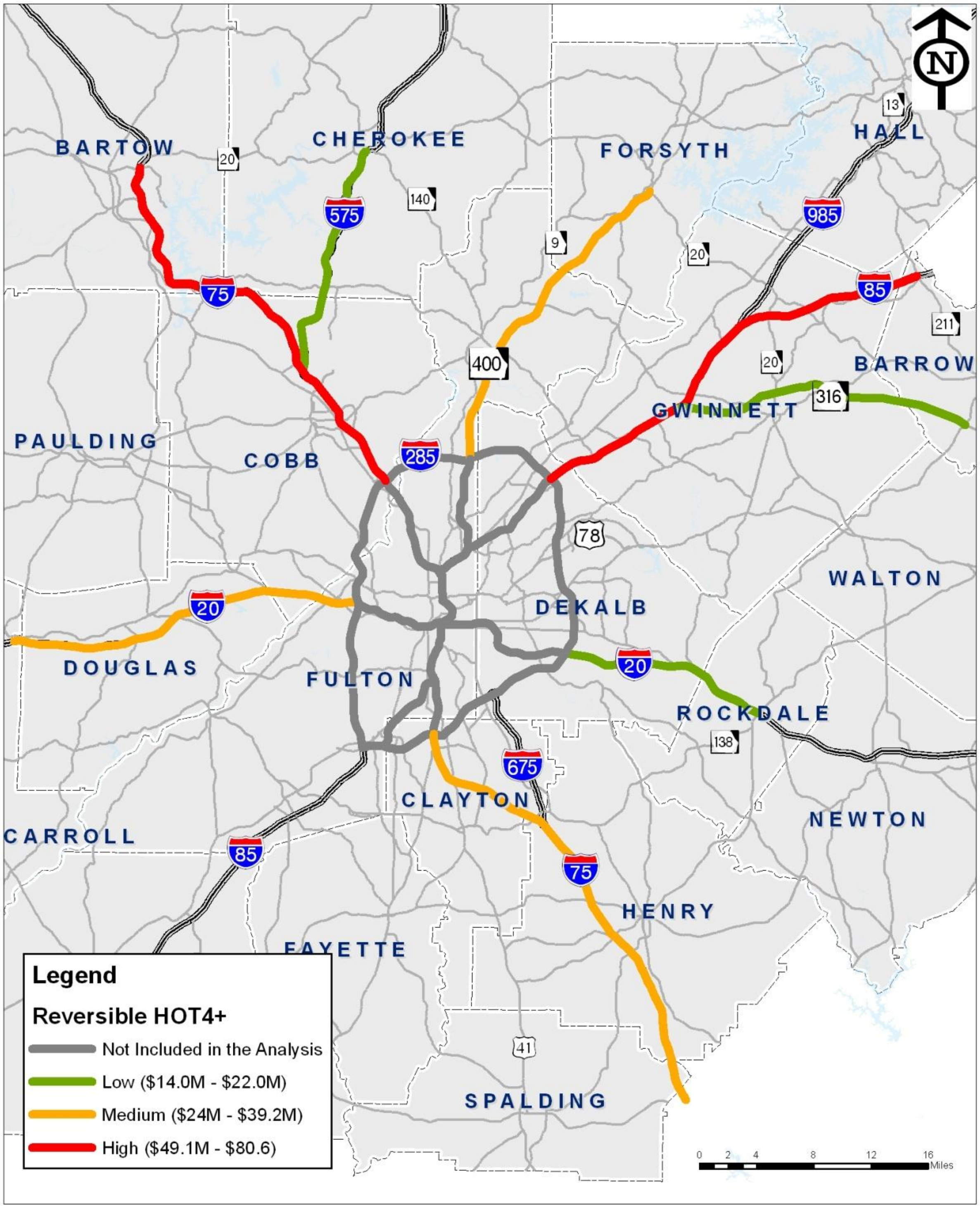
Table 12: Demand and Revenue
- 3 Lane Reversible Managed Lane Candidate Corridors with HOT4+ Policy

Reversible Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	45.7	143,022	80.6	150,587
I-75 South	13.4	125,230	27.2	138,723
I-85 North	32.1	135,583	50.9	147,225
SR 400	13.5	127,127	24.0	138,630

Similar to HOT3+, under the maximum efficiency scenario, the reversible managed lanes with a HOT4+ policy only realize approximately 5% increase in total daily corridor demand with the additional lane in each direction (i.e. from 2-lane to 3-lane reversible system). Since the capacity increase far exceeds the demand increased on managed lanes, there is only a slight change in annual revenue. Among all the corridors, I-75 North has the highest revenue increase from 43.1M to 45.7M (6% increase) and from 74.2M to 80.6M (9% increase), in 2020 and 2030, respectively. Clearly, the benefits of adding additional capacity in reversible managed lanes, in terms of vehicles served and annual revenue generated diminish as the number of managed lanes increase from two to three in each direction.

Figure 25 is the map of 2030 annual revenue ranking for HOT4+ 2-lane and 3-lane reversible managed lane corridors. I-75 North and I-85 North were identified as high HOT4+ revenue generating corridors with estimated revenue ranges from $49.1M to $80.6M in 2030. SR 400, I-75 South and I-20 West were identified as medium HOT4+ revenue generating corridors with estimated revenue ranges from $24M to $39.2M in 2030. I-575, I-20 East and SR 316 were identified as low HOT4+ revenue generating corridors with estimated revenue ranges from $14.0M to $22M in 2030.

Figure 25: 2030 HOT4+ Reversible Managed Lane Revenue Ranking - 2-lane and 3-lane with Maximum Efficiency Policy



- **Express Toll Lanes (ETL) Policy**

  Year 2020 and 2030 traffic and revenue forecasts for 2-lane reversible managed lanes and 3-lane reversible managed lanes with a ETL policy under the maximum efficiency scenario are presented in Tables 13 and 14 respectively.

Table 13: Demand and Revenue
- 2 Lane Reversible Managed Lane Candidate Corridors with ETL Policy

Reversible Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	44.2	140,714	76.6	150,124
I-75 South	13.1	124,268	29.4	134,317
I-85 North	31.0	134,365	50.9	145,492
I-20 East	7.5	104,290	20.4	116,636
I-20 West	15.4	107,984	40.1	123,308
I-575	8.4	77,954	22.6	101,621
SR 400	13.5	126,597	25.9	137,850
SR 316	5.7	86,516	14.5	88,956

