MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

2018 Maryland State Highway Mobility Report

2018 Maryland State Highway Mobility Report

Seventh Edition

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MESSAGE FROM THE ADMINISTRATOR

At the Maryland Department of Transportation State Highway Administration (MDOT SHA), we support the daily lives of Marylanders by helping them take advantage of life's opportunities. Now more than ever, local roads are becoming just as congested as highways. This shift in mobility trends is creating the need for new, innovative operations management, engineering and road design. Using a combination of policies, programs and projects, MDOT SHA is addressing congestion and improving safety to ensure you have the best experience while using our highways. By keeping a close eye on existing travel demands and establishing long-term strategies for improvement, the 2018 Mobility Report will dive into performance and mobility trends from 2017 and compare the results to past performance.

The Hogan Administration has invested $14.7 billion in Maryland's transportation network as a whole with 56 percent of that budget going to our roads and bridges. With 108 of these major road projects complete totaling $531,548,714, we've addressed all 69 structurally deficient bridges that were identified by the Governor in 2015, as well. To make congestion relief and safety at the forefront of all we do here at MDOT SHA, we continue to drive forward with the $10 billion Traffic Relief Plan, part of a system of systems that will address congestion statewide. By adding capacity to major commuter sections and installing smart traffic signals to 14 corridors around the region, MDOT SHA is paving the way for motorists to trust state highways to deliver them to life's opportunities quicker and safer.

Every completed project - or those that are in progress - has elements of Transportation Systems Management and Operations (TSMO). TSMO will connect MDOT SHA's many dots. Making the transportation system itself functional, aesthetically pleasing and safe will ensure traffic flows freely and get everyone to their homes, jobs, vacations and schools.

Delivering the best customer experience possible, we are working every day to keep Maryland moving forward. Coordinated Highway Action Response Team (CHART) monitoring and reporting of traffic conditions, emergency traffic patrol response to stranded motorists and incidents, and sophisticated technology paving the wave for connected vehicles, we will do even more in 2019 and many years to come. This is a new year, and we're in the next gear!

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EXECUTIVE SUMMARY

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Executive Summary

The 2018 Maryland Mobility Report provides a summary of performance along Maryland Department of Transportation State Highway Administration (MDOT SHA) roadways and the areas of joint partnership with other MDOT business unit facilities for the calendar year 2017. The goals of MDOT SHA is to deliver safe, sustainable, intelligent, and exceptional transportation solutions with a focus on customer service that allows for the millions of motorists the mobility they desire. MDOT SHA focuses on policies, programs, and projects with a performance-based and practical transportation approach that systematically addresses recurring and non-recurring congestion.

CONGESTION AND RELIABILITY TRENDS

The following is a summary of congestion and reliability trends on the Maryland highway system in 2017:

VEHICLE MILES OF TRAVEL (VMT)

- For the third straight year, Maryland experienced an all time record number of vehicle miles of travel (VMT) on its roadway systems. This amounted to nearly 60 billion miles in 2017 which is a 1.6% increase over 2016.
- Almost 71% of the statewide VMT occurred on MDOT facilities. The largest volume increase in VMT was on state facilities with almost a billion mile increase over 2016.
- The growth in VMT occurred mainly in the Baltimore - Washington region where VMT increased by approximately 0.9 billion miles to 46.3 billion. The VMT on the Eastern Shore, southern and western Maryland facilities was 12.6 billion which was approximately the same as 2016.

AVERAGE DAILY TRAFFIC (ADT)

- The highest volume roadway locations include:

HIGHEST AVERAGE DAILY TRAFFIC (ADT) SECTIONS		
Freeway Section		2017 ADT (Thousands)
I-270	I-270 Split to MD 117	223-267
I-495	I-270 East Spur to I-95	215-254
I-495	Va. State Line to I-270 West Spur	231-253
I-95/I-495	MD 4 to I-95	206-237
I-695	Greenspring Ave to MD 139	191-227
Arterial Section		2017 ADT (Thousands)
MD 5	US 301 to MD 223	65-99
MD 3	MD 450 to MD 175	68-81
MD 650	MD 212 to US 29	47-81
MD 210	Ft. Washington Road to I-95/ I-495	68-77
MD 4	MD 223 to Forestville Rd	61-76

CONGESTION & RELIABILITY

- Analysis of vehicle probe speed data identified that heavy to severe congested conditions occurred on 151 miles (9%) of the freeway/expressway network in the AM peak hour. Motorists on 254 miles (15%) of the network experienced heavy to severe congested conditions in PM peak hour. There was a slight increase in the number of miles but the percentage remained unchanged versus 2016 levels.
- On the freeway/expressway system, 19% of the AM peak hour and 29% of the PM peak hour VMT occurred in congested conditions. This was a 2% and 3% increase in congested VMT in the AM and PM peak hour, respectively, compared to 2016.
- The worst congestion for any particular freeway/ expressway in the AM peak hour was along I-695 (14 miles) and in the PM peak hour along I-495 (14 miles).
- Motorists on approximately 73 miles of the arterial system experience heavy to severe congestion in the AM peak hour and 160 miles in the PM peak hour. This is a 9 mile decrease in the morning and 22 mile decrease in the afternoon in 2017 compared to 2016.
- Highly to extremely unreliable conditions occur on 6% of the freeway/expressway system in the AM peak hour and 12% in the PM peak hour. The 2017 conditions showed a 1% improvement in the AM peak hour and no change in reliability systemwide in the PM peak hour.
- A failing level of service (LOS F) occurred at thirty-four (34) state highway intersections based on traffic count data from the last three years. This included three intersections that failed in both the AM and PM peak hours.

- The cost of congestion to travelers on Maryland freeway/expressway system amounted to more than $2.87 billion dollars annually. This is an increase of approximately $763 million over 2016 levels.
- Congestion cost on the major arterial system remained relatively flat at $1.18 billion.
- Total congestion costs for freeways/expressways and arterials are estimated to be $4.05 billion.

The most congested freeway/expressway and arterial corridor sections for the AM and PM peak hours are as follows:

2017 MOST CONGESTED FREEWAYS/EXPRESSWAY SECTIONS (AVERAGE WEEKDAY)

AM Peak (8-9 AM)	PM Peak (5-6 PM)
I-495 Outer Loop - I-95 to US 29	I-695 Inner Loop - MD 139 to MD 542
I-695 Outer Loop - US 1 to Cromwell Bridge Road	I-495 Inner Loop - Virginia Line to I-270 West Spur
US 50 WB - MD 410 to MD 295	I-495 Inner Loop - I-270 East Spur to MD 97
I-695 Outer Loop - MD 140 to Edmondson Avenue	I-495 Outer Loop - I-270 West Spur to Virginia Line
I-695 Outer Loop - MD 129 to I-83	I-95/I-495 Inner Loop - I-95 to MD 295
I-270 SB - I-370 to Montrose Road	I-270 West Spur NB - I-495 to I-270 Split
MD 295 SB - MD 198 to Powder Mill Road	MD 295 NB - I-495/I-95 to Powder Mill Road
I-95/I-495 Inner Loop - MD 414 to I-295	I-270 West Spur SB - I-270 Split to I-495
I-270 (Local) SB - I-370 to Montrose Road	I-695 Inner Loop - US 1 to MD 122
I-95 SB - South of MD 200 to I-495	I-95/I-495 Outer Loop - US 50 to MD 201

2017 MOST CONGESTED ARTERIAL SECTIONS (AVERAGE WEEKDAY)

AM Peak (8-9 AM)	PM Peak (5-6 PM)
US 29 Southbound - Cherry Hill Rd/ Randolph Rd to MD 193	MD 5 Southbound - MD 223 to US 301
MD 212 Westbound - Beltsville Dr to Powder Mill Rd	MD 210 Southbound - Livingston Rd to Kirby Hill Rd
MD 210 Northbound - Fort Washington Rd to Livingston Rd	MD 185 Northbound - Washington, DC Line to Jones Bridge Rd
MD 28 Westbound - Bel Pre Rd to MD 586	MD 410 Eastbound - US 1 to MD 295
MD 185 Southbound - MD 586 to MD 191	MD 3 Northbound - US 50 to Davidsonville Rd/Conway Rd
MD 410 Westbound - MD 650 to US 29	MD 355 Northbound - MD 191 to Cedar Lane
MD 2 Southbound - College Pkwy to US 50	MD 4 Northbound - MD 235 to Thomas Johnson Bridge
MD 355 Southbound - I-495 to MD 410	MD 28 Eastbound - MD 586 to Bel Pre Rd
MD 97 Southbound - MD 586 to Seminary Rd	US 1 Northbound - MD 193 to Montgomery Rd
MD 190 Eastbound - Seven Locks Rd to MD 614	MD 152 Northbound - MD 7 to Singer Rd

MDOT SHA ACCOMPLISHMENTS

Various policies, programs, and projects have been established to address congestion and improve mobility and reliability. These projects and programs that MDOT SHA delivers not only provide benefits for motorists but also for multi-modal users to yield a safe and modern transportation system. These combined efforts of all these resulted in more than $1.61 billion of annual user savings. User cost savings is achieved by a reduction in delay, fuel consumption and emissions. A summary of the accomplishments associated with these efforts to improve mobility include:

2017 USER SAVINGS DUE TO MDOT CONGESTION MANAGEMENT	
CHART	$1,460 Million
Signals	$35 Million
Capital Projects	$67 Million
Park and Ride Program	$52 Million
Total	**$ 1,614 Million**

CHART

- The Coordinated Highways Action Response Team (CHART) program efforts included clearing more than 30,000 incidents and assisting approximately 42,000 stranded motorists on Maryland roadways.
- CHART's commitment to improve mobility, reliability, and safety has resulted in a reduction of an estimated 38.6 million vehicle hours of delay amounting to approximately $1.46 billion in user savings.

SIGNALS

- Traffic signal timings were reviewed for 317 signals in 46 systems. Signal retiming was undertaken for 242 of those signals. The retiming of traffic signals resulted in $35 million annual user savings that will continue to provide recurring benefits in the future years.
- A $50 million investment is being made to upgrade 14 major corridors to provide for Smart Traffic Signals which are adaptive to real time traffic conditions. The Smart Signal systems have been implemented along MD 2 in Brooklyn Park, MD 139 in Towson and US 301 in Bowie.

CAPITAL PROJECTS

- Numerous mobility projects were completed in 2017. This included projects at the intersections of MD 51 @ Virginia Avenue, MD 45 @ Corbett Road/ Piney Hill Road, MD 31 @ Tahoma Farm Road, MD 273 @ Appleton Road, MD 16 @ Woods Road, MD 180 @ Solarex Court/US 340 Ramp, MD 187 @ W Cedar Lane/Oakmont Ave, MD 147 @ Connelley Drive and along US 13 Business between Dogwood Drive and College Ave.
- Roadway widening projects were completed along US 40 from Middle River Road to Campbell Boulevard/ Mohr's Lane, MD 404 from US 50 to Holly Road, MD 140 from Royer Road to WMC Drive and US 29 northbound from Seneca Drive to MD 175.
- Interstate improvement projects included I-695 over Leeds Road/Benson Ave and Amtrak Railroad, I-695 from MD 147 to MD 41, I-81 Northbound from I-70 to Halfway Boulevard and I-81 southbound from MD 58 to US 40.
- These completed projects result in an annual user savings of $67 million.
- Several mobility improvement projects are under construction including the widening of I-695 from US 40 to MD 144 and I-95 from Eastern Ave. to the Ft. McHenry Tunnel.
- The I-270 Innovative Congestion Management Project is under construction. This provides for active travel demand management which includes such features as ramp metering.
- Governor Hogan announced the commencement of a $9 billion Traffic Relief Plan to improve I-270 and I-495 as part of a P3 project that would add express toll lanes to these facilities.

MULTI-MODAL STRATEGIES

- MDOT focuses on a Complete Streets approach to all highway projects and completed several pedestrian and bicycle projects. This includes construction of approximately eight miles of new sidewalks, 60 miles of marked bicycle lanes and over two miles of marked shared use bike lanes. There was a 4% increase in the number of bike facilities within three miles of transit stations. Statewide more than 68% of the sidewalks are ADA compliant.
- Over 6,800 commuters on an average weekday utilize a MDOT SHA or MDTA park and ride lot to connect to transit or ride with other commuters. These 106 lots are operated in 20 counties. This provided a savings of more than 97 million annual VMT and user savings of $52 million.
- The I-270 and US 50 corridors provide for high occupancy vehicle (HOV) lanes to encourage ridesharing and increased person throughput. The I-270 HOV lanes provide as much as 15 minutes in the morning and 25 minutes in the evening in travel time savings. Person throughput along the corridor is substantially increased with a HOV lane accommodating as much as 600 additional people compared to a non-HOV lane.

FREIGHT MOVEMENT

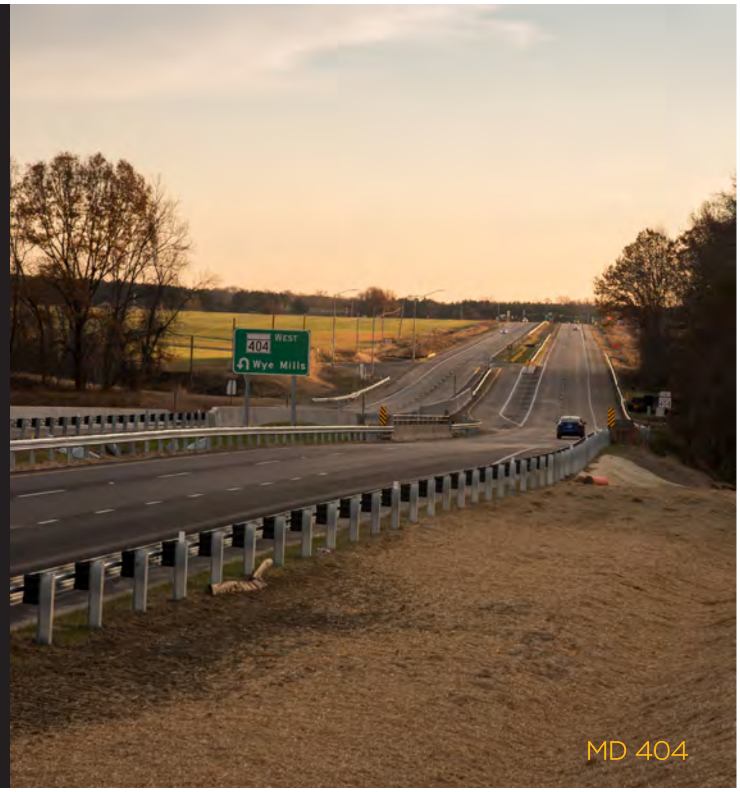
- Design and construction are underway to complete nine new virtual weigh stations. In 2017, upgrades were performed to seven at-grade railroad crossings. In addition, design is underway to provide up to ten additional truck parking spaces on I-70 eastbound and westbound Welcome Centers at South Mountain.
- Various other commercial vehicle initiatives included expediting the processing of permits through the One Hauling Permit System, evaluating methods to improve overnight truck parking, establishing the National Highway Freight Network and the Maryland Multi-Modal Freight Network, developing a 2017 Maryland Strategic Goods Movement Plan and a Maryland Freight Story Map.

TSMO IMPLEMENTATION

- The Transportation Systems Management and Operations (TSMO) Strategic/Implementation Plan, developed in 2016 is being implemented to maximize the efficiency of the existing system and improve travel time reliability. Among the initiatives underway include methods to incorporate TSMO into projects, developing a list of sample corridors for TSMO, and developing a data supported system for performance reporting.
- MDOT continues to invest in advanced modeling and analytical tools that uses big data and other innovations to inform transportation decision making. A total of seven projects are being implemented to advance mobility performance management, state-of-the-art modeling tools, and innovations for transportation planning and operations.
- Connected and automated vehicle (CAV) activities are on-going including developing strategic plans, working groups, web applications, developing permitting processes for testing CAV, applying for grants and integrating equipment along the US 1 Innovative Technology Deployment Corridor.

What is in the

Maryland State Highway Mobility Report?



