MANAGED LANES CONNECTING METRO AREAS: THE PRAGMATIC SOLUTION

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EXECUTIVE SUMMARY

America's Interstate Highway System is facing two major problems: congestion and lifespan. Traffic congestion continues to grow throughout the country. Originally occurring only during rush hour in urban corridors, many highways are now congested for up to 18 hours a day, every day of the week. Worse, many of these highways are not in urban or suburban locations but between metro areas, hampering mobility of people and goods. Freight vehicles must limit travel to certain time periods or travel circuitous routes to avoid the congestion, limiting productivity and increasing shipping costs. With limited right-of-way, increasing material costs and neighborhood opposition to widening, it is not surprising that urban Interstate modernization projects have not kept pace with the growth in vehicle-miles traveled. But even outside of metro areas, an increasing number of Interstates have become congested for up to 10 hours per day. Travelers on these highways, which are too narrow for today's traffic volumes, encounter traffic delays, safety problems, and decreased economic activity.

Further, most Interstate highways are reaching the end of their designated lifespan. While state DOTs have generally maintained Interstate pavement conditions through resurfacing, most of the foundation down to the roadbed itself is worn out. As a result, the different layers of the roadway need to be rebuilt starting with the roadbed. Rebuilding the Interstate Highway System is estimated to cost more than a trillion dollars.

Value-added tolling (VAT), which uses tolling to generate the revenue needed to rebuild the highways, is the most realistic way to pay for this reconstruction. The overall principle is to toll only when and where it creates a *better deal* for highway users than the status quo. Value-added tolling has five principles:

- Toll only after major improvements (modernization/reconstruction) are completed;
- Limit the use of toll revenues to the specific highway or highway system where they are collected;
- Charge only enough to cover the cost to build (or rebuild) the highway, maintain it, and improve and eventually rebuild its facilities;
- Use tolls to *replace* existing user taxes, not add to them; and
- Provide a better level-of-service (LOS—a measure of congestion) than what prevails on the highways where tolling is introduced.

Unfortunately, while acceptance for tolling selected lanes of a freeway is growing substantially, acceptance of tolling the entire roadway is more limited.

A near-term approach would be to add new express toll lanes to the facility without rebuilding the existing general lanes. This option is not ideal, as it delays needed reconstruction of the road forcing state departments of transportation (DOTs) to invest in pavement overlays to extend the life of the roadway. However, the option does have many advantages:

- The express toll lanes would provide an uncongested alternative that offers a consistent travel time for travelers who choose to pay a variable toll to bypass congestion;
- The express toll lanes would help reduce traffic in the general purpose lanes by providing new capacity;
- The express toll lanes would help increase reliability and therefore the popularity of intercity bus service. Buses operate on some of the most congested rural corridors. Unlike Amtrak rail, buses are not subsidized and offer many different types of service along the corridor;
- The express toll lanes would help familiarize travelers with 21st century tolling technology and would increase the popularity of tolling; and
- The express toll lanes could be used to relieve traffic congestion when the rest of the highway is rebuilt.

This brief includes case studies of four corridors connecting metro areas that may be good candidates for managed lanes: I-5 in California between San Diego and Orange County, I-85 in North Carolina between Greensboro and Durham, I-95 in Connecticut between the New York State Line and New Haven, and I-95 in Virginia between the Richmond and Washington, D.C. metro areas. The case studies include the location of the managed lanes, information on traffic accidents as well as congestion, historical information about the highway and future growth projections.

TABLE OF CONTENTS

PART 1: THE HISTORY OF MANAGED LANES **1**

PART 2: THE STATE OF AMERICAN INFRASTRUCTURE **5**

PART 3: THE IDEAL SOLUTION **7**

PART 4: THE PRAGMATIC ALTERNATIVE **10**

CORRIDOR 1: I-95 IN VIRGINIA 13

CORRIDOR 2: I-95 IN CONNECTICUT 16

CORRIDOR 3: I-85 IN NORTH CAROLINA 18

CORRIDOR 4: I-5 IN CALIFORNIA 20

PART 5: ADVANTAGES OF EXPRESS TOLL LANES **23**

TRANSIT SERVICE 23

ENERGY AND ENVIRONMENT 24

PART 6: CONCLUSION AND RECOMMENDATIONS **25**

ABOUT THE AUTHOR **27**

PART 1

THE HISTORY OF MANAGED LANES

Express toll lanes are one type of managed lanes. The Federal Highway Administration defines managed lanes as a highway facility or set of lanes where operational strategies are implemented and managed in response to changing roadway conditions.[1] The first managed lanes in the U.S. were actually busways—dedicated lanes on freeways designed to allow high-quality high-speed transit service. Many major regions were facing traffic congestion problems, and buses were a low-cost solution. Buses took up less space per capita than individual cars on freeways and also offered the flexibility to travel where needed. Both the Federal Highway Administration (FHWA) and the Urban Mass Transportation Administration (UMTA)—the predecessors to today's Federal Transit Administration—encouraged the development of busways.[2] To help travelers distinguish between busways and regular travel lanes open to all vehicles, transportation practitioners began calling the regular lanes "general purpose" (GP) lanes.

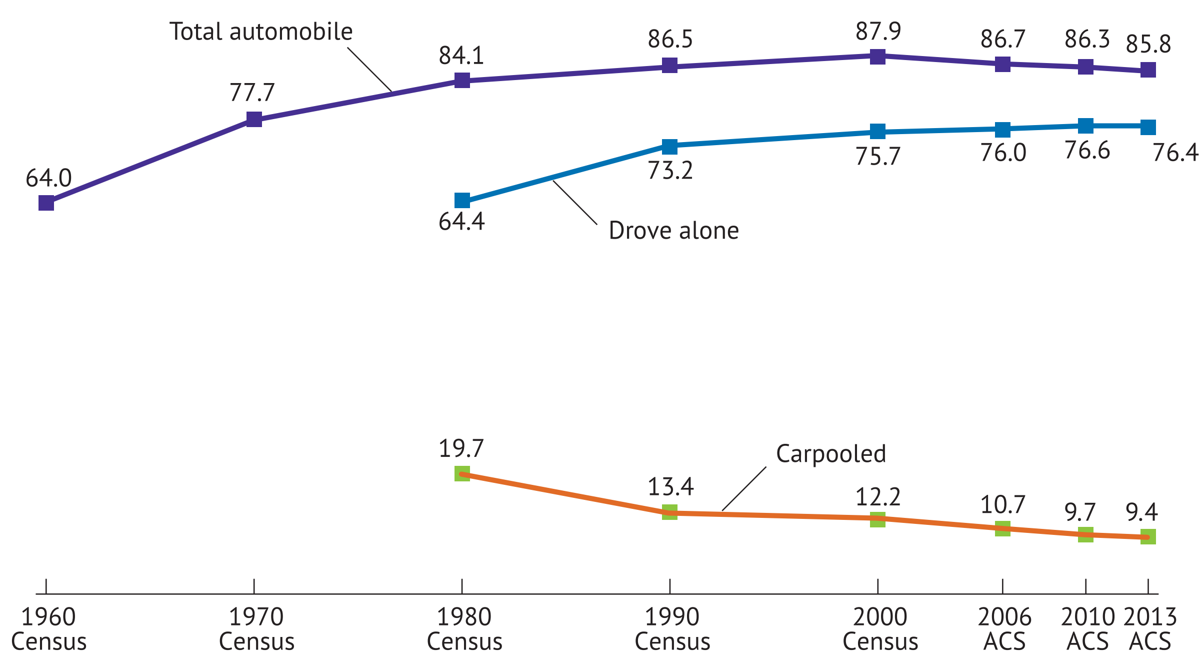
1 "Managed Lanes: A Primer." U.S. Department of Transportation. Federal Highway Administration Office of Operations. *ops.fhwa.dot.gov*. Web. https://ops.fhwa.dot.gov/publications/managelanes_primer/. 13 Dec. 2018.