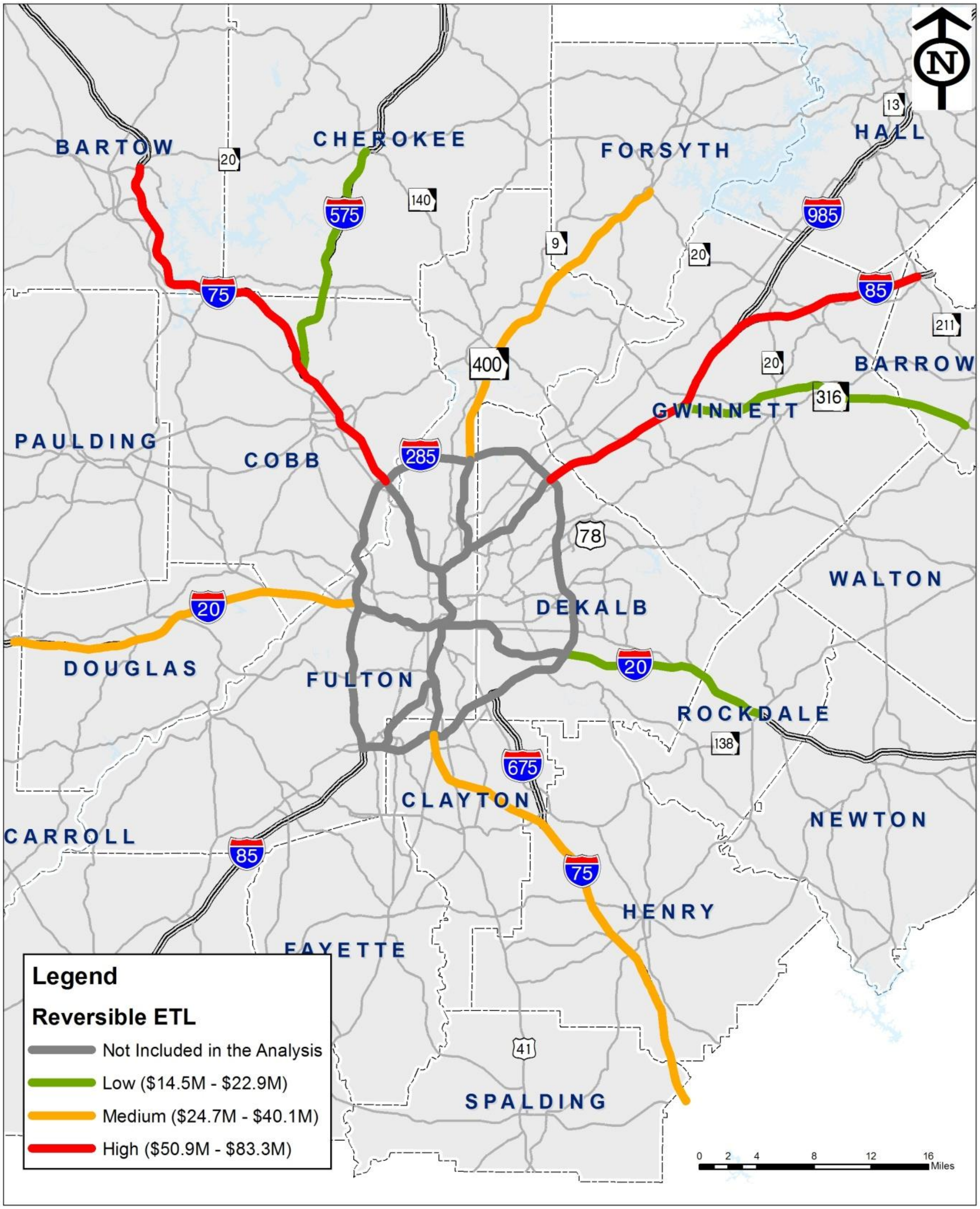
Table 14: Demand and Revenue
- 3 Lane Reversible Managed Lane Candidate Corridors with ETL Policy

Reversible Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	47.0	142,735	83.3	150,285
I-75 South	13.5	124,979	27.6	138,445
I-85 North	33.1	135,311	52.7	146,930
SR 400	13.9	126,872	24.7	138,352

Similar to HOT3+ and HOT4+, under the maximum efficiency scenario, the benefits of adding additional capacity in reversible managed lanes, in terms of vehicles served and annual revenue generated diminish as the number of managed lanes increase from two to three in each direction.

Figure 26 shows the 2030 annual revenue ranking for 2-lane and 3-lane reversible managed lane corridors with ETL policy. I-75 North and I-85 North were identified as high ETL revenue generating corridors with estimated revenue ranges from $50.9M to $83.3M in 2030. SR 400, I-75 South and I-20 West were identified as medium ETL revenue generating corridors with estimated revenue in 2030 ranges from $24.7M to $40.1M. I-575, I-20 East and SR 316 were identified as low ETL revenue generating corridors with estimated revenue ranges from $14.5M to $22.9M in 2030.

Figure 26: 2030 ETL Reversible Managed Lane Revenue Ranking - 2-lane and 3-lane with Maximum Efficiency Policy



- **Mixed Express Toll Lanes (METL) Policy**

  Year 2020 and 2030 traffic and revenue forecasts under the maximum efficiency scenario are presented in Table 15 for reversible managed lane candidate corridors with a METL eligibility policy. Corridor I-575, SR 400, I-20 East and I-20 West were identified as not eligible for the METL policy.

Table 15: Demand and Revenue
- 3 Lane Reversible Managed Lane Candidate Corridors with METL Policy

Reversible Managed Lane Candidate Corridors	2020		2030	
	Annual Revenue (Million $)	Average Daily Demand (Vehicles)	Annual Revenue (Million $)	Average Daily Demand (Vehicles)
I-75 North	59.7	145,561	98.4	156,346
I-75 South	27.2	124,673	56.0	138,179
I-85 North	33.6	141,040	59.2	153,121

Figure 27 shows a map of 2030 annual corridor revenue ranking for three METL managed lane corridors. I-75 North was identified as the highest METL revenue generating corridor with estimated revenue of $98.4M in 2030. I-85 North has the second highest METL revenue of 59.2M in 2030. I-75 South was identified as the lowest METL revenue generating corridor with estimated revenue of 56.0M in 2030.

Figure 27: 2030 METL Reversible Managed Lane Revenue Ranking - with Maximum Efficiency Policy

D. System Analysis

The purpose of the system analysis was to assess how the managed lanes will operate within the existing interstate corridors, and quantify the impacts to the surrounding transportation system.

The following sections document the methodology used to evaluate corridor and system level transportation impacts, and present the analysis results of one sample corridor - I-285 North from I-75 North to I-85 North (Results from all other corridors are included in Appendix A). The transportation impacts were evaluated by comparing the managed lane investment scenarios to the “No Project” scenario. The “No Project” scenario refers to a scenario that no managed lanes will be constructed in the Atlanta Region. The evaluation was performed at the corridor and system levels.

Evaluation Levels and Performance Measures

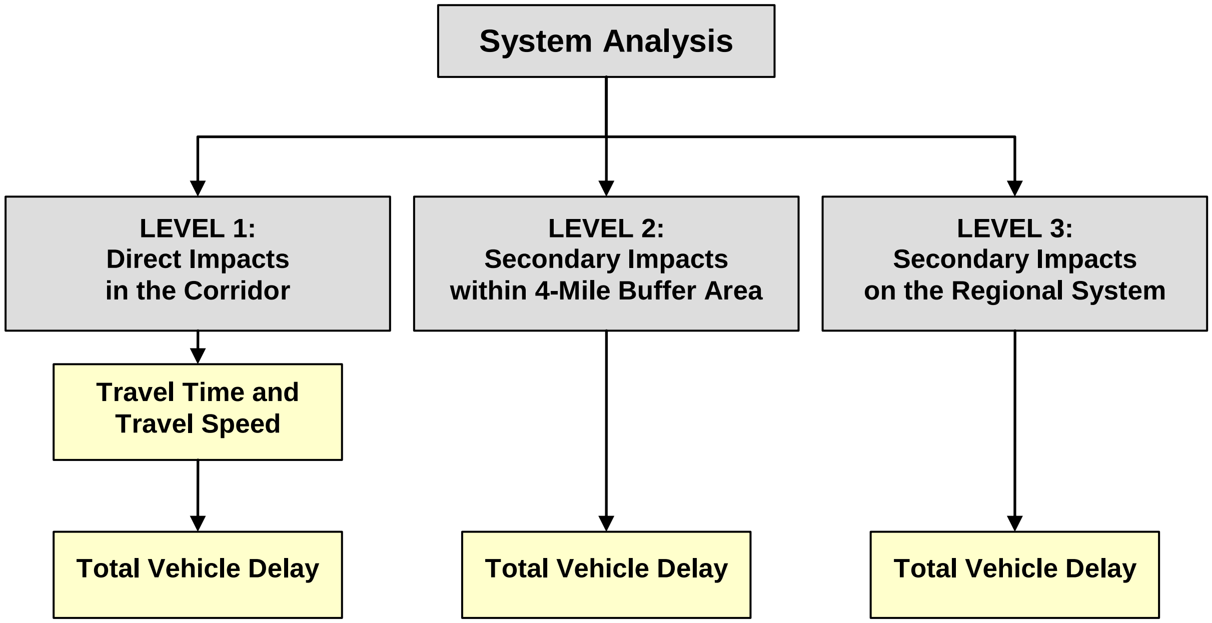
With additional capacity, managed lane investments provide direct travel time benefits and improved reliability to travelers who choose to use the lanes. The managed lane investments also have indirect transportation impacts on the general-purpose (GP) lanes, parallel corridors, and regional transportation network due to the shift of automobiles and trucks to the managed lane sets.