MD 404

Introduction

The Maryland Department of Transportation State Highway Administration (MDOT SHA) owns, operates, and maintains the interstate, US and non-tolled MD routes in Maryland. A key goal of MDOT SHA is to provide, a safe, efficient, reliable, and modern travel experience. In order to deliver cost effective and targeted improvements, MDOT SHA has developed data driven methodologies to identify and address congestion issues. The Maryland State Highway Mobility Report illustrates MDOT SHA's data driven transportation investments for safe, efficient, and reliable movement of people and goods on our highway system. This includes monitoring existing travel trends, identifying successes, challenges, and strategies to improve the transportation services, that the agency delivers to Marylanders and the traveling public. MDOT SHA continues to focus its efforts to systematically address both recurring (every day congestion) and non-recurring congestion (due to weather, crashes, vehicle breakdowns, work zones, etc.) through practical transportation and innovation in technologies, solutions, and project delivery. While looking at the present investments, MDOT SHA also has an eye on the future with the advancement of connected and automated vehicles (CAV).

The 2018 Maryland Mobility Report identifies accomplishments in the past calendar year along with performance and mobility trends over past years. This follows a general theme of "What is Happening" and "What is MDOT SHA Doing and What are the Outcomes." Key elements reviewed include Transportation Systems Management and Operations (TSMO), freight, multi-modal programs, and major capital projects that were completed in the past calendar year.

Organization Of The Report:

- **What is Happening? (Trends and Needs Identification - Chapter I)**
  - Chapter I identifies Mobility Trends in the calendar year 2017. This includes review of traffic volumes, congestion, reliability and freight movement trends. Highlights include statewide and Top 15 congestion maps for the peak hours on the Freeway/Expressway/Arterial system. Statewide arterial corridor metrics are part of this chapter.
- **What is MDOT SHA doing and what are the outcomes? (Mitigation Strategies/Solutions - Chapter II)**
  - Chapter II reviews the Capital Projects completed in 2017 along with the user benefits. Programs and policies include CHART activities and other multimodal strategies such as Park & Ride, HOV lanes, and bicycle and pedestrian facility improvements implemented to improve mobility.
- Appendices
  - Appendix A: Major Corridor Mobility Performance Fact Sheets
  - Appendix B: AM and PM Countywide Congestion Maps
  - Appendix C: Capital Projects Before/After

What's New In The 2018 Report:

- Arterial Corridor Metrics
- Freeway Corridor Comparisons

I. Maryland Mobility Trends and Needs

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A.

TRANSPORTATION INFRASTRUCTURE AND TRAFFIC TRENDS

US 13 @ Bateman Street

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Maryland Transportation Infrastructure and Traffic Trends

MARYLAND TRANSPORTATION INFRASTRUCTURE

Maryland is home to 6.1 million people within a diverse socio-economic and geographic areas including the; Baltimore-Washington urban areas and the more rural areas of the Eastern Shore, and Western Maryland. Maryland offers a strong multimodal transportation infrastructure that includes roadways, mass transit, waterways, aviation, and non-motorized travel modes.

The roadways throughout the State are owned and maintained by various agencies. This includes private entities, cities and towns, counties, State, and federal agencies such as the National Park Service. This includes roadways ranging from interstate highways carrying over 250,000 motorists per day to local cul-de-sac streets.

MDOT Maryland Transit Administration (MDOT MTA), Washington Metropolitan Area Transit Authority (WMATA) and local transit operators offer mass transit service through subways, commuter rail, light rail, and buses. Maryland transportation infrastructure consists of bicycle and walking facilities including a series of off road trails such as the Chesapeake and Ohio Canal Towpath to sidewalks or bikepaths along its highways. Heavy rail passengers are served by the Amtrak Northeast Corridor with major stops in Baltimore at Penn Station and BWI Thurgood Marshall Airport. By air, almost 26 million annual passengers arrive/ depart at Baltimore – Washington Thurgood Marshall Airport. Finally the transportation network includes the Port, which handles the 9th largest amount of international cargo and 400,000 persons in fiscal year 2017 access cruise lines. Figure I-1 identifies the breadth of Maryland's transportation infrastructures.

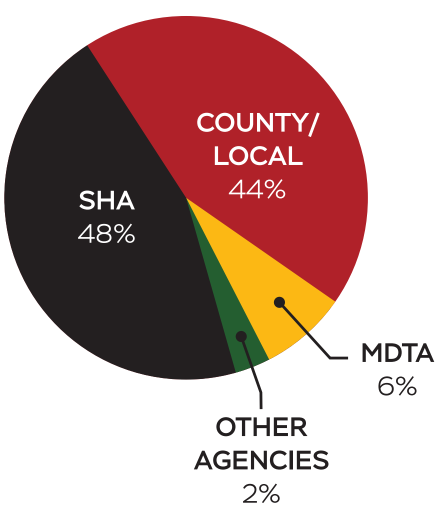
MDOT SHA operates the numbered, non-toll routes in Maryland's 23 counties, a total of 14,805 lane-miles which includes all ramps, spurs, and service roads. These roadways form the majority of the National Highway System (NHS) which includes interstate highways, freeways and major arterial roadways. These roadways provide for both long distance travel and for local access to major commercial/office/residential developments and mixed-use centers. The MDTA owns and operates all toll roads in the state including I-95 from the Baltimore City line (south side) to the Delaware State Line, I-895 including spurs to I-97 and MD 2, MD 695 from east of MD 10 to MD 151, the Hatem Bridge (US 40), the Chesapeake Bay Bridge (US 50/301), the Nice Bridge (US 301) and MD 200 (Intercounty Connector). The Key Bridge, Fort McHenry Tunnel, Harbor Tunnel, and Tydings Memorial Bridge are part of the MDOT MDTA system.

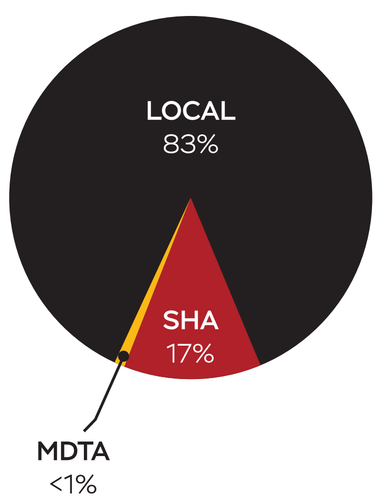
Maryland's' roadway network commenced in 1908 under the direction of the Maryland State Roads Commission. Some of the earliest constructed roads include MD 2, MD 3, MD 4, MD 313, MD 404, US 1 and US 40. The National Highway which later became US 40 was the first federally funded road between Cumberland, Maryland and Wheeling, West Virginia. The interstate system has a long history in Maryland ranging from President John F. Kennedy's dedication of the opening of I-95 in 1963 through the completion of I-97 which uniquely traverses through only one county. Among the last segments of the interstate system to be completed in Maryland include I-68, I-70 through Frederick, I-95 Ft. McHenry Tunnel, I-97 and I-795 which were all built in the last 25 years.

Bridges provide for the valuable connection over waterways, around rail or across other highways. The MDOT SHA roadway network includes 2,569 bridges. Some of the most distinctive bridges include the US 50/US 301 Chesapeake Bay Bridge, the Thomas Johnson Bridge on MD 4 over the Patuxent River, the Harry Nice Bridge on US 301 over the Potomac River and the Key Bridge on Maryland 695 over the Patapsco River.

Road Type	Center Line Miles	Lane Miles
Interstate	488	2,845
US Routes	752	2,677
Maryland Routes	4,156	10,466
County and Other	25,754	52,658

BRIDGES | **CENTER LINE MILES BY OWNERSHIP** | **CENTER LINE MILES BY FUNCTIONAL CLASS**





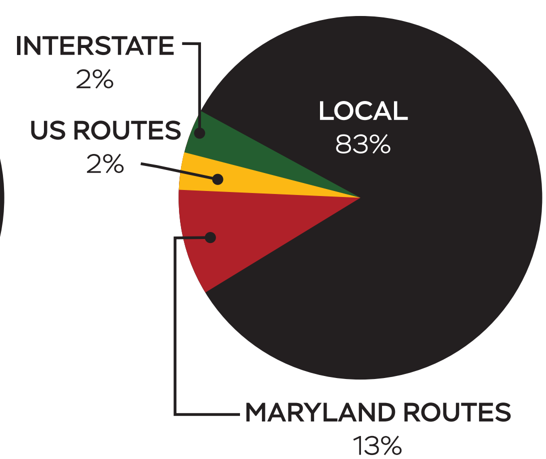
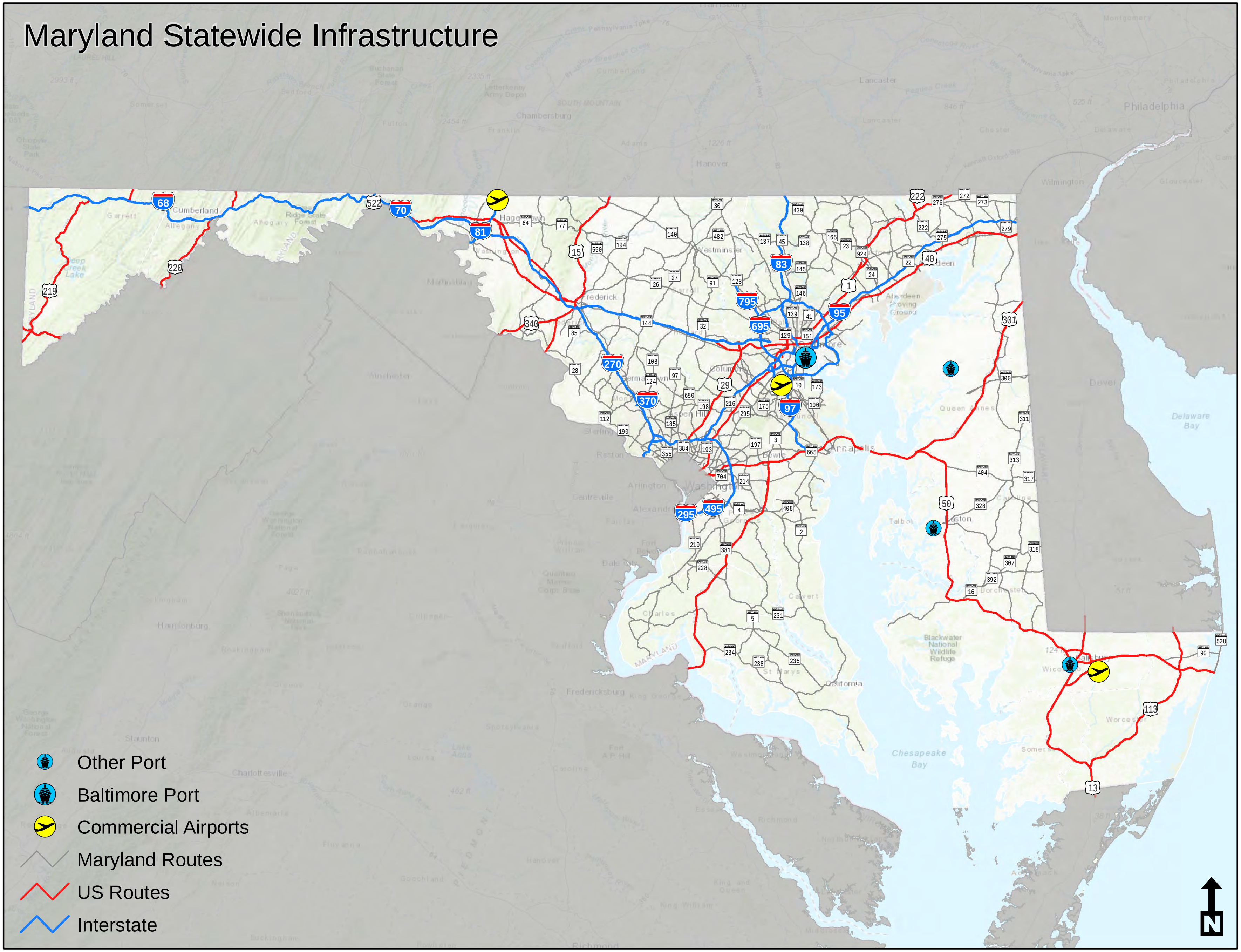


Figure I-1


Maryland Statewide Infrastructure
Other Port
Baltimore Port
Commercial Airports
Maryland Routes
US Routes
Interstate
N

Traffic Trends

Nationally, traffic volumes continue to grow but at a slightly slower pace than the past few years. In 2017, volume grew by 1.2%. This was the sixth straight year of volume increases nationwide although the percentage increase was the lowest since 2014. The trends in Maryland replicate the nationwide pattern.

I-70 West of Frederick

The following facts highlight trip patterns and factors that influence travel in Maryland:

- The American Community Survey identified Maryland as having the second longest commuting times in the nation with an average of 32.4 minutes.
- The 2017 INRIX Traffic Scorecard that analyzes congestion throughout the United States ranked Washington D.C. 6th, Columbia, Maryland 31st, Baltimore 34rd, and Annapolis 49th worst in peak hours spent in congestion. This amounts to 63 hours in Washington, 31 hours for Columbia, 27 hours for Baltimore, and 24 hours for Annapolis. Baltimore and Columbia showed a slight improvement over 2016 levels.
- Approximately 465,000 people or twelve percent (12%) of the people that work in Maryland originate from other states.
- Almost 260,000 people commute from Maryland into Washington, DC to work.
- Maryland's population in 2017 was approximately 6.05 million, about 240,000 people higher than 2010 according to the US Census Bureau. By 2040, population is projected to increase to approximately 6.9 million based on projections from the Maryland Department of Planning. In addition, job growth in Maryland is expected to keep pace with an estimated 600,000 additional jobs between 2015 and 2040 with Montgomery County seeing the largest increase in jobs over that period. In 2017, approximately 26,000 new jobs were created.
- The Energy Administration identified that gas prices for the region increased approximately $0.25/gallon from 2016 to 2017.

A standard performance measure to evaluate overall roadway usage is Vehicle Miles Traveled (VMT). VMT is defined as the number of vehicles times the distance traversed along the system and is calculated for various roadway classifications on a local, regional, state and national level. A comparison of VMT allows for a method to track growth and MDOT SHA's ability to manage the roadway system.

The variation in traffic volumes depends upon the area. Suburbs have seen a greater increase while rural roadways and in the center of cities have seen negative or flat growth over the last several years. In cities, possibly contributing to this is the number of multi-modal options including bicycling, transit and other options such as telecommuting.

For the third straight year a new record was established for statewide VMT. In 2017, the statewide VMT climbed to 59.9 billion vehicle miles, a 1.6% increase over 2016 levels. Travel along and through urban area roadways accounted for all the growth in VMT statewide. Urban area VMT was approximately 49.3 billion, an increase of 0.9 million miles from 2016. The increase in urban VMT could be attributed to the strong job and population growth in the Baltimore-Washington area. Rural VMT remained flat between 2016 and 2017. Figure I-2 shows statewide VMT in the last 4 years.

Maryland VMT grew by 1.6% exceeding the national average of 1.2%.