2 Christiansen, Dennis. "High Occupancy Vehicle System Development in the United States." Texas A&M Transportation Institute. December 1990. Web. https://ops.fhwa.dot.gov/freewaymgmt/publications/hov/00101628.pdf. 13 Dec. 2018.

However, despite their efficiency, busways had a lot of unused capacity. Transportation officials thought that, by converting busways to high-occupancy vehicle (HOV) lanes that restricted usage to vehicles with a minimum number of occupants, they could incentivize solo drivers to carpool (commuters traveling from the same general origin to the same general destination ride together in a vehicle). The 1970s oil crisis led to a policy of promoting carpools. At first, busways were converted to 4-person or 3-person carpools. However, as space remained, many DOTs allowed 2-person carpools. Houston, Los Angeles and Washington, D.C. busways were converted to HOV lanes.

Largely as a result of the increase in HOV lanes and the 1970s oil crisis, carpooling enjoyed a brief renaissance, peaking in 1980 when nearly 20% of Americans commuted to work with another person.[3] However, growing wealth, declining gas prices, and the growth in low-density suburban development patterns caused a rapid decline in carpooling from 19.7% in 1980 to 9.4% in 2013. Figure 1 below shows the decline of carpooling.

FIGURE 1: U.S. AUTOMOBILE COMMUTING: DRIVING ALONE VS. CARPOOLING, 1960-2013



https://www.census.gov/content/dam/Census/library/publications/2015/acs/acs-32.pdf

3 Shaheen, Susan, Adam Cohen and Alexandre Bayen. "The Benefits of Carpooling." University of California, Berkeley. October 2018. Web. https://cloudfront.escholarship.org/dist/prd/content/qt7jx6z631/qt7jx6z631.pdf?t=ph0r4f, 13 Dec 2018.

This decline did not stop federal policy from incentivizing carpools or DOTs from building new carpool lanes. Over the last 20 years, many states have built HOV lanes with a minimum vehicle occupancy of as little as two people. Atlanta famously used some of its Olympics transportation funding to build a network of 2+ HOV lanes.[4]

In addition to declining popularity, the biggest problem with carpool lanes is that they suffer from the Goldilocks Paradox: they are either “too hot” or “too cold.” Lanes that are “too hot” have too many vehicles in them. Travel speeds are below the federally required 45 miles per hour. Vehicles in these lanes often travel at the same speed as vehicles in the general purpose lanes. Buses that operate in “too hot” lanes tend to have lower ridership than buses that operate in free flow traffic, as transit choice customers (those who own or have ready access to a vehicle) choose to drive if taking transit is not faster than driving. Increasing travel speeds requires raising the lane occupancy requirement, which is politically challenging and may cause other problems. HOV 2+ lanes are the most common type of “too hot” lane.

Lanes that are “too cold” have too few vehicles using them. An underused lane wastes valuable roadway infrastructure, particularly during rush hour. “Too cold” lanes lead to pushback from drivers in the general purpose lanes. Such pushback could pressure policy makers to allow additional vehicles in managed lanes, jeopardizing bus transit service. HOV 3+ lanes are the most common type of “too cold” lane.

In many regions, including Atlanta and Houston, the biggest beneficiaries of carpool lanes are fampools.[5] Fampools are two or more members of the same household traveling together from home to work or school. Studies show that HOV lanes are not the reason that family members ride together. Family members share the commute to reduce the number of household vehicles, to spend less money on operating expenses (maintenance, gasoline, etc.) or to spend more time with each other. More concerning, most fampools are not two adults but rather an adult and a child. This type of fampool involves a parent dropping a child off for school or daycare and then continuing to a job or returning home. This is not a

4 Poole, Robert and Ted Balaker. “Virtual Exclusive Busways: Improving Urban Transit While Relieving Congestion.” Reason Foundation, September 2005. Web. https://reason.org/wp-content/uploads/files/f74f4436cd5e98624899baf1c02c384f.pdf, 14 December, 2018.

5 Goodin, Ginger et. al. “The Role for Preferential Treatment of Carpools in Managed Lanes.” Texas A&M Transportation Institute, April 2009. Web. https://ceprofs.civil.tamu.edu/mburris/Papers/0-5286-02_transmittal_032409.pdf, 14 December 2018.

true carpool because the child is not old enough to drive. Further, incentivizing these fampools decreases the popularity of express bus service, as carpools receive the same priority lane benefits as transit vehicles. HOV lanes and HOT lanes ("high-occupancy toll" lanes charging drivers of single-occupant vehicles a variable toll to use carpool lanes) that allow 2-person carpools incentivize this type of behavior.

Creating express toll lanes (ETLs) provides a better way to manage limited capacity. To maximize throughput of the lanes at all times, prices are adjusted based on the number of vehicles using the ETL and GP lanes. To incentivize transit usage, buses and registered vanpools with seven or more people ride for free 24 hours a day/seven days a week. Finally, to limit the number of fampools, all automobile drivers, regardless of occupancy, pay to use the lane. Travelers using buses and registered vanpools are the only users that receive free passage. Having more users pay allows the project to be paid off more quickly, an added benefit. In addition, it may provide additional revenue that can be used for corridor improvements.

For example, on the Transform I-66 project—a public-private partnership (P3) between the State of Virginia and I-66 Express Mobility Partners (Cintra, Meridiam, John Laing, APG)—the toll revenue will be used for the project construction ($2.3 billion), and upfront payment to the state to fund other projects in the corridor ($500 million), transit expansions ($800 million) and other I-66 improvements over the next 50 years ($350 million).[6]

[6] "Transform I-66 Outside the Beltway." *cintra.us*, Cintra USA. 2018. https://cintra.us/ourprojects/transform-66-outside-the-beltway/. 1 February, 2019.

PART 2

THE STATE OF AMERICAN INFRASTRUCTURE

The surface pavement of U.S. primary arterials, including Interstate highways, is in very good shape.[7] The Federal Highway Administration measures pavement quality using the International Roughness Index (IRI). Since record-keeping began in 1992, the percentage of pavement in poor quality (with a higher IRI) has steadily declined. Yet, American infrastructure continues to age. Many parts of the Interstate System are older than the 50 years of their designated lifespan. Some sections are more than 60 years old. As roadbed nears the end of its lifespan, resurfacing the pavement becomes more expensive and less tenable.

The main reason that Interstate System pavement (and the pavement of other major primary arterials) is in such good condition is because over the last 20 years state DOTs have prioritized good surface repair.[8] Between 1964 and 1991, most DOTs prioritized construction. After the Interstate System was constructed, partly as a result of reduced

7 Fields, Gregory, Spence Purnell and Baruch Feigenbaum. *23rd Annual Highway Report on the Performance of State Highway Systems*. Reason Foundation, February 2018. Web. https://reason.org/wp-content/uploads/2018/01/23rd_annual_highway_report.pdf. 15 December, 2018.

8 Many states, including Georgia, North Carolina and Virginia, have moved to a metric-driven process that prioritizes maintenance over new construction. States using a metric-driven process have higher pavement quality scores than other states.

funding, DOTs shifted to prioritizing maintenance. The good pavement condition of most Interstates shows how well DOTs manage their primary roadway network. DOTs have found ways to improve maintenance quality at a lower cost through innovation, by contracting with the private sector, or both.

