Review of Maryland I-495 & I-270 Managed Lanes Project Draft Environmental Impact Statement and Draft Section 4(f) Evaluation

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Qualifications

I received a B.S. in Mathematics from Worcester Polytechnic Institute (1977) and an M.S. in Engineering Sciences from Dartmouth College (1982). My studies at Dartmouth College included graduate courses in transportation modeling.

I have 33 years of professional experience in transportation modeling and transportation planning including 14 years at RSG Inc. (1987-2001) and 19 years at Smart Mobility Inc. (2001-now).

My primary professional focus is regional travel demand modeling and related transportation planning. I am a nationally known expert in this field and have completed projects in over 30 states including work for the U.S. government, state Departments of Transportation, Metropolitan Planning Organizations, cities and non-profit organizations. One of my particularly notable projects is a $250,000 project with the California Air Resources Board where I led a team including the University of California in reviewing the state's regional travel demand models.

I have many peer-reviewed publications and conference presentations, including presentations at national Transportation Research Board conferences in 2017, 2018 and 2019.

I am an Associate Member of the Transportation Research Board.

My resume is attached as Appendix D.

Executive Summary

The Maryland I-495 & I-270 Managed Lanes Project Draft Environmental Impact Statement and Draft Section 4(f) Evaluation (DEIS) tells a simplistic traffic story. It claims that if the project is not constructed, corridor traffic volumes will grow significantly, and delays will grow exponentially. It claims that the project will reduce congestion on the general-purpose lanes relative to traffic conditions today. It claims that the project will alleviate congestion on other roads.

This simple story is wrong. The same promises were made in the Virginia I-495 Express Lanes Final Environmental Impact Statement (FEIS), and the results were completely different. During the peak traffic periods, the Express Toll lanes created what is the worst bottleneck on I-495 today – at the northern terminus of the lanes. The FEIS either did not disclose this impact or it was not anticipated. As a result, the Virginia Department of Transportation (VDOT) had to quickly open a shoulder lane to partially mitigate this bottleneck.

(Pre-Covid) travel times in the Virginia I-495 general-purpose lanes are <u>higher</u> today than they were before the Express Lanes opened and much higher than forecast in the FEIS. The FEIS got this wrong. Otherwise in the peak periods, the effects of the Express Lanes are complex, causing both increases in traffic on some roads and decreases on others. The FEIS wrongly claimed only benefits to other roads.

Part of why things didn't turn out as anticipated is due to reliance on flawed modeling. Flaws in the Metropolitan Washington Council of Governments (MWCOG) model include that it: (1) does not constrain traffic flow to capacity; (2) does not properly feed congested travel times back to non-work trip destinations; (3) assumes no increased traffic from road expansion; (4) fails to accurately forecast bottlenecks; (5) cannot calculate net congestion tradeoffs; and (6) cannot accurately model peak period conditions.

The claims made in the Maryland DEIS are the same as those made in the Virginia FEIS. The underlying modeling approach is the same.

Based on empirical data from Virginia and Maryland, understanding of model flaws, and data analysis, the reasonably foreseeable impacts of constructing managed lanes on I-495 and I-270 follow.

1) Expanding I-495 and I-270 will shift traffic from the shoulder hours into the peak hours and create and/or exacerbate bottlenecks. The flawed models employed in the DEIS analyses are incapable of forecasting this type of problem. As bottlenecks are most likely at the terminus of the managed lanes, project phasing is critically important as well as the final extent of the project.

2) An improvement in general-purpose lane speed is unlikely because constructing the managed lanes will shift traffic from the shoulder hours into the peak hours, and the general-purpose lanes will be just as congested during the peak hours as they would have been otherwise. The foundational premise of this project is that extreme congestion in the general-purpose lanes is needed to justify the high tolls that will be required to fund the project.

3) Constructing the I-495 and I-270 managed lanes is likely to make arterial congestion worse. No trip begins or ends on a limited access highway, and traffic does not magically switch between limited access highways and arterials as is presented in the DEIS. Any shifts between these roadway classes causes traffic increases on some arterials and traffic decreases on others. As managed lanes concentrate traffic in the peak hour, arterial roads at I-495 and I-270 interchanges will be severely impacted, and these impacts are likely to outweigh the congestion benefits of traffic diversion from other arterials. The DEIS models are incapable of calculating these tradeoffs.

4) If the managed lanes are constructed, it is likely that there will be significant traffic growth (induced travel) and induced land use impacts.

5) Managed lane proponents stress “choice.” In fact, the choice is between two bad options: extreme congestion vs. extremely high tolls. Only about 1/6 of the daily traffic is carried by the Virginia I-495 Express Lanes despite the Express Lanes having 1/3 of the roadway capacity. This is an inefficient use of infrastructure. The other 5/6 of traffic is carried by the general-purpose lanes. The estimates in the DEIS are consistent with those ratios. The toll lanes are “chosen” primarily by high-income travelers and/or travelers who are having the tolls reimbursed. This elite group will remain small because increases in demand by other users will prompt the tolls to increase further, becoming even less affordable.

6) The managed lanes would benefit only the few who are able to outbid the majority of travelers. There would be no benefits for non-users of the toll lanes. Non-users of the toll lanes (most travelers) would face continued high congestion in the general-purpose lanes and increased congestion on arterial roadways accessing I-495 and I-270 interchanges. Nevertheless, a portion of their taxes likely would go toward subsidizing the private toll lanes as has occurred in Virginia.

In conclusion, the flawed traffic models used in the DEIS overestimate future congestion to justify the project. The DEIS then fails to acknowledge that the project depends on peak period general purpose lane congestion while also causing additional connecting arterial congestion and large bottlenecks where the toll lanes end. The proposed managed lanes in Maryland would make congestion worse for the majority of peak period drivers and push drivers to choose between extreme congestion and extremely high tolls to make the lanes profitable. The promised benefits for non-users of the toll lanes will not materialize, and taxpayers will likely have to subsidize the project.

1. Flaws in the MWCOG Model Used in the I-495 and I-270 DEIS

Traffic growth forecasts in the Maryland I-495 & I-270 Managed Lanes Project Draft Environmental Impact Statement (DEIS) are not as high as those in the 1998 FEIS for the Virginia Express Lanes (Appendix A), but they are still unrealistically high. Both sets of forecasts are based on the Metropolitan Washington Council of Governments (MWCOG) regional travel demand model, which has two fatal flaws that make it exaggerate traffic growth in congested conditions:

1) The MWCOG model does not constrain traffic flow to capacity.
2) The MWCOG model does not properly feed congested travel times back to non-work trips.

1.1 MWCOG Model Does Not Constrain Traffic Flow to Capacity

The MWCOG model includes an hourly capacity value for each roadway segment. Modeling best practice is to use "ultimate capacity", i.e. the "maximum volume that should be assigned to a link by the forecasting model."[1] The MWCOG model sets freeway capacity at 2000 vehicles per lane per hour in lower-density areas and 1900 per-lane per hour in higher-density areas. As shown in Figure 1 reproduced from the DEIS, the maximum traffic volumes mostly max out around 8000 for the four-lane sections (not including segments with more lanes including the American Legion Bridge, the split south of the I-270 spur, the I-95 interchange area, and the approach to the Woodrow Wilson Bridge).

The MWCOG model capacity is, as is stated in the modeling reference the "maximum volume that should be assigned to a link by the forecasting model." Assigned volumes that exceed capacity are errors, and assigned volumes that greatly exceed capacity are serious model errors. Alan Horowitz, one of the most respected experts in travel demand modeling wrote:

> *I am quite familiar with alternatives that assign traffic well beyond a volume-to-capacity ratios (v/c) of 1, and I cannot fathom why anybody would take any of this seriously, either as a realistic representation of the future or as a strawman case study…*
>
> *… do not publish any alternative/scenarios with facilities loaded beyond a v/c ratio of 1.1.*[2] *(Horowitz 2019)*

In the DEIS, many segments of I-495, I-270 and other roads are loaded with v/c greater than 1.1 (Figure 2). Horowitz admonishes that the DEIS modeling should not be published with v/c > 1.1. Therefore, these model results should not be used for planning purposes. The DEIS not only does publish these modeling results and uses them for planning, but even goes so far as to represent these over-capacity assignments as a performance measure. This claim is false and is rebutted in the Appendix B of this report.

The MWCOG model relies on 40-year-old Static Assignment Algorithm (STA) that was adopted 40 years ago when computers were less powerful that today's smart phones. STA treats every road segment as independent of other road segments. In peak periods, traffic on I-495 and I-270 is characterized by queues behind bottlenecks. In STA there are no queues behind bottlenecks, and the MWCOG models cannot capture backups at the merges on I-270/I-495 or accurately model conditions during the peak of rush hour traffic

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[1] Cambridge Systematics, Vanassse Hangen Brustlin, Gallop, Bhat, C.R., Shapiro Transportation Consulting and Martin/Alexious/Bryson. Travel Demand Forecasting: Parameters and Techniques, National Cooperative Highway Research Program Report 716, 2012.

[2] Horowitz, Alan. Posting on the Travel Model Improvement Program (TMIP) listserv, March 2019.

In my peer-reviewed journal article: *Forecasting the impossible: The status quo of estimating traffic flows with static traffic assignment and the future of dynamic traffic assignment*[3], I document that STA always produces impossibly high freeway traffic volumes in congested networks and cannot be relied on for planning. The only solution is to replace STA with a more modern Dynamic Traffic Assignment (DTA) algorithm. MWCOG has a long-term plan to replace STA with DTA. Alan Horowitz also wrote: "*Choose DTA over STA whenever possible.*"[4]

Figure 1: 2017 I-495 Inner and Outer Loop Peak Period Hourly Volumes

Figure 2-12: I-495 Existing (2017) Inner Loop Peak Period Hourly Volumes

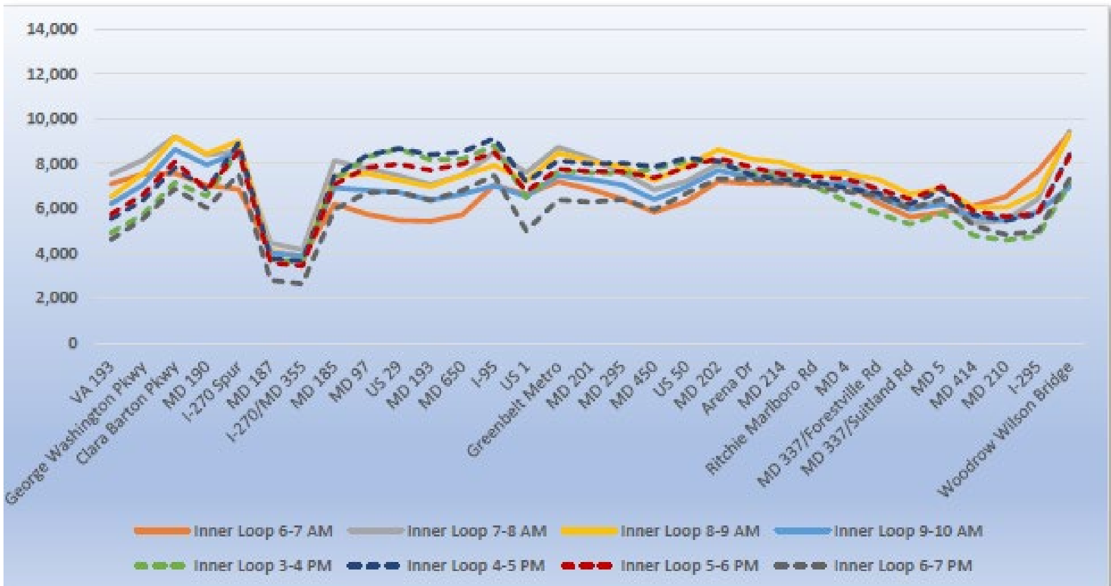
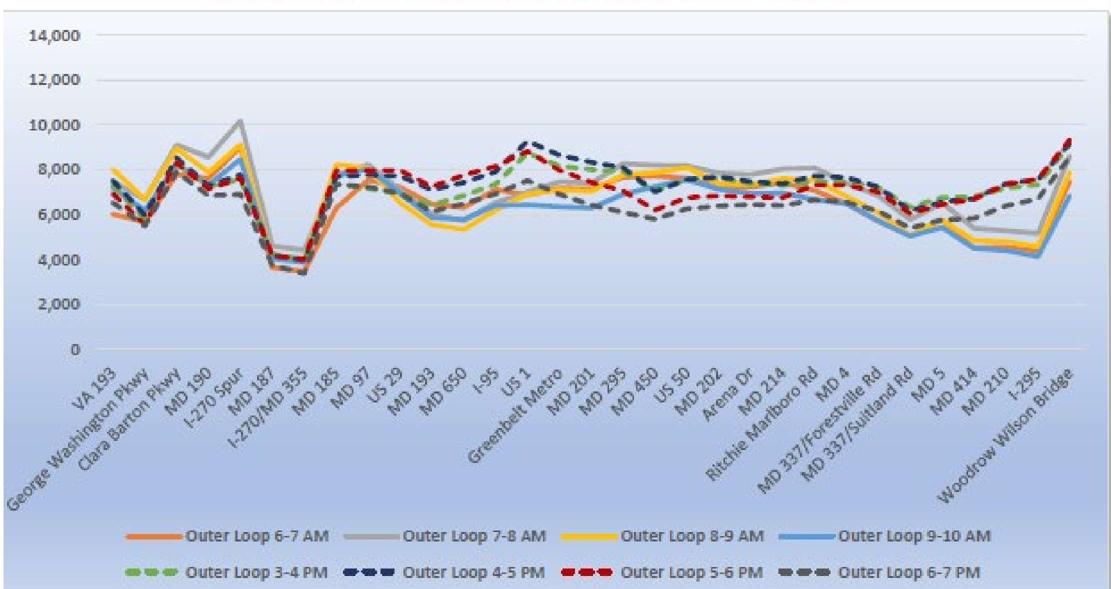


Figure 2-13: I-495 Existing (2017) Outer Loop Peak Period Hourly Volumes

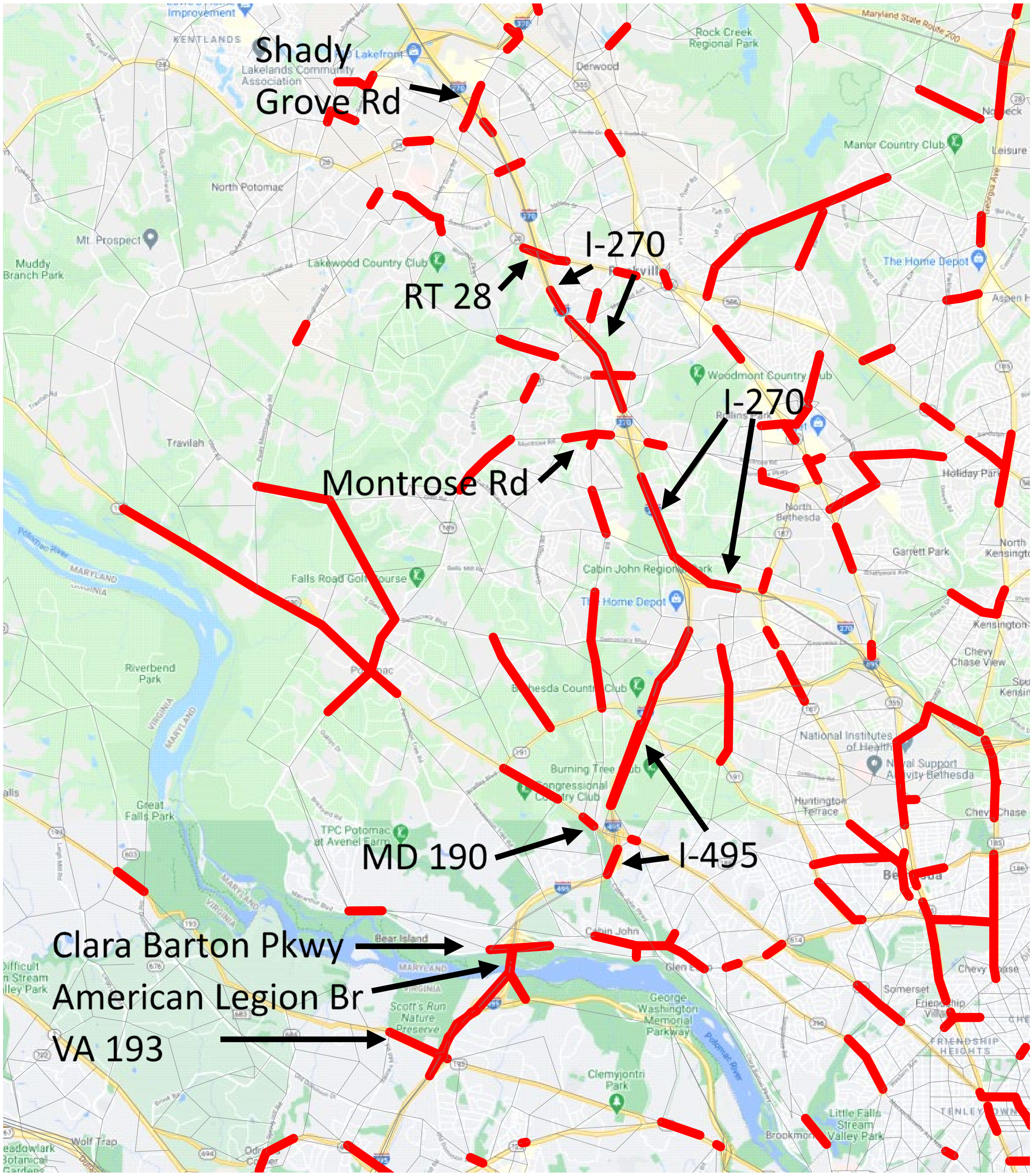


Source: DEIS, 2020.