To fully understand the magnitude of impacts to the transportation system, all managed lane investment alternatives were analyzed within the context of the following evaluation framework:

- Level 1 - Direct impacts in the project corridor (managed lanes and GP Lanes);
- Level 2 - Secondary impacts within a 4-mile area; and
- Level 3 - Secondary impacts to the regional transportation system.

The analysis framework is illustrated in Figure 28 on the following page. Transportation performance measures including travel times, travel speeds and total vehicle delay for all managed lane investment scenarios were calculated from the output of the updated Managed Lane Travel Demand Models. These performance measures were then compared to the “No Project” scenario (i.e. no managed lanes are constructed in the corridor) to understand and quantify the transportation impacts resulting from managed lane investments.

Figure 28: Transportation Impact Analysis Performance Measures



Corridor Level Analysis

Travel Time and Travel Speed

Year 2030 travel times and travel speeds in the GP lanes and managed lanes were calculated for all investment alternatives and the “No Project” scenario.

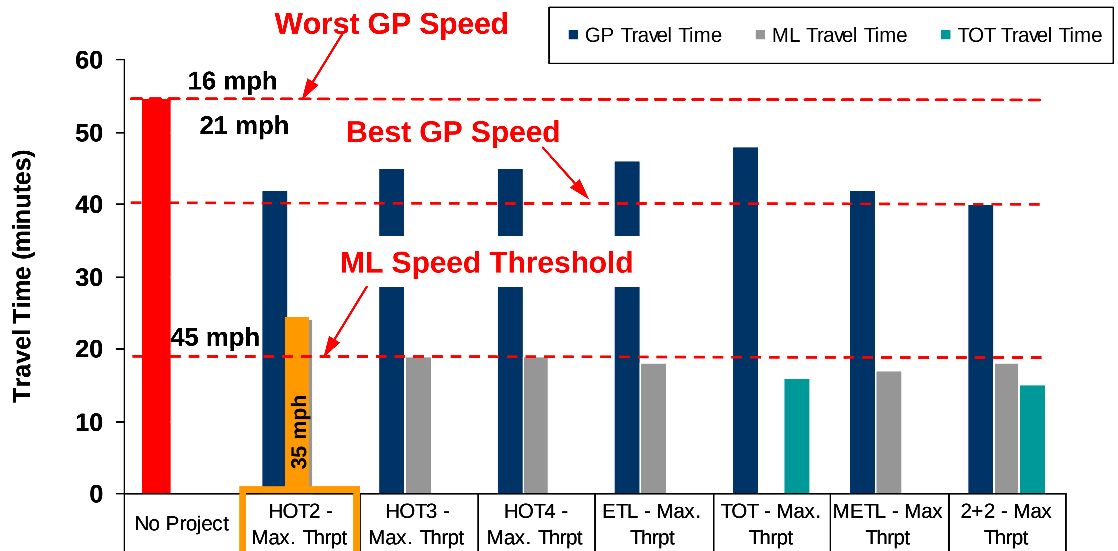
Figure 29 shows an example of travel time and travel speeds in year 2030 under the Maximum Throughput Policy for the most congested 4-hour period in a typical weekday along the I-285 North corridor from I-75 North to I-85 North.

In the figure, the y-axis represents travel times in minutes and the dashed red lines show the corresponding travel speeds for GP lanes under the worst scenario (“No Project”), the travel speeds for GP lane under the best scenario (with combined ETL and TOT investments), and the travel speed threshold of 45 mph for managed lanes.

As illustrated in Figure 29, with the implementation of managed lanes, travel speeds in managed lanes can be maintained at a rate of 45 mph or higher for all managed investment alternatives, with exception of HOT2+ alternative. Travel speeds on managed lanes range from 45 mph to 49 mph, compared to GP lane speeds of 16 mph under the “No Project” scenario. In the figure, the yellow bar and box highlighted the HOT2+ conditions that falls short of the managed lane travel speed threshold of 45 mph. Under the HOT2+ managed lane investment policy, all of managed lane capacity will be utilized by free HOVs; therefore, there is no toll rate that can be charged to improve conditions beyond that threshold.

The travel time in the GP lanes for all managed lane investment alternatives are forecasted to decrease slightly within the corridor of managed lanes. In the example below, travel times in the general purpose lanes are expected to improve by at least 6 minutes (TOT investments) and up to 10 minutes (ETL+TOT investments).

Figure 29: 2030 Travel Time and Travel Speed



	No Project	HOT2 - Max. Thrpt	HOT3 - Max. Thrpt	HOT4 - Max. Thrpt	ETL - Max. Thrpt	TOT - Max. Thrpt	METL - Max Thrpt	2+2 - Max Thrpt
GP Travel Time	54	42	45	45	46	48	42	40
ML Travel Time	N/A	24	19	19	18	N/A	17	18
TOT Travel Time	N/A	N/A	N/A	N/A	N/A	16	N/A	15

Investment Policy

The Travel Time and Travel Speed impact analysis was conducted for all managed lane corridors under various eligibility policies (e.g. ETL, TOT, etc.). The analysis results that came out of this effort have been incorporated into the Alternative Visualization Analysis Tool (AltaViz) and can be found in the respective *Corridor Resources Guide Documentation.*

Total Daily Vehicle Delay

A major portion of traveler benefits is represented by the reduction in total daily vehicle delay. Total daily vehicle delay was estimated for both existing travelers as well as diverted or induced travelers. Transportation performance of total daily vehicle delay along managed lane candidate corridors was calculated to evaluate system impacts in detail, for each investment alternative and the “No Project” scenario.

Initially, the delay in four analysis periods (Morning peak from 6:00 AM to 10:00 AM, Mid-day period from 10:00 AM to 3:00 PM, Afternoon peak from 3:00 PM to 7:00 PM; and Night period from 7:00 PM to 6:00 AM) was computed by subtracting free flow travel time from congested travel time for each network link that consisted of the project corridors (GP Lanes and Managed Lanes). Total vehicles were multiplied by the delay in each direction to arrive at total vehicle delay on the project corridors for each of the four analyses time periods. The total vehicle delay during the four analysis periods was then added up to arrive at total daily vehicle delay.