NEARLY

60

Billion miles VMT

39.3

billion miles occur on MDOT SHA roadways

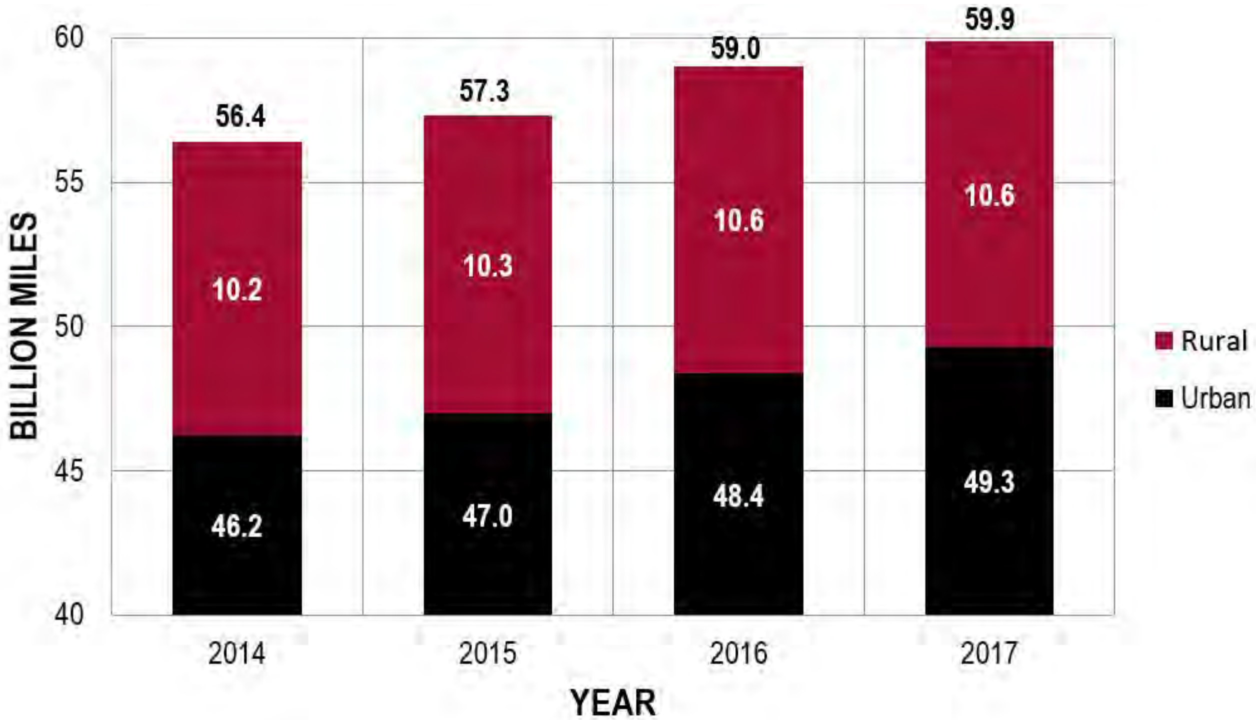
Montgomery/Prince George's Counties

195

Million Mile VMT increase, highest of any county.

Figure I-2

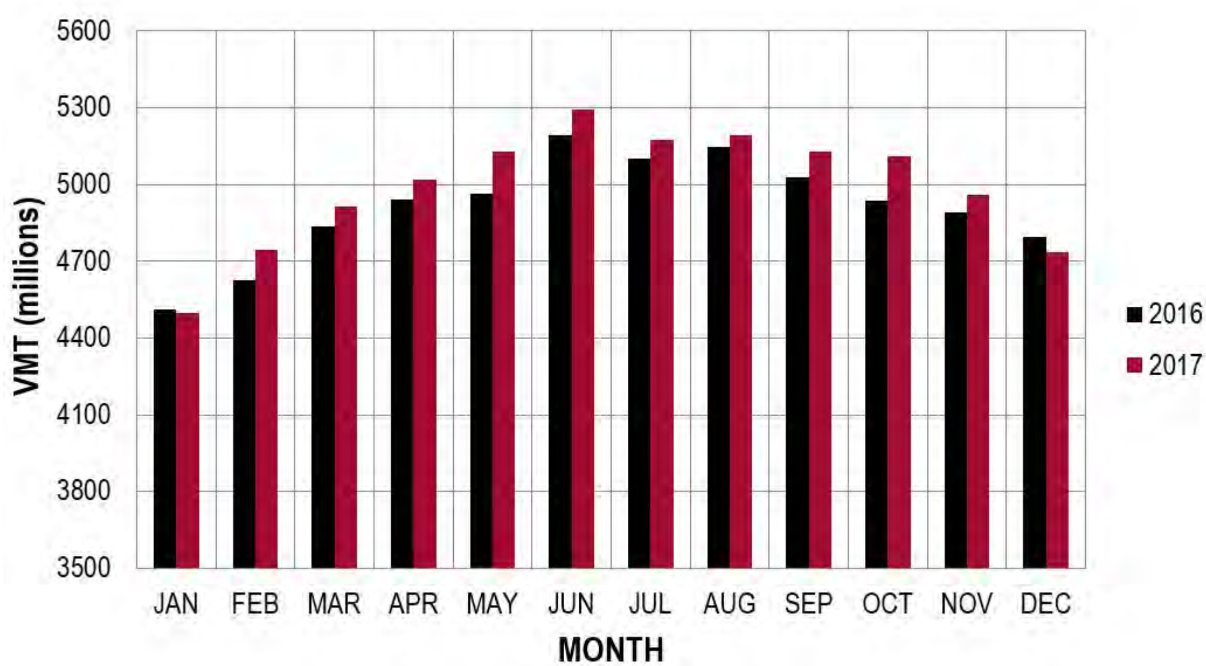
MARYLAND VEHICLE MILES OF TRAVEL (BILLIONS)

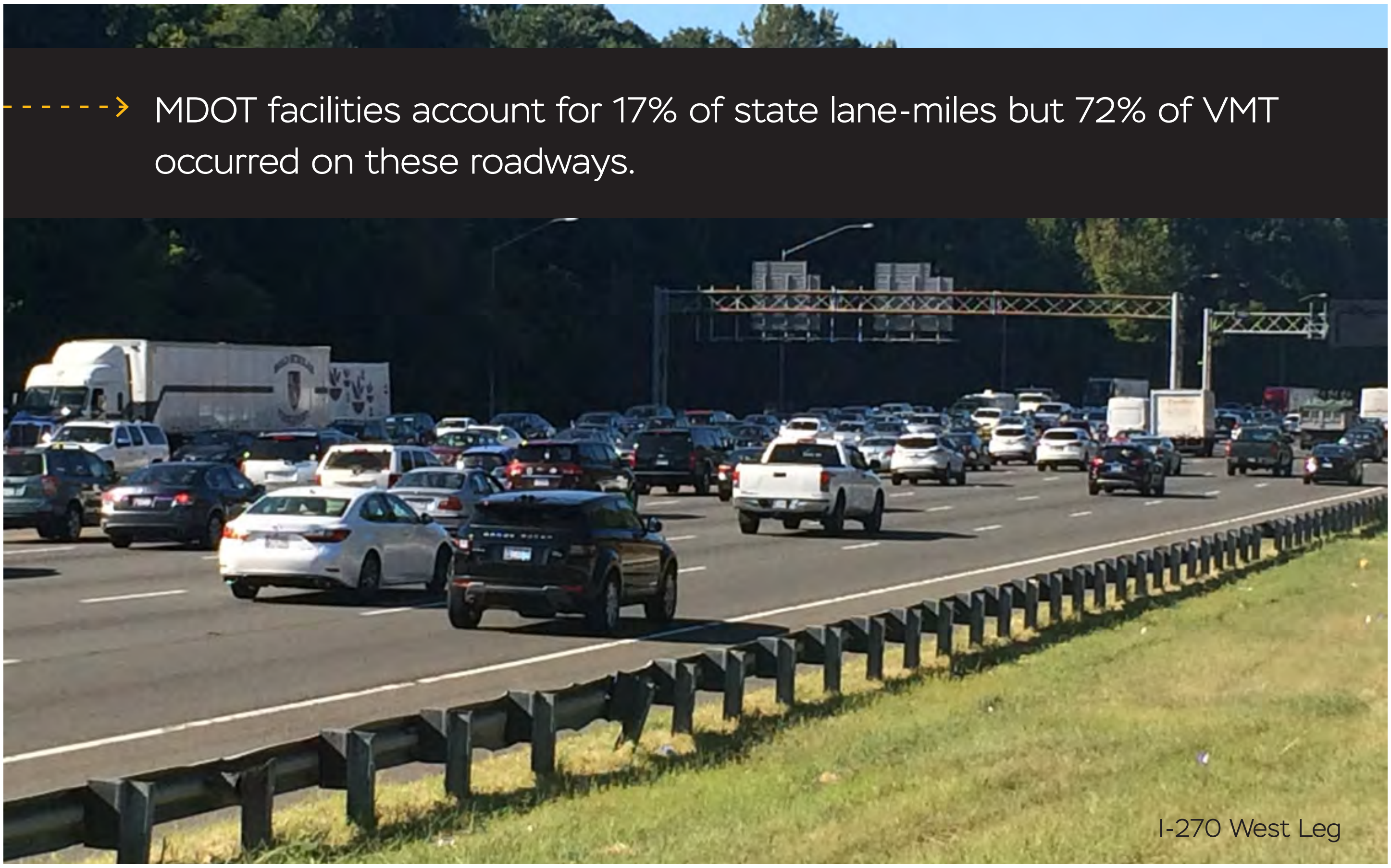


The monthly distribution of VMT is shown in Figure I-3 which depicts that 10 of the 12 months saw an increase in travel over the previous year.

Figure I-3

MONTHLY DISTRIBUTION OF ANNUAL VEHICLE MILES OF TRAVEL



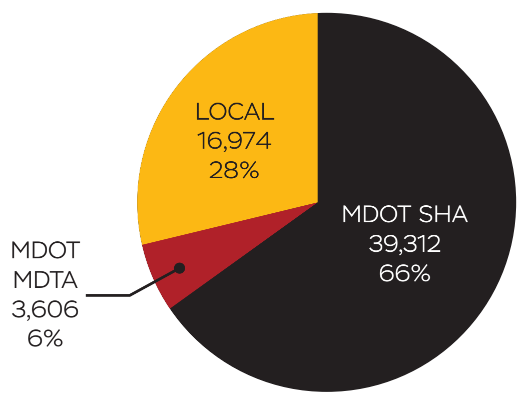


The majority of VMT occurs on state and toll maintained roadways. MDOT facilities account for only 17% of the states lane miles, but 72% of the VMT occurs on these roadways. The VMT on MDOT SHA roadways was 39.3 billion, which was an increase of approximately 685 million miles (1.8%). The 2017 VMT along local roadways increased to 17.0 billion from 16.8 billion (0.9%) in 2016. Figure I-4 shows VMT by ownership and the type of roadway.

The change in VMT from 2016 to 2017 varies based on the county. The largest VMT increase occurred in Montgomery and Prince George's Counties with both counties increasing by almost 200 million VMT. Queen Anne's County saw the biggest decrease down 25 million from 2016 levels. On a percentage basis Worcester County experienced a growth of over 4% or greater while Caroline County experienced a decrease of over 3%. Figure I-5 identifies the total VMT on a county by county basis and the change in VMT in each County.

Figure I-4

2017 VMT BY OWNERSHIP (MILLION)



2017 VMT BY ROADWAY TYPE (MILLION)

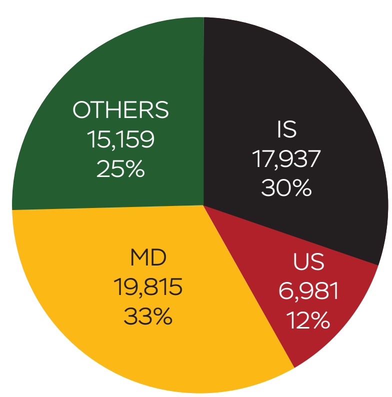
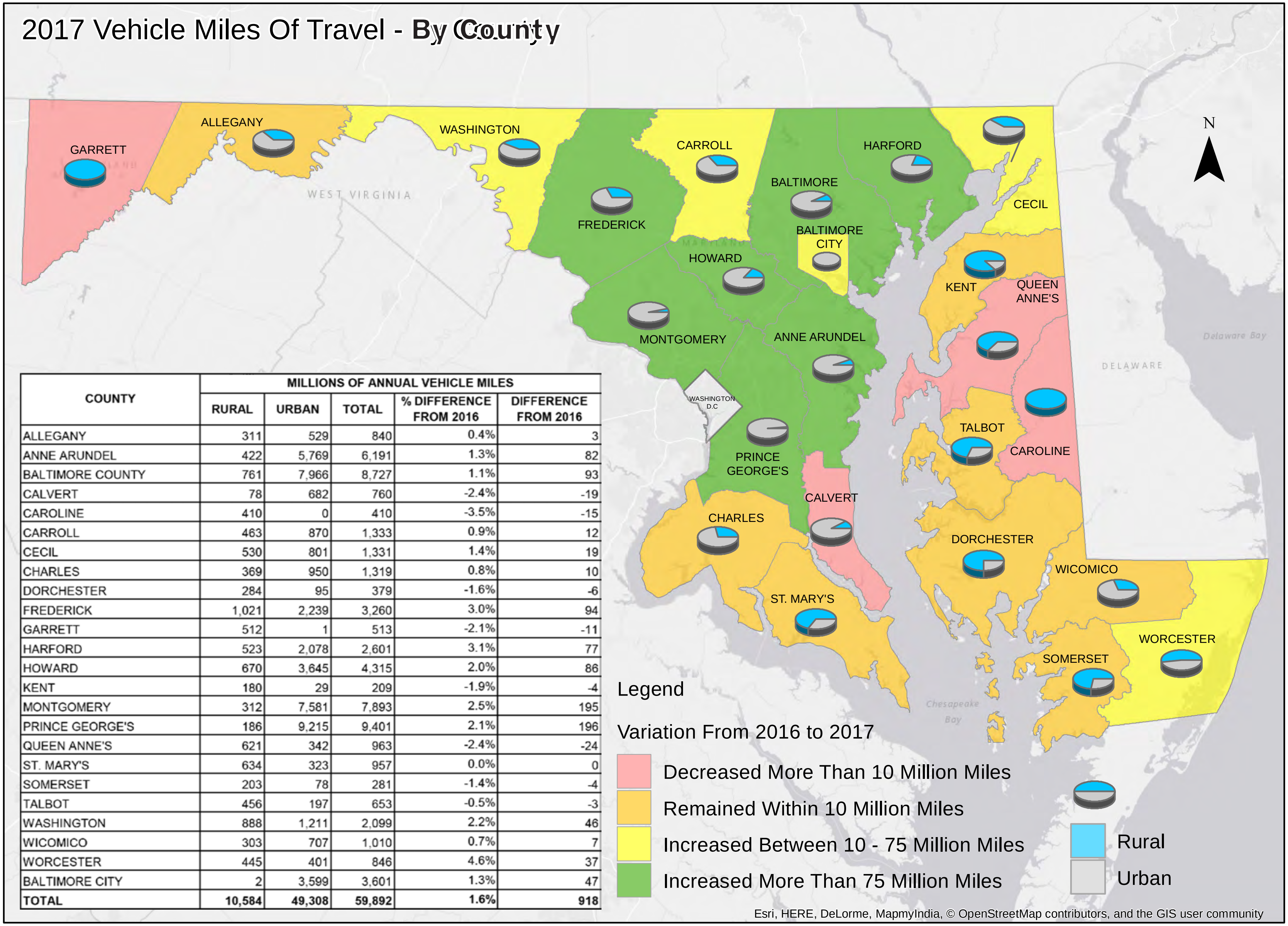


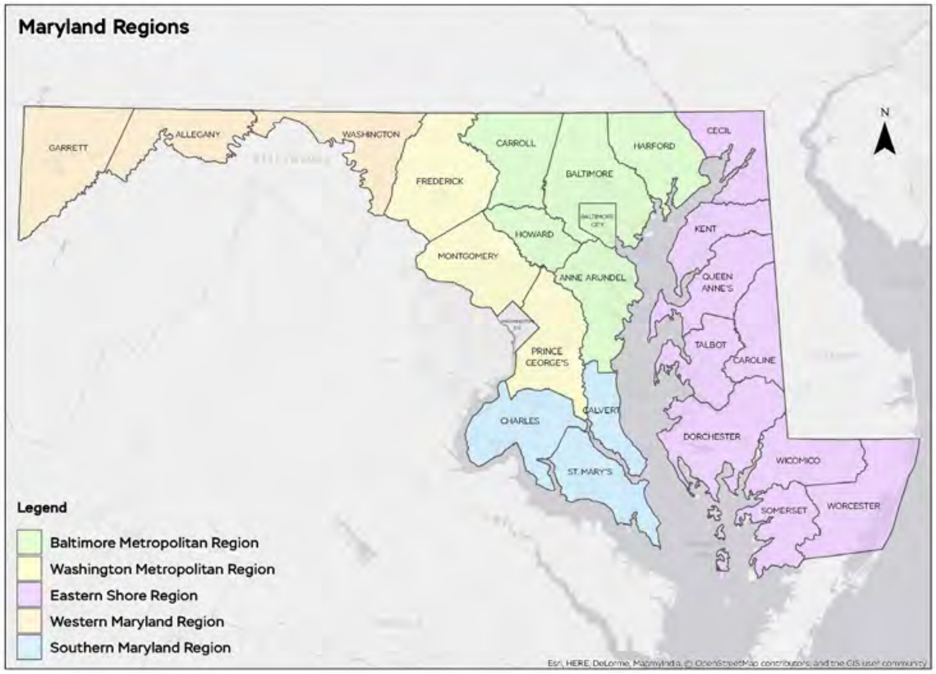
Figure I-5



COUNTY	MILLIONS OF ANNUAL VEHICLE MILES				
	RURAL	URBAN	TOTAL	% DIFFERENCE FROM 2016	DIFFERENCE FROM 2016
ALLEGANY	311	529	840	0.4%	3
ANNE ARUNDEL	422	5,769	6,191	1.3%	82
BALTIMORE COUNTY	761	7,966	8,727	1.1%	93
CALVERT	78	682	760	-2.4%	-19
CAROLINE	410	0	410	-3.5%	-15
CARROLL	463	870	1,333	0.9%	12
CECIL	530	801	1,331	1.4%	19
CHARLES	369	950	1,319	0.8%	10
DORCHESTER	284	95	379	-1.6%	-6
FREDERICK	1,021	2,239	3,260	3.0%	94
GARRETT	512	1	513	-2.1%	-11
HARFORD	523	2,078	2,601	3.1%	77
HOWARD	670	3,645	4,315	2.0%	86
KENT	180	29	209	-1.9%	-4
MONTGOMERY	312	7,581	7,893	2.5%	195
PRINCE GEORGE'S	186	9,215	9,401	2.1%	196
QUEEN ANNE'S	621	342	963	-2.4%	-24
ST. MARY'S	634	323	957	0.0%	0
SOMERSET	203	78	281	-1.4%	-4
TALBOT	456	197	653	-0.5%	-3
WASHINGTON	888	1,211	2,099	2.2%	46
WICOMICO	303	707	1,010	0.7%	7
WORCESTER	445	401	846	4.6%	37
BALTIMORE CITY	2	3,599	3,601	1.3%	47
TOTAL	**10,584**	**49,308**	**59,892**	**1.6%**	**918**

Maryland is subdivided into five geographic regions as shown in Figure I-6 for analysis purposes.