[3] Marshall, Norman. Forecasting the impossible: The status quo of estimating traffic flows with static traffic assignment and the future of dynamic traffic assignment, *Research in Transportation Business & Management*, Volume 29, 2018, 85-92. https://www.sciencedirect.com/science/article/pii/S2210539517301232?via%3Dihub

[4] Horowitz, Alan. Posting on the Travel Model Improvement Program (TMIP) listserv, March 2019.

Figure 2: Impossible Traffic Forecasts in MWCOG 2040 No Build Afternoon Peak Period (Segments with Volume/Capacity Greater than 1.1 Shown in Red)[5]



Source: I mapped from MWCOG model link in DEIS.

All the model traffic forecasts for roadway segments shown in red have volume-to-capacity ratios greater than 1.1. As Horowitz advises, these results should not be published – or used in planning. The AM peak period map is similar.

[5] Loaded network file downloaded from ftp://dtpcog:cog.dtp@ftp.mwcog.org/MD_SHA_TRP_Study_2040_Alt1_Model_Files.zip referenced in DEIS Appendix C, p. 841.

1.2 MWCOG Model Does Not Properly Feed Congested Travel Times Back to Non-Work Trip Destinations

All good travel demand models employ a feedback process so that the destinations chosen are sensitive to congested travel time. The MWCOG model feeds back congested travel time from the morning peak period, but only for work trips. The destination choices for the other trip types are based on off-peak travel times. This is inadequate. As I commented about the MWCOG model in 2002:

> The TPB DCV2 model does include distribution feedback. However, the feedback mechanism is only applied to home-based work trips. Specifically, AM congested times are used to distribute HBW trips while off-peak uncongested times are used to distribute HBS, HBO, and NHB trips.[6] The underlying assumption by TPB staff is that congestion does not influence non-work trip making…
>
> In a publication by the Travel Model Improvement Program (TMIP) – a program sponsored by the EPA and U.S. DOT – entitled *Incorporating Feedback in Travel Forecasting: Methods, Pitfalls, and Common Concerns* dated March 1996, the authors provide technical guidance on incorporating feedback in the traditional four-step model. Some of the findings published in the report … [include] … Feedback should be implemented for the work-related trips at a minimum, and the other purposes should be examined for their percentage of peak travel.[7]

In my 2002 review, I found that in the forecast year, modeled congestion on the Potomac River crossings was severe. The MWCOG model assumed that non-work travelers, including those making shopping trips, would cross the river regardless of congestion, because peak period congestion did not affect their destination choices in the model. Perversely, these non-work travelers crowded out work trips from the Potomac River bridges in the model during peak times. It appears that these problems remain in the MWCOG model today and are especially relevant to modeling the American Legion Bridge. The MWCOG model over-assigns non-work trips to all the bridges during peak periods because the model is not representing travel times for these trips properly.

In the DEIS 2040 No Build model, MWCOG morning and afternoon peak period traffic volumes for all Potomac River bridge crossings are ridiculously high (Figure 3). All greatly exceed the 1.1 volume-to-capacity ratio threshold, and range as high as 2.75, i.e. the bridge traffic volume is 275% of the highest possible volume.

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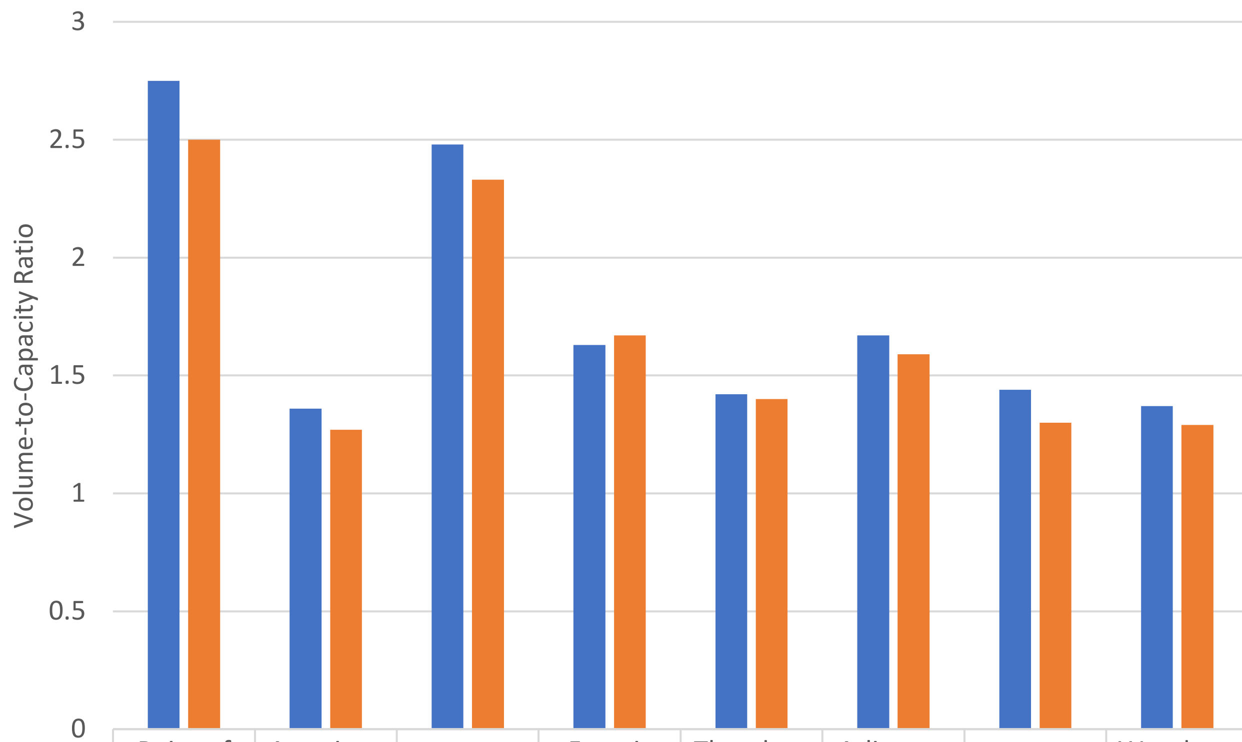
[6] HBS - Home-based Shop; HBO - Home-Based Other, NHB - Non Home-Based

[7] Letter concerning "Effects of Proposed Potomac River Crossings on Land Use and Traffic and Identification of Serious Deficiencies in TPB Version 2 Transportation Model." November 4, 2002. http://www1.mwcog.org/uploads/committee-documents/pF1eWV020040726152612.pdf

Figure 3: Wildly Impossible Potomac Bridge Traffic Forecasts in MWCOG 2040 No Build Morning and Afternoon Peak Periods



	Point of Rocks	American Legion	Chain	Francis Scott Key	Theodore Roosevelt	Arlington Memorial	I-395	Woodrow Wilson
AM	2.75	1.36	2.48	1.63	1.42	1.67	1.44	1.37
PM	2.50	1.27	2.33	1.67	1.40	1.59	1.30	1.29

Source: I extracted data from MWCOG model link in DEIS.

1.3 MWCOG Model Assumes No Increased Traffic from Road Expansion

In general, freeway expansion causes induced travel. A review of the induced travel research by Handy and Boarnet (2014) concluded that induced travel is real, and that the magnitude is enough to prevent capacity expansion from reducing congestion:

> *Thus, the best estimate for the long-run effect of highway capacity on VMT [vehicle miles traveled] is an elasticity close to 1.0, implying that in congested metropolitan areas, adding new capacity to the existing system of limited-access highways is unlikely to reduce congestion or associated GHG [greenhouse gas] in the long-run.*[8]

The DEIS rejected Alternative 6 adding only general-purpose lanes because of the induced travel impacts:

> *The results of the Alternative 6 modeling indicated that latent demand, meaning trips from other routes, times and modes, would be expected to fill the GP lanes by 2040, resulting in worse traffic operations than all of the Screened Alternatives in several metrics, including network-wide delay and average travel time.* (DEIS, p. 2-12)[9]

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[8] Handy, Susan and Marlon G. Boarnet. Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions: Policy Brief prepared for California Air Resources Board, September 30, 2014.

[9] See Appendix B of this report for a discussion of latent demand, induced travel and generated traffic.

Induced travel represents the difference between Build Vehicle Miles Traveled (VMT) and No Build VMT. The DEIS models cannot accurately account for induced travel because the MWCOG model overestimates traffic growth in the No Build alternative.

In the long-term induced land use is an important cause of induced travel. Widening I-270 in the late 1980s is a classic case study.

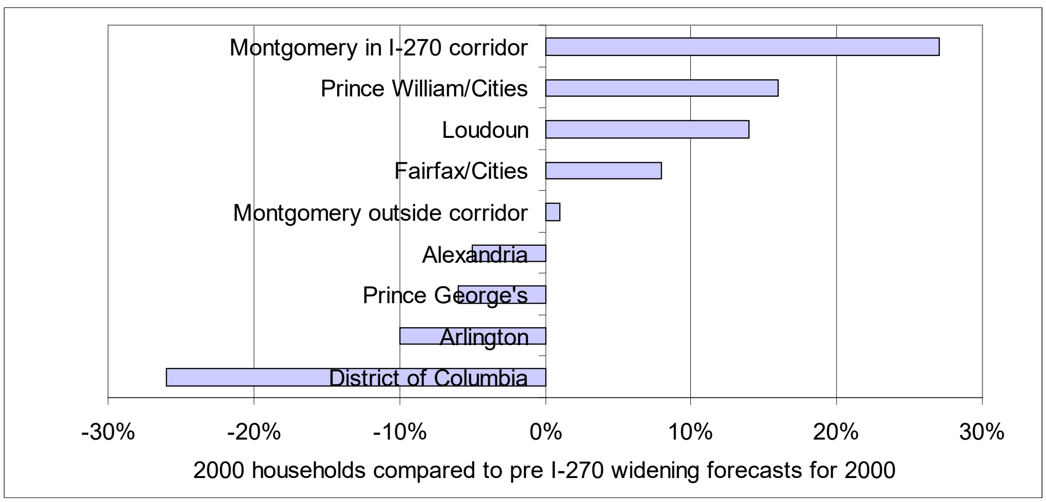
> *In the five years before construction began, officials endorsed 1,745 new homes in the area stretching from Rockville to Clarksburg. During the next five years, 13,642 won approval.*[10]

By 1997, I-270 was routinely overrunning its designed capacity, and peak-hour traffic volumes on some segments had surpassed levels forecasted for 2010.

A primary cause of the inaccurate traffic forecasts was inaccurate land use forecasts which were assumed to be the same for both no build and build analyses. The total number of households forecast for the Washington region for the year 2000 was only off by 2 percent. However, the forecasts were completely wrong about the distribution of the households. [11] Growth was much lower in the region's core than forecast, and much higher in western suburban areas, especially in the I-270 corridor.

Figure 4 compares the 2000 forecast made before the I-270 widening with actual 2000 numbers. The largest forecasting error was for Montgomery County in the I-270 corridor, where the actual number of households in 2000 exceeded the forecast by 27 percent. Widening I-270 was a primary cause.

Figure 4: Washington DC Region: Suburban Freeway Projects Shifted Households to Suburbs from Core[12]



Source: Data from National Capital Region Transportation Planning Board and MWCOG.

The total number of regional households in 2000 was 2 percent less than forecast prior to the I-270 widening project. When the I-270 widening project was planned, forecast housing and employment growth in the corridor

[10] Sipress, Alan. Md.'s Lesson: Widen the Roads, Drivers Will Come. *Washington Post*, January 4, 1999. https://www.washingtonpost.com/wp-srv/digest/traffic4.htm

[11] Data from National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, "Comparison of 1984 Study Forecasts with Most Recent Data: I-270 Corridor, June 18, 2001.

[12] National Capital Region Transportation Planning Board and Metropolitan Washington Council of Governments. Induced Travel: Definition, Forecasting Process, and a Case Study in the Metropolitan Washington Region, September 19, 2001.

was moderate, and growth in the region's core was expected to be much stronger.[13] The forecasts were completely wrong about the distribution of the households. Growth was much lower in the region's core than forecast, and much higher in western suburban areas, especially in the I-270 corridor.

The other areas where growth exceeded the forecast are suburban Virginia areas where freeway capacity also was expanded. Projects in these areas include construction of the Dulles Greenway, the Route 234 Bypass and widening I-66.

The suburban increases were balanced by declines and slower growth in the core of the region, including D.C., Arlington, Prince George's County, and Alexandria.

The I-495 and I-270 DEIS states on page 144, "As the land use assumptions do not vary between Alternative 1/No Build and the Build Screened Alternatives, all the trip generators are equal among scenarios: there will not be new housing developments or new places of employment." Such assumptions are clearly debatable. Widening I-270 and I-495 likely will cause induced land use and induced travel. Induced travel causes increased energy use and air pollution, including greenhouse gas emissions.

The DEIS also asserts: "Induced demand represents new trips. While the project may generate some new trips, MWCOG modeling shows that the amount of induced demand caused directly by the project would be less than 1% of the total VMT in the region."[14] Despite this assertion, due to its deficiencies, the MWCOG model cannot accurately account for induced travel. (See Appendix B.)

[13] Data from National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, "Comparison of 1984 Study Forecasts with Most Recent Data: I-270 Corridor, June 18, 2001.
[14] DEIS Appendix C: Traffic Analysis Technical Report, May 2020, p. 144. https://495-270-p3.com/wp-content/uploads/2020/07/APP-C_MLS_Traffic-Tech-Report-Appendices.pdf

1.4 MWCOG Model Fails to Accurately Forecast Bottlenecks

Figures 5 and 6 show the traffic increases in peak hour traffic on Virginia I-495 following the opening of the Express Lanes (EL) and General-Purpose Lanes (GPL). The increases are calculated as the average of post-construction 2013-2019 to pre-construction 2005-2007. Appendix C provides details of how these numbers were estimated.