As the country's population continues to grow, particularly in the South, in the Rocky Mountain region and along the West coast, new capacity is needed. Despite a 300% increase in population, many states have not widened or improved their four-lane Interstates built in the late 1950s or early 1960s.[9] These facilities suffer from significant congestion and a growing number of fatalities.[10]

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9 "Nevada and Idaho are the Nation's Fastest Growing States." United States Census Bureau. census.gov. 19 December 2018. Web. https://www.census.gov/newsroom/press-releases/2018/estimates-national-state.html 21 December 2018.

10 "Conditions and Performance Report: Chapter 4 Safety." Federal Highway Administration. *fhwa.dot.gov*. 20 December 2016. Web. https://www.fhwa.dot.gov/policy/2015cpr/chap4.cfm. 4 February 2019.

PART 3

THE IDEAL SOLUTION

The ideal solution is to modernize those older Interstates. Modernizing the highway encompasses removing the old pavement down to the roadbed, repairing the roadbed if necessary and then adding several new layers of concrete or asphalt above the roadbed. On some Interstates, additional lanes will need to be added. Many state DOTs have rebuilt some of their Interstates as they have widened them. For example, the states of Florida and Georgia have widened most of I-75 to six lanes. For the section between Macon and Tampa, the states have rebuilt the roadbed. Yet, there are other roads, such as I-16 between Macon and Savannah, that are reaching the end of their pavement life, are not in need of new capacity and have not been rebuilt. Other states such as Virginia, have rebuilt and modernized almost none of their Interstate highways. Nationwide, most of the entire 49,000-mile Interstate System will need to be rebuilt over the next 20 years.[11]

The biggest challenge in rebuilding these Interstates is finding the revenue. Reason Foundation continues to recommend financing the reconstruction of the Interstate System with per-mile tolls collected using all-electronic tolling (AET). Over several decades, the transformation of the Interstate System, state by state, would convert at least one-fourth of all travel from per-gallon fuel taxes to per-mile charging. The cost estimates include fitting

[11] "Renewing the National Commitment to the Interstate Highway System: A Foundation for the Future." National Academy of Sciences. Engineering and Medicine, 2018. Web. https://www.nap.edu/download/25334#, 4 February 2018.

the entire Interstate Highway System, both rural and urban, with state-of-the-art all-electronic tolling (AET) equipment.

To determine the feasibility of toll financing, an earlier Reason study[12] modeled the creation of a tolling system in 2010 dollars based on 3.5¢ per mile for cars and 14¢ per mile for trucks, indexed annually for inflation. Using state-by-state estimates of annual growth in travel by cars and by trucks over a 35-year period, the net present value (NPV) of toll revenue equals 99% of the net present value of construction and reconstruction costs. These results indicate that the overall system is likely to be toll-financeable.

To make the transition attractive to highway users, the earlier study proposed using the principle of “value-added tolling.” Tolls would only be introduced in a corridor once it was reconstructed and modernized, designed to operate at a higher “level of service”[13] than today’s design standards require (technically, a minimum of LOS C on rural Interstates and LOS D on urban Interstates). If a state has not yet replaced its per-gallon fuel taxes with a standard mileage-based user fee at the time Interstate tolls are introduced, the AET system will allow rebates of fuel taxes generated by the miles driven on the tolled Interstates, thereby avoiding “double taxation.”

There are several reasons why a variably priced toll system is better than the current system based on a flat gas tax:

- Per-mile tolls can be tailored to the cost of each road and bridge, rather than being averaged across all types of roads, from neighborhood streets to Interstates. This new approach ensures adequate funding for major highway projects such as Interstate reconstruction and modernization.
- Per-mile tolling reflects greater fairness, since those who drive mostly on Interstates will pay higher rates than those who drive mostly on local streets.
- If per-mile tolling is implemented as a true user fee, it will be self-limiting, dedicated solely to the purpose for which it was implemented (and enforceable via bond covenants with those who buy toll revenue bonds).

12 Poole, Robert. “Interstate 2.0: Modernizing the Interstate Highway System via Toll Finance.” Reason Foundation, 2013. Web. https://reason.org/wp-content/uploads/files/modernizing_interstates_toll_finance.pdf, accessed 4 February 2019.

13 Level of service measures the speed, spacing, comfort and convenience of traffic flow. Levels range from A (free flow traffic) to F (congestion traffic with an increased likelihood of accidents).

- Per-mile tolling will guarantee proper ongoing maintenance of the tolled corridors, since bond-buyers and other investors require this as a legal condition of providing the funds.
- Per-mile tolling also provides a ready source of funding for future improvements to the tolled corridor.
- Toll financing means that needed projects, such as reconstruction and widening, can be constructed as needed, and paid for over several decades while highway users enjoy the benefits of the improved facilities.
- Finally, a per-mile tolling system using AET can easily implement variable pricing on urban expressways to reduce and manage traffic congestion.

A 2013 study estimated the net present value (NPV) for reconstruction at $589 billion in 2010 dollars and NPV of new capacity at $394 billion in 2010 dollars for a total cost of $983 billion.[14] Given the significant increases in vehicle-miles traveled as the U.S. came out of the Great Recession and inflation, the overall NPV is well over $1 trillion.

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14 Poole. "Interstate 2.0."

PART 4

THE PRAGMATIC ALTERNATIVE

Despite several studies that recommend using tolls to rebuild the Interstate System, significant opposition remains. Many trucking organizations, including some of the state chapters of the American Trucking Associations (ATA) remain opposed to tolls, arguing it will increase the cost of freight.[15] Many right-wing populists believe toll-free roads are an American right and have organized local chapters to fight toll-roads.[16] Finally, many Republicans believe the imposition or increase of a toll is the same as a tax increase. Despite the technical differences, these politicians rail against perceived elements of tolling, such as double taxation and tollbooth workers, even if the project uses all-electronic tolling.

15 Casey, Monica. "Small Trucking Companies Worry About the Possibility of I-81 Tolls." *WHSV 3 News*. 19 April 2018, *whsv.com*. Web. *https://www.whsv.com/content/news/Small-trucking-companies-worry-about-the-possibility-of-I-81-tolls-480232623.html*. 14 December 2018.

16 Alexander, Rachel. "Libertarians Can't Leave Their Love of Toll Roads." Selous Foundation for Public Policy Research. September 2014. Web. http://sfppr.org/2014/09/libertarians-cant-leave-their-love-of-toll-roads/. 15 December 2018.

Unfortunately, congestion on many Interstates connecting major urban areas is interfering with economic activity. On these facilities, the state cannot wait 20 or more years until political acceptance of tolling is achieved; these states need to take action immediately.

As a result, this study recommends an interim solution: states add variably priced express toll lanes where needed on their busiest corridors. State DOTs and metropolitan planning organizations (MPOs) are building variably priced express lanes within metro areas. Many metro areas including Atlanta, Los Angeles, Miami and Washington, D.C. are building a network of managed lanes. Adding this type of managed lanes in busy corridors, as exemplified later in this section, can address similar problems between metro areas.

To encourage states to rebuild all lanes and segments of their Interstate networks with tolling, express toll lanes are recommended only on corridors with the following characteristics.

- The average annual daily traffic (AADT) on the corridor, adjusted for heavy trucks and seasonal variations, must total over 110,000.
- Traffic on these corridors must be growing at a rate of 0.5% or higher annually, over a five-year period.
- These corridors must connect metro areas.