Figure I-6



The five geographical regions in Maryland are: Baltimore Metropolitan; Washington Metropolitan; Southern Maryland; Eastern Shore; and Western Maryland.

BALTIMORE METROPOLITAN REGION

- Anne Arundel (AA)
- Baltimore (BC) City
- Baltimore (BA)
- Carroll (CL)
- Harford (HA)
- Howard (HO)

WASHINGTON METROPOLITAN REGION (MARYLAND COUNTIES)

- Frederick (FR)
- Montgomery (MO)
- Prince George's (PG)

SOUTHERN MARYLAND

- Calvert (CA)
- Charles (CH)
- St. Mary's (SM)

EASTERN SHORE

- Caroline (CO)
- Cecil (CE)
- Dorchester (DO)
- Kent (KE)
- Queen Anne's (QA)
- Somerset (SO)
- Talbot (TA)
- Wicomico (WI)
- Worcester (WO)

WESTERN MARYLAND

- Allegany (AL)
- Garrett (GA)
- Washington (WA)

The MDOT SHA county abbreviation is in parenthesis.

- - -> Three of the five regions including Baltimore, Washington, and Western saw a growth in VMT in 2017 as depicted in Table I-3.

Table I-1

VMT BY REGION (BILLIONS)					
VMT	**2014**	**2015**	**2016**	**2017**	**CHANGE 2016 TO 2017**
Baltimore Region	25.2	25.6	26.4	26.8	0.4
Washington Region	19.2	19.5	20.0	20.5	0.5
Southern Region	2.9	3.0	3.1	3.0	-0.1
Eastern Shore Region	5.8	5.9	6.1	6.1	0.0
Western Region	3.3	3.3	3.4	3.5	0.1
Total	**56.4**	**57.3**	**59.0**	**59.9**	**0.9**

- - -> The highest volume MDOT SHA freeway and arterial roadways based on the MDOT SHA Traffic Volume Maps is depicted in Table I-2. The majority of these roadways are in Montgomery and Prince George's Counties. Table I-2 also shows the highest volumes for MDTA toll facilities.

Table I-2

HIGHEST AVERAGE DAILY TRAFFIC (ADT) VOLUMES	
Freeway Section	2017 ADT
I-270 N of I-270 Split	267,000
I-270 N of Montrose Road	263,000
I-495 E of MD 650	254,000
I-495 N of Virginia State Line	253,000
I-495 N of MD 190	249,000
Arterial Section	2016 ADT
US 301/MD 5 S of McKendree Rd	99,000
MD 5 S of MD 223	82,000
MD 3 N of MD 424	81,000
MD 3 N of Prince George's Co Line	81,000
MD 650 S of I-495	81,000
MDTA Toll Facility Crossings	2016 ADT
I-95 Ft. McHenry Tunnel	124,000
I-95 Tydings Bridge	86,000
I-895 Harbor Tunnel	78,000
US 50/301 Bay Bridge	74,000

B.

CONGESTION AND RELIABILITY TRENDS

US 50 @ the Bay Bridge

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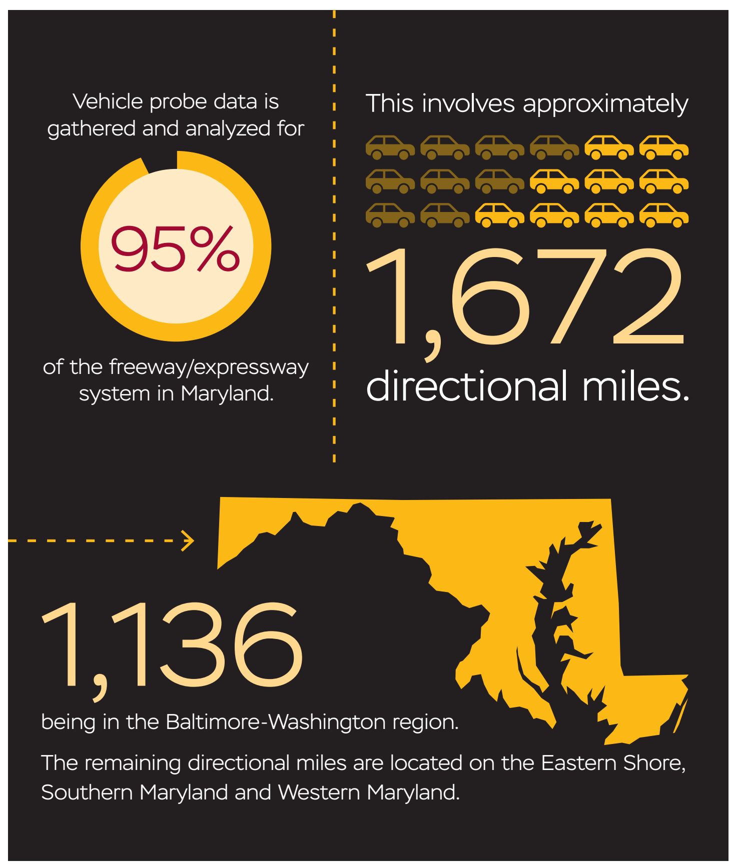
Congestion Trends

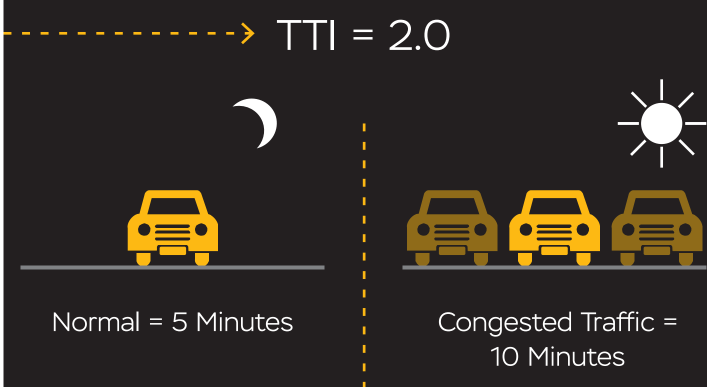
The ease of mobility on Maryland roadways is influenced by the amount of congestion that drivers face. There are two types of congestion that motorists may experience. The first type of congestion is the general everyday congestion that normally occurs due to capacity constraints in the morning (AM) and afternoon (PM) peak periods. This is referred to as recurring congestion. Factors that influence the level of congestion include high automobile and truck traffic volumes, restricted geometrics or narrow lane widths and shoulder widths. Sections of a freeway where motorists merge or diverge from the roadway, where the volume is greater than the capacity, or in weave sections where traffic is both trying to enter or exit from the freeway are locations that experience localized recurring congestion. In addition, along arterials motorists confront delays at traffic signals, trying to enter the mainline from the side streets, and from motorists driving at different speeds. These are instances of recurring congestion.

The second type of congestion is non-recurring. This relates to events including crashes, vehicle breakdowns, work zones, and inclement weather that cause motorists to experience slowing or stop and go conditions. The impacts of a congested system are detrimental to the individual user and businesses, including increased costs, environmental impacts, and degradation of the overall quality of life.

The primary source for many years to measure congestion was the Highway Capacity Manual which utilizes various factors to determine a level of service from A to F. This was based on a sample of traffic count data. Although still used today other methods have been developed to measure congestion. Vehicle probe speed data sets are now available from a variety of private sources on a minute by minute basis over the entire year. Probes are sensors in GPS systems integrated into vehicles that transmit real time data. This data, together with analyses methodologies that have been developed and tested over time, provides a snapshot of mobility for travelers using the highway system in Maryland. The data for the analysis in Maryland is from INRIX, a company that provides both real-time and historic traffic speed data collected from an estimated 100 million probe vehicles nationwide including commercial vehicle fleets. Other traffic data is developed from a MDOT SHA led statewide program that collects traffic volume data on all of its roadways in a continual cycle. The University of Maryland Center for Advanced Transportation Technology (UMD CATT) uses the vehicle probe speed data, together with detailed traffic volume data from the MDOT SHA to develop metrics to measure congestion and reliability for major roadways. These congestion and reliability measures are closely coordinated with the Baltimore Regional Transportation Board (BRTB) and National Capital Regional Transportation Planning Board (NCRTPB) Metropolitan Planning Organizations (MPOs) to ensure regional consistency in reporting.



One of the primary measures of congestion on freeways/expressways is referred to as the Travel Time Index (TTI). The TTI compares the average (50th percentile) travel time on a segment of freeway/expressway for a particular hour to the travel time of a trip during off peak (free-flow or uncongested) conditions. The higher the TTI, for a given hour of the day, the longer the travel times. For example, a TTI of 2.0 indicates that a trip that takes 5 minutes in light traffic will take 10 minutes during that hour in a congested condition.



Three key metrics used by MDOT SHA to measure congestion on the freeway/expressway system are:

1. Percent System Congested
2. Percent Peak Hour VMT in Congested Conditions
3. Annual Cost of Congestion

The TTI for each highway segment is calculated to provide an understanding of the statewide freeway/expressway system for average weekday during the AM and PM peak hour conditions. The analysis was conducted on a statewide basis plus broken down into the five major geographic regions.

MDOT SHA, defines the various levels of congestion in four categories based on TTI. These are:

- Uncongested (TTI < 1.15)
- Moderate Congestion (1.15 < TTI < 1.3)
- Heavy Congestion (1.3 < TTI < 2.0)
- Severe Congestion (TTI > 2.0)


I-68 near Rocky Gap

CONGESTION MEASURES ON THE MARYLAND STATE FREEWAY/EXPRESSWAY SYSTEM

1. Percent System Congested

The TTI values were calculated for each segment of the freeway/expressway system in Maryland for an average weekday travel. This analysis was performed for the highest levels of congestion in the morning and afternoon peak hour which occur from 8-9 AM and from 5-6 PM, respectively.

Figures I-7 and I-8 show the average weekday AM and PM peak hour level of congestion on the Maryland freeway/expressway system based on TTI. Heavy to severe congestion is experienced by motorists on the freeway/expressway system when the TTI value is greater than 1.3. The 1.3 value represents the locations motorists travel at or below approximately 75% of the free-flow speed. This occurs on a total of 151 road miles (9% of the statewide freeway/expressway system) during the AM peak hour (8-9 AM). The PM peak hour is more congested than the AM peak hour. For the 5-6 PM peak hour, heavy to severe congestion occurs on a total of 254 road miles, which is 15% of the statewide freeway/expressway system. Between 2016 and 2017, the AM peak hour mileage in heavy to severe congestion increased by 3 road miles, while the PM peak hour showed an increase of 8 roadway miles on the freeway/expressway system for 2017 over 2016.

Each freeway/expressway was analyzed to determine the level of congestion experienced along the entire roadway. This was conducted for both directions in the AM and PM peak hours. Severe congestion (TTI > 2.0) occurs on seven (7) freeways/expressways in the AM peak hours and on ten (10) freeways/expressways in the PM peak hour. I-695 Outer Loop, I-270 southbound (mainline and local), and I-495 Outer Loop are the worse operating roadways with over six miles or more of severe congestion in the AM peak hour. The PM analysis showed that I-495 Inner Loop, I-270 northbound (mainline and local), I-695 Inner Loop, MD 295 northbound, and I-495 Outer Loop all have over five miles of severe congestion. The largest changes occurred along I-95 southbound in the AM peak hour (2.7 additional miles of severe congestion) and I-95 northbound in the PM peak hour (1.8 reduction). The number of miles of severe congestion for each individual facility is shown in Figure I-9.

Nine (9%) and fifteen (15%) of the Maryland freeway/expressway system experiences heavy to severe congestion in AM and PM peak hours respectively.

In the AM peak hour, I-695 Outer Loop has the most number of miles of congestion in the State. For the PM peak hour, I-495 Inner Loop has the worst congestion.

I-695 @ Providence Road

Figure I-7

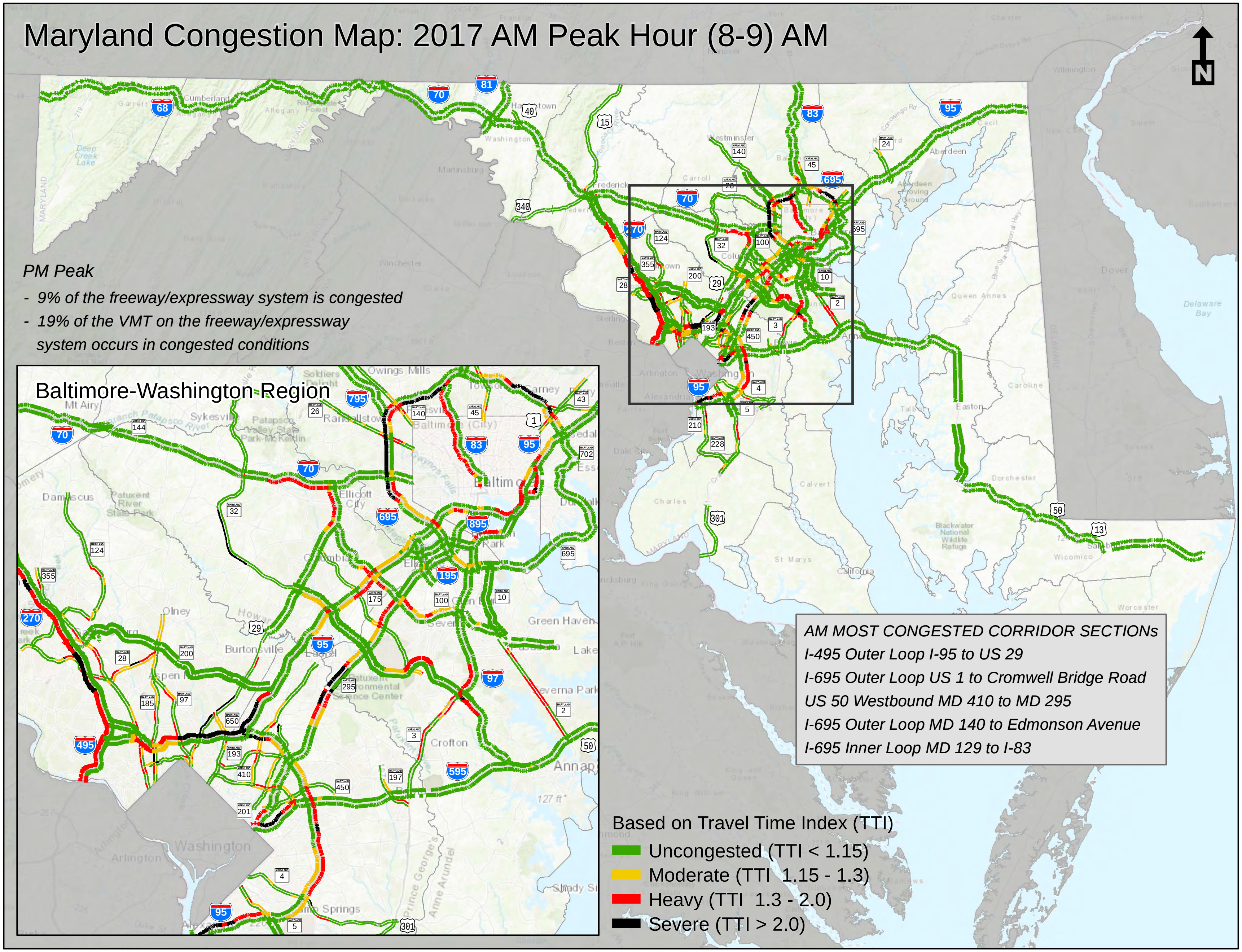

Maryland Congestion Map: 2017 AM Peak Hour (8-9) AM
PM Peak
- 9% of the freeway/expressway system is congested
- 19% of the VMT on the freeway/expressway system occurs in congested conditions
Baltimore-Washington Region
AM MOST CONGESTED CORRIDOR SECTIONs
I-495 Outer Loop I-95 to US 29
I-695 Outer Loop US 1 to Cromwell Bridge Road
US 50 Westbound MD 410 to MD 295
I-695 Outer Loop MD 140 to Edmonson Avenue
I-695 Inner Loop MD 129 to I-83
Based on Travel Time Index (TTI)
Uncongested (TTI < 1.15)
Moderate (TTI 1.15 - 1.3)
Heavy (TTI 1.3 - 2.0)
Severe (TTI > 2.0)
N