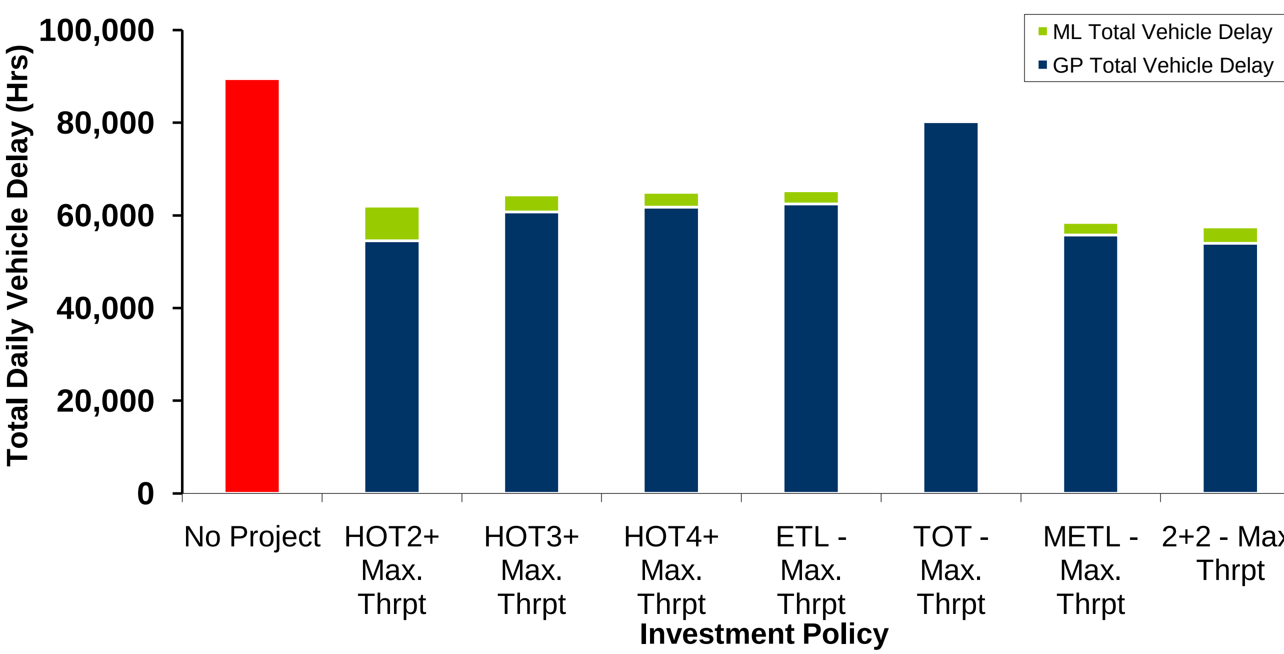
Figure 30 shows an example of total daily vehicle delay in year 2030 under the Maximum Throughput Policy along the I-285 North corridor from I-75 North to I-85 North.

In the figure, the y-axis shows total daily vehicle delay in hours; the red bar represents the total daily vehicle delay under "No Project" scenario; the blue bar represents the total daily vehicle delay on the GP lanes and the green bar represents the total daily vehicle delay on the managed lanes. This delay in the managed lanes is attributed to the free flow speed of 60 mph compared to the expected travel speeds (45 mph – 50 mph). It is observed that the total daily vehicle delay on the managed lanes is minimal when compared to the GP lane delay.

As illustrated in Figure 30, with the implementation of managed lanes, the total daily vehicle delay at the project corridor level (general purpose lanes and managed lanes) decreases significantly by a range of 10% to 36%. The dashed blue lines and percentage show the corresponding percentage of decrease in total daily vehicle delay along this corridor relative to the "No Project" scenario.

Among all the managed lane investment alternatives, investment alternative of 2+2, which includes the construction of both ETL and voluntary TOT lanes, is expected to reduce total daily vehicle delay by the greatest level (-36%) when compared to the "No Project" scenario. Under this 2+2 policy, eight new lanes (four lanes in each direction) were constructed. The investment alternative of voluntary TOT lanes is expected to have the smallest reduction in total daily vehicle delay (-10%).

Figure 30: 2030 Total Daily Vehicle Delay – Project Corridor Level



Using Texas Transportation Institute's assumptions of $17.20 per hour and 0.68 gallons of fuel per hour, the potential range of annual monetary time savings and gallon savings that can be realized in this corridor were estimated. In year 2030, if managed lanes are implemented, the annual monetary time savings range from $45 million to $165 million and the gallon savings range from 1.8 million gallons to 6.5 million gallons. Low end of the range is associated with TOT investment policy and high end of the range is associated with 2+2 investment policy, which includes the construction of both ETL and voluntary TOT lanes.

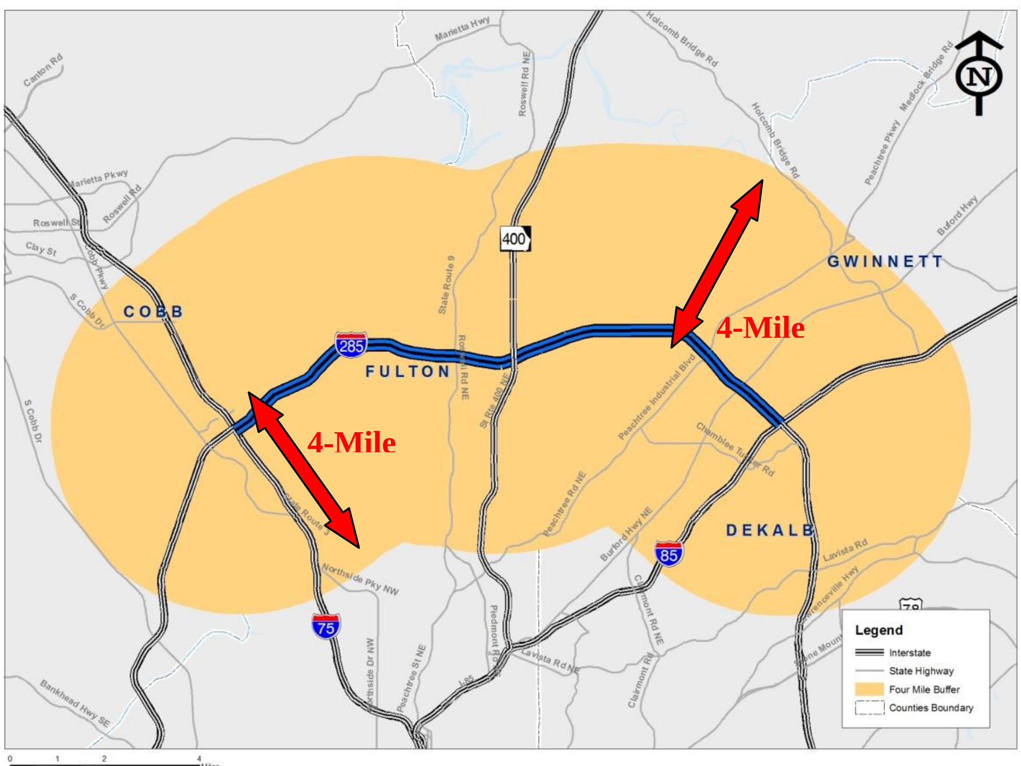
The total daily vehicle delay impact analysis was conducted for all other managed lane candidate corridor under various eligibility policies (e.g. ETL, TOT, etc.). The analysis results that came out of this effort have been incorporated into the Alternative Visualization Analysis Tool (AltaViz) and can be found in the respective *Corridor Resources Guide Documentation.*

4-Mile Buffer Analysis

To better understand transportation benefits on corridors in the vicinity of managed lane facilities, a 4-mile buffer (on each side) was placed around the managed lane corridors using Geographic Information System (GIS) software.

Figure 31 shows an example of a 4-mile buffer around I-285 North corridor, which includes segments of I-75 corridor, I-85 corridor, I-285 East and West corridor, SR 400 and other major arterials, such as Cobb Parkway, Roswell Road, Peachtree Industrial Blvd, Buford Highway, etc.

Figure 31: Sub-area Transportation System within 4-Mile Buffer



For each managed lane investment alternative and the "No Project" scenario, transportation performance of total vehicle delay within the 4-mile buffer area was calculated to evaluate system impacts in detail. As discussed in the previous section, total vehicle delay was calculated based on the travel demand model outputs. The delay in four analysis periods (Morning peak from 6:00 AM to 10:00 AM, Mid-day period from 10:00 AM to 3:00 PM, Afternoon peak from 3:00 PM to 7:00 PM; and Night period from 7:00 PM to 6:00 AM) was computed by subtracting free flow travel time from congested travel time for each network link inside of the 4-mile buffer area. Total vehicles are then multiplied by the delay in each direction to arrive at total vehicle delay for each of the four analyses time periods. The total vehicle delays for each network link inside of 4-mile buffer and during four analysis periods were then added up to a sub-area transportation system total delay.