Figure 5: Change in Outer Loop GPL Peak Hour Traffic in Virginia After Express Lanes Opening (change per segment comparing 2013-2019 to 2005-2007 traffic volumes)

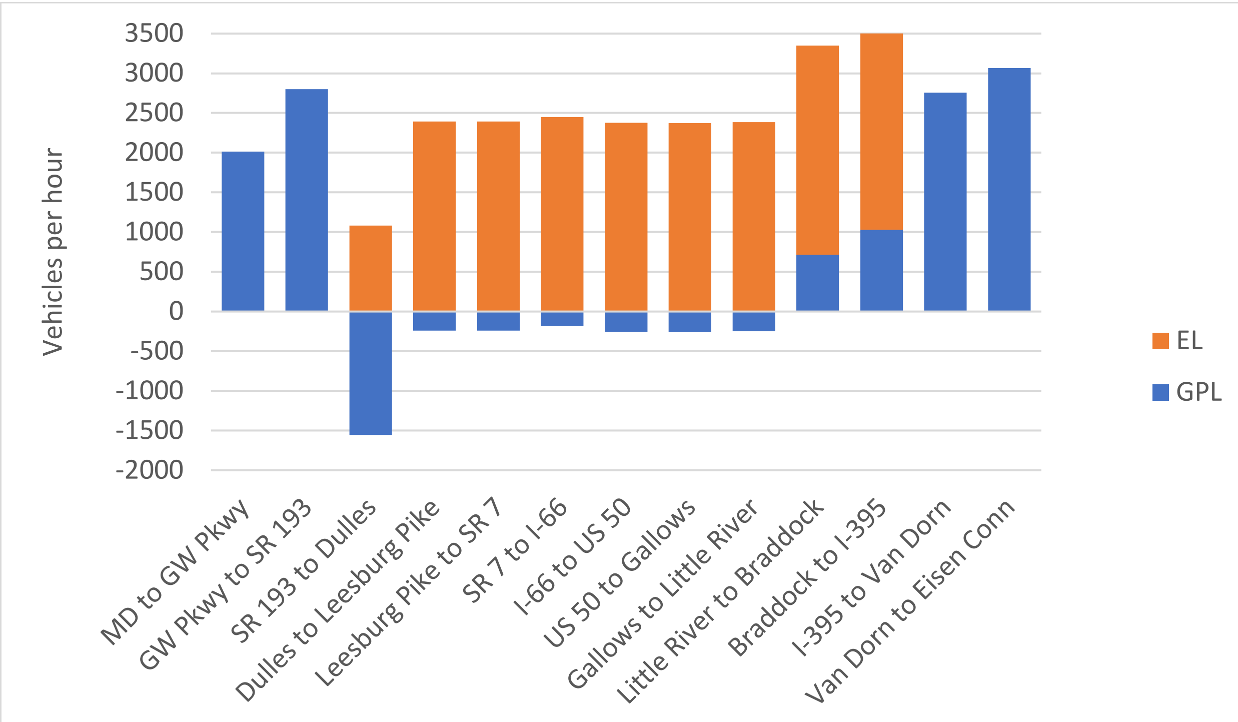
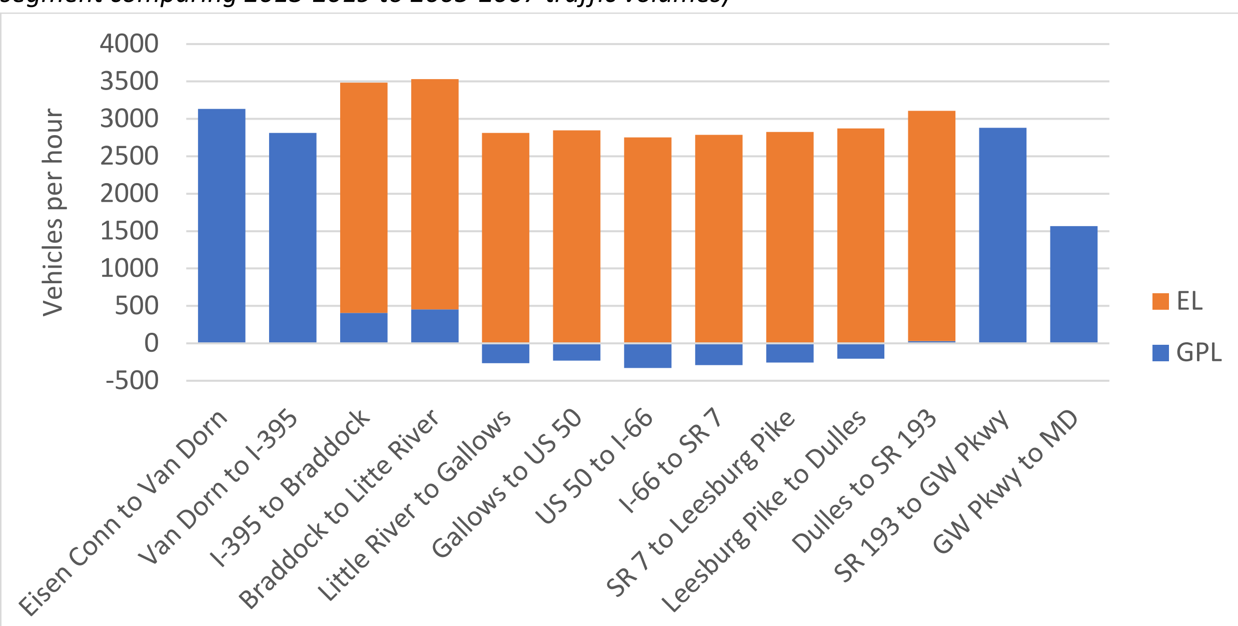


Figure 6. Change in Inner Loop GPL Peak Hour Traffic in Virginia After Express Lanes Opening (change per segment comparing 2013-2019 to 2005-2007 traffic volumes)



Source: Virginia Department of Transportation traffic count reports.

In general, the before and after decreases in peak hour GPL traffic volumes are small, on the order of 200-300 per hour, or less than 5% of the total GPL peak hour traffic volume. The one outlier shown in Figure 5 for the Outer Loop southbound between SR 193 to the Dulles Toll Road is not an exception but is just a quirk in the data. The Express Lanes begin in this section, and the VDOT traffic count is after the split. If the count were upstream of the split, no such large reduction would be shown.

What is most striking in the data is that the higher peak hour volumes carried in 6 lanes (4 GPL + 2 EL) also extend into the 4-lane GPL sections north and south of the endpoints of the Express Lanes. There is little, if any, congestion relief where the Express Lanes are parallel to the general-purpose lanes, but much worse congestion upstream and downstream. This large increase in peak hour traffic was caused by the opening of the Express Lanes and has resulted in the worst bottleneck on I-495 in the afternoon on the Inner Loop where the Express Lanes must merge back into the general-purpose lanes. (See Appendix C for more details.)

The Express Lanes opened in November 2012. This bottleneck problem was not anticipated or disclosed in the planning process. Only a few months later in June 2013, VDOT announced a plan to partially address these problems by opening a shoulder lane on the left side of the Inner Beltway to increase the effective width to five general-purpose lanes at the merge.

Expanding I-495 and I-270 in Maryland likely will result in similar unintended negative congestion impacts, creating and/or exacerbating bottlenecks. The Virginia modeling was not up to the task of forecasting these types of problems and the DEIS modeling is not either.

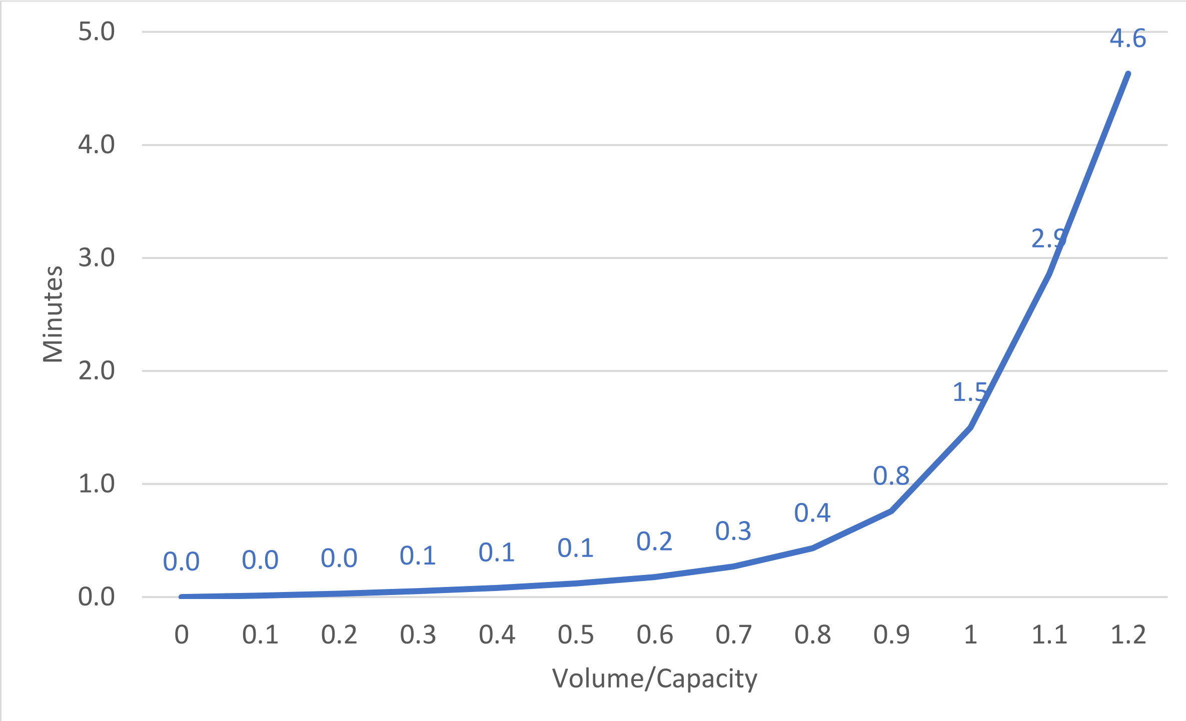
1.5 MWCOG Model Cannot Calculate Net Congestion Tradeoffs

The MWCOG model treats daily traffic as a composite of four time periods[15] including a 3-hour morning peak period (6-9 a.m.) and a 4-hour afternoon peak period (3-7 p.m.). The time shifts that resulted from the opening of the Express Lanes in Virginia is mostly within these peak periods, i.e. it shifts traffic from what planners call the “shoulder” hours into the peak hour. The MWCOG model does not have any way of considering time shifts within the peak periods and cannot calculate the congestion changes related to such shifts.

Instead it calculates vehicle hours of delay (VHD) as if traffic volumes are constant throughout the 3-hour morning peak period and 4-hour afternoon peak period. The calculated VHD grows exponentially as a function of the volume-to-capacity ratio (V/C) – especially when modeled V/C exceeds 1.0. As discussed above, V/C greater than 1.0 is impossible and represents model errors. Figure 7 shows MWCOG model arterial delay in minutes per mile as a function of V/C.

[15] Four time periods: morning peak, midday, afternoon peak, and overnight.

Figure 7: MWCOG Model Vehicle Minutes of Delay Per Mile for 40 mph Arterial[16]



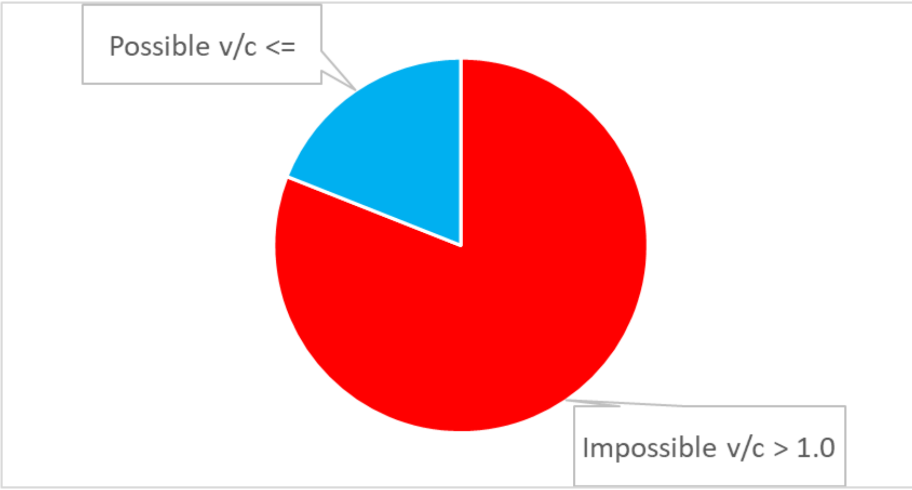
Source: MWCOG model documentation.

In the figure, a road segment with calculated V/C = 1.0 has 1.5 minutes of delay per mile, and modeled delay grows exponentially with an impossible V/C > 1.0. V/C in the MWCOG model is not capped at 1.2, and there are higher V/C road segments in the model, including the value of 2.75 for the Point of Rocks Bridge shown in Figure 3. Beyond the V/C point shown in the Figure 7, MWCOG model VHD continues to increase exponentially – 6.6 minutes per mile at V/C = 1.3, 8.6 minutes per mile at V/C = 1.4, and so forth with MWCOG model table values as high as V/C = 3.0.

As shown in Figure 8, most (81%) of regional afternoon peak period VHD in the 2040 No Build modeling is from impossible assignments with volume-to-capacity ratio exceeding 1.0. The exponential increases in modeled delay as a function of V/C makes MWCOG model VHD more of a metric of model errors than a metric of real-world performance.

[16] Calculated from MWCOG. Calibration Report for the TPB Travel Forecasting Model, Version 2.3, on the 3,722-Zone Area System: Final Report, January 20, 2012.

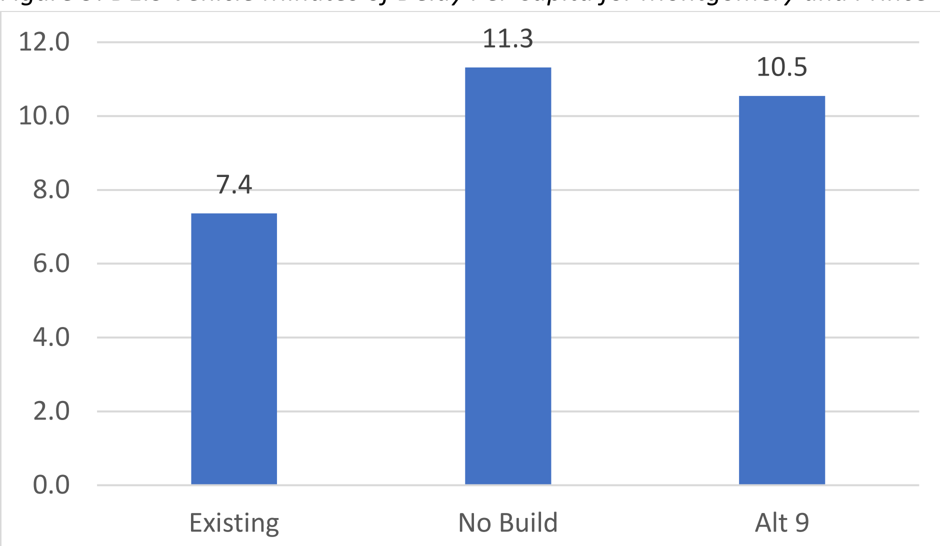
Figure 8: 2040 No Build Regional Afternoon Peak Period VHD – Road Segments with Possible v/c ≤ 1.0 vs. Impossible v/c > 1.0



Source: I extracted data from MWCOG model link in DEIS and calculated totals.

The DEIS VHD calculations are invalid. However, even if they were valid, they do not provide a compelling case for the proposed managed lanes project. Figure 9 takes the DEIS VHD numbers for a combination of Montgomery and Prince George's Counties and divides by current and 2040 population so the alternatives can be compared on a per capita basis.

Figure 9: DEIS Vehicle Minutes of Delay Per Capita for Montgomery and Prince George's Counties[17]



Source: DEIS, 2020.

The DEIS modeling indicates that congestion is going to get much worse in the future, but that I-495/I-270 managed lanes will make it somewhat less bad. In fact, the real story the VHD outputs tell us is that the MWCOG model overestimates future traffic volumes and translates relatively small increases in VMT into larger increases in VHD. For example, for an arterial roadway in the model where the volume has reached capacity in the peak period, a 1% increase in traffic volume in the MWCOG model translates into a 10% increase in VHD per vehicle. This amplification of small VMT changes into large VHD numbers is just a way of making impacts look larger.

[17] Numbers from DEIS Table 1-1, p. 1-5 and DEIS Appendix C, Table 5-23, p. 149.

1.6 DEIS Models Cannot Accurately Model Peak Period Conditions

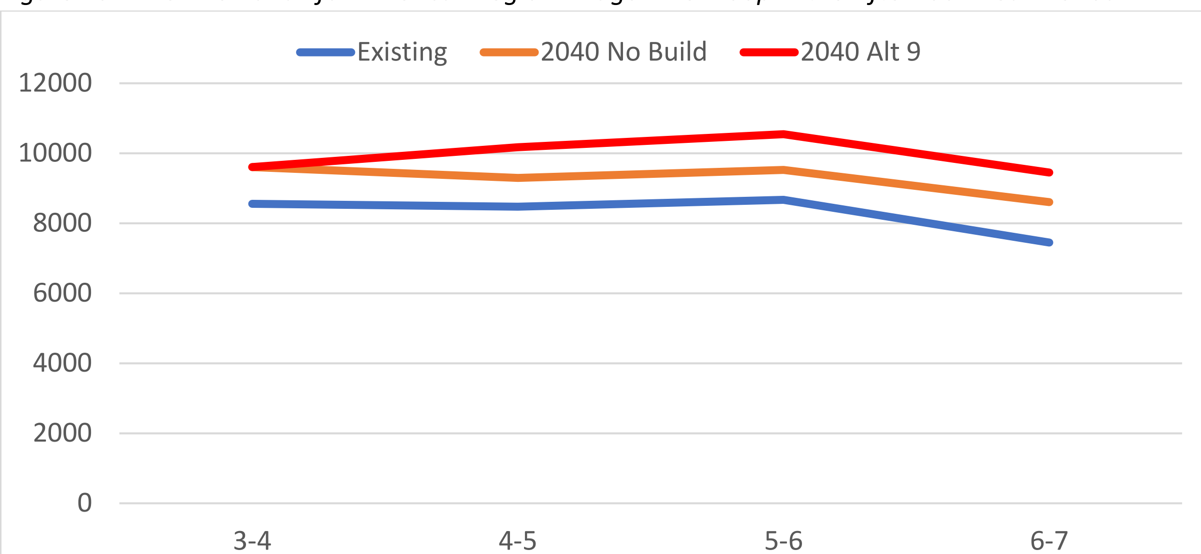
As documented above, the peak period traffic volumes outputs from the MWCOG model are not capacity constrained. The model forecasts impossibly high volumes for many roadway segments including segments of I-495 and I-270 that are the focus of the DEIS.