Figure I-8

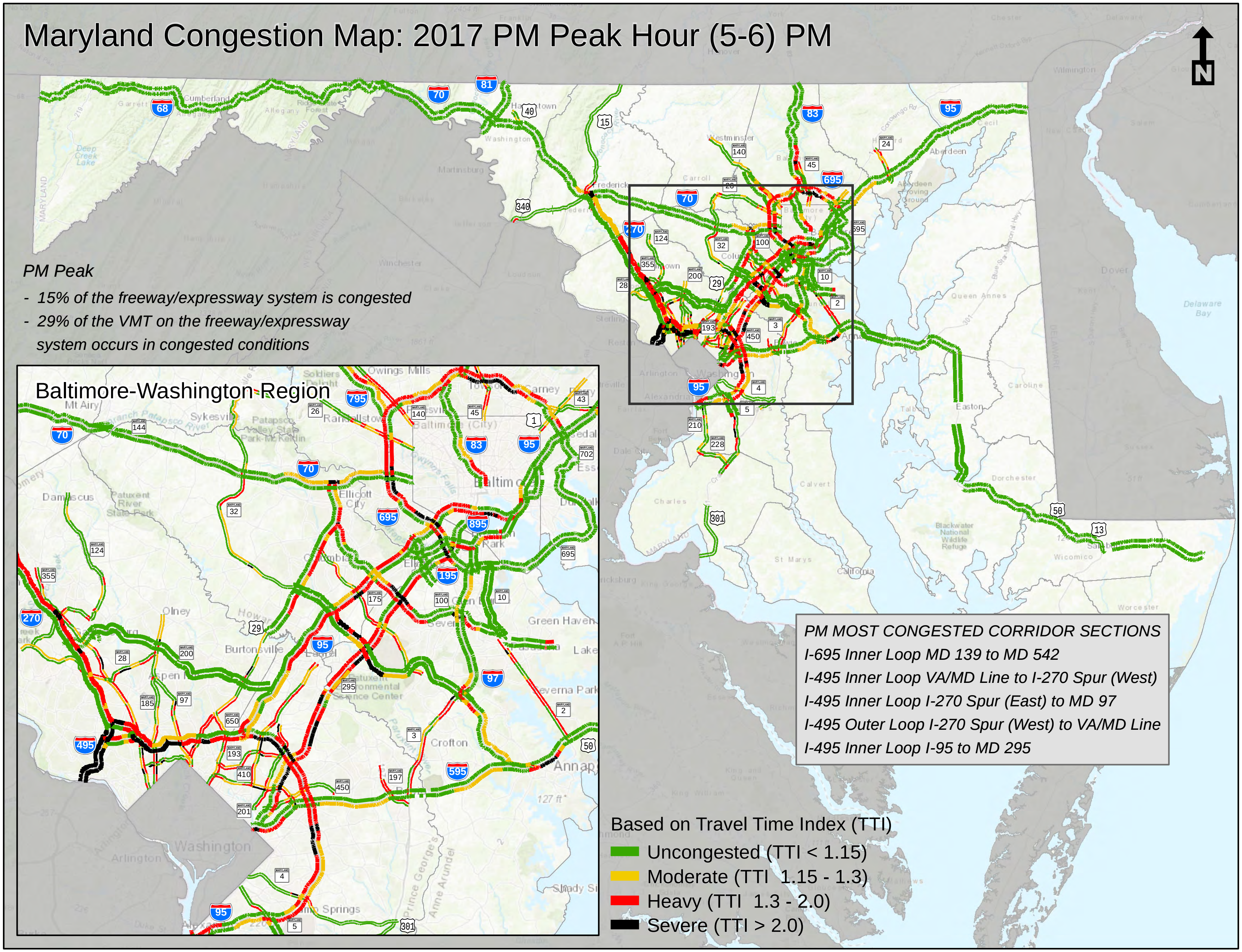
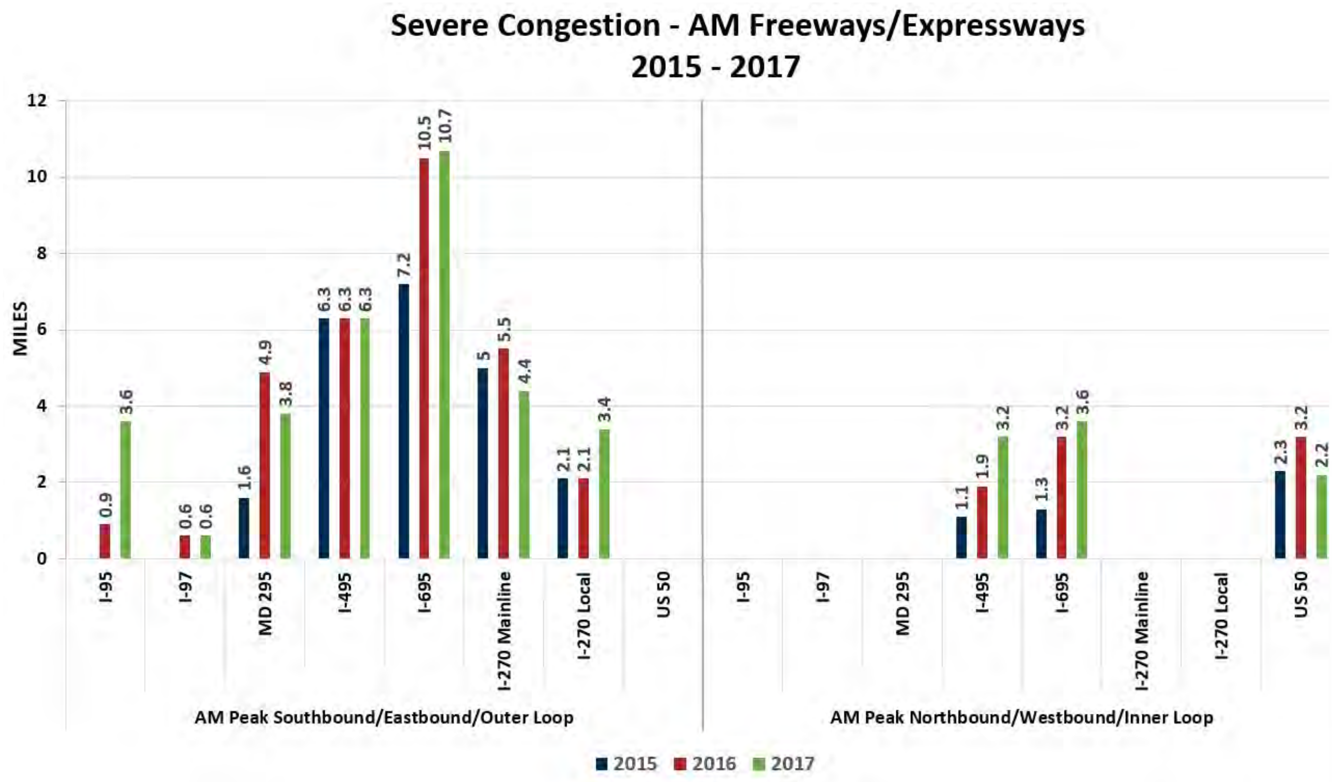
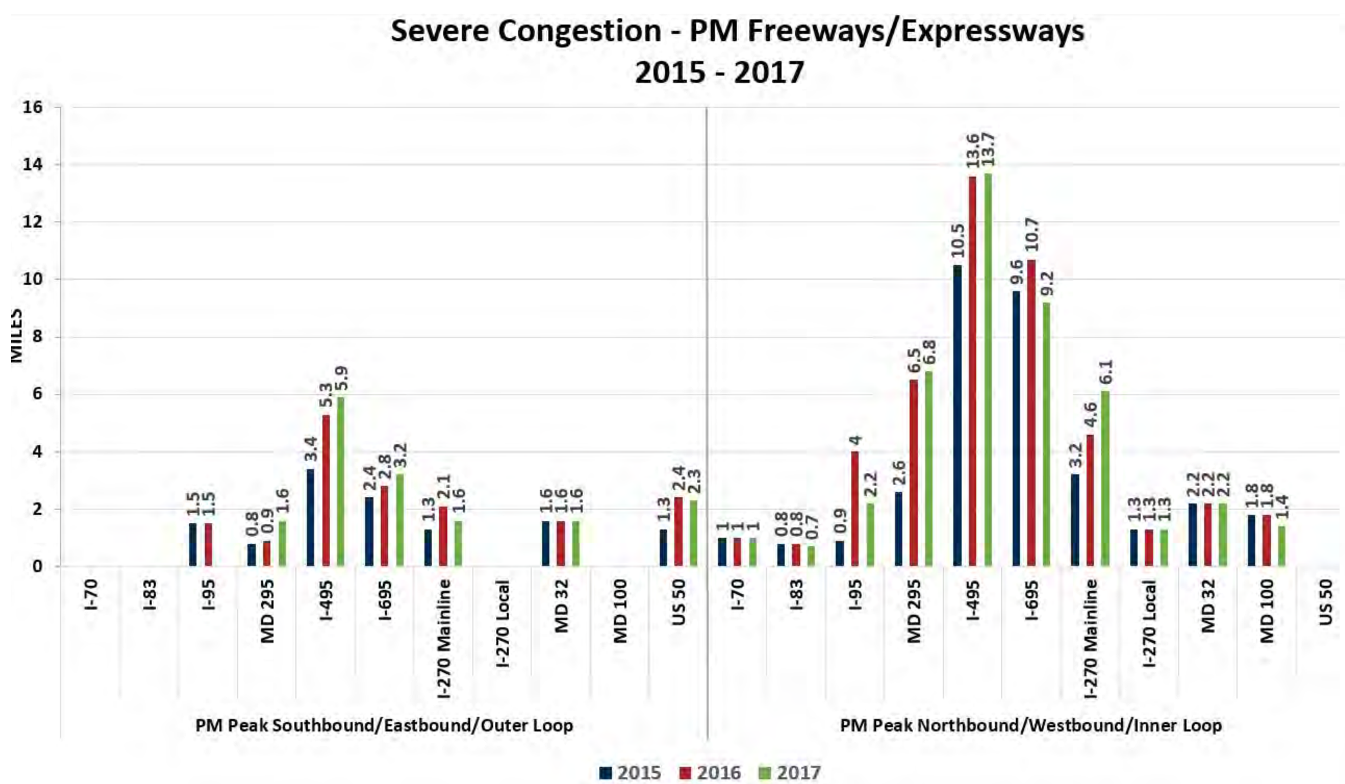

Maryland Congestion Map: 2017 PM Peak Hour (5-6) PM
PM Peak
- 15% of the freeway/expressway system is congested
- 29% of the VMT on the freeway/expressway system occurs in congested conditions
Baltimore-Washington Region
PM MOST CONGESTED CORRIDOR SECTIONS
I-695 Inner Loop MD 139 to MD 542
I-495 Inner Loop VA/MD Line to I-270 Spur (West)
I-495 Inner Loop I-270 Spur (East) to MD 97
I-495 Outer Loop I-270 Spur (West) to VA/MD Line
I-495 Inner Loop I-95 to MD 295
Based on Travel Time Index (TTI)
Uncongested (TTI < 1.15)
Moderate (TTI 1.15 - 1.3)
Heavy (TTI 1.3 - 2.0)
Severe (TTI > 2.0)
N

Figure I-9



Severe Congestion - AM Freeways/Expressways
2015 - 2017
MILES
AM Peak Southbound/Eastbound/Outer Loop
AM Peak Northbound/Westbound/Inner Loop
I-95
I-97
MD 295
I-495
I-695
I-270 Mainline
I-270 Local
US 50
2015
2016
2017



Severe Congestion - PM Freeways/Expressways
2015 - 2017
MILES
PM Peak Southbound/Eastbound/Outer Loop
PM Peak Northbound/Westbound/Inner Loop
I-70
I-83
I-95
MD 295
I-495
I-695
I-270 Mainline
I-270 Local
MD 32
MD 100
US 50
2015
2016
2017

The majority of the average weekday congestion occurs in the Baltimore - Washington region. The roadways in this region have the highest traffic volumes consisting of a mixture of commuting and through travel plus visitors to the region. The high traffic volumes impact mobility by reducing speeds not only to motorists but also to on-road transit and freight operators.

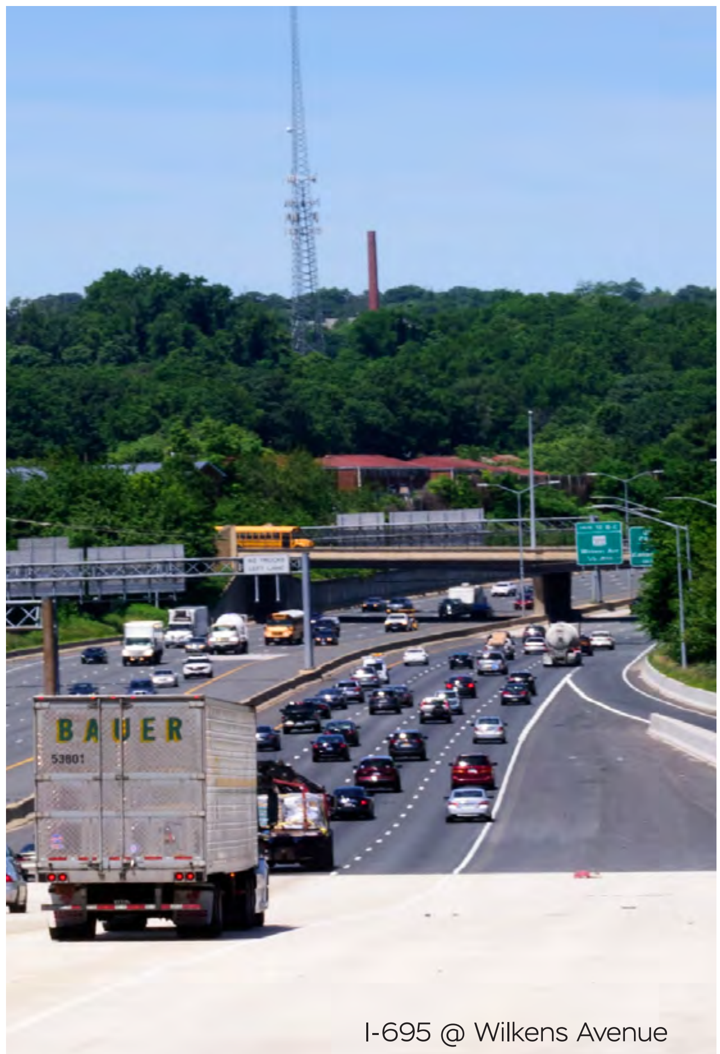
The most congested locations on the Eastern Shore, Southern Maryland and Western Maryland are limited to select areas. The Eastern Shore including northeast Maryland is characterized by seasonal congestion along the US 50 and I-95 corridors. Kent Island and the Town of Elkton experience more traditional peak period operational issues. In Southern Maryland, corridors such as US 301, MD 5, MD 228, and MD 2/4 experience congestion as commuters utilize these roadways to access Washington D.C. and its suburbs. Motorists in the Leonardtown and Lexington Park area encounter congestion along MD 4, MD 5 and MD 235 in peak periods. The highest levels of congestion in Western Maryland occurs mainly near the Hagerstown area and at certain times along I-70. Congestion in these regions also occurs at three major bridge structures where the roadway approaching the structure is four lanes while the bridge is two lanes. This includes the Nice Bridge (US 301), the Thomas Johnson Bridge (MD 4) and the US 340 bridge over the Potomac River.