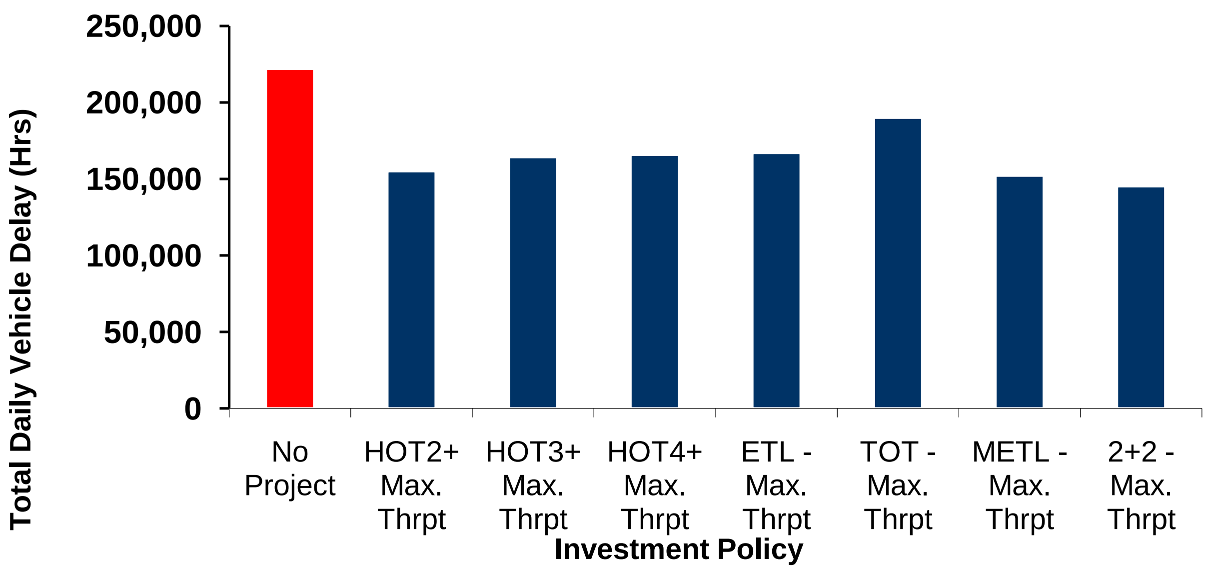
Figure 32 shows an example of total daily vehicle delay in year 2030 under the Maximum Throughput Policy within a 4-mile buffer (on each side) of I-285 North corridor.

In the figure, the y-axis shows total daily vehicle delay in hours; the red bar represents the total daily vehicle delay within 4-mile buffer under "No Project" scenario; and the blue bar represents the total daily vehicle delay within 4-mile buffer under all managed lane investment alternatives. The dashed blue lines and percentage show the corresponding percentage of decrease in total daily vehicle delay along this corridor relative to the "No Project" scenario.

As illustrated in Figure 33, with the implementation of managed lanes, the total daily vehicle delay inside of the 4-mile buffer area decreases significantly by a range of 14% to 35%.

Among all the managed lane investment alternatives, investment alternative of 2+2, which includes the construction of both ETL and voluntary TOT lanes, is expected to reduce total daily vehicle delay within the 4-mile buffer area by the greatest level (-35%) when compared to the "No Project" scenario. The investment alternative of voluntary TOT lanes is expected to have the smallest reduction in total daily vehicle delay (-14%) within the 4-mile buffer area.

Figure 33: 2030 Total Daily Vehicle Delay – 4-Mile Buffer Area



Using Texas Transportation Institute's assumptions of $17.20 per hour and 0.68 gallons of fuel per hour, the potential range of annual monetary time savings and gallon savings that can be realized within the 4-mile buffer along this corridor were estimated. In year 2030, if managed lanes are implemented, the annual monetary time savings range from $165 million to $396 million and the gallon savings range from 6.5 million gallons to 15.7 million gallons within the 4-mile buffer area. Low end of the range is associated with TOT investment policy and high end of the range is associated with 2+2 investment policy.

The total daily vehicle delay within 4-mile buffer (on each side) for all other managed lane candidate corridors are presented in their respective *Corridor Resources Guide Documentation.*

Regional Transportation System Analysis

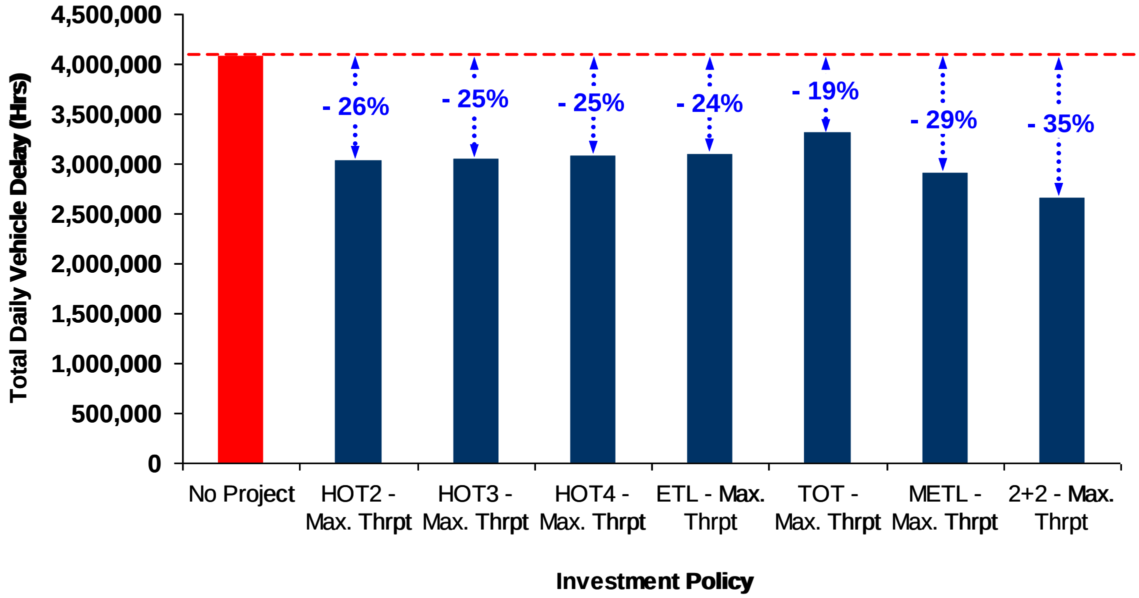
The impacts to the entire Atlanta regional transportation system were evaluated by examining overall daily vehicle delay for each investment alternative and the "No Project" scenario. For each network link in the Atlanta Regional Commission's (ARC) travel demand model, the delay in four analysis periods (Morning peak from 6:00 AM to 10:00 AM, Mid-day period from 10:00 AM to 3:00 PM, Afternoon peak from 3:00 PM to 7:00 PM; and Night period from 7:00 PM to 6:00 AM) was computed by subtracting free flow travel time from congested travel time. Total vehicles are then multiplied by the delay in each direction to arrive at total-vehicle-delay for each of the four analyses time periods. The total vehicle delay for each network link in the Atlanta regional model during four analysis periods were then added up to an regional transportation system total daily delay.

Figure 34 shows the total daily vehicle delay in year 2030 under the Maximum Throughput Policy for the regional transportation system under various managed lane system investments.

In the figure, the y-axis shows total daily vehicle delay in hours; the red bar represents the system total daily vehicle delay under "No Project" scenario; and the blue bar represents the system Total Daily Vehicle under all managed lane system investment. The dashed blue lines and percentage show the corresponding percentage of decrease in total daily vehicle delay along this corridor relative to the "No Project" scenario.