Additionally, freeway operations researchers have generally found that Interstates with four or five lanes per direction are the most efficient (carry the most vehicles per lane) compared to narrower or wider facilities.[17] This occurs due to traffic patterns resulting from changing lanes and merging. For Interstates with two or three lanes per direction, merging activity (when vehicles exit or enter the facility) lessens the ability of congested lanes to accommodate more traffic. Consider how vehicles move away from the right lane at interchanges as slower traffic enters the facility. For wide freeways (12 lanes or wider), excessive weaving (lane changing) causes significant delays. Each time a vehicle changes lanes in congested traffic, there is a small delay to vehicles behind it. Wide freeways induce motorists to change lanes more frequently than do narrower freeways. This cumulative delay can reduce the throughput of wider facilities.

[17] Van Meter, Daryl. Interview in person. Savannah GA: 28 September 2017.
Guensler, Randall. Interview in person. Washington, D.C.: 10 January 2018.

It is important to use this research on merge and lane change activity properly. There is no one correct number of lanes to use for a freeway. Freeways with lower traffic volumes may experience little to no delay at merge points. Some freeways with extremely high traffic volumes need to have 12 or more lanes in major metro areas. The takeaway is that congested 8-lane or 10-lane freeways are more efficient and move more people per lane than congested 4-lane, 6-lane, 12-lane or larger freeways. Additionally, the placement of exits and ratio of cars to trucks on the highway also affect traffic flow characteristics. As a result, from a traffic engineering perspective, it is good practice to widen busy, congested freeways to eight general purpose lanes before adding variably priced HOT lanes.

While actual numbers vary by location and traffic characteristics, Table 1 provides a general guide to the traffic volume carrying capacity of rural freeways.

TABLE 1: FREEWAY LANES AND CONGESTION

Number of GP Lanes	Number of ET Lanes	Level of Service at Max*	AADT
4	0	B-	0-40,000
6	0	B-	40,000-60,000
8	0	C	60,000-110,000
8	2	C-F	110,000-150,000
8	4	C-F	150,000 +

*** Uses directional distribution factor d of 0.55 (55/45 directional split) and k factor (peak hour value) of .010.**

Only some Interstate corridors between metro areas meet these criteria. This section focuses on four segments:

- I-95 between Richmond, VA and Washington, D.C.
- I-85 between Greensboro and Durham, North Carolina
- I-5 between Los Angeles and San Diego, California, and
- I-95 between the New York State Line and New Haven, CT.

The following section provides details on the traffic pattern, geometric configuration, traffic accident rates, lost economic activity and future plans for the corridor. While each highway is unique, they suffer from many of the same problems.

CORRIDOR 1: I-95 IN VIRGINIA

I-95 in Virginia between Richmond and the I-395/I-495 interchange in Fairfax County is the most congested corridor connecting metropolitan areas in the nation. Not surprisingly, it also encounters the most delay. The corridor operates at level of service F (on an A-F scale) for a minimum of four hours each day during weekdays and up to 12 hours per day on weekends.[18] When traffic data firm INRIX analyzed traffic hotspots, it found the I-95 corridor to be the worst in the nation with 1,384 traffic jams lasting an average of 33 minutes in the March and April 2017 time period alone.

The road also suffers from safety problems. There were 12 fatalities on the corridor in 2017.[19] Lost economic activity totals almost $10 billion per year.[20] The good news is that the Virginia Department of Transportation (VDOT) has already built managed lanes on I-95 between Stafford, VA and the I-95/I-395/I-495 interchange in Fairfax County and is converting HOV lanes from the I-95/I-395/I-495 interchange to Washington, D.C. to express toll lanes. VDOT has plans to extend the HOT lanes south to US 17 just north of Fredericksburg. Unfortunately, the managed lanes are a 2- to 3-lane reversible facility that operates in only one direction. I-95 traffic is increasingly bidirectional with severe backups on weekday afternoons and weekends. The current traffic volumes and roadway cross sections are shown in Table 2 below.

TABLE 2: I-95 IN VIRGINIA 2017 TRAFFIC VOLUMES

From	To	Average Annual Daily Traffic	Current Cross Section	From	To	Average Annual Daily Traffic	Current Cross Section
I-295	SR 656	135,000	6 GP	**SR 610**	Russell Rd	146,000	6 GP + 2 HOT
SR 656	SR 802	131,000	6 GP	**Russell Rd**	SR 619	139,000	6 GP + 2 HOT
SR 802	SR 54	119,000	6 GP	**SR 619**	SR 234	167,000	6 GP + 2 HOT
SR 54	SR 30	111,000	6 GP	**SR 234**	SR 784	171,000	6 GP + 2 HOT

18 "2017 Global Traffic Scorecard." INRIX. 2018. Web. http://inrix.com/resources/inrix-2017-global-traffic-scorecard/. 19 December 2018.

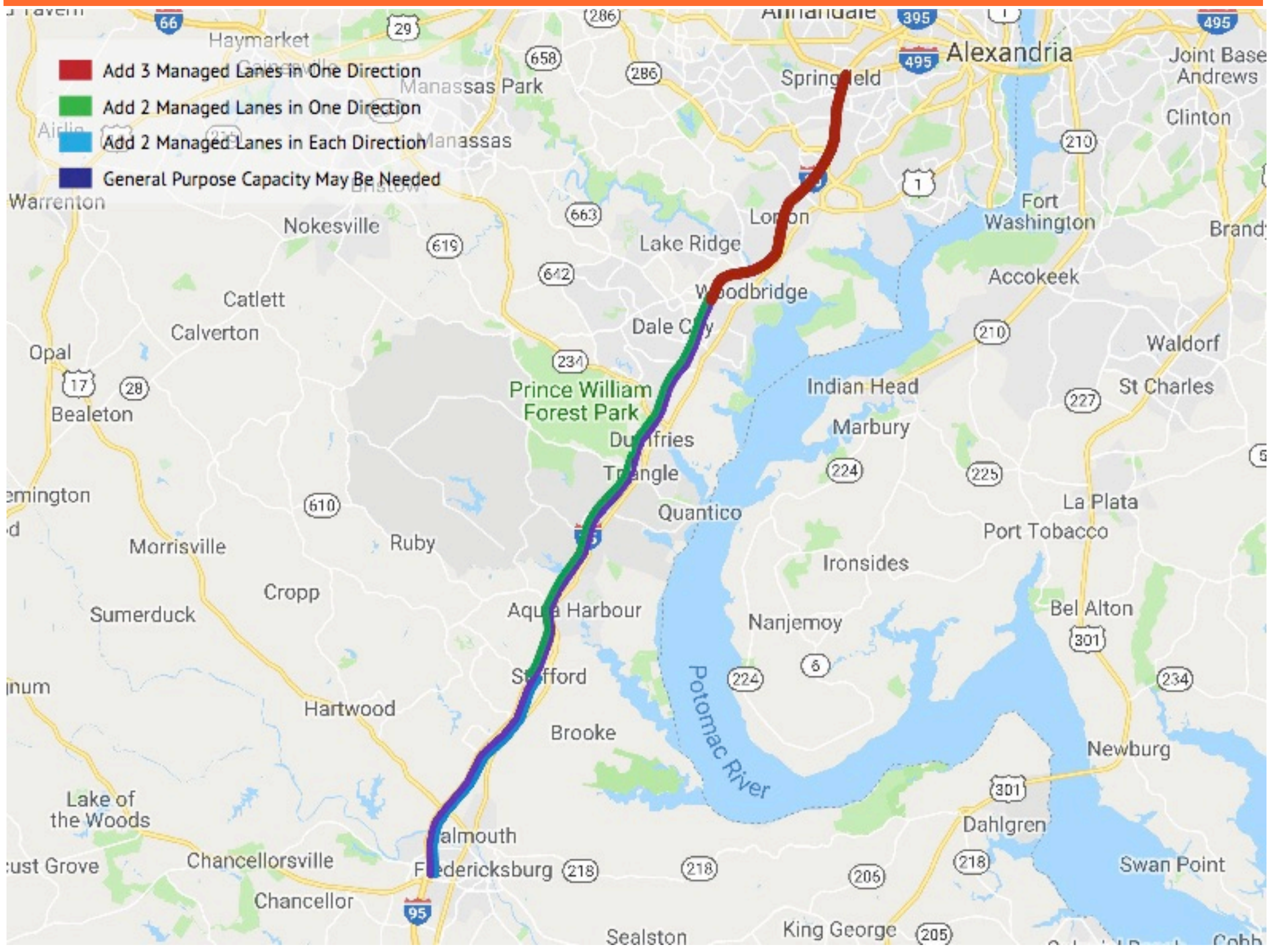
19 "Fatality Analysis Reporting System." National Highway Traffic Safety Administration. nhtsa.gov, 2018. Web. https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars, 28 January 2019.