The DEIS analysis takes these over-capacity assignments and uses them as inputs to a VISSIM microsimulation model that is capacity constrained. This is a useless exercise because the VISSIM model can only report that the inputs are impossible. The DEIS tries to represent what are essentially VISSIM error messages as measure of latent demand. This claim is false and is rebutted in the Appendix B of this report.

This is an example of an old computer adage – “garbage in – garbage out.” The two-model process is analogous to money laundering. Bad forecasts from the MWCOG model are filtered through the VISSIM model and come out as very detailed precise-looking numbers. However, the underlying MWCOG model forecasts are invalid, and the VISSIM outputs also are invalid.

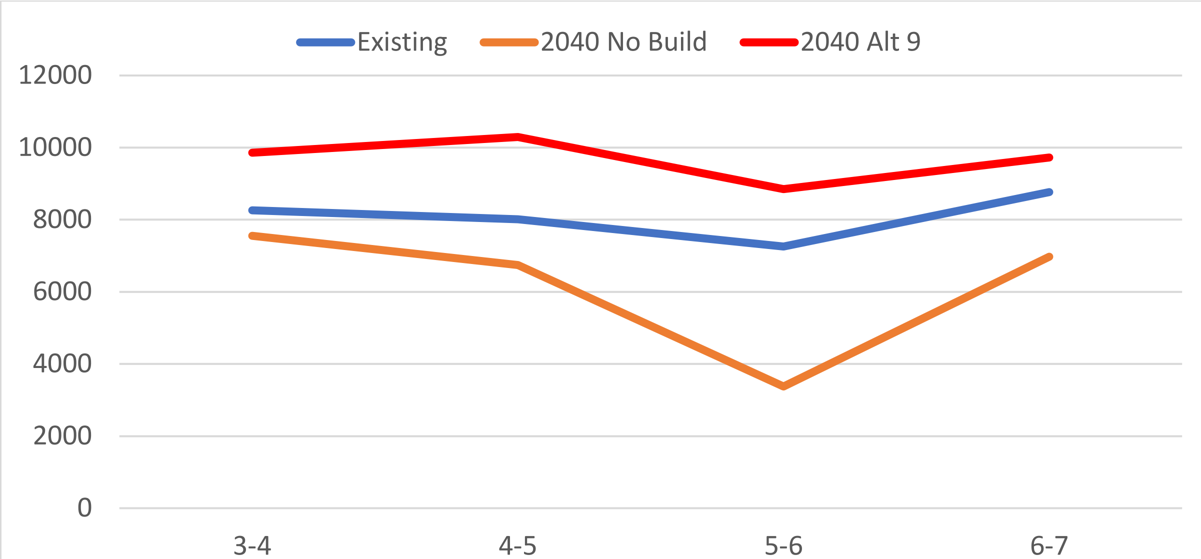
Figure 10 shows afternoon peak period “demand” (vehicles per hour) on the American Legion Bridge Inner Loop from the MWCOG model. Figure 11 shows afternoon peak period “throughput” (vehicles per hour) on the American Legion Inner Loop from the VISSIM model.

Figure 10: DEIS “Demand” for American Legion Bridge Inner Loop in the Afternoon Peak Period



Source: I graphed numbers from DEIS Appendix C.

Figure 11: DEIS “Throughput” for American Legion Bridge Inner Loop in the Afternoon Peak Period



Source: I graphed numbers from DEIS Appendix C.

Neither of the graphics represents reality. As discussed above, the 2040 No Build alternative afternoon period volumes cannot increase significantly from existing volumes due to capacity constraints; therefore, the DEIS “demand” volumes are impossible. The graphic showing future No Build throughput being much less than throughput today is implausible and the large dip in throughput is ridiculous. It would never happen and is just an artifact of VISSIM model limitations. The impossible over-capacity inputs cause VISSIM model errors. Congestion can never get so bad that it will reduce traffic volumes by 50% on a road that is already very congested.

The DEIS framing of “demand” vs. “throughput” is fundamentally wrong. Demand is not a point, as anyone who has taken Economics 101 has had hammered into them repeatedly; demand is a curve with more demand when the price is lower and less demand when the price is higher. For un-tolled roads, this “price” is primarily based on the value of travel time. The generalized price for toll roads includes both cost and time. As shown in this illustration from the Federal Highway administration, there is a market equilibrium balance between demand and price/supply (Figure 12).

Figure 12: Market Equilibrium User Costs and Traffic Volumes (FHWA)[18]

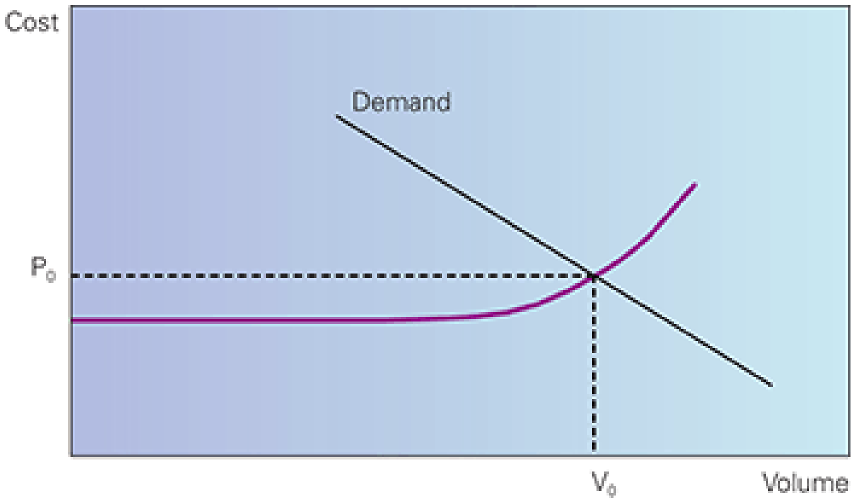


Exhibit 4. Equilibrium user costs and traffic volumes.
P = price. V = volume.

Source: Federal Highway Administration, 2017.

The narrative accompanying the figure reproduced above states:

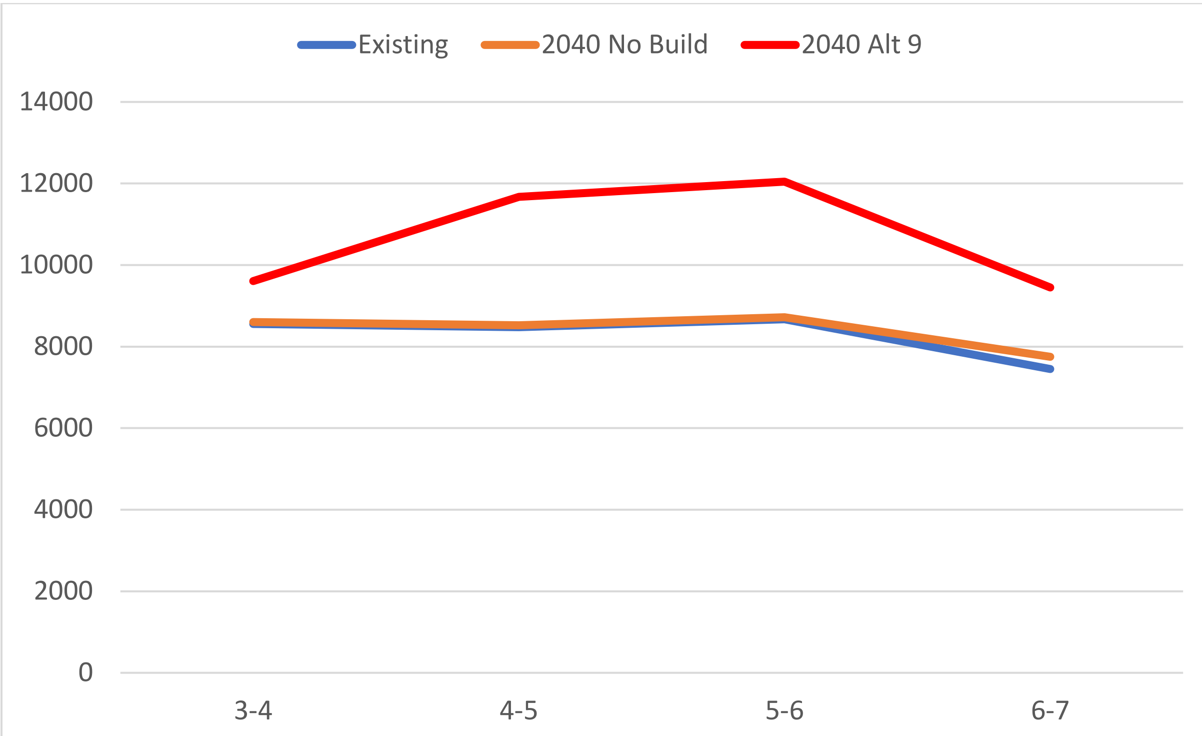
> When supply and demand are in balance, a market is said to be in *equilibrium*. This is often represented as the intersection of a supply curve and a demand curve, which determines the market-clearing price and quantity (see Exhibit 4). At this point, everyone who purchases the good is willing to (collectively) buy that amount at that price, and producers are willing to supply that quantity at that price. If either the supply or demand curves shift, the market price and quantity will also change.
>
> For highway travel, demand is determined as described above. The "supply" curve, however, is essentially represented by the generalized cost curve. The intersection of these two curves determines how high traffic volumes will be and what the associated average highway-user costs will be at that volume level. When the level of demand is low relative to the capacity of the road, it will be uncongested, and prices will be relatively constant even as volumes increase (the "flat" part of the user cost curve in Exhibit 4). However, when demand levels are high and the road is congested, both user costs and traffic volumes will be higher, potentially rising sharply as demand continues to increase.

The dichotomy put forward in the DEIS of "demand" vs "throughput" does not exist. There are only traffic volumes at the equilibrium point. The volume V_0 represents the point on the demand curve where the cost equals P_0. The "throughput" should equal this equilibrium traffic volume.

[18] Federal Highway Administration. Economics: Pricing, Demand, and Economic Efficiency – A Primer. 2017. https://ops.fhwa.dot.gov/publications/fhwahop08041/cp_prim4_03.htm

Figure 13 shows a more realistic estimate of forecast traffic based on the experience of the Virginia Express Lanes. The 2040 No Build traffic volumes would be very similar to existing traffic volumes because of capacity constraints. The 2040 Build volumes (represented here as Alternative 9)[19] would be significantly higher – and particularly higher during the mid-point of the afternoon peak period in the 4-5 and 5-6 hours. This shift happened following the opening of the Virginia Express Lanes.

Figure 13: Realistic American Legion Bridge Inner Loop in the Afternoon Peak Period Traffic Volumes



Source: I created this graphic based on Virginia Express Lanes data.

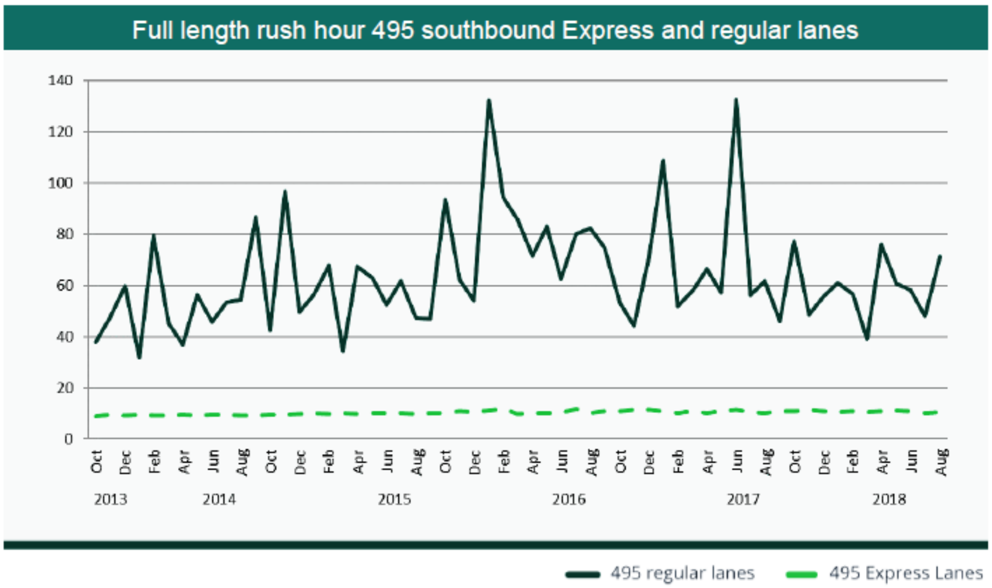
[19] Alternative 9, according to the DEIS, is two priced managed lanes in each direction on I-495 and convert one existing HOV lane to a priced managed lane and add one priced managed lane in each direction on I-270.

2. Foreseeable Impacts of Building I-495 and I-270 Managed Lanes

2.1 Managed Lanes Are Unlikely to Reduce Congestion on the General-Purpose Lanes

The small reductions in general-purpose lane volumes shown in Figures 5 and 6 have not improved general-purpose lane travel times. As shown In Figure 14, The Express Lanes operator, Transurban, reports reliably fast travel times in the southbound Express Lanes and large average time savings compared to the general-purpose lanes.

Figure 14: Transurban Travel Time Data[20]



Source: Transurban, 2019.

Figure 14 shows average general-purpose lane travel times of about 60 minutes. Assuming that this is for the entire 14-mile length, this represents a speed of about 15 mph. However, Figure 13 could represent a shorter distance because the average time shown for the Express Lanes of about 10 minutes is impossible for the entire 14-mile length (because it would require at average speed of 84 mph). If the segment underlying the data is shorter than the full 14 miles, the actual general-purpose lane speeds may have been even lower than 15 mph.

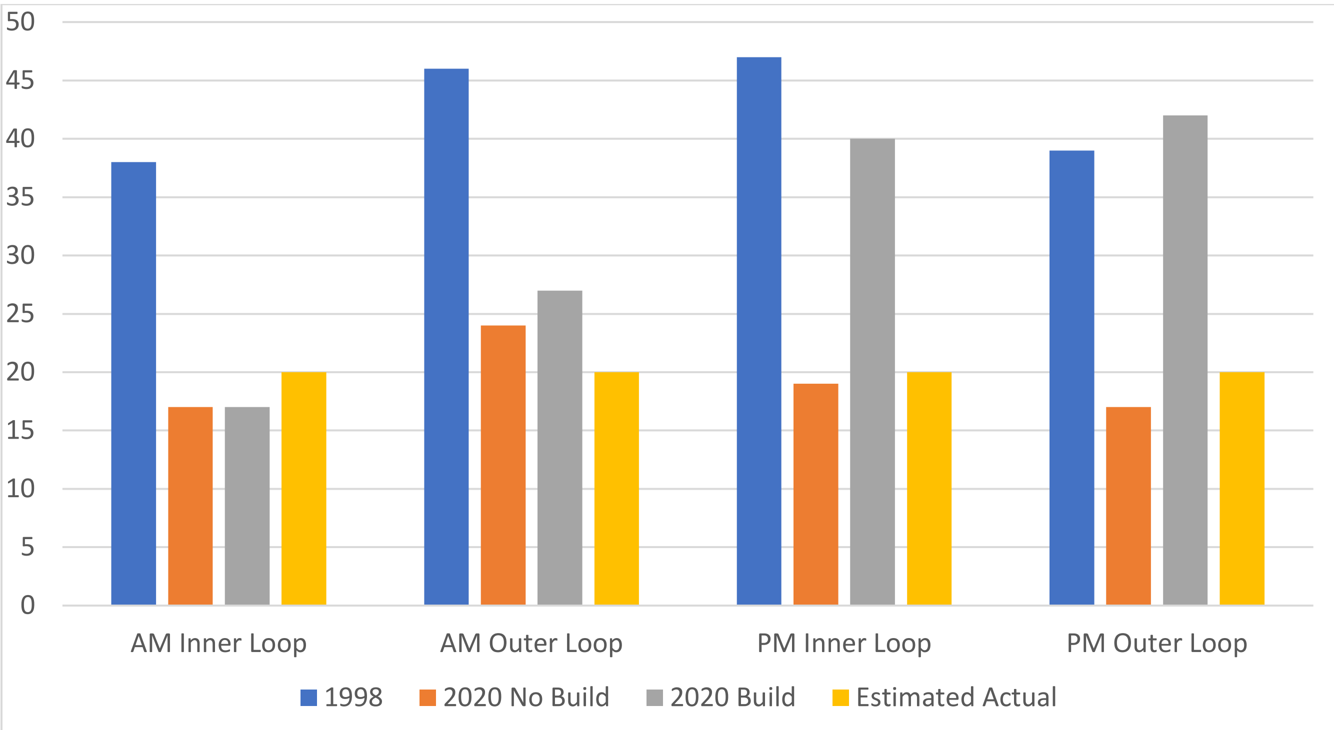
Researchers at the University of Virginia found that in March 2018, average morning and peak hour travel times in the general-purpose lanes were typically 20-30 mph.[21] March 2018 was one of the better months in the Transurban data. However, the discrepancy between the two sets of data is unexplained. An estimate of 20 mph is used in the figure below.