As illustrated in Figure 34, with the implementation of managed lane system, the system total daily vehicle delay decreases significantly by a range of 19% to 35%. Similar with 4-mile buffer area delay observation, among all the managed lane investment alternatives, investment alternative of 2+2, which includes the construction of both ETL and voluntary TOT lanes, is expected to reduce system-wide total daily vehicle delay by the greatest level (-35%), while investment alternative of voluntary TOT lanes is expected to have the smallest reduction in system-wide total daily vehicle delay (-19%).

Figure 34: 2030 Total Daily Vehicle Delay – Entire Transportation System



Using Texas Transportation Institute's assumptions of $17.20 per hour and 0.68 gallons of fuel per hour, the potential range of annual monetary time savings and gallon savings that can be realized in the regional transportation system were estimated. In year 2030, if managed lane system investments are implemented, the annual monetary time savings range from $3.96 million to $7.36 billion and the gallon savings range from 157 million gallons to 291 million gallons. Low end of the range is associated with TOT investment policy and high end of the range is associated with 2+2 investment policy.

E. Risk Analysis

As with any feasibility study, the resulting traffic and toll revenue forecasts are based on a variety of fundamental assumptions and estimates, such as demographic and economic growth, user's willingness to pay, improvements on transportation systems either on parallel routes or alternative modes, among others.

Given that a number of critical assumptions were used to develop the traffic and revenue forecasts, risk analysis was carried out to determine the effects of a change in some of these baseline inputs. The objective of the risk analysis is to gain an understanding of the sensitivities of some of the forecast's underlying assumptions. For example, what if growth targets are not met? Or what if willingness-to-pay levels are higher than initially expected? This analysis will provide answers to these and other questions.

Some of the key assumptions are based on data which possess a high degree of accuracy and consequently a small range of uncertainty. Other key assumptions, where reliable information is not available, or forecasts are made over long time periods have a higher degree of uncertainty. The risk analysis evaluates the forecasting uncertainties to produce a baseline estimate and a range of uncertainty for revenue forecasts.

The following sections identify the key risk factors for the traffic and revenue forecast; discuss the probable variations of each of the risk factors; and present the methodology used to evaluate the potential impacts on revenue associated with these key risk factors for the model year of 2030.

Identification of Key Risk Factors

The traffic and toll revenue forecasts for the Managed Lane System Plan (MLSP) were developed based on the assumptions in the following key areas:

- Socio-economic Growth;
- Willingness-to-Pay (Cars and Trucks);
- Transportation Investments (Roadway and Transit);
- Transit Frequency;
- HOV Formation; and
- General Purpose Lane Speed.

Risk Factor #1 – Socio-economic Growth

Growth (population, employment and truck traffic) is one of the primary factors affecting travel demand and revenue projections. If growth were to occur either more quickly or more slowly than currently assumed, that would have a direct impact on demand and revenue on the managed lanes.

The MLSP employed the population and employment forecasts housed in the region's most recent long range transportation plan, Envision 6 adopted by the Atlanta Regional Commission (ARC).

To understand how variations in the growth forecast would affect the revenue outcome, the planning team conducted a growth risk analysis and examined the following two growth scenarios:

- 5-year accelerated growth
- 5-year delayed growth

Five-year accelerated growth was studied by applying year 2025 socioeconomic forecasts to the year 2020 travel demand model stream. The model script and input files for the 2020 model, including the 2020 highway network, were retained for this analysis. The only exceptions to this were the socioeconomic files, which were replaced with new files representing 2025 socio-economic values. Year 2025 household and employment projections were calculated by interpolating between ARC's 2020 and 2030 forecasts. Likewise, new trip tables were generated for commercial vehicles, medium duty trucks, and heavy duty trucks for year 2025. These updated files were used to conduct a series of model runs, and the results from these runs allowed the planning team to see the demand and revenue impacts under a more accelerated growth condition than that contained in the regional plan. Revenue jumped by as much as 40% on some corridors under this assumption.

In the same way, year 2025 socioeconomic forecasts were used to study 5-year delayed growth. For this analysis, the model script and most of the input files for the 2030 model, including the 2030 highway network, remained fixed. Again, year 2025 household and employment files, along with year 2025 truck trip tables, were used to replace the original model files for year 2030. This analysis allowed the planning team to see the demand and revenue impacts due to lower growth than that originally assumed. Under this case revenues fell by as much as 50% on some corridors.

These two analyses were conducted for various eligibility policies (e.g. ETL, TOT, etc.) to establish relationships between socioeconomic growth assumptions and managed lane revenue. The factors that came out of this effort have been incorporated into the Alternative Visualization Analysis Tool (AltaViz) and an example set of results can also be seen in Table 16. These factors are multipliers to be applied to the base case revenue numbers. For example, under the accelerated growth assumption, base case revenue would be multiplied by 1.09 (a 9% increase) for segment 1 of the I-75 North corridor.

Table 16: Revenue Factors for Growth Risk Factor

Corridor (Outside I-285)	Segment	ETL		TOT		ETL + TOT	
		Accelerated Growth	Delayed Growth	Accelerated Growth	Delayed Growth	Accelerated Growth	Delayed Growth
I-75 North	1	109%	81%	119%	78%	112%	78%
I-75 North	2	110%	80%	118%	77%	115%	77%
I-75 North	3	117%	77%	118%	77%	119%	75%
I-75 South	1	129%	81%	126%	79%	130%	78%
I-75 South	2	129%	79%	125%	79%	129%	78%
I-75 South	3	129%	84%	125%	79%	129%	80%

Risk Factor #2 – Willingness-to-Pay (Cars and Trucks)

Another key factor as to whether people choose to pay a toll to use the managed lanes or use alternative free routes (General-Purpose Lanes or arterials) is how they value time savings or other benefits that managed lanes can offer, such as reliability and safety. The risk analysis of willingness to pay evaluated how receptive motorists are to the idea of managed lanes and quantify utilization rates at different price points.

As mentioned in the previous Traffic and Toll Revenue Estimation section, the MLSP refined the ARC's travel demand model and incorporated the most recent Willingness-to-Pay (WTP) results in the model. The Willingness-to-Pay curves were developed based on Stated Preference Surveys conducted in summer 2007. This survey information was used to determine the percentage of managed lanes eligible users who are willing to pay to use the managed lanes for a predetermined price.

To understand how variations in the willingness to pay would affect the revenue outcome, the planning team conducted risk analyses and examined the following four scenarios that involved modifying willingness to pay levels:

- Willingness-to-Pay for Cars - Increased by 50%
- Willingness-to-Pay for Cars - Decreased by 50%
- Willingness-to-Pay for Trucks - Increased by 50%
- Willingness-to-Pay for Trucks - Decreased by 50%

These four scenarios were studied by incorporating the various willingness- to-pay curves to the year 2030 travel demand model script. Increased willingness-to-pay means that the amount of drivers who are willing to pay to use the managed lanes will be greater for the same travel time saving condition, compared to the base case; while decreased willingness to pay means the amount of drivers who are willing to pay to use the managed lanes will be lower under the same travel time saving condition, compared to the base case.

It should be noted that these risk analyses were conducted based on premises of "no other factors altered". So in the willingness-to-pay risk analysis, the model scripts and all other input files for the 2030 model, including the socio-economic data, highway network remained fixed.

This allowed the planning team to see the direct and sole impacts to demand and revenue if the willingness-to-pay levels vary from the stated preference survey results.

The risk analyses of willingness-to-pay were conducted under various eligibility policies (e.g. ETL, METL, etc.). The factors that came out of this effort have been incorporated into the Alternative Visualization Analysis Tool (AltaViz) and an example set of results can also be seen in Table 17.