2. Percent Peak Hour VMT in Congested Conditions

A second metric that evaluates congestion is the amount of VMT travel that occurs in heavy to severe conditions. This measure takes into account how many motorists and the distance they travel are impacted by this level of congestion.

On Maryland freeways/ expressways, nineteen (19)% of the AM peak hour VMT and 29% of the PM peak hour VMT occur in heavy to severe congested conditions.

The amount of VMT occurring in heavy to severe congestion statewide has increased slightly over the past year. The percent of peak hour VMT occurring in these conditions increased by 2% in the AM peak hour and 3% PM peak hour compared to 2016.



I-695 @ Wilkens Avenue

A summary of the congestion metrics for the last three years is shown in Table I-4.

Table I-4

STATEWIDE FREEWAY/EXPRESSWAY SYSTEM (AVERAGE WEEKDAY AM & PM PEAK HOUR HEAVY TO SEVERE CONGESTION SUMMARY)								
HEAVY TO SEVERE CONGESTION	2015		2016		2017		CHANGE 2016 TO 2017	
	AM	PM	AM	PM	AM	PM	AM	PM
Roadway Miles	149	252	148	246	151	254	+3	+8
Percent of Roadway Miles	9	15	9	15	9	15	0	0
Percent of Peak Hour VMT Impacted	18	27	17	26	19	29	+2	+3

3. Statewide Annual Cost of Congestion on the Freeway/Expressway Network (Under Review)

The statewide cost of congestion was estimated based on the auto delay, truck delay, and wasted fuel and emissions that occurs on the freeway/expressway system on a statewide and region-wide basis. The statewide cost for 2017 is estimated to be $2.87 billion which includes:

- Auto Delay Cost: $2.46 billion
- Truck Delay Cost: $256 million
- Wasted Fuel Cost: $84 million
- Emissions Cost: $73 million

Freeway/expressway congestion cost motorists $2.87 billion in 2017.

The cost of congestion was broken down by region. The Washington region accounts for approximately 62% of the overall congestion cost which is the highest statewide. This was about $507 million greater than last year which is the largest increase in the State. The Baltimore region accounts by approximately 37% of the congestion cost. This was a $252 million over 2016. The cost associated with congestion for the Eastern Shore, Southern and Western Maryland regions is estimated at $23 million, which is $4 million higher than last year. The overall State and region wide congestion costs for this year and previous three years is depicted in Table I-5.

Table I-5

TOTAL COST OF CONGESTION ON FREEWAYS/EXPRESSWAYS ($ MILLIONS)				
REGION	2015	2016	2017	CHANGE 2016 TO 2017
Statewide	2,052	2,111	2,874	+763
Baltimore Region	806	827	1,079	+252
Washington Region	1,222	1,265	1,772	+507
Eastern Shore Region	20	14	17	+3
Southern Region	1	2	2	0
Western Region	3	3	4	+1

The delay experienced by motorists account for approximately 86% of the costs associated with congestion. The cost breakdown is illustrated in Figure I-11.

Figure I-10

PERCENT OF STATEWIDE CONGESTION COST BY REGION FOR FREEWAY/EXPRESSWAY ROUTES

(TOTAL CONGESTION COST = $2.87 BILLION)

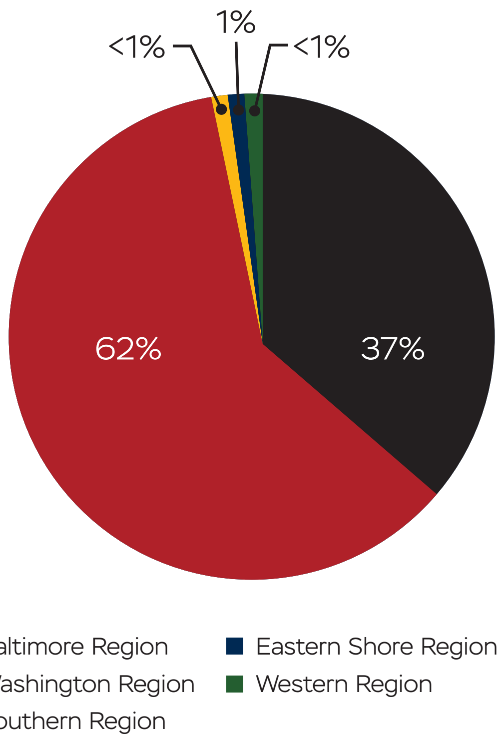
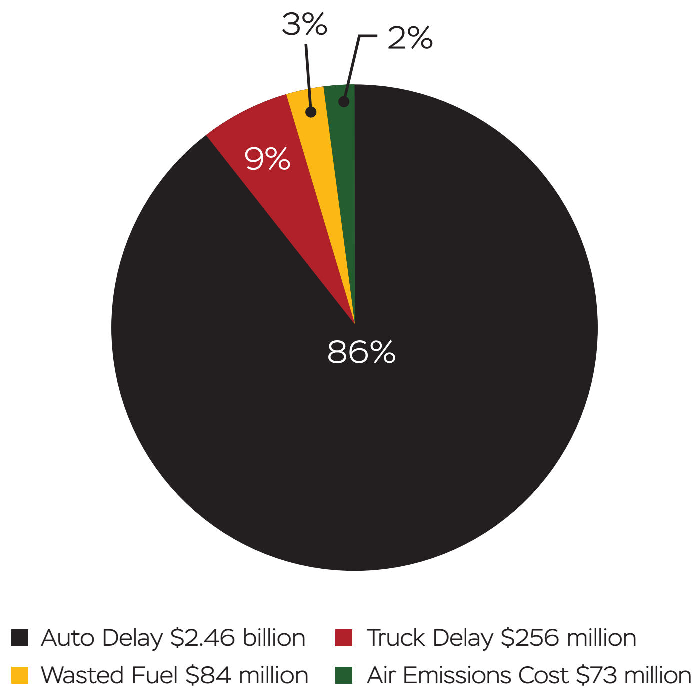


Figure I-11

PERCENT OF STATEWIDE CONGESTION COST BY SOURCE

(TOTAL CONGESTION COST = $2.87 BILLION)



TOP 15 FREEWAY/EXPRESSWAY CONGESTED CORRIDOR SECTIONS

The Top 15 most congested freeway/expressway corridors were determined. This analysis was accomplished to determine the freeways and expressways that experience the highest levels of congestion based on the TTI. The individual segments utilized to develop the TTI were combined together to develop roadway corridor sections with similar characteristics. These corridors range from approximately three (3) miles to eight (8) miles in length with the exception of entire freeways (I-370) or spurs (I-270 East and West leg). The length of the corridor was based on the individual segment TTI and engineering judgement for logical limits. A weighted average was developed for each corridor section by multiplying the individual segment TTI by the segment length for each segment and dividing it by the total section length. The Top 15 Corridor Sections were developed for the AM and PM peak hours.

Tables I-6 and I-7 and Figures I-12 and I-13 identify the Top 15 freeway/expressway corridor locations.

Table I-6

2017 MOST CONGESTED FREEWAY/EXPRESSWAY CORRIDORS - AM PEAK HOUR

AM Rank	Route/Direction	Limits	TTI Value	County	Mileage
1	I-495 Outer Loop	I-95 to US 29	4.4	Montgomery/ Prince George’s	3.4
2	I-695 Outer Loop	US 1 to Cromwell Bridge Road	2.8	Baltimore	3.3
3	US 50 WB	MD 410 to MD 295	2.4	Prince George’s	3.7
4	I-695 Outer Loop	MD 140 to Edmonson Avenue	2.4	Baltimore	8.1
5	I-695 Inner Loop	MD 129 to I-83	2.3	Baltimore	3.9
6	I-270 SB	I-370 to Montrose Road	2.2	Montgomery	5.7
7	MD 295 SB	MD 198 to Powder Mill Road	2.2	Anne Arundel/ Price George’s	5.2
8	I-495 Inner Loop	MD 414 to I-295	2.1	Prince George’s	3.5
9	I-270 (Local) SB	I-370 to Montrose Road	2.1	Montgomery	5.0
10	I-95 SB	South of MD 200 to I-495	2.0	Prince George’s	4.2
11	I-270 SB	Father Hurley Blvd. to MD 124	1.9	Montgomery	4.0
12	I-270 Spur SB	I-270 Split to I-495 (West)	1.8	Montgomery	2.1
13	I-97 SB	Benfield Blvd. to MD 178	1.8	Anne Arundel	4.0
14	I-495 Outer Loop	MD 202 to MD 450	1.7	Prince George’s	3.6
15	US 29 SB	I-70 to MD 100	1.5	Howard	3.1

Figure I-12

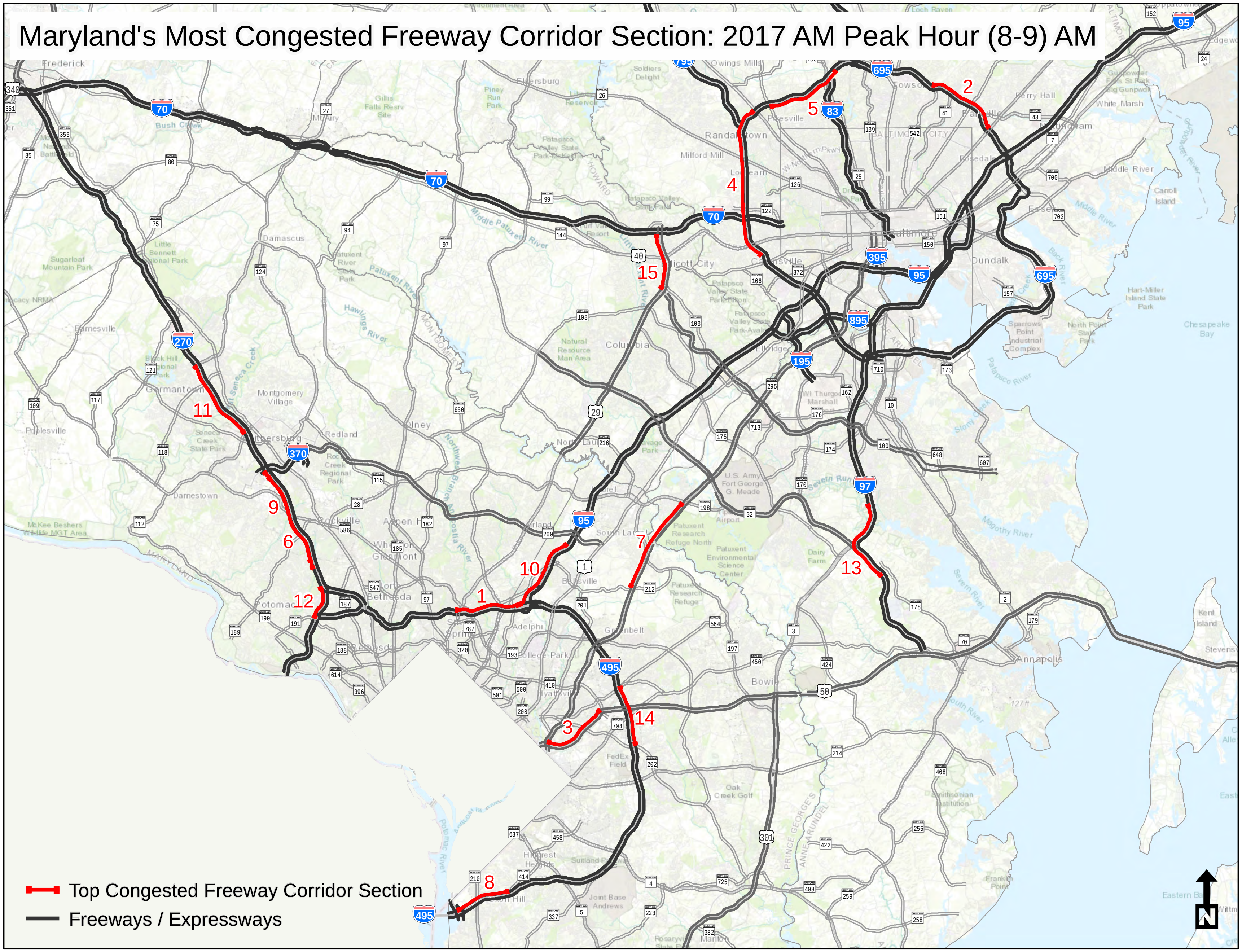
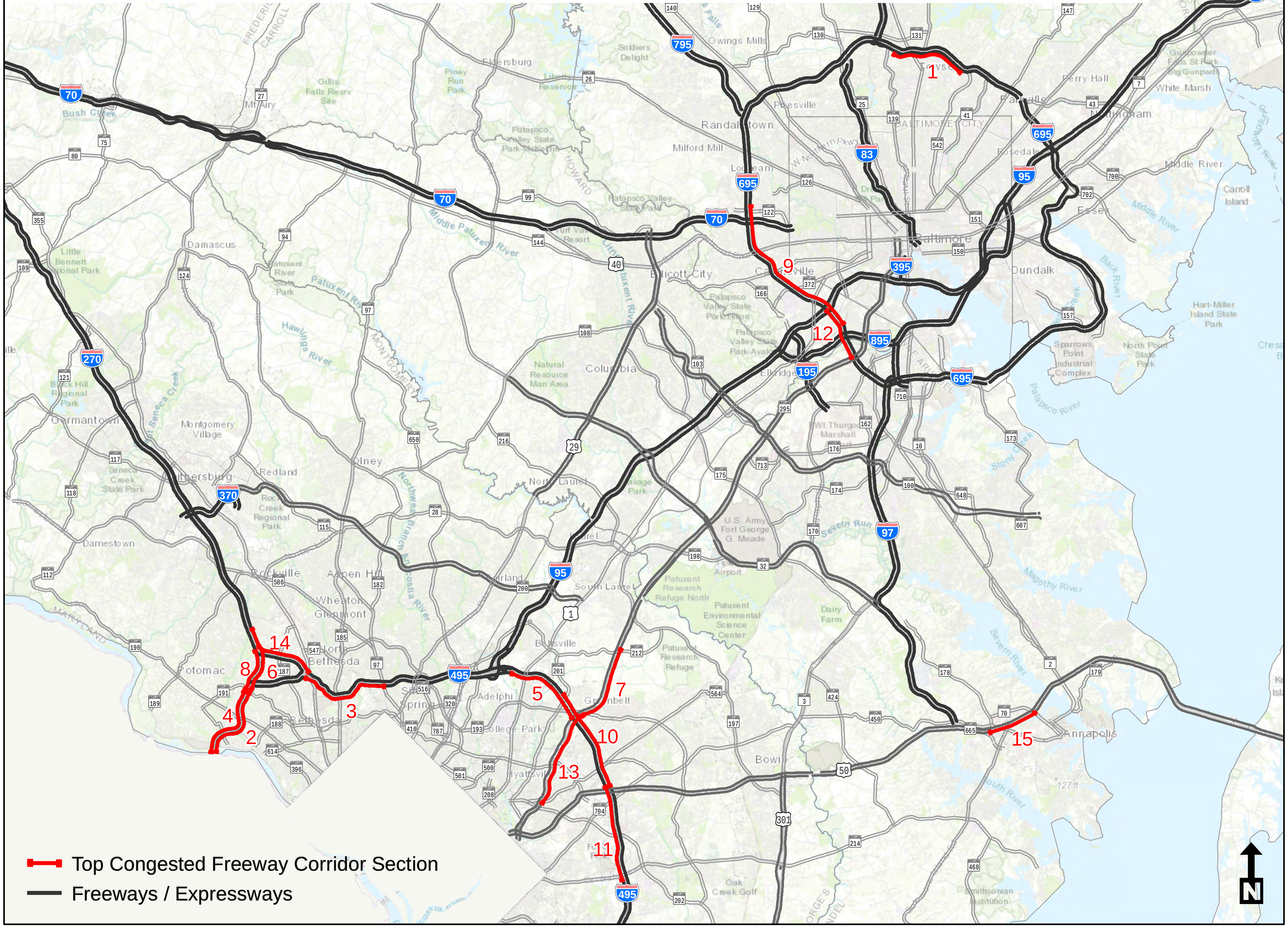