[20] Bell, Elisa, Transurban. 495 and 95 Express lanes: Customer choice regional benefit. Presented as part of the Transportation Research Board's Webinar on Ensuring Equity with Priced Managed Lanes in April 2019. http://onlinepubs.trb.org/onlinepubs/webinars/190429.pdf

[21] Babiceanu, Simona and Donna Chen. Empirical Evidence for Estimating the Value of Travel Time on Express Lanes: Northern Virginia Regional Case Study, 2018.

The Virginia I-495 Express Lanes FEIS reported pre-construction "Existing" speeds for the Outer Loop of 46 mph in the AM peak hour and 39 MPH in the PM peak hour, i.e. twice the speeds reported for today by Transurban. This suggests that peak hour general-purpose lane speeds have declined significantly since opening the Express Lanes. As shown in Figure 15, current general-purpose lane speeds are generally much lower than was forecast in the FEIS.

Figure 15: I-495 General-Purpose Speed – Historical, FEIS Forecast, and Estimated Actual[22]



Source: Virginia Express Lanes 2006 FEIS and current data.

The DEIS general-purpose lane travel time forecasts are invalid because (as discussed above):

- The models overestimate No Build traffic volumes
- The models fail to account for the shift to the peak hours that would follow managed lanes construction.

These two factors cause the models to overestimate general-purpose lane congestion in the No Build alternative and underestimate general-purpose-lane congestion in the Build alternative.

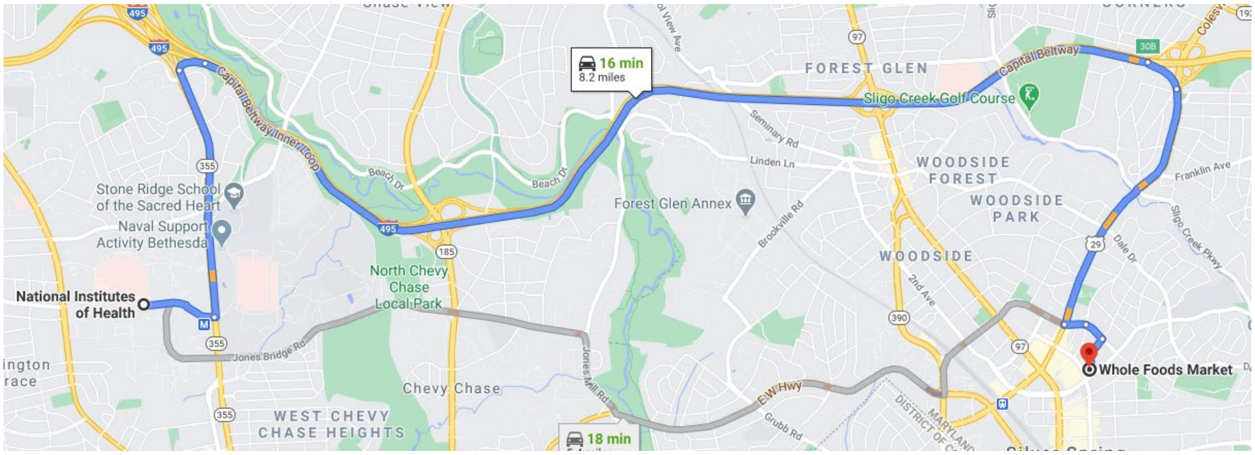
The Virginia experience suggests that constructing similar managed lanes in Maryland would do little or nothing to reduce congestion on the general-purpose lanes. In fact, as discussed in a subsequent section of this report, the entire premise of this project is that extreme congestion is needed to justify the extremely high tolls required to pay for the project.

[22] Virginia Department of Transportation (VDOT). Capital Beltway Study: Final Environmental Impact Statement and Section 4(f) Evaluation, Table 2-9, p. 45, April 2006.
http://www.virginiadot.org/VDOT/Projects/Northern_Virginia/asset_upload_file77_72985.pdf

2.2 Managed Lanes Are Likely to Make Arterial Congestion Worse

The DEIS puts forward a simplistic and incorrect framing of diversion from arterial roadways to I-495/I-270. It pretends that traffic magically is subtracted from one class of roadway and added to the other. In fact, no trip begins and ends on a limited access roadway and a traffic shift from arterials to I-495/I2-70 necessarily adds traffic to some arterials as it reduces traffic on others. Figure 16 shows a typical example from Google Maps comparing routes between Bethesda and Silver Spring.

Figure 16: Google Maps Recommended Route from Bethesda to Silver Spring



Source: Google Maps, 2020.

Google Maps recommends a route using I-495 over an arterial route even through the I-495 route is more than 50% longer in miles (8.2 miles vs. 5-4 miles) because it is 2 minutes faster (16 minutes vs. 18 minutes). The I-495 route reduces the traffic volume on Jones Bridge Road and East-West Highway, but it adds traffic to MD 355 and US 29. Whether this represents a net congestion benefit depends on the congestion levels on all these roads.

The DEIS assumes trips like this should be on I-495 and that the non-freeway route represents undesirable diversion. However, circuitous routing that adds vehicle miles traveled (VMT) and air pollution including greenhouse gas emissions is undesirable. Adding express toll lanes also is likely to make arterial congestion worse because it counteracts peak spreading and will increase peak hour arterial traffic in the areas around I-495 and I-270 interchanges. The increased peak hour traffic congestion in these areas is likely to outweigh the congestion benefits on other roads.

Here is real world example. As discussed above, the opening of the Express Lanes in Virginia in November 2012 caused the worst I-495 bottleneck. Several months later in June 2013, VDOT announced a plan to partially address these problems by opening a shoulder lane on the left side of the Inner Beltway to increase the effective width to five general-purpose lanes at the merge. The public relations handout developed at this time stated that there would be “no impact to nearby bridges and neighborhoods.[23]

This change was implemented in 2015. Residents of McLean have complained that this seemingly minor change has had a large impact on their community as it shifts the bottleneck farther north and adds significant

[23] VDOT 495 North traffic congestion to get better with new VDOT shoulder-use lane project, *Express Lanes*, June 28, 2013. https://www.expresslanes.com/uploads/1000/382-Shoulder_use_Lane_Project_121013.pdf

congestion to Georgetown Pike and other intersecting local streets.[24] Figure 17 shows traffic congestion at one of the key intersections where McLean residents are concerned about I-495 congestion spreading to I-495.

Figure 17: Georgetown Pike Westbound at I-495

Source: Google Maps, 2020.

As a response to these complaints, in 2018 VDOT analyzed returning to the original configuration. It found that such a return would improve operations at the SR 193 intersection [contradicting their 2013 public relations handout]: "as a result of the merge area for the Express Lanes moving back to the Old Dominion Drive area, which meters the traffic and provides a more consistent flow to the mainline near Route 193."[25] However, it also found that the closure of the shoulder lane would increase delay on the I-495 Express Lanes. The change was not made because Express Lanes traffic was prioritized over MacLean traffic. Nevertheless, even with the use of the shoulder lane, this merge area remains the worst bottleneck on I-495.

The VDOT quote uses the word "meters." Traffic metering is an underappreciated congestion control measure. Peak period traffic bottlenecks are inevitable but can be used as a management tool by choosing the bottleneck locations, metering traffic there, and providing peak period protection to other roadways. Constructing managing lanes focuses more traffic in the peak hours and undermines peak spreading and traffic metering.

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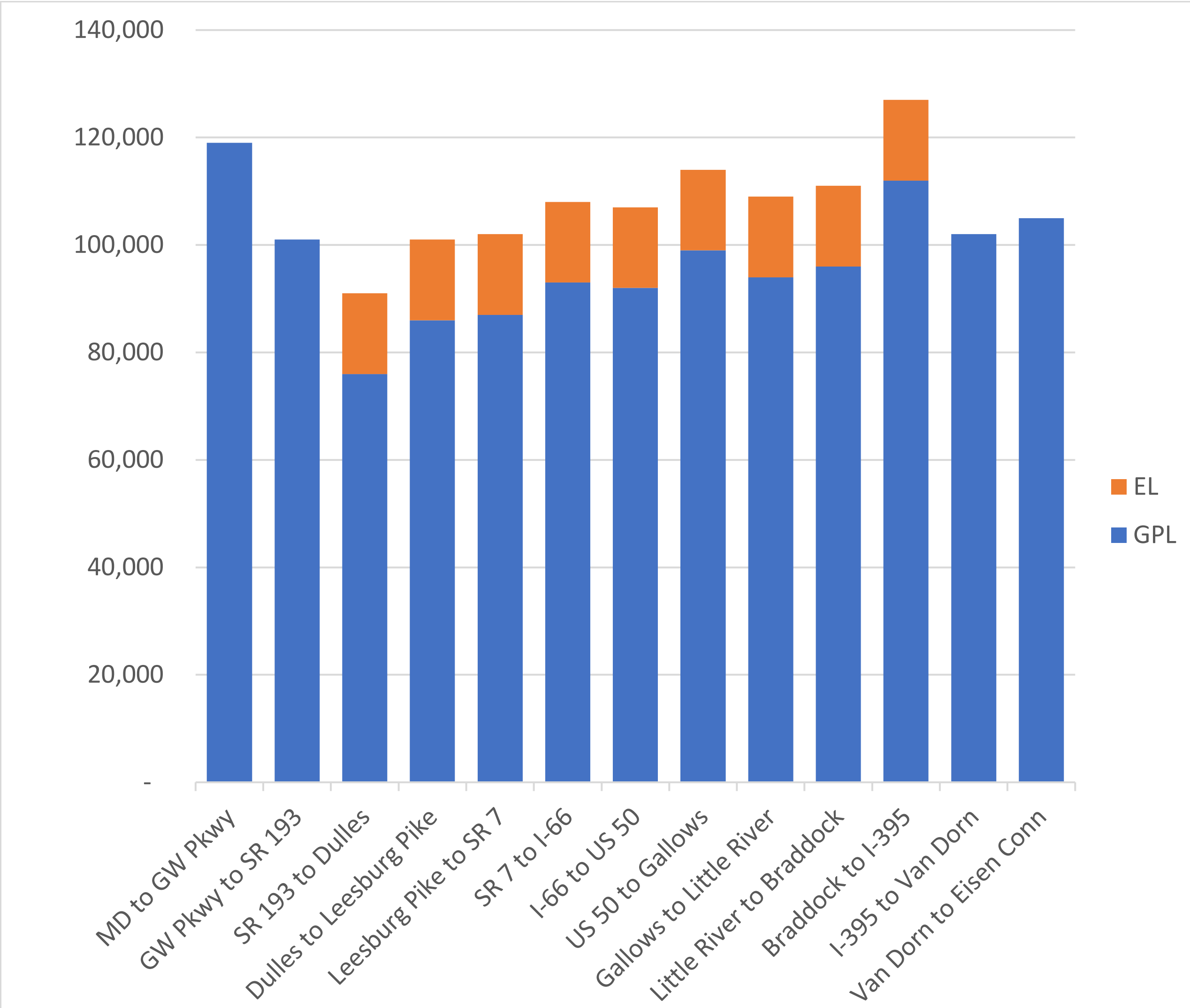
[24] Trompeter, Brian. Residents fume over I-495 shoulder lane in McLean, *InsideNova*, January 16, 2018. https://www.insidenova.com/news/arlington/residents-fume-over-i-495-shoulder-lane-in-mclean/article_da2f87a2-f871-11e7-8a7b-a7b93e288cea.html

[25] VDOT. I-495 Auxiliary Lane Study, May 9, 2018.

2.3 Managed Lanes Would Benefit Only the Few Able to Pay Large Tolls

The Virginia I-495 Express toll lanes only carry about 1/6 of the daily traffic volume on the sections with Express Lanes despite being 1/3 of roadway capacity (Figures 18 and 19). The other 5/6 of traffic is carried in the general-purpose lanes. This is an inefficient use of infrastructure.

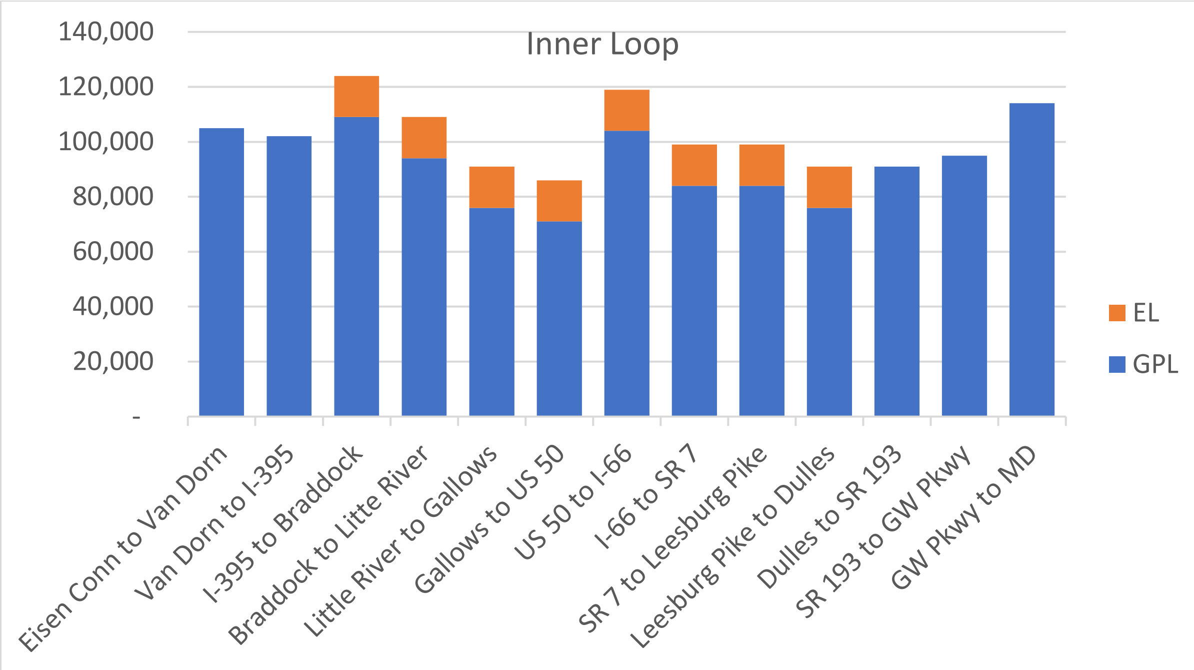
Figure 18: 2019 Daily Virginia Outer Loop Average Daily Traffic Volumes[26]



Source: Virginia Department of Transportation traffic count data, 2019.

[26] Commonwealth of Virginia Department of Transportation Average Daily Traffic Volumes with Vehicle Classification Data on Interstate, Arterial and Primary Route 2019.
https://www.virginiadot.org/info/resources/Traffic_2019/AADT_PrimaryInterstate_2019.pdf

Figure 19: 2019 Daily Virginia Inner Loop Average Daily Traffic Volumes



Source: Virginia Department of Transportation traffic count data, 2019.

The DEIS forecasts managed lane usage for Alternative 9 ranging from 10% to 31% during the 7-8 a.m. peak hour and from 12% to 35% during the 4-5 p.m. peak hour (DEIS, Appendix C, Figures 5-19 – 5-22, p. 99-100). These numbers are consistent with the estimate of 1/6 of daily traffic for Virginia because the managed lanes will attract a larger share of traffic during the peak hour. Only about 1/6 of the Maryland I-495 and I-270 traffic will be carried by the managed lanes despite being 1/3 of roadway capacity.