Table 17: Revenue Factors for Willingness-to-Pay (WTP) Risk Factor

Corridor (Outside I-285)	Segment	ETL (Cars)		TOT (Trucks)		METL (Cars)	
		Higher WTP	Lower WTP	Higher WTP	Lower WTP	Higher WTP	Lower WTP
I-75 North	1	130%	65%	128%	53%	130%	65%
I-75 North	2	128%	64%	127%	53%	128%	64%
I-75 North	3	130%	62%	127%	53%	130%	62%
I-75 South	1	122%	62%	127%	56%	122%	62%
I-75 South	2	126%	60%	125%	55%	126%	60%
I-75 South	3	125%	61%	125%	56%	125%	61%

Risk Factor #3 – Transportation Investments (Roadway & Transit)

One of the primary drivers of managed lane use is congestion. Additional transportation investments that potentially reduce congestion will impact the feasibility of managed lane investments. The transportation investment risk analysis accounts for the uncertainty and dynamic context of transportation project implementation and evaluates the impact of additional roadway or transit investments.

As mentioned in the Traffic and Toll Revenue Estimation section, the MLSP employed the latest version of ARC's travel demand model, which is based on the most recent long range transportation plan, Envision 6. Hence, the highway network and transit network used in the MLSP reflect the most up-to-date transportation projects from Transportation Improvement Program (TIP) and Regional transportation Plan (RTP).

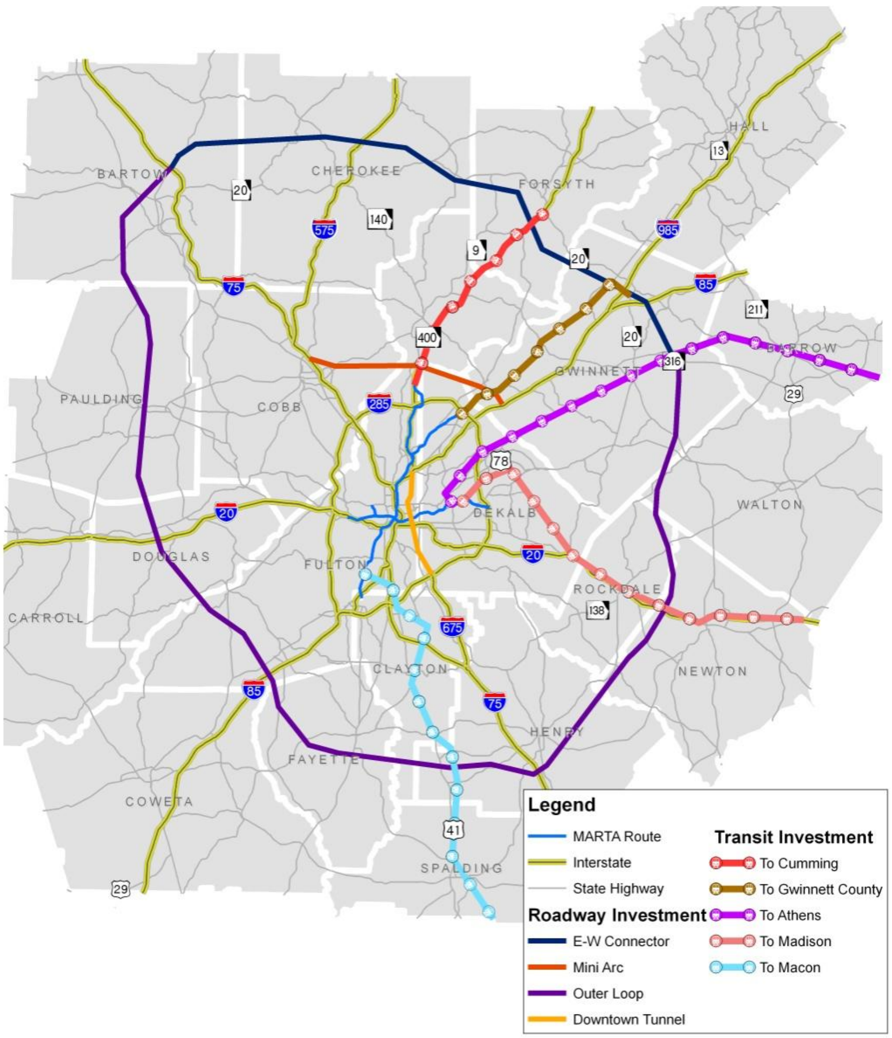
Under this risk analysis, the following two scenarios were developed to quantify the impacts on managed lane traffic and toll revenue forecasts if significant transportation investments were made:

- Heavy Roadway Investment
- Heavy Transit Investment

The scenario of heavy roadway investments was evaluated by adding the following additional capacity projects into the 2030 roadway network: East-West Connector; Outer Loop; Mini Arc and Downtown Tunnel. These roadway investments are displayed in Figure 35 and are documented in greater detail in Technical Memorandum #5: Scenario Testing. All these roadway investments were assumed to be free in order to ascertain the greatest impacts on the managed lane corridors.

The scenario of heavy transit investments was analyzed by incorporating two expanded transit routes and three completely new transit routes in the transit network. Figure 35 shows the alignments of the transit routes which are also documented in greater detail in Technical Memorandum #5.

Figure 35: Possible Roadway Investments and Transit Investments



It is important to note that all these transportation investments are conceptual in nature and are not included in ARC's long range plan. They were developed through coordination with GDOT staff and represent "big idea" projects. **These projects are for analysis purposes only and neither this study nor GDOT necessarily endorse these projects**.

Similar to previous risk analyses, both of the transportation risk analysis scenarios were conducted based on premises of "no other factors altered", i.e. the model scripts, socio-economic data, and willingness-to-pay remained fixed. This allowed the planning team to see the direct and sole impacts to demand and revenue when the transportation network goes beyond the Atlanta Regional Commission's Long Range Transportation Plan.

The risk analyses of transportation network were conducted under various eligibility policies (e.g. ETL, TOT, etc.). The factors that came out of this effort have been incorporated into the Alternative Visualization Analysis Tool (AltaViz) and an example set of results can also be seen in Table 18.

Table 18: Revenue Factors for Transportation Investment Risk Factor

Corridor (Outside I-285)	Segment	ETL		TOT		ETL + TOT	
		Heavy Transit	Heavy Roadway	Heavy Transit	Heavy Roadway	Heavy Transit	Heavy Roadway
I-75 North	1	98%	63%	96%	55%	98%	61%
I-75 North	2	95%	58%	95%	59%	95%	58%
I-75 North	3	97%	47%	95%	59%	96%	52%
I-285 South	1	98%	63%	96%	66%	97%	65%
I-285 South	2	98%	66%	96%	66%	97%	66%
I-285 South	3	97%	64%	95%	64%	96%	64%

Risk Factor #4 – Transit Frequency

This sensitivity test was performed to evaluate the impact of buses using the managed lanes for free. Current ARC policy states that a maximum of 60 buses an hour will be eligible to operate in a managed lane for free. The purpose of this risk analysis was to help determine the impact that could result from this policy. This analysis reduced the usage of passenger vehicles in the managed lanes based on the addition of buses. The number of buses allowed to operate in the managed lanes for free has a direct impact on the amount of capacity available to paying vehicles and therefore revenue.

To quantify the traffic and revenue impacts of buses in the managed lanes, the planning team conducted a risk analysis on transit frequency based on the following three scenarios:

- 12 Buses an hour;
- 30 Buses an hour; and
- 60 Buses an hour.

This risk analysis was performed using a post processing technique. The managed lane usage (volume compare to capacity) was first analyzed. Corridors that operated with sufficient additional capacity (approximately v/c = 0.64 to 0.68) in their various time periods were considered unaffected by allowing buses into their lanes. Corridors with less additional capacity (typically v/c > 0.70) were considered impacted by allowing buses into their lanes.