Maryland's Most Congested Freeway Corridor Section: 2017 AM Peak Hour (8-9) AM
Top Congested Freeway Corridor Section
Freeways / Expressways
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Table I-7

2017 MOST CONGESTED FREEWAY/EXPRESSWAY CORRIDORS - PM PEAK HOUR					
PM Rank	Route/Direction	Limits	TTI Value	County	Mileage
1	I-695 Inner Loop	MD 139 to MD 542	3.5	Baltimore	3.7
2	I-495 Inner Loop	Virginia Line to I-270 West Spur	3.4	Montgomery	3.9
3	I-495 Inner Loop	I-270 East Spur to MD 97	2.8	Montgomery	3.7
4	I-495 Outer Loop	I-270 West Spur to Virginia Line	2.8	Montgomery	3.5
5	I-495 Inner Loop	I-95 to MD 295	2.5	Prince George's	3.2
6	I-270 West Spur NB	I-495 to I-270 Split	2.4	Montgomery	2.3
7	MD 295 NB	I-495/I-95 to Powder Mill Road	2.3	Prince George's	3.6
8	I-270 West Spur SB	I-270 Split to I-495	2.3	Montgomery	2.1
9	I-695 Inner Loop	US 1 Alt to MD 122	2.1	Baltimore	7.5
10	I-495 Outer Loop	US 50 to MD 201	2.1	Prince George's	4.3
11	I-495 Inner Loop	US 50 to MD 214	2.1	Prince George's	5.6
12	I-695 Outer Loop	I-95 to MD 295	2.0	Anne Arundel/ Baltimore	3.4
13	MD 295 NB	MD 450 to I-95/I-495	2.0	Montgomery	3.6
14	I-270 NB	I-495 (East) to Montrose Road	2.0	Montgomery	2.4
15	US 50 EB	MD 665 to MD 70	1.9	Anne Arundel	2.4

Maryland's Most Congested Freeway Corridor Section: 2017 PM Peak Hour (5-6) PM



CONGESTION MEASURES ON THE MARYLAND ARTERIAL SYSTEM

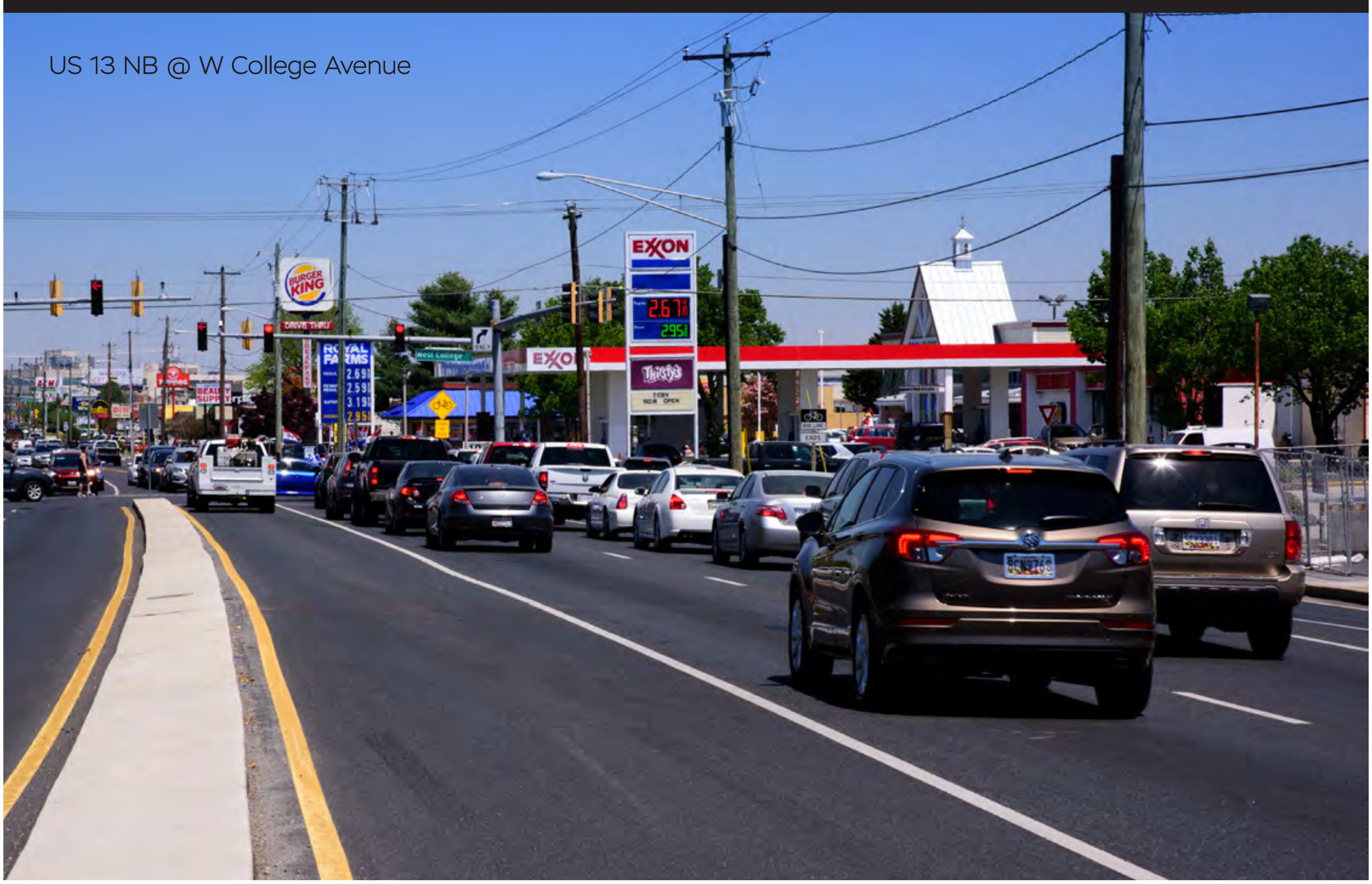
The next highest level of roadways after the freeway/expressway system is the arterial network. Arterials experience the same type of recurring and non-recurring congestion that the freeway/expressway system endures due to over capacity conditions and incidents. In addition, motorists on arterials experience delays due to traffic signals and the interaction of access points. Other factors such as type of median can influence operations. The congestion metrics for arterials as defined by MDOT SHA is divided into the same four measures as freeway/expressway system which are as follows:

- Uncongested (TTI < 1.15)
- Moderate Congestion (1.15 < TTI < 1.3)
- Heavy Congestion (1.3 < TTI < 2.0)
- Severe Congestion (TTI > 2.0)

1. Percent System Congestion

Analysis was performed to determine the TTI values for the major arterial system on an average weekday. This analysis was performed for the highest congested hour in the AM peak (8-9 AM) and the PM peak (5-6 PM). The arterial system analyzed based on vehicle probe data consists of 552 miles of which 494 miles are located within the Baltimore - Washington region. This represents many major arterials but not the entire State system. The results of the analysis are presented in Figure I-8 and I-9.

There are approximately 73 miles (13%) of heavy to severe congestion on the arterial system in the AM peak. Motorists on the arterial system in the PM peak hour face 160 miles of heavy to severe congestion (29%).



US 13 NB @ W College Avenue

2. Statewide Annual Cost of Congestion of the Arterial System

The congestion costs for the roadways analyzed as part of the arterial system were determined taking into account auto delay cost, truck delay cost, wasted fuel and emissions cost. The congestion cost statewide were estimated to be $1.18 billion based on these four factors. This consisted of:

- Auto Delay Cost: $1.01 billion
- Truck Delay Cost: $100.9 million
- Wasted Fuel Cost: $41.4 million
- Air Emission Cost: $30.4 million

TOP 15 ARTERIAL CONGESTED CORRIDORS

The most congested arterial corridors were determined based on the TTI values. Each individual segment was combined together in approximately two (2) to five (5) mile sections. The length of the section was based on the analysis of the individual segment TTI and engineering judgement. The section TTI was developed as a weighted average of TTIs of individual segments. Each of these individual segments were added together and divided by the total length. The Top 15 congested corridors for the AM and PM peak hour are shown in Table I-8 and I-9 and Figures I-14 and I-15.

Congestion cost for the arterial system is $1.18 Billion.

Table I-8

2017 MOST CONGESTED ARTERIAL CORRIDORS - AM PEAK HOUR

AM Rank	Route/Direction	Limits	TTI Value	County	Mileage
1	US 29 Southbound	Cherry Hill Road/Randolph Road to MD 193	2.4	Montgomery	3.8
2	MD 212 Westbound	Beltsville Drive to Powder Mill Road	1.9	Prince George's	2.2
3	MD 210 Northbound	Fort Washington Road to Livingston Road	1.8	Prince George's	2.6
4	MD 28 Westbound	Bel Pre Road to MD 586	1.7	Montgomery	2.6
5	MD 185 Southbound	MD 586 to MD 410	1.6	Montgomery	5.3
6	MD 410 Westbound	MD 650 to US 29	1.6	Montgomery	2.1
7	MD 2 Southbound	College Parkway to US 50	1.5	Anne Arundel	2.7
8	MD 355 Southbound	I-495 to MD 191	1.5	Montgomery	2.2
9	MD 97 Southbound	MD 586 to Seminary Road	1.5	Montgomery	2.0
10	MD 190 Eastbound	Seven Locks Road to MD 614	1.5	Montgomery	2.5
11	MD 190 Eastbound	Luvie Lane to Piney Meetinghouse Road	1.5	Montgomery	2.5
12	MD 201 Southbound	MD 212 to I-495/I-95	1.5	Prince George's	2.4
13	MD 410 Westbound	MD 295 Ramps to US 1	1.5	Prince George's	2.2
14	MD 3 Southbound	Johns Hopkins Road to MD 450/ Defense Highway	1.4	Anne Arundel	2.8
15	MD 97 Southbound	Old Stone Road to MD 140	1.4	Carroll	3.4