One of the "big ideas" from the 2018 Capital Region Transportation Forum was that "There's a market for $40 toll lanes." As reported in an article on the event, Nicholas Donohue from the Virginia Department of Transportation explained that "paying a $40 toll won't be an everyday choice for most people."[27]

The DEIS stresses "choice" – but who are these 1/6 that can afford to choose the Express Lanes? Researchers at the University of Virginia studied Virginia Express Lanes tolls and time savings. They found:

> The I-495 Express Lanes appear to provide the most time savings around 8:45 a.m. Mondays, when the toll rate also rises to around $1.75 per mile, and Wednesday evenings around 5:30 p.m. when tolls rise to a similar level. [28]

Whether paying $1.75 per mile is worth it depends on how much time is saved and, on an individual's, "value of time" expressed in $/hour. Figure 20 shows how high a value of time is needed to justify using the Express Lanes vs the speed on the general-purpose lanes.

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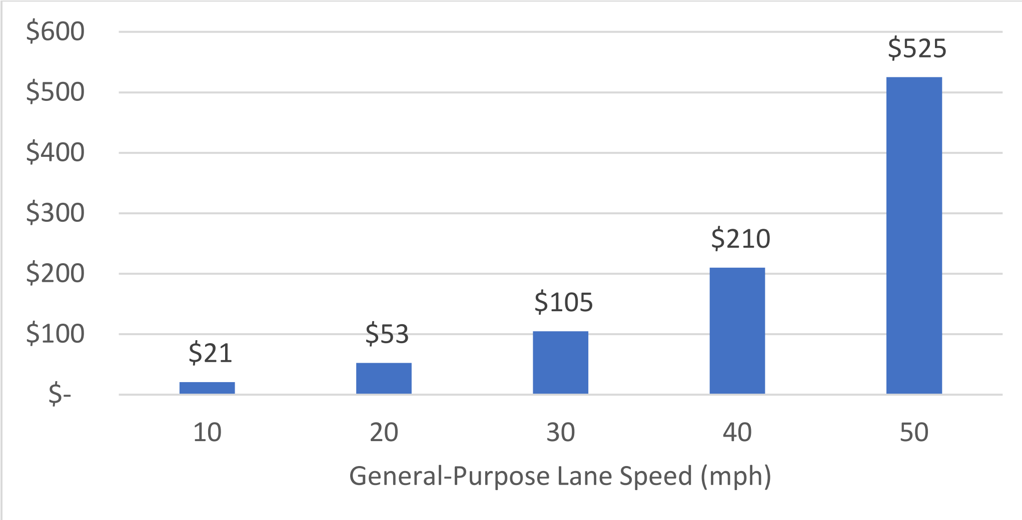
[27] Longendyke, Lindsey. Five Big Ideas from the Capital Region Transportation Forum, Greater Washington Board of Trade December 13, 2018. https://www.bot.org/five-big-ideas-from-the-capital-region-transportation-forum/

[28] Smith, Max. Are tolls worth it on Virginia's HOT lanes? *WTOP News*, July 24, 2018. https://wtop.com/dc-transit/2018/07/are-tolls-worth-it-on-virginias-hot-lanes/

Figure 20: Value of Time Needed to Justify Paying $1.75 Per Mile Toll (Toll Lanes at 60 mph)



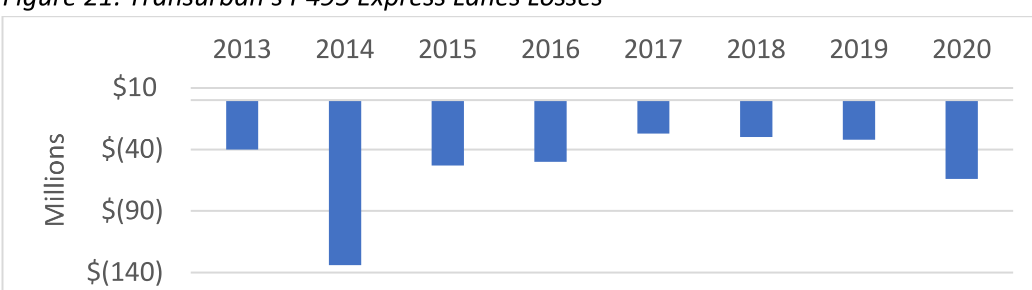
Source: I created this figure using basic mathematics.

The U.S. General Accountability Office recommends using half the median wage for a typical value of time. The median wage in Maryland is $22.10 per hour.[29] This corresponds to a value of time of $11.05 per hour which would not justify a $1.75 per mile toll until general-purpose speeds decline to 5 mph. Wages in the study area are higher than the Maryland average, so it is possible that the median income worker might be willing to pay up to the $21 per hour at a general-purpose lane speed of 10 mph. However, such a worker would not be able to buy in at this price because with this much congestion, higher-income travelers would outbid them and the dynamic price would rise above $1.75. In fact, the DEIS shows a preliminary toll estimate as high as $2.36 per mile on I-270.[30]

2.4 Taxpayers May Not Be Off the Hook for Managed Lane Costs

This choice between extreme congestion and extremely high tolls is fundamental to making the managed lanes attractive to private operators. They need high peak hour tolls to pay off bonds. They need extreme congestion to justify high tolls. Most toll roads including the Virginia I-495 Express Lanes lose money in the early years and count on increasing congestion in the future to allow them to raise tolls to the point that the investment finally pays off. Figure 21 shows Transurban's I-495 losses by year since the project was opened.

Figure 21: Transurban's I-495 Express Lanes Losses[31]



Source: I created graph using information from Transurban financial reports.

[29] Occupational Employment Statistics. May 2019 State Occupational Employment and Wage Estimates Maryland. Bureau of Labor Statistics. https://www.bls.gov/oes/current/oes_md.htm#00-0000

[30] DEIS, Appendix C, p. 883.

[31] Reporting Suite. Transurban. https://www.transurban.com/investor-centre/reporting-suite

The Virginia I-495 Express Lanes have never been profitable, and cumulative losses now exceed $400 million. The 2020 fiscal year ending June 30th includes Covid impacts, but it doesn't appear the road was on its way to profitability even before this. If the Virginia I-495 Express Lanes are ever to break even, the worst toll rates are yet to come.

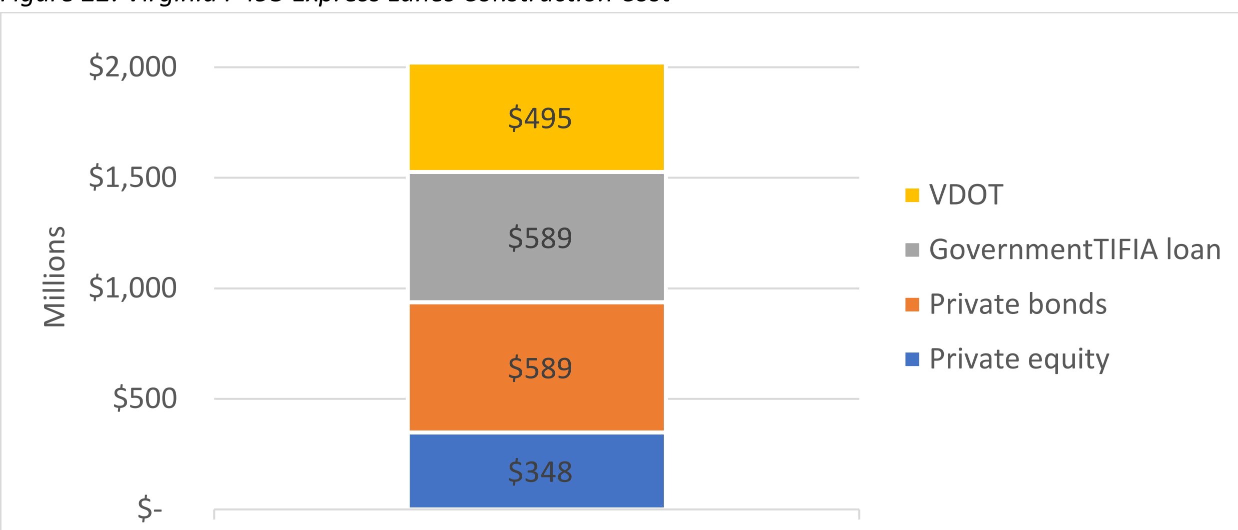
The I-95 Express Lanes (also managed by Transurban) were profitable pre-Covid – but were not in FY 2020. It appears that a radial commuting route like I-95 is a better market than a circumferential highway like I-495. It is likely that the private operators are hoping to duplicate the I-95 success by extending the I-495 Express Lanes into Maryland in order to emphasize a radial north-south I-270/I-495 commuter route Maryland into Virginia.

The DEIS promises a free lunch where the entire project is paid for by private funding. As shown in Figure 22, this is not what happened in Virginia. The Virginia I-495 Express Lanes were constructed at a cost of over $2 billion with private equity and private bonds providing less than half the total. The larger share (over $1 billion) came from a government Transportation Infrastructure Finance and Innovation (TIFIA loan) and $495 million from the Virginia Department of Transportation.

The VDOT $495 million contribution was, pre-Covid, supporting just 46,000 transactions per day for the VA I-495 Express Lanes.

Virginia did not plan to contribute to the Express Lanes but was pushed into it in order to make a deal that was acceptable to the private entities. Maryland likely will be in an even weaker bargaining position. This project will look riskier post-Covid, because it is not certain that prior travel patterns ever will return completely. The poor I-495 Express Lanes financial performance will cast doubt on the financial viability of the east-west I-495 sections in Maryland.

Figure 22: Virginia I-495 Express Lanes Construction Cost[32]



Source: Federal Highway Administration project profile.

[32] Federal Highway Administration. Project Profile: Capital Beltway High Occupancy Toll (HOT) Lanes (I-495). https://www.fhwa.dot.gov/ipd/project_profiles/va_capital_beltway.aspx

When asked about the potential for high tolls, Terry Owens, a state spokesman for the project,

> *… said the group's assertion that motorists "will" pay the amounts projected by COG is "inaccurate, misleading and suggests a lack of understanding" of the federal environmental review process. The final toll rates will be set by the Maryland Transportation Authority's board after public hearings, he said*.[33]

This contention that the private operators will assume all the risk for construction but allow a public board to hold down toll rates is frankly implausible. If Maryland goes ahead with this project, it can be expected that negotiations with private operators on a binding long-term contract will include discussions of:

- Maryland making financial contributions (in addition to the many millions already being spent on studies and that will be spent on a bidding process),
- Maryland committing to a minimum rate of return and/or specified high toll rates,
- Maryland assuming risk, and/or
- the private operators agreeing only to build a small section of the entire project which they see as most profitable, creating the type of bottleneck problem that has occurred in Virginia at the end of the managed lanes.

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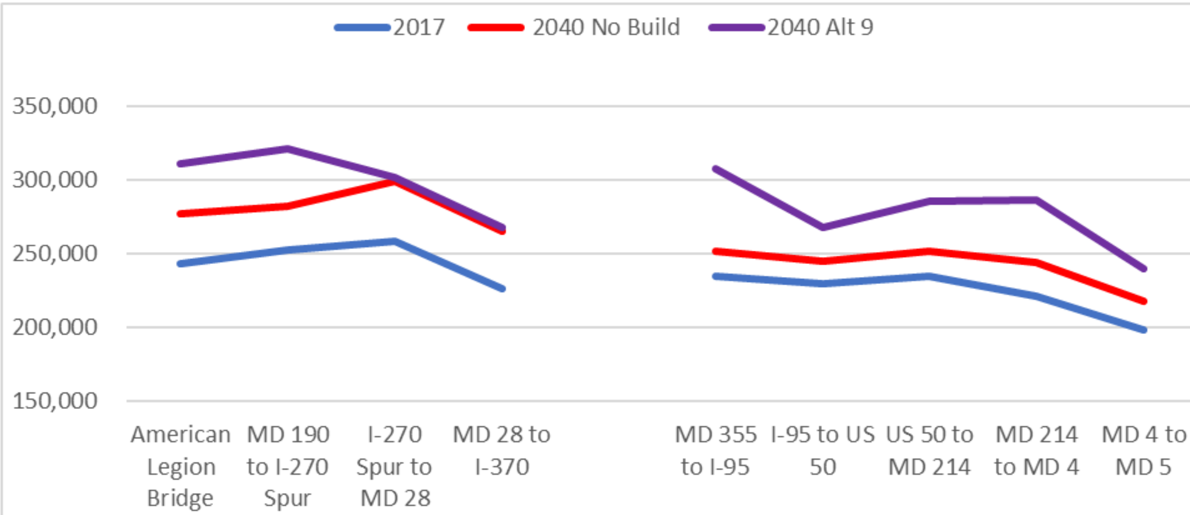
[33] Shaver, Katherine. Beltway, I-270 toll lanes could cost more than $1.50 and $2 per mile, study says. *Washington Pos*t, October 16, 2020. https://www.washingtonpost.com/local/trafficandcommuting/beltway-i-270-toll-lanes-could-cost-more-than-2-per-mile-study-says/2020/10/15/3d3e7fa0-0f27-11eb-8a35-237ef1eb2ef7_story.html

Appendix A: Traffic Forecasts

Figure A1 shows DEIS daily traffic data and forecasts for I-495 and I-270. The DEIS forecasts significant traffic growth in the 2040 No Build alternative, particularly in the north-south direction, and considerably higher growth in the build alternatives (Alternative 9, which appears to be preferred by MDOT).[34]

Figure A1: Maryland DEIS Daily Traffic Data and Forecasts (Tables 3-1 and 3-2)



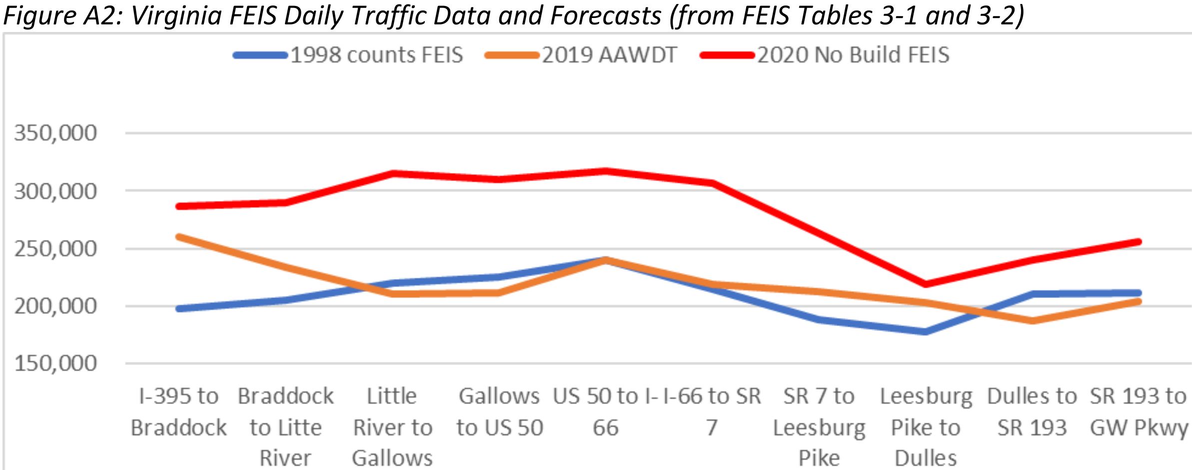
I-495/I-270 south to north I-495 west to east

Source: DEIS, 2020.

Figure A2 shows the traffic data and forecasts from the 1998 FEIS for the Virginia Express Lanes, along with 2019 actual Average Annual Weekday Traffic (AAWDT).

Officials offered a similar forecast of significant growth in the 1998 FEIS for the Virginia Express Lanes (Figure A2), but total daily I-495 traffic has changed little in 21 years and is much lower today than what was forecast in the FEIS No Build scenario. Presumably, the 1998 FEIS modeling forecast even higher traffic volume for the Build alternative but those numbers are not reported in the FEIS and therefore are not shown in Figure A2.

Figure A2: Virginia FEIS Daily Traffic Data and Forecasts (from FEIS Tables 3-1 and 3-2)



Source: Virginia Express Lanes FEIS, 2006.

[34] Alternative 9, according to the DEIS, is two priced managed lanes in each direction on I-495 and convert one existing HOV lane to a priced managed lane and add one priced managed lane in each direction on I-270.

Appendix B: DEIS Wrongly Claims that Over-Capacity Assignments Indicate Latent Demand

Generated traffic is a critical concept that is explained by Litman in Box B1.

Box B1. Excerpt from Generated Traffic and Induced Travel: Implications for Transport Planning

Todd Litman, Victoria Transport Policy Institute, July 1, 2020 https://www.vtpi.org/gentraf.pdf

Traffic engineers often compare traffic to a fluid, assuming that a certain volume must flow through the road system, but it is more appropriate to compare urban traffic to a gas that expands to fill available space (Jacobsen 1997). Traffic congestion tends to maintain equilibrium: traffic volumes increase to the point that congestion delays discourage additional peak-period vehicle trips. Expanding congested roads attracts *latent demand*, trips from other routes, times and modes, and encourage longer and more frequent travel. This is called *generated traffic*, referring to additional peak-period vehicle traffic on a particular road. This consists in part of *induced travel*, which refers to absolute increases in vehicle miles travel (VMT) compared with what would otherwise occur (Hills 1996; Schneider 2018).