20 Calculated from information in INRIX's global scorecard.

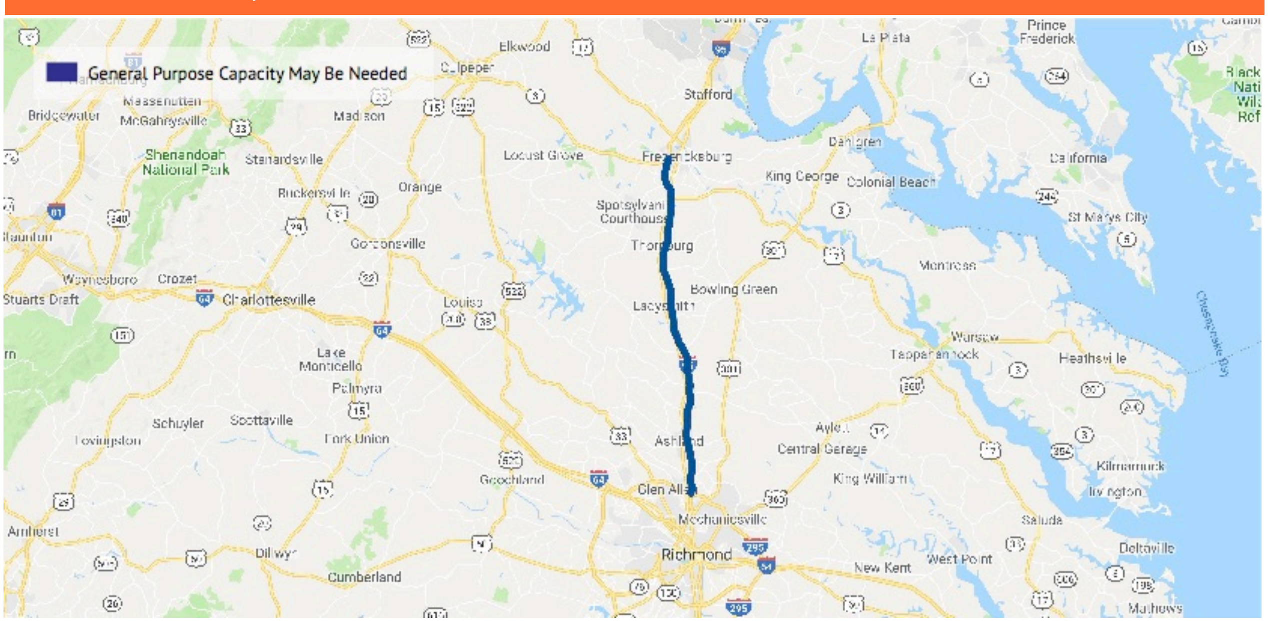
From	To	Average Annual Daily Traffic	Current Cross Section	From	To	Average Annual Daily Traffic	Current Cross Section
SR 30	SR 207	107,000	6 GP	**SR 784**	SR 3000	198,000	6 GP + 2 HOT
SR 207	SR 639	106,000	6 GP	**SR 3000**	SR 123	206,000	6 GP + 3 HOT
SR 639	SR 606	102,000	6 GP	**SR 123**	US 1	224,000	8 GP + 3 HOT
SR 606	US 1, US 17S	104,000	6 GP	**US 1**	SR 642	228,000	8 GP + 3 HOT
US 1, US 17S	SR 3	126,000	6 GP	**SR 642**	Ramp to Express Lanes	246,000	8 GP + 3 HOT
SR 3	US 17N	150,000	6 GP	**Ramp to Express Lanes**	SR 286	211,000	8 GP + 3 HOT
US 17N	SR 8900	134,000	6 GP	**SR 286**	Ramp to Express Lanes	255,000	9 GP + 3 HOT
SR 8900	SR 630	136,000	6 GP	**Ramp to Express Lanes**	SR 644	262,000	9 GP + 3 HOT
SR 630	SR 610	137,000	6 GP	**SR 644**	I-495	230,000	9 GP + 3 HOT

A s a result, VDOT needs to add two additional managed lanes in each direction from Fredericksburg to SR 610 in Stafford (see light blue line on Virginia Northern Corridor map), two additional managed lanes in one direction from the SR 610 in Stafford to SR 3000 in Woodbridge (see green line on map), and three additional managed lanes in one direction from SR 3000 in Woodbridge to the I-95/I-395/I-495 interchange in Springfield (see red line on map). The 2-lane sections can be built at ground level in the current right-of-way. The 3-lane section will either have to be elevated or require additional right-of-way. VDOT should also consider adding a fourth GP lane per direction from SR 802 in Hanover County to SR 123 in Prince William County. VDOT may be able to narrow existing lanes and use parts of the shoulder to minimize GP lane construction costs.