The risk analyses of transportation network were conducted under various eligibility policies (e.g. ETL, METL, etc.). The factors that came out of this effort have been incorporated into the Alternative Visualization Analysis Tool (AltaViz) and an example set of results can also be seen in Table 19.

Table 19: Revenue Factors for Transit Frequency Risk Factor

Corridor (Outside I-285)	Segment	ETL			METL		
		12 buses/hr	30 buses/hr	60 buses/hr	12 buses/hr	30 buses/hr	60 buses/hr
I-75 North	1	100%	97%	95%	100%	97%	95%
I-75 North	2	97%	93%	87%	97%	93%	87%
I-75 North	3	100%	100%	95%	100%	100%	95%
I-75 South	1	99%	98%	97%	99%	98%	97%
I-75 South	2	99%	99%	97%	99%	99%	97%
I-75 South	3	100%	100%	100%	100%	100%	100%

Risk Factor #5 – HOV Formation

HOV formation rates by occupancy class (HOV2+, HOV3+, and HOV4+) also affect the traffic and revenue projections for managed lanes facilities. If high occupancy trips (i.e. carpools) were to form more or less frequently than currently assumed, it would not only change the overall vehicle traffic volumes on the transportation system, but also impact the number of HOV vehicles eligible to use managed lanes for free.

As mentioned in Technical Memorandum #3: Global Demand Estimation Process, the HOV trip tables (HOV2+, HOV3+, and HOV4+) used in the MLSP were based on ARC's mode choice model. These trip tables were then calibrated and refined to reflect the observed field data in terms of the percentage split of HOV2+, HOV3+ and HOV4+.

To quantify the demand and revenue impacts on managed lanes if future HOV formation varies from what was assumed as base case, the planning team conducted a HOV risk analysis and examined the following two scenarios:

- Base MLSP HOV Formation + 10% Increase
- Base MLSP HOV Formation + 25% Increase

The first scenario was evaluated by adjusting 2030 base MLSP HOV trips tables (HOV2+, HOV3+ and HOV4+) by a increase of 10% in the 2030 travel demand model. The second scenario was evaluated by adjusting 2030 base MLSP HOV trips tables (HOV2+, HOV3+ and HOV4+) by a increase of 25%. It is important to note that with increased HOV formation, the number of SOV trips in the transportation system would decrease assuming the person trips remain the same in the region. So for both of these scenarios, the SOV trip table was updated accordingly to reflect the reduction in overall vehicle traffic volumes.

A series of 2030 model runs with the adjusted HOV and SOV trip tables were conducted under various eligibility policies (e.g. ETL, METL, etc.). The factors that came out of this effort have been incorporated into the Alternative Visualization Analysis Tool (AltaViz) and an example set of results can also be seen in Table 20.

Table 20: Revenue Factors for HOV Formation Risk Factor

Corridor (Outside I-285)	Segment	ETL		METL		ETL + TOT	
		10% Increase	25% Increase	10% Increase	25% Increase	10% Increase	25% Increase
I-75 North	1	95%	85%	96%	89%	96%	88%
I-75 North	2	96%	85%	97%	90%	97%	90%
I-75 North	3	95%	84%	97%	91%	97%	90%
I-75 South	1	95%	86%	97%	92%	98%	93%
I-75 South	2	96%	87%	98%	93%	98%	94%
I-75 South	3	97%	89%	99%	95%	99%	95%

Risk Factor #6 – General Purpose Lane Speed

General purpose lane congestion, and the resulting travel time savings offered by the managed lanes, is the primary driver of managed lane use. Analysis of 2030 traffic conditions shows that, even with managed lane investments, the GP lane speed on certain corridors, such as I-75 North, I-285 North and East, and the Downtown Connector (I-75/I-85) fall below 20 mph during the peak period. This drives strong demand for the managed lanes and results in relatively high revenue forecasts along these most congested routes.

To quantify how congestion levels on GP lanes will impact the demand and revenue on managed lanes, the planning team conducted a risk analysis of the GP lane speed. This analysis assumed that some unspecified changes will be made so that GP lane speed will always be maintained at a minimum of 20 mph even during the most congested travel period. 20 mph was used as a speed floor because recurring congestion is unlikely to lead to speeds much lower than this, even though model forecasts suggest this will be the case on a few corridors in the region. Extremely low congested travel speeds are likely to generate shifts in behavior (e.g. mode shift, alternate route) in the short term. In the long term, these conditions can have impacts on where people decide to live and work. And in order to maintain economic competitiveness, the region is likely to make transportation improvements and/or land use changes in order to improve conditions on the most congested facilities. Therefore it was important to understand the impacts to traffic and revenue forecasts if the managed lane travel time savings was limited, and a GP lane speed floor was a good way to test this.

This risk analysis was performed using a post processing technique. The first step was to calculate the travel time savings between managed lanes and GP lanes assuming the minimum GP lane speed is 20 mph. Then based on the updated travel time savings and willingness-to-pay curves, the percentage of managed lane eligible users who are willing to pay to use the managed lanes were estimated.

The GP lane speed risk analysis was conducted under various policies, but only for those corridors whose GP lane speeds are well below 20 mph during the congested travel period. The revenue change factors due to the change of GP lane speed have been incorporated into the

Alternative Visualization Analysis Tool (AltaViz) and an example set of results can also be seen in Table 21.

Table 21: Revenue Factors for GP Lane Speed Risk Factor

Corridor (Outside I-285)	Segment	ETL	METL	ETL + TOT
		Above 20 mph	Above 20 mph	Above 20 mph
I-75 North	1	79%	93%	93%
I-75 North	2	73%	93%	92%
I-75 North	3	91%	100%	100%
I-75 South	1	100%	100%	100%
I-75 South	2	100%	100%	100%
I-75 South	3	91%	98%	100%

Composite Impacts of Multiple Risk Factors

Each of the individual risk factors has a direct impact on traffic and revenue forecasts. If multiple risk factors are considered simultaneously, the impacts are potentially more significant. The planning team has developed a framework to evaluate these composite impacts, which has been included in the AltaViz tool. Every available factor is associated with a percentage change from the baseline revenue number. This percentage change is recorded as a value above or below 100%, representing positive or negative impact on revenue generation. If more than one risk factor varies from the base case, their associated percentages are multiplied together, and the product of the risks is used to update the forecast revenue. For example, if delayed growth leads to revenue that is 85% of the base case, and higher willingness to pay leads to revenue that is 112% of the base case, the cumulative impact of both of these risk factors would be 85% * 112% = 95%. The base case forecast revenue would be multiplied by 95% to calculate the adjusted revenue resulting from these two risks.

This methodology establishes a quantitative response to risk. However, base case conditions represent the most likely scenario, and the greatest level of confidence is associated with these revenue numbers. Every risk factor that is considered lowers the confidence one has in the likelihood of realizing the adjusted forecast revenue. For this reason, the planning team included a series of qualifying statements associated with the selection of various risks. These statements are as follows:

- Reasonable
- Fairly Unlikely
- Highly Unlikely
- Extremely Unlikely
- Nearly Impossible

If one or more risk factors are varied, one of the statements above is assigned to the adjusted revenue number. The specific statement assigned is based on the extent to which the scenario deviates from the base case. Two factors influence this. The first is the number of risk factors that are varied, and the second is the magnitude of the difference between the base case revenue and the adjusted revenue. The more factors that are varied and the more the final revenue numbers differ from the base case, the more unlikely the scenario becomes. A scale from one to five was established for both of these measures, and their results were averaged to come up with a final value associated with a qualifying statement. An average score of 5 equates to nearly impossible, while a score of 2 equates to fairly unlikely, etc. When using the AltaViz tool, the appropriate statement is included in the results if the user chooses to explore the impacts of various risk factors.