This is not to suggest that increasing road capacity provides no benefits, but generated traffic affects the nature of these benefits. It means that road capacity expansion benefits consist more of increased peak-period mobility and less of reduced traffic congestion. Accurate transport planning and project appraisal must consider these three impacts:

1. Generated traffic reduces the predicted congestion reduction benefits of road capacity expansion (a type of rebound effect).
2. Induced travel imposes costs, including downstream congestion, accidents, parking costs, pollution, and other environmental impacts.
3. The additional travel that is generated provides relatively modest user benefits, since it consists of marginal value trips (travel that consumers are most willing to forego).

Ignoring these factors distorts planning decisions…

Litman makes an important distinction between latent demand and induced travel, with generated traffic encompassing both.

- *Latent demand: Additional trips that would be made if travel conditions improved (less congested, higher design speeds, lower vehicle costs or tolls)*
- *Induced travel: An increase in total vehicle mileage due to roadway improvements that increase vehicle trip frequency and distance, but exclude travel shifted from other times and routes*
- *Generated traffic: Additional peak-period vehicle trips on a particular roadway that occur when capacity is increased. This may consist of shifts in travel time, route, mode, destination and frequency.*[35]

[35] Litman, 2020, p. 3.

The MWCOG Model Assignments Are Not Intended to Include Any Latent Travel

The DEIS uses the phrase latent demand in the same way Litman does: "… latent demand refers to people who want to use I-495 or I-270 during the peak hours, but do not because of the congestion." (DEIS, Appendix C, p. 76). The DEIS then mistakenly assumes that over-capacity MWCOG model forecasts can be used to quantify latent demand. This assumption is not supported by MWCOG model documentation or by the professional travel demand modeling literature in general.

The DEIS used MWCOG Version 2.3.71. The MWCOG website includes travel demand model documentation on the versions 2.3.70, 2.3.75 and 2.3.78. including:

- The TPB Version 2.3 Travel Model, Build 70, also known as the Version 2.3.70 Travel Mode became the adopted travel model on October 18, 2017.
    - User's Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.70 (Volume 1)
    - Highway and Transit Networks from the VDOT and MDOT Off-Cycle Amendment to the 2016 CLRP (TPB Version 2.3.70 Travel Model)
- The TPB Version 2.3 Travel Model, Build 75, also known as the Version 2.3.75 Travel Mode became the adopted travel model on October 17, 2018.
    - User's Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.75: Volume 1 of 2: Main Report and Appendix A (Flowcharts)
    - User's Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.75: Volume 2 of 2: Appendices B (Batch Files), C (Cube Voyager Scripts), and D (AEMS Fortran Control Files)
    - Highway and Transit Networks for the TPB Ver. 2.3.75 Travel Model and Air Quality Conformity Analysis of Visualize 2045 and the FY 2019-2024 TIP
- The user's guide and the highway and transit networks documentation for the current model, Ver.2.3.78, were released April 14, 2020.
    - User's Guide for the COG/TPB Travel Demand Forecasting Model, Version 2.3.78. Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, April 14, 2020.
    - Highway and Transit Networks used in the Air Quality Conformity Analysis of the 2020 Amendment to Visualize 2045 and the FY 2021-2024 TIP (Ver. 2.3.78 Travel Model). Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, April 14, 2020.
- Validation reports:
    - Calibration Report for the TPB Travel Forecasting Model, Version 2.3, on the 3,722-Zone Area System. Final Report. Washington, D.C.: National Capital Region Transportation Planning Board, January 20, 2012.
    - In 2013, the Version 2.3 Travel Model was validated to year-2010 conditions. Updates to the model resulting from this validation work were part of Ver.2.3.52. The model validation effort was documented in the following memo: Milone, Ronald. Memorandum to Files. "2010 Validation of the Version 2.3 Travel Demand Model." Memorandum, June 30, 2013.
    - In 2019, TPB staff conducted a re-validation of Version 2.3.75 to year-2014 conditions. The work was documented in the following memo: Feng Xie to Dusan Vuksan and Mark Moran, "Year-2014 Validation of TPB's Version 2.3 Travel Demand Model," Memorandum, March 12, 2019.

It appears that the version 2.3.75 documentation and validation report are generally consistent with the version used in the DEIS (2.3.71).

None of the ten model documents on the MWCOG website make any reference to "latent", "induced" or "generated" demand, The MWCOG model's traffic volume outputs are intended to represent actual traffic volumes - either for the base year or for a forecast year. This is apparent in the latest validation report (2019). It compares traffic volumes assigned by the model to traffic counts – both for an entire day (Figure B1) and for each of the four model time periods (Figure 26). In each case, the target is an exact match.

Figure B1: MWCOG Model Daily Model Traffic Volumes vs. Counts[36]

Table A3-1. Estimated and Observed 2014 Daily VMT by Facility Type*

Facility Type	Links w/ Counts	Observed ("O")	Estimated ("E")	Ratio (E/O)	Standard ƚ	
					Acceptable	Preferable
Freeway	517	29,419,832	31,618,131	1.07	±7%	±6%
Major Arterial	1,867	14,795,795	15,845,341	1.07	±15%	±10%
Minor Arterial	2,939	10,897,071	12,343,027	1.13	±15%	±10%
Collector	1,144	2,311,056	1,718,105	0.74	±25%	±20%
Expressway	224	5,063,294	4,826,940	0.95	±15%	±10%
Ramp	2	30,176	26,161	0.87	N/A	N/A
Total:	***6,693***	***62,517,224***	***66,377,704***	***1.06***	***±5%***	***±2%***

Source: MWCOG, 2019.

Figure 26: MWCOG Model Daily Model Traffic Volumes vs. Counts[37]

Table A4. 2014 VMT Estimated to Observed Ratio (E/O) by Time Period and Facility Type*

	Links w/ Counts	AM Peak	Mid-day	PM Peak	Night	*Daily*
Freeway	125	1.12	1.40	0.93	1.12	***1.13***
Major Arterial	543	1.05	1.08	0.87	1.15	***1.02***
Minor Arterial	596	1.33	1.12	1.17	1.37	***1.22***
Collector	319	0.81	0.68	0.71	0.72	***0.72***
Expressway	93	0.91	1.07	0.82	0.98	***0.94***
Total:	***1,676***	***1.09***	***1.20***	***0.92***	***1.12***	***1.07***

Note: * Based on 1,676 directional links with hourly traffic counts (none of them are ramps)

Source: MWCOG, 2019.

The model outputs summarized in the tables above include both overestimated and underestimated traffic volumes relative to counts. Some of the overestimated volumes are impossibly high because they exceed roadway capacity, but these errors are not an estimate of latent demand – they are just errors.

[36] Xie, Feng. "Year-2014 Validation of TPB's Version 2.3 Travel Demand Model," Memorandum, March 12, 2019..

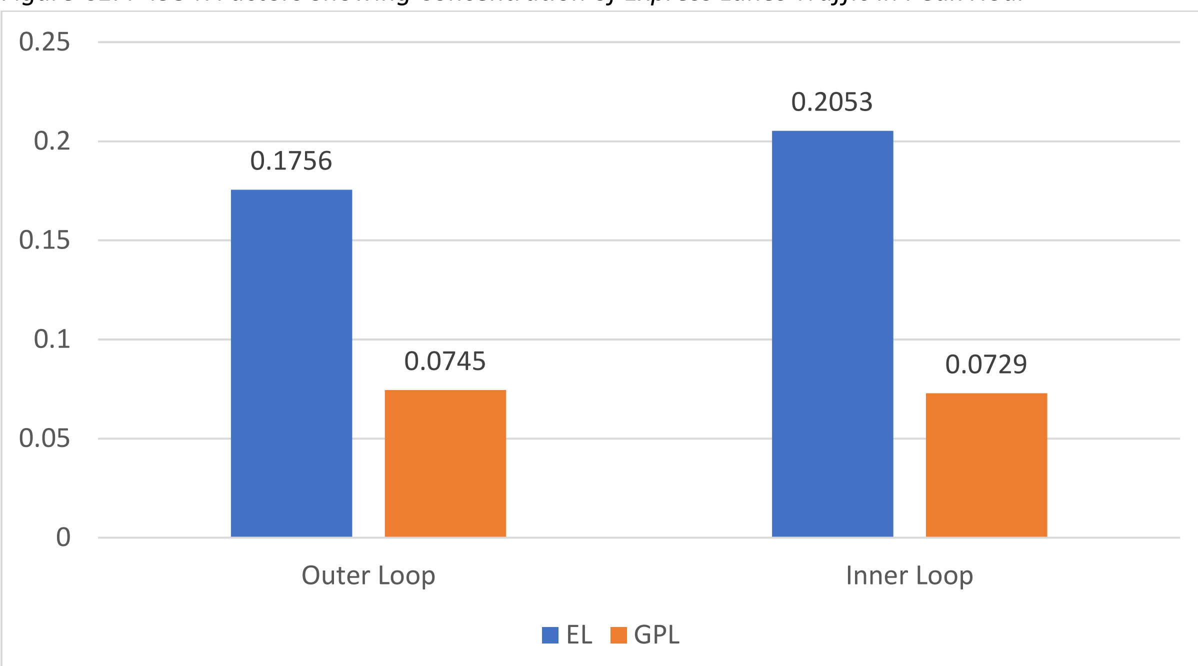
[37] Xie, Feng. "Year-2014 Validation of TPB's Version 2.3 Travel Demand Model," Memorandum, March 12, 2019..

Appendix C: The Virginia Express Lanes Caused the Worst Bottleneck on I-495

Peak hour traffic volumes increased sharply after the Express Lanes opened. Peak hour traffic numbers were extracted from VDOT traffic reports by multiplying Annual Average Daily Traffic (AADT) by the estimate of the portion traveling during the peak hour or design hour (K Factor).

The VDOT reports do not include AADT for the Express Lanes except for a 2019 value of 15,000 at the southern exit. This 15,000 per direction number is used as an estimate. The VDOT traffic reports include K factors for the Express Lanes at the southern end in both directions. In 2019, these K factors were 0.1756 for the Outer Loop and 0.2053 for the Inner Loop. As shown in Figure C1, these are over two times the average K factors for parallel general-purpose lane (GPL) segment. This is logical because there is much less incentive to use the Express Lanes during off-peak periods, even given lower toll rates.

Figure C1: I-495 K Factors Showing Concentration of Express Lanes Traffic in Peak Hour[38]



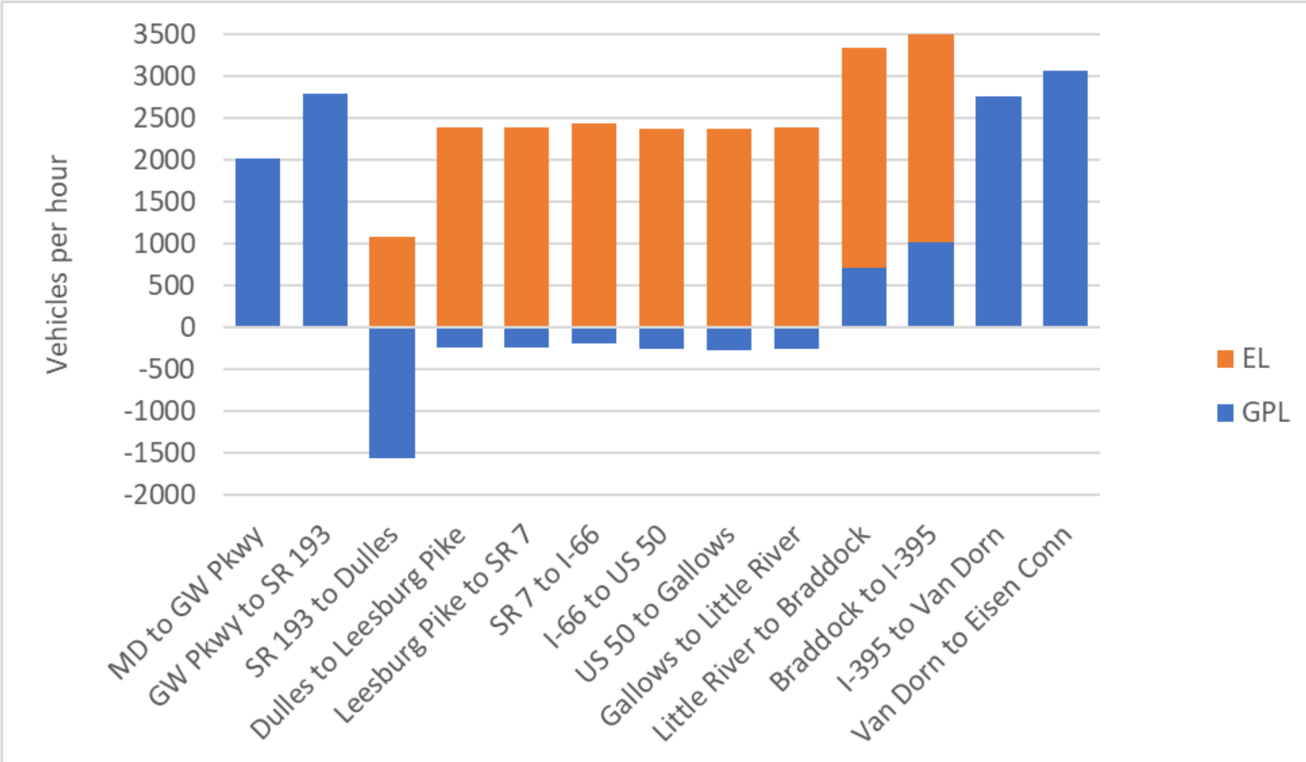
Source: Virginia Department of Transportation traffic count reports, 2019.

The K-factors in Figure C1 show that traffic on the general-purpose lanes is spread widely across the day. This is an efficient use of the roadway capacity. "Peak spreading" is an underappreciated congestion management strategy. In sharp contrast, a large proportion of traffic on the Express Lanes is during the peak hours. This undermines the congestion relief that otherwise would result from peak spreading and causes unintended negative consequences.

Figures 5 and 6 earlier in this report (reinserted for convenience as Figures C2 and C3 show the estimated change in peak hour traffic volume[39] for the Outer and Inner Loop GPL before and after construction. The "Before" numbers are averages from 2005-2007. The "After" numbers are averages from 2013-2019. The period 2008-2012 is omitted due to the extended construction period.

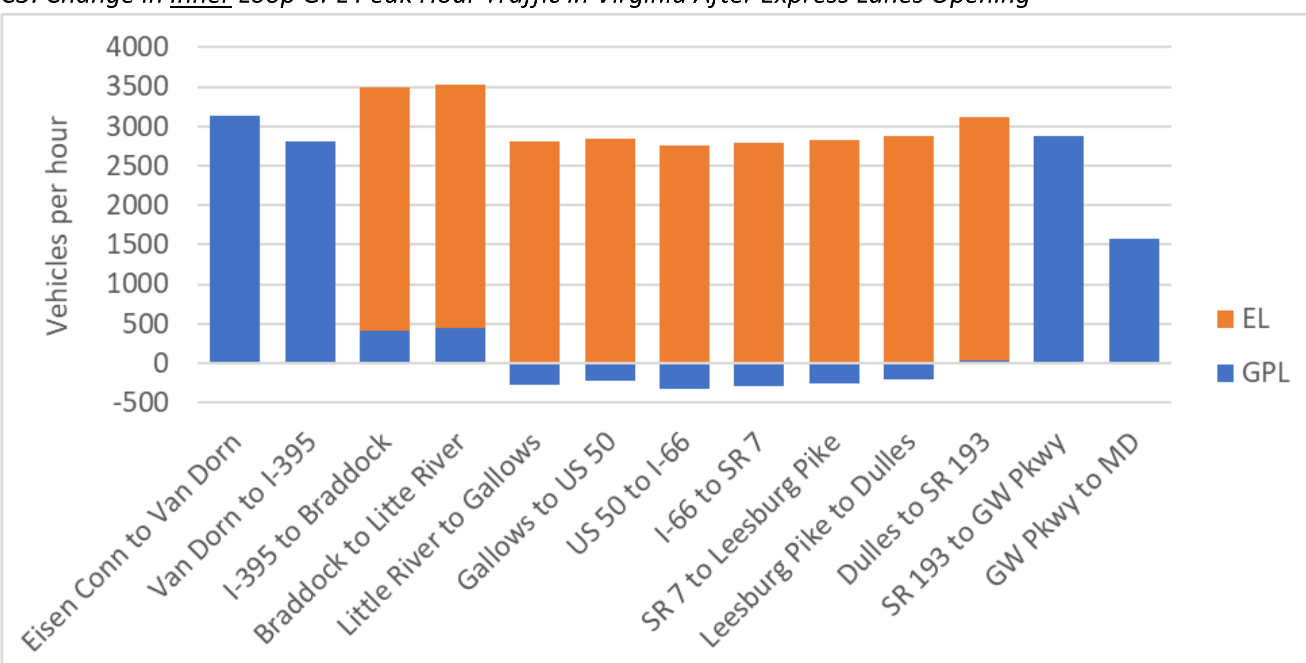
[38] From VDOT traffic data report. General-purpose-lanes K Factor is average of segments parallel to Express Lanes.
[39] Calculated as AADT x K Factor.