I-95 VIRGINIA NORTHERN CORRIDOR: FREDERICKSBURG TO SPRINGFIELD



I-95 IN VIRGINIA, SOUTHERN CORRIDOR: GLEN ALLEN TO FREDERICKSBURG



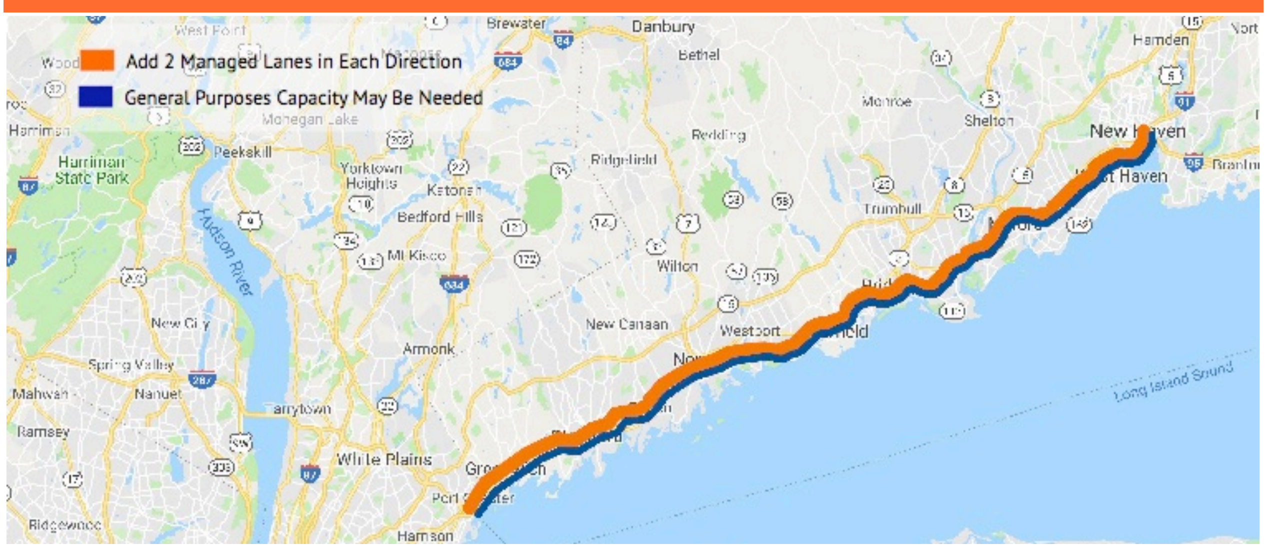
CORRIDOR 2: I-95 IN CONNECTICUT

I-95 between the New York State Line and I-91 in New Haven is one of the busiest corridors in the nation. It operates at level of service F (on an A-F scale) for a minimum of four hours each day during weekdays and up to 12 hours per day on weekends.[21] Traffic measurement firm INRIX identified it as one of the 25 worst corridors in the nation, with an estimated projected congestion cost of $6.2 billion. There were seven fatalities on the corridor in 2017.[22] Lost economic activity totals almost $10 billion per year.[23]

At one time, the Connecticut Department of Transportation (CTDOT) planned to use one of the three slots available in the Interstate System Reconstruction and Rehabilitation Pilot Program to rebuild an Interstate highway using tolling. However, CTDOT was forced to eliminate that option due to political opposition.

One possible alternative would involve adding a general purpose lane in each direction and building two express toll lanes in each direction (see map). The new GP lanes could be added by converting parts of the shoulder and widening the existing through-lanes.

I-95 CONNECTICUT: NEW YORK STATE LINE TO NEW HAVEN



21 "2017 Global Traffic Scorecard." INRIX. 2018.

22 "Fatality Analysis Reporting System." National Highway Traffic Safety Administration.

23 Calculated from information in INRIX's global scorecard.

The new toll lanes would either need to be elevated or built in an acquired right-of-way. Several DOTs, including Georgia, have built new elevated lanes cost effectively by constructing them using precast concrete. Regardless of where they were built, such lanes would be vital in a future rebuild on the corridor. AADT on the corridor of 150,000 indicates Connecticut has the traffic volumes to support two toll lanes in each direction (see Table 3).

TABLE 3: I-95 IN CONNECTICUT 2014 TRAFFIC VOLUMES

From	To	Average Annual Daily Traffic	Current Cross Section	From	To	Average Annual Daily Traffic	Current Cross Section
NY State Line	Delwyn Ave/ Doryn Ave	131,500	6 GP	**Exit 24, Stephens Ln.**	Commerce St	147,800	6 GP
Louden St/ Ritch Ave	Arch St	137,100	6 GP	**Commerce St**	Worden Ave	158,200	6 GP
Arch St	Indian Field Rd	143,700	6 GP	**Worden Ave**	Exit 27	162,500	6 GP
Indian Field Rd	East Putnum Ave	146,800	6 GP	**Exit 27**	Exit 28, SR 127	153,100	6 GP
East Putnum Ave	Harvard Ave	145,100	6 GP	**Exit 28, SR 127**	Seaview Ave	144,400	6 GP
Harvard Ave	Washington Blvd	153,600	6 GP	**Seaview Ave**	Surf Ave	136,800	6 GP
Washington Blvd	Elm St	128,700	6 GP	**Surf Ave**	South Ave	122,000	6 GP
Elm St	Seaside Ave, Main St	150,400	6 GP	**South Ave**	West Broad St	124,500	6 GP
Seaside Ave, Main St	Norton Ave	149,600	6 GP	**West Broad St**	Ferry Blvd	123,100	6 GP
Norton Ave	US 1	149,500	6 GP	**Ferry Blvd**	Exit 34, Bridgeport Ave	109,400	6 GP
US 1	SR 136	153,000	6 GP	**Exit 34, Bridgeport Ave**	Schoolhouse Rd	117,300	6 GP

From	To	Average Annual Daily Traffic	Current Cross Section	From	To	Average Annual Daily Traffic	Current Cross Section
SR 136	Exit 13, US 1	144,100	6 GP	**Schoolhouse Rd**	Plains Rd	121,000	6 GP
Exit 13, US 1	Exit 14, US 1	136,700	6 GP	**Plains Rd**	Millford Parkway	127,000	6 GP
Exit 14, US 1	Exit 15, US 7	147,300	6 GP	**Millford Parkway**	Exit 39, US 1	136,000	6 GP
Exit 15, US 7	Exit 16, East Ave	150,900	6 GP	**Exit 39, US 1**	Woodmont Rd	131,500	6 GP
Exit 16, East Ave	SR 33	131,800	6 GP	**Woodmont Rd**	Marsh Hill Rd	129,100	6 GP
SR 33	Sherwood Island Connector	129,800	6 GP	**Marsh Hill Rd**	SR 162	128,000	6 GP
Sherwood Island Connector	Center St	128,400	6 GP	**SR 162**	Campbell Ave/SR 122	133,200	6 GP
Center St.	Bronson Rd	134,700	6 GP	**Campbell Ave/SR 122**	SR 10	136,400	6 GP
Bronson Rd	Mill Plain Rd	139,200	6 GP	**SR 10**	Sargent Dr	151,700	6 GP
Mill Plain Rd	Round Hill Rd	143,400	6 GP	**Sargent Dr**	Water St	149,000	6 GP
Round Hill Rd	Exit 23, US 1	147,300	6 GP	**Water St**	I-91	135,200	6 GP
Exit 23, US 1	Exit 24, Stephens Ln	146,800	6 GP				

CORRIDOR 3: I-85 IN NORTH CAROLINA

I-85 between the I-40 West split near Greensboro and the I-40 East split near Durham is one of the busiest corridors in the nation. Congestion and traffic accidents are a problem.

There were four fatalities on the facility last year.[24] Lost economic activity totals almost $3 billion.[25]

Its overall LOS is C but it operates at LOS D and E for much of the day. Congestion is worsening with the rapid population growth in this corridor (about 3.5% annually), necessitating new capacity (see Table 4).[26]

TABLE 4: I-85 IN NORTH CAROLINA 2017 TRAFFIC VOLUMES

From	To	Average Annual Daily Traffic	Current Cross Section	From	To	Average Annual Daily Traffic	Current Cross Section
I-40W	Rock Creek Dairy Rd	128,000	8 GP	**Jimmie Kerr Rd**	Trollingwood-Hawfields Rd	117,000	8 GP
Rock Creek Dairy Rd	SR 61	126,000	8 GP	**Trollingwood-Hawfields Rd**	SR 119	114,000	8 GP
SR 61	University Dr	124,000	8 GP	**SR 119**	Mebane Oaks Rd	115,000	8 GP
University Dr	Huffman Mill Rd	126,000	8 GP	**Mebane Oaks Rd**	Buckhorn Rd	114,000	8 GP
Huffman Mill Rd	Alamance Rd	132,000	8 GP	**Buckhorn Rd**	Willing Rd	118,000	8 GP
Alamance Rd	SR 87	128,000	8 GP	**Willing Rd**	US 70	125,000	8 GP
SR 87	Jimmie Kerr Rd	123,000	8 GP	**US 70**	I-40E	121,000	8 GP

This corridor is different from the I-95 corridors in Connecticut and Virginia in that it does not experience severe congestion yet. The 8-lane corridor, reconstructed in the last 25 years, experiences few geometric design issues with its long on-ramps, off-ramps and merge lanes. It has no sharp curves, leaving it free from the design problems of the I-95 sections. No changes to the general purpose lanes are needed on this facility.