C2: Change in Outer Loop GPL Peak Hour Traffic in Virginia After Express Lanes Opening



Source: Virginia Department of Transportation traffic count reports.

C3: Change in Inner Loop GPL Peak Hour Traffic in Virginia After Express Lanes Opening



Source: Virginia Department of Transportation traffic count reports.

The I-495 Inner Loop often is severely congested for several miles both north and south of the Potomac River in the afternoon. Therefore, the American Legion Bridge is often considered a primary bottleneck in the system.

However, a close examination of speed data shows that the worst bottleneck is the first mile north of the end of the Express Lanes north of the Dulles Toll Road. This case is presented fully in Appendix A of this report.

Figure C4 shows Inner Loop speeds for 15-minute intervals from 7 a.m. to 10 a.m. Speeds for 11 Inner Loop segments are shown – from the Route 123 interchange at the bottom/south to the Cabin John Parkway interchange at the top/north. The gray dashed line above the GW Parkway interchange line represents the state line. The northbound speeds at the Georgetown Pike interchange just north of the Express Lane merge are 20 mph or less for a 2-hour period, but the speeds at the American Legion Bridge (above the gray dashed line) never fall below 35 mph. The bridge is not the primary bottleneck in the morning peak period.

Figure C4: Inner Loop Morning Peak Period Speed Data (INRIX)[40]

	7:00 AM	7:15 AM	7:30 AM	7:45 AM	8:00 AM	8:15 AM	8:30 AM	8:45 AM	9:00 AM	9:15 AM	9:30 AM	9:45 AM	10:00 AM
Cabin John Parkway Interchange	62	61	62	61	61	61	60	59	60	60	61	61	61
	56	55	55	54	55	55	55	54	55	55	56	56	55
Clara Barton Parkway Interchange	48	46	45	45	45	44	44	44	44	44	44	44	43
	46	40	37	35	35	35	35	36	36	36	35	36	36
GW Parkway Interchange	41	31	28	27	26	26	26	27	27	28	27	27	29
	38	28	23	21	20	20	19	19	20	21	20	21	23
Georgetown Pike Interchange	39	29	22	20	20	19	18	18	19	20	20	21	23
	43	35	27	25	25	23	22	23	25	27	28	29	31
Dulles Toll Road Interchange	43	32	21	20	21	20	19	20	24	27	28	30	34
	47	38	27	24	29	28	26	28	34	38	39	41	44
Route 123 Interchange	50	42	33	30	34	34	30	33	37	40	42	45	49

Source: Virginia Department of Transportation, 2018.
Legend: Purple box peak hour for core study area; white box longer study period.

[40] Extracted from VDOT, I-495 Express Lanes Northern Extension Environmental Assessment Scoping Framework Document (November 15, 2018), Figure 7, p. 22. The purple box highlights the peak hour and the white box is for the peak period.

The afternoon picture is murkier because queues behind bottlenecks spill back into upstream bottlenecks. Nevertheless, Figure C5 shows that the worst afternoon bottleneck in the system is also north of the Express Lanes merge. Compared to the American Legion Bridge, the Express Lanes merge area:

- becomes severely congested (red) about an hour earlier,
- is severely congested for about two hours longer, and
- has lower minimum speeds (8 mph vs 15 mph).

Figure C5: Inner Loop Afternoon Peak Period Speed Data (INRIX[41]

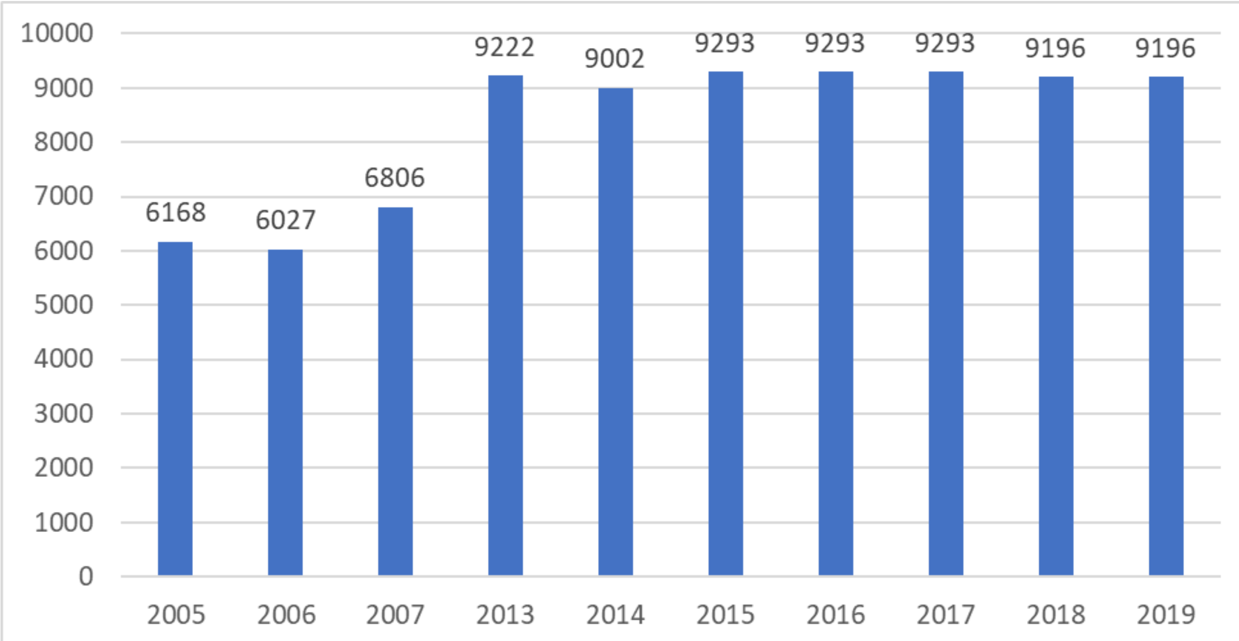
	2:00 PM	2:15 PM	2:30 PM	2:45 PM	3:00 PM	3:15 PM	3:30 PM	3:45 PM	4:00 PM	4:15 PM	4:30 PM	4:45 PM	5:00 PM	5:15 PM	5:30 PM	5:45 PM	6:00 PM	6:15 PM	6:30 PM	6:45 PM	7:00 PM	7:15 PM	7:30 PM	7:45 PM	8:00 PM
Cabin John Parkway Interchange	56	54	52	50	43	29	20	14	12	12	11	11	11	11	10	11	12	14	17	25	27	34	43	50	55
	54	52	50	49	46	35	25	17	15	14	13	14	13	14	13	13	15	17	20	30	31	38	44	50	53
Clara Barton Parkway Interchange	46	42	38	38	37	31	25	19	16	15	15	15	15	15	15	15	16	18	20	27	28	33	37	40	44
	38	34	28	27	26	24	21	17	15	15	14	15	15	15	15	15	16	17	18	22	24	27	30	33	38
GW Parkway Interchange	34	28	21	20	19	18	16	14	12	12	12	12	12	12	13	12	13	13	14	17	19	21	24	27	33
	34	25	18	15	14	13	12	11	9	9	9	9	9	9	9	9	9	10	10	12	14	16	19	22	29
Georgetown Pike Interchange	36	26	18	15	14	13	11	10	9	8	8	8	8	8	8	8	9	9	9	11	14	15	18	22	30
	43	36	26	20	18	17	14	13	11	10	9	9	9	9	9	9	9	10	11	12	16	18	22	29	39
Dulles Toll Road Interchange	42	39	27	21	19	18	16	14	13	12	10	9	9	9	9	9	9	9	10	11	16	19	26	38	45
	49	48	38	31	30	29	27	25	25	24	21	20	19	21	19	19	17	17	17	18	23	33	41	50	55
Route 123 Interchange	53	54	45	36	33	33	32	31	31	32	29	28	27	28	28	30	29	27	27	27	32	42	48	54	56

Source: Virginia Department of Transportation, 2018.
Legend: Purple box peak hour for core study area; white box longer study period.

Finally, Figure C6 shows Inner Loop peak hour traffic for the segment from Georgetown Pike (SR 193) to the George Washington Parkway (the first segment with VDOT data after the Express Lanes merge).

[41] Extracted from VDOT, I-495 Express Lanes Northern Extension Environmental Assessment Scoping Framework Document (November 15, 2018), Figure 7, p. 22. The purple box highlights the peak hour and the white box is for the peak period.

Figure C6: I-495 Inner Loop from SR 193 to George Washington Parkway Peak Hour Traffic Volume (Vehicles) by Year[42]



Source: Virginia Department of Transportation traffic count reports.
Note: 2008-2012 omitted because of construction during this period.

Figure C6 shows that there was adequate capacity for the pre-Express Lanes traffic volume on four general purpose lanes (less than 8000 vehicles per hour) but not enough for the post-Express Lanes traffic volume. After the Express Lanes opened, the peak hour volume immediately shot up to about 9200 vehicles per hour and has stayed constant at that level from 2013 through 2019. This constant value indicates that this is the maximum capacity for this roadway segment – even with the use of the shoulder lane. The extreme delay results from the queue that spills back behind this bottleneck – a bottleneck that was caused by the Express Lanes project and the worst bottleneck on I-495 in Virginia.

[42] Estimated from VDOT annual Daily Traffic Volume Estimates reports.

Appendix D: Norman L. Marshall Resume

NORMAN L. MARSHALL, PRESIDENT

nmarshall@smartmobility.com

EDUCATION:

Master of Science in Engineering Sciences, Dartmouth College, Hanover, NH, 1982----------------
Bachelor of Science in Mathematics, Worcester Polytechnic Institute, Worcester, MA, 1977

PROFESSIONAL EXPERIENCE: (31 Years, 17 at Smart Mobility, Inc.)

Norm Marshall helped found Smart Mobility, Inc. in 2001. Prior to this, he was at RSG for 14 years where he developed a national practice in travel demand modeling. He specializes in analyzing the relationships between the built environment and travel behavior and doing planning that coordinates multi-modal transportation with land use and community needs.

Regional Land Use/Transportation Scenario Planning

Portland Area Comprehensive Transportation System (PACTS) – the Portland Maine Metropolitan Planning Organization. Updating regional travel demand model with new data (including AirSage), adding a truck model, and multiclass Dynamic Traffic Assignment (DTA) including differentiation between cash toll and transponder payments.

Loudoun County Virginia Dynamic Traffic Assignment – Enhanced subarea travel demand model to include Dynamic Traffic Assignment (Cube). Model being used to better understand impacts of roadway expansion on induced travel.

Vermont Agency of Transportation-Enhanced statewide travel demand model to evaluate travel impacts of closures and delays resulting from severe storm events. Model uses innovate Monte Carlo simulations process to account for combinations of failures.

California Air Resources Board – Led team including the University of California in $250k project that reviewed the ability of the new generation of regional activity-based models and land use models to accurately account for greenhouse gas emissions from alternative scenarios including more compact walkable land use and roadway pricing. This work included hands-on testing of the most complex travel demand models in use in the U.S. today.

Climate Plan (California statewide) – Assisted large coalition of groups in reviewing and participating in the target setting process required by Senate Bill 375 and administered by the California Air Resources Board to reduce future greenhouse gas emissions through land use measures and other regional initiatives.

Chittenden County (2060 Land use and Transportation Vision Burlington Vermont region) – led extensive public visioning project as part of MPO's long-range transportation plan update.

Flagstaff Metropolitan Planning Organization – Implemented walk, transit and bike models within regional travel demand model. The bike model includes skimming bike networks including on-road and off-road bicycle facilities with a bike level of service established for each segment.

Chicago Metropolis Plan and Chicago Metropolis Freight Plan (6-county region)— developed alternative transportation scenarios, made enhancements in the regional travel demand model, and used the enhanced model to evaluate alternative scenarios including development of alternative regional transit concepts. Developed multi-class assignment model and used it to analyze freight alternatives including congestion pricing and other peak shifting strategies.

Municipal Planning

City of Grand Rapids – Michigan Street Corridor – developed peak period subarea model including non-motorized trips based on urban form. Model is being used to develop traffic volumes for several alternatives that are being additional analyzed using the City's Synchro model

City of Omaha – Modified regional travel demand model to properly account for non-motorized trips, transit trips and shorter auto trips that would result from more compact mixed-use development. Scenarios with different roadway, transit, and land use alternatives were modeled.

City of Dublin (Columbus region) – Modified regional travel demand model to properly account for non-motorized trips and shorter auto trips that would result from more compact mixed-use development. The model was applied in analyses for a new downtown to be constructed in the Bridge Street corridor on both sides of an historic village center.

City of Portland, Maine – Implemented model improvements that better account for non-motorized trips and interactions between land use and transportation and applied the enhanced model to two subarea studies.

City of Honolulu – Kaka'ako Transit Oriented Development (TOD) – applied regional travel demand model in estimating impacts of proposed TOD including estimating internal trip capture.

City of Burlington (Vermont) Transportation Plan – Led team that developing Transportation Plan focused on supporting increased population and employment without increases in traffic by focusing investments and policies on transit, walking, biking and Transportation Demand Management.

Transit Planning

Regional Transportation Authority (Chicago) and Chicago Metropolis 2020 – evaluated alternative 2020 and 2030 system-wide transit scenarios including deterioration and enhance/expand under alternative land use and energy pricing assumptions in support of initiatives for increased public funding.

Capital Metropolitan Transportation Authority (Austin, TX) Transit Vision – analyzed the regional effects of implementing the transit vision in concert with an aggressive transit-oriented development plan developed by Calthorpe Associates. Transit vision includes commuter rail and BRT.

Bus Rapid Transit for Northern Virginia HOT Lanes (Breakthrough Technologies, Inc and Environmental Defense.) – analyzed alternative Bus Rapid Transit (BRT) strategies for proposed privately-developing High Occupancy Toll lanes on I-95 and I-495 (Capital Beltway) including different service alternatives (point-to-point services, trunk lines intersecting connecting routes at in-line stations, and hybrid).

Roadway Corridor Planning

I-30 Little Rock Arkansas – Developed enhanced version of regional travel demand model that integrates TransCAD with open source Dynamic Traffic Assignment (DTA) software, and used to model I-30 alternatives. This model models freeway bottlenecks much more accurately than the base TransCAD model.

South Evacuation Lifeline (SELL) – In work for the South Carolina Coastal Conservation League, used Dynamic Travel Assignment (DTA) to estimate evaluation times with different transportation alternatives in coastal South Caroline including a new proposed freeway.

Hudson River Crossing Study (Capital District Transportation Committee and NYSDOT) – Analyzing long term capacity needs for Hudson River bridges which a special focus on the I-90 Patroon Island Bridge where a microsimulation VISSIM model was developed and applied.

PUBLICATIONS AND PRESENTATIONS (partial list)

DTA Love: Co-leader of workshop on Dynamic Traffic Assignment at the June 2019 Transportation Research Board Planning Applications Conference.

Forecasting the Impossible: The Status Quo of Estimating Traffic Flows with Static Traffic Assignment and the Future of Dynamic Traffic Assignment. *Research in Transportation Business and Management* 2018.

Assessing Freeway Expansion Projects with Regional Dynamic Traffic Assignment. Presented at the August 2018 Transportation Research Board Tools of the Trade Conference on Transportation Planning for Small and Medium Sized Communities.

Vermont Statewide Resilience Modeling. With Joseph Segale, James Sullivan and Roy Schiff. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

Assessing Freeway Expansion Projects with Regional Dynamic Traffic Assignment. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

Pre-Destination Choice Walk Mode Choice Modeling. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

A Statistical Model of Regional Traffic Congestion in the United States. Presented at the 2016 Annual Meeting of the Transportation Research Board.

MEMBERSHIP/AFFILIATIONS

Associate Member, Transportation Research Board (TRB)

Member and Co-Leader Project for Transportation Modeling Reform, Congress for the New Urbanism (CNU)