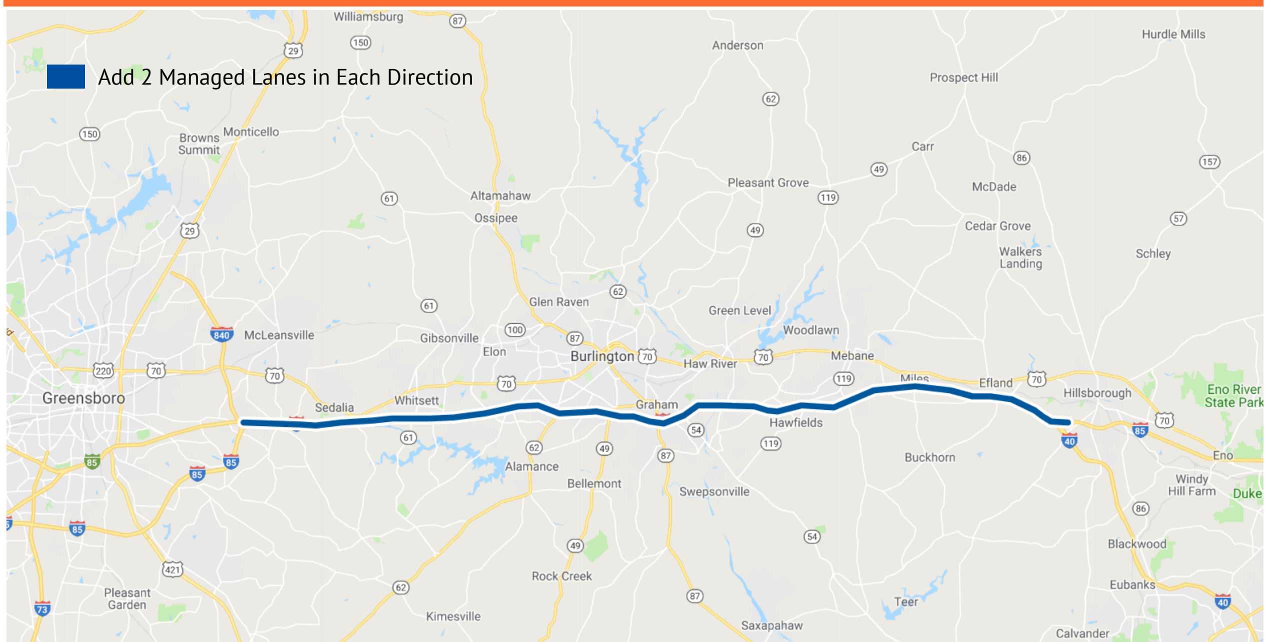
24 "Fatality Analysis Reporting System." National Highway Traffic Safety Administration.

25 Calculated from information in INRIX's global scorecard.

26 "2017 Global Traffic Scorecard." INRIX, 2018.

Given its geometric qualities, the roadway is perfect for new express toll lanes. Given future growth, the roadway could accommodate four express toll lanes, two in each direction (see map). There is significant right-of-way to build the lanes either outside of the existing lanes or inside of the lanes (although inside would require rebuilding the existing general purpose lanes).

I-95 IN NORTH CAROLINA: GREENSBORO TO HILLSBOROUGH



CORRIDOR 4: I-5 IN CALIFORNIA

I-5 between I-805 in San Diego and the San Diego/Orange County line is one of the busiest corridors in the nation. It operates mostly at level of service D-F. Southern sections of the corridor operate at level of service F for 12 hours per day and up to 16 hours on weekends.[27]

Congestion and traffic accidents are a major problem on this highway. There were 11 fatalities on the facility last year.[28] Lost economic activity totals more than $12 billion.[29]

27 "2017 Global Traffic Scorecard." INRIX, 2018.

28 "Fatality Analysis Reporting System." National Highway Traffic Safety Administration.

29 Calculated from information in INRIX's global scorecard.

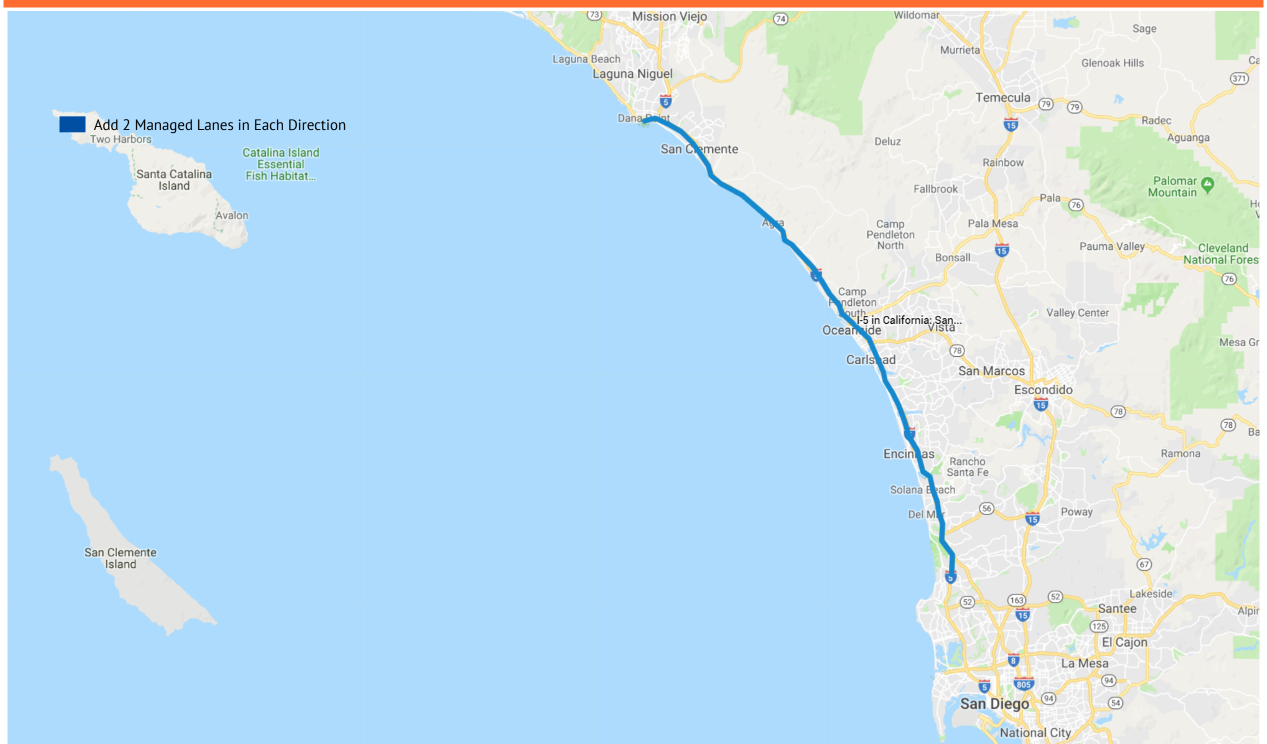
TABLE 5: I-5 IN CALIFORNIA 2017 TRAFFIC VOLUMES

From	To	Average Annual Daily Traffic	Current Cross Section	From	To	Average Annual Daily Traffic	Current Cross Section
I-805S	Carmel Mountain Rd	217,000	8 GP, 8 Local, 2 HOV	Palomar Airport Rd	Tamarack Ave	211,000	8 GP*, 1 AUX*; 8 GP**
Carmel Mountain Rd	Del Mar Heights Rd	263,000	8 GP*, 8 Local*, 2 HOV*; 12 GP**, 2 HOV**	Tamarack Ave	Carlsbad Village Rd	208,000	8 GP
Del Mar Heights Rd	Via de la Valle	239,000	10 GP, 2 HOV	Carlsbad Village Rd	Las Flores Drive	206,000	8 GP, 2 AUX
Via de la Valle	Manchester Ave	240,000	4 GP*, 2 AUX*, 2 HOV*, 4 GP, 2 HOV	Las Flores Drive	SR 78E	211,000	8 GP, 2 AUX
Manchester Ave	Birmingham Dr	212,000	8 GP	SR 78	California St	210,000	8 GP, 1 AUX
Birmingham Dr	Santa Fe Dr	218,000	8 GP	California St	Oceanside Blvd	209,000	8 GP, 1 AUX
Santa Fe Dr	Encinitas Blvd	217,000	8 GP	Oceanside Blvd	SR 76	174,000	8 GP
Encinitas Blvd	Leucadia Blvd	218,000	8 GP	SR 76	Harbor Dr	171,000	8 GP, 2 AUX
Leucadia Blvd	La Costa Ave	215,000	8 GP	Harbor Dr	Las Pulgas Rd	145,000	8 GP
La Costa Ave	Pointsettia Lane	211,000	8 GP	Las Pulgas Rd	Basilone Rd	144,000	8 GP
Pointsettia Lane	Palomar Airport Rd	208,000	8 GP	Basilone Rd	Orange County Line	151,000	8 GP

*** For table row 3, columns 1-4 section between Carmel Mountain Rd and SR 56; for table row 5 columns 1-4, section between Via de la Valle and Lomas Santa Fe Dr; for table row 2 columns 5-8, section between Palomar Airport Rd and Cannon Rd**
**** For table row 3, columns 1-4, section between SR 56 and Del Mar Heights Rd, for table row 5 columns 1-4, section between Lomas Santa Fe Dr and Manchester Ave; for table row 2 columns 5-8, section between Cannon Rd and Carlsbad Village Rd.**

The good news is this corridor is a good candidate for express toll lanes. It has eight general purpose lanes and is basically straight with few curves. On-ramps and off-ramps are of sufficient length and generally well spaced. Current traffic conditions could accommodate four express toll lanes, two in each direction. Some parts of the express toll lanes may need to be elevated, but other parts could be placed at grade level. Given the high traffic volumes in this corridor, the express lanes are expected to come close to paying for their full costs.

I-5 IN CALIFORNIA: SAN DIEGO TO SAN CLEMENTE



PART 5

ADVANTAGES OF EXPRESS TOLL LANES

5.1 TRANSIT SERVICE

Express toll lanes don't just benefit automobile users; they can also benefit transit users. In metro areas, express toll lanes have led to an increase in express bus service. In the five years since the I-95 express toll lanes opened in Miami-Dade County, bus ridership in the corridor has increased by 400%. Since this report focuses on express toll lanes that connect metro areas, the type of transit usage will differ. Transit customers in these lanes will be making intercity trips (trips between metro areas) as opposed to intracity trips (trips within a metro area). Intercity bus operators include Megabus, Bolt, Amtrak Express and a variety of smaller independent operators, particularly in the Northeast. Megabus and Boltbus already operate a comprehensive route network of 247 intercity pairs (bus service endpoints). Intercity bus service is operated on the Interstate general purpose lanes of all four of the express toll lane sections that we are proposing. Further, many companies provide bus service in three of the four (I-95 in VA I-95 in CT, I-5) corridors highlighted in this section.

Unfortunately, if these buses get stuck in the same congestion as automobiles, there is less of an incentive for customers to use these services. Unlike Amtrak, their main competitor, buses receive no operating or capital subsidies. As such, intercity buses are a taxpayer-friendly alternative to rail service. All Amtrak rail lines receive operations subsidies except the Acela and Northeast regional service. Further, when accounting for capital expenditures (the rail track), all Amtrak lines are subsidized.

In addition to requiring fewer taxpayer subsidies than rail, buses provide a low-cost mobility option for the elderly, the disabled, and the travelers who would prefer not to drive. As a result, this report recommends that buses travel for free in express toll lanes. Buses are an efficient travel mode due to the large number of passengers that they can accommodate. U.S. transportation policy seeks to incentivize efficiencies and buses move more people than any other vehicle on U.S. roadways.

5.2 ENERGY AND ENVIRONMENT

Express toll lanes provide two types of environmental benefits that policymakers often overlook. First, by providing free passage to buses, the lanes lower the overall cost of bus service compared with passenger cars and rail. And, by providing a congestion-free travel option, the lanes allow buses to travel faster than cars and trains between the two metro areas. This makes bus service an attractive alternative to travelers. Second, express lanes have been shown to increase travel speeds in congested corridors. Environmental emissions make a U-shaped curve. At stop-and-go speeds (the upper left part of the U) motor vehicles emit significant emissions, at moderate travel speeds (55 miles per hour or the lower center part of the U), motor vehicles emit their lowest emissions, and then at very fast travels speeds (the upper right part of the U) motor vehicles again emit significant emissions. This results from different greenhouse gases being expended at different levels. Regardless, stop-and-go traffic can produce as many greenhouse gas emissions as vehicles traveling 100 miles per hour or faster. By keeping traffic moving at free-flow speed, ETLs reduce high emissions from congested, stop-and-go traffic.

PART 6

CONCLUSION AND RECOMMENDATIONS

Building express toll lanes (ETLs) has proven to be a successful strategy for increasing mobility and reducing congestion. While most express toll lanes are located in metropolitan areas, growing congestion between metro areas offers an opportunity for innovative state DOTs to add ETLs outside metro areas as well. ETLs do more than increase mobility for cars; they offer semi-exclusive guideways for buses and vanpools. Managed lanes between metro areas provide a congestion-free guideway for intercity buses. Free from the congestion in the general purpose lanes, intercity buses would offer more convenient and quicker travel times, increasing the number of bus riders in these corridors.

While the best long-term solution is to rebuild the entire Interstate cross-section and toll all lanes, political realities may make that alternative challenging in the short to medium term. If rebuilding and tolling the highway is not feasible, adding new express toll lanes is an option for those willing to pay to bypass congestion in the GP lanes, and benefits transit users as well.

Advantages of express toll lanes include:

- Providing a congestion-free alternative that offers a consistent travel time for travelers who choose to pay a variable toll to bypass congestion.
- Reducing traffic in the general purpose lanes by providing new capacity.
- Increasing the reliability and therefore the popularity of intercity bus service. Buses operate on some of the most congested rural corridors. Unlike Amtrak rail, buses are not subsidized and offer many different types of service along the corridor.
- Familiarizing travelers with 21st century tolling technology, increasing the popularity and political acceptance of toll-financed Interstate reconstruction.

Travelers encounter severe congestion on many Interstate segments between metro areas. The congestion poses a severe economic cost on the U.S. economy. Bus users get trapped in the same congestion, decreasing the attractiveness of intercity transit. Building express toll lanes between metro areas is a mobility improvement state DOTs should consider.

ABOUT THE AUTHOR

Baruch Feigenbaum is assistant director of transportation policy at Reason Foundation, a non-profit think tank advancing free minds and free markets. Feigenbaum has a diverse background researching and implementing transportation issues, including revenue and finance, public-private partnerships, highways, transit, high-speed rail, ports, intelligent transportation systems, land use and local policymaking.

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Prior to joining Reason, Feigenbaum handled transportation issues on Capitol Hill for Representative Lynn Westmoreland. He earned his master's degree in transportation from the Georgia Institute of Technology.