Figure I-14

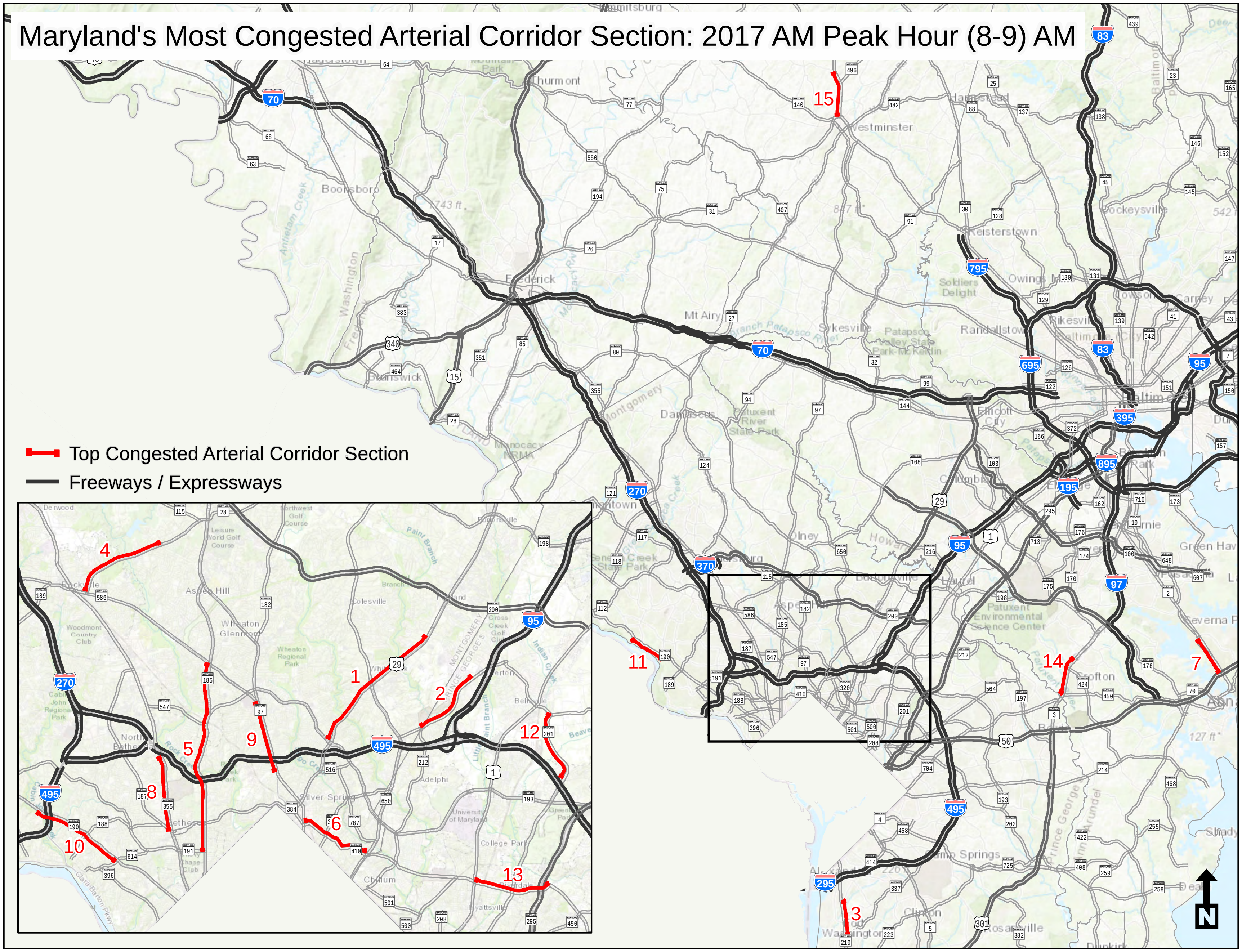

Maryland's Most Congested Arterial Corridor Section: 2017 AM Peak Hour (8-9) AM
Top Congested Arterial Corridor Section
Freeways / Expressways
1
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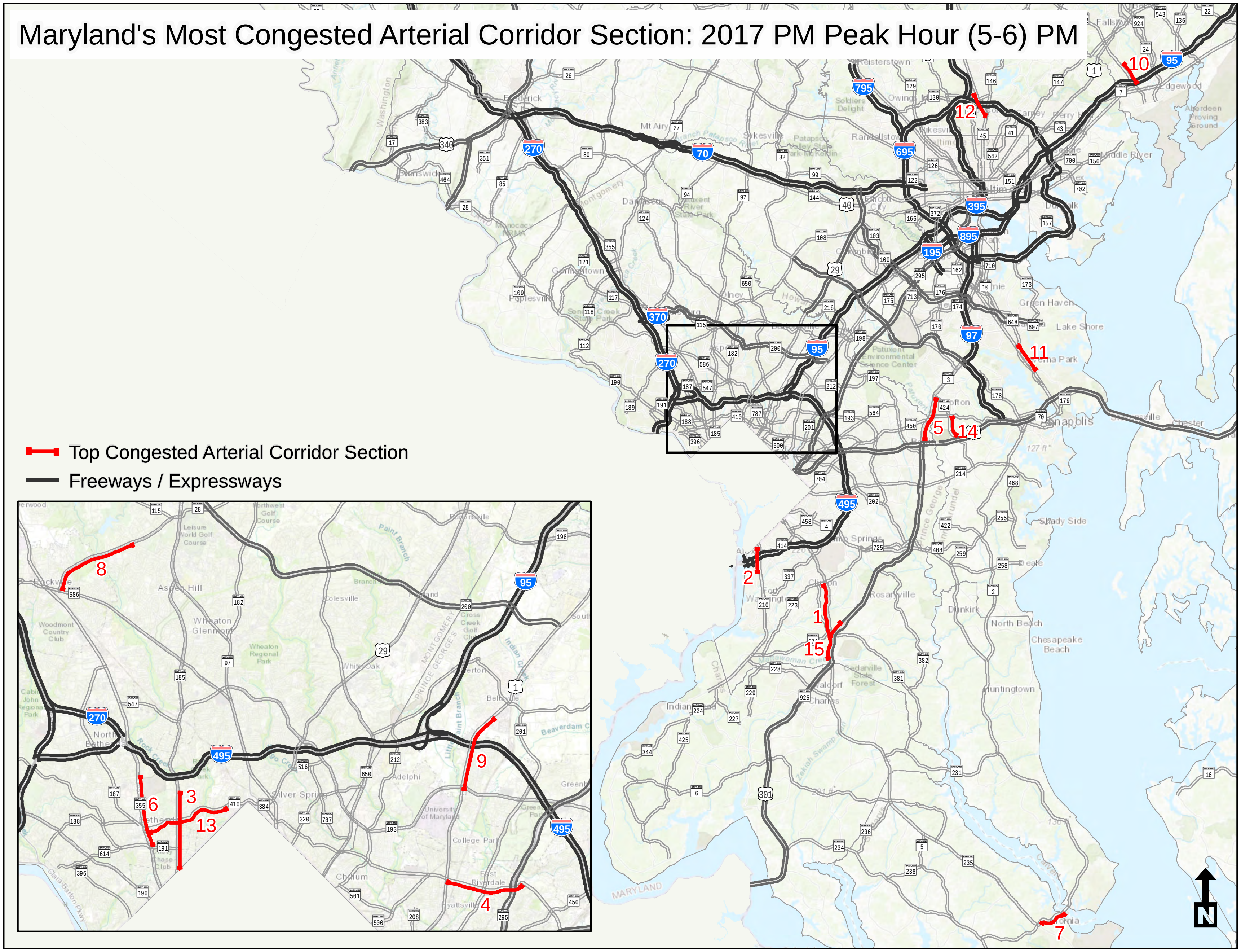
Table I-9

2017 MOST CONGESTED ARTERIAL CORRIDORS - PM PEAK HOUR					
PM Rank	Route/Direction	Limits	TTI Value	County	Mileage
1	MD 5 Southbound	MD 223 to US 301	2.0	Prince George's	4.3
2	MD 210 Southbound	Livingston Road to Kirby Hill Road	2.0	Prince George's	2.4
3	MD 185 Northbound	Washington, DC Line to Jones Bridge Road	2.0	Montgomery	2.2
4	MD 410 Eastbound	US 1 to MD 295	1.8	Prince George's	2.2
5	MD 3 Northbound	US 50 to Davidsonville Road/ Conway Road	1.8	Anne Arundel/ Prince George's	3.8
6	MD 355 Northbound	MD 191 to Cedar Lane	1.8	Montgomery	2.1
7	MD 4 Northbound	MD 235 to Thomas Johnson Bridge	1.7	Calvert/ Saint Mary's	3.5
8	MD 28 Eastbound	MD 586 to Bel Pre Road	1.7	Montgomery	2.6
9	US 1 Northbound	MD 193 to Montgomery Road	1.7	Prince George's	2.3
10	MD 152 Northbound	MD 7 to Singer Road	1.7	Harford	2.3
11	MD 2 Northbound	College Parkway to Baltimore Annapolis Boulevard/Whites Road	1.7	Anne Arundel	3.0
12	MD 45 Southbound	Ridgely Road to Joppa Road	1.7	Baltimore	2.2
13	MD 410 Eastbound	MD 355 to Grubb Road	1.7	Montgomery	2.1
14	MD 424 Northbound	US 50 to MD 450	1.6	Anne Arundel	2.4
15	US 301 Southbound	Missouri Avenue to McKendree Road/ Cedarville Road	1.6	Prince George's	3.8

Figure I-15


Maryland's Most Congested Arterial Corridor Section: 2017 PM Peak Hour (5-6) PM
Top Congested Arterial Corridor Section
Freeways / Expressways

Reliability Trends

Roadway users have certain expectations of predictability of travel time on various corridors when they make their trip. Non-recurring events such as incidents, vehicular breakdowns, crashes, weather, or lane reductions through work zones can cause the variability of the travel time to change greatly. It is the variability in travel times from day to day that shows unreliability of the system and frustrates motorists. This unreliability impacts automobiles, trucks and on-street transit services. Reliability is critical for transit operations. Variations in travel time make it difficult for transit operators to provide reliable schedules which in turn leads to a decrease in rider confidence and the potential of reduced ridership on the impacted routes. For all travelers there is a cost associated with the additional travel time due to the unreliability of the network. These motorists must add a buffer to reach their destination on time which take away from time where they could be accomplishing other tasks. An unreliable system causes an undesirable customer experience whether it is a motorist, truck, or a transit rider. The cost of any trip varies by purpose, nature and the importance to that particular motorist. For example, to catch a flight, to have a freight delivery occur on time, or just to be able to attend a child's event may have variable cost implications to that particular person or business. A more reliable freeway system allows for trips to be better planned and meet expectations of the motorists using the network to minimize cost implications and improve the quality of life. MDOT SHA recognizes the importance of providing a reliable transportation system and continues to deliver programs and policies to support the effort of improved reliability.

The measure that MDOT SHA uses to evaluate trip reliability is the Planning Time Index (PTI). The PTI represents the total time motorists should allow to ensure they arrive at their destination on-time while taking into account potential impacts due to non-recurring congestion. Various states/agencies utilize different percentile values for the PTI. In Maryland, the criteria for the PTI is the 95^{th} percentile travel time for a section of roadway. For example, motorists travelling in free flow conditions that take ten (10) minutes to traverse a section of roadway should allow for 20 minutes to ensure arriving on time when the PTI is 2.0. The lower the PTI number, the more reliable the trip. The higher the value, the less reliable and longer a trip might take. The PTI values for freeways/expressways are categorized into three categories:

- Reliable (PTI < 1.5)
- Moderately Unreliable (1.5 < PTI < 2.5)
- Highly to Extremely Unreliable (PTI > 2.5)

MDOT SHA uses two key metrics to measure reliability on the freeway/expressway system.

1. Percent System Unreliable
2. Percent Peak Hour VMT in Unreliable Conditions

I-83 at Warren Road

RELIABILITY MEASURES ON THE MARYLAND STATEWIDE FREEWAY/EXPRESSWAY SYSTEM

1. Percent System Unreliable

The AM (8-9 AM) and PM (5-6 PM) peak hours were evaluated to determine the PTI on the freeway/expressway system. The results of the analysis are shown in Figures I-16 and I-17. The most unreliable conditions as defined by MDOT SHA is when the PTI > 2.5. This is termed highly to extremely unreliable. Analysis of the AM Peak hour (8-9 AM) shows highly to extremely unreliable conditions occur on a total of 101 road miles (6% of the statewide freeway/expressway system) The number of roadway miles in highly to extremely unreliable conditions decreased by 10 miles compared to 2016 or 1%.

In the PM peak hour, 12% of the statewide freeway/expressway system operates under highly to extremely unreliable conditions (200 road miles). The results of analysis show that conditions in 2017 in comparison to 2016 remained the same as shown in Table I-10.

Almost all the freeway/expressway segments that have a PTI > 2.5 are in the Baltimore - Washington region.

2. Percent Peak Hour VMT in Unreliable Conditions

Another measure of year to year variability in conditions along the freeway/expressway system is the number and percentage of VMT that occur in unreliable conditions. Statewide, an estimated 13% of the morning peak hour VMT and 23% of the afternoon peak hour VMT occurs in these travel conditions.

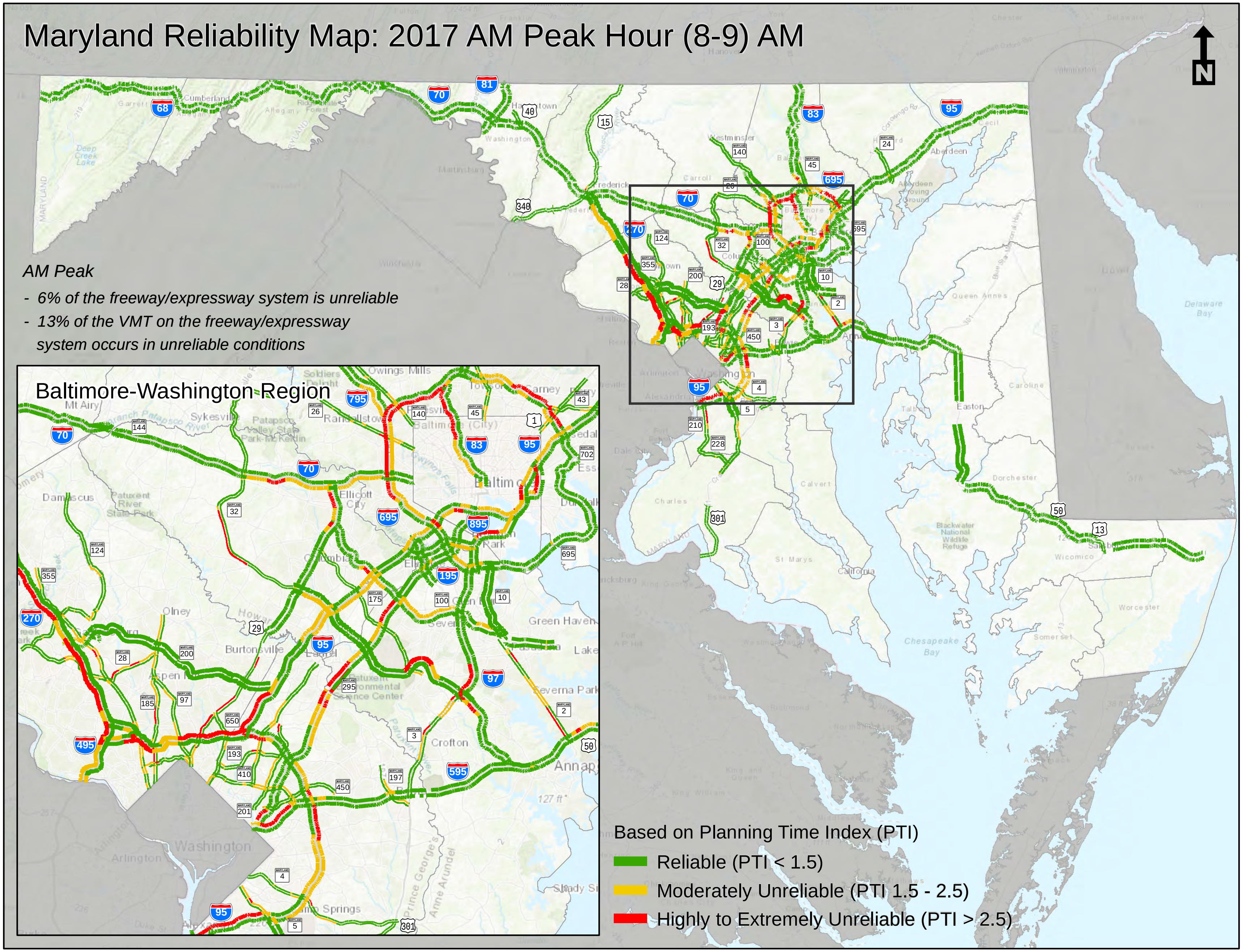
Compared to 2016, reliability trends statewide over the past year have remained stable. There was no change in the VMT that occurred under highly or extremely unreliable conditions in the AM peak hour. In the PM peak hour, operations there was a 1% increase in the percent of peak hour VMT that occurred in highly to extremely unreliable conditions. This is depicted in the Table I-10.

Table I-10

STATEWIDE FREEWAY/EXPRESSWAY SYSTEM
AVERAGE WEEKDAY AM & PM PEAK HOUR RELIABILITY SUMMARY

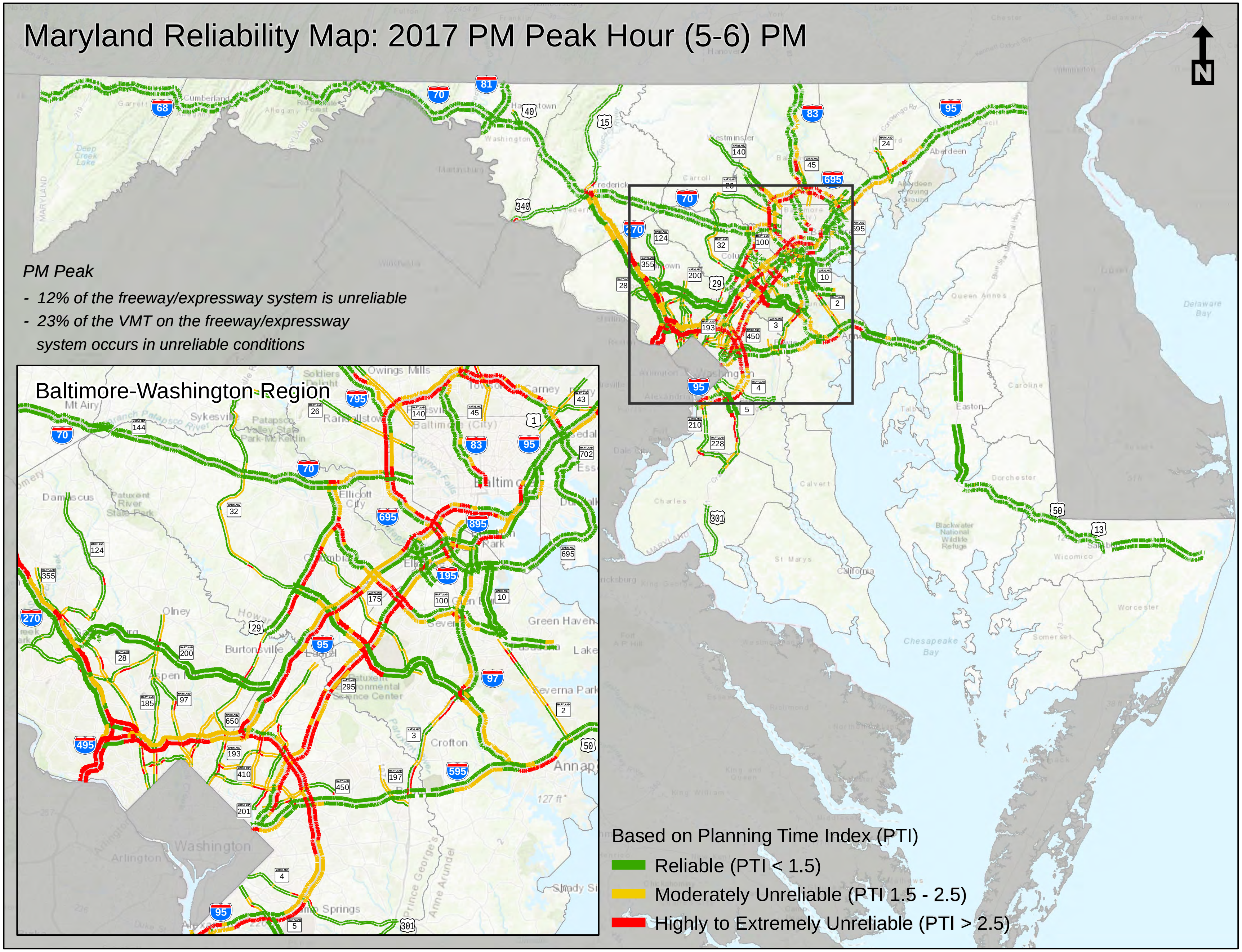
Highly to Extremely Unreliable Conditions	2015		2016		2017		CHANGE 2016 to 2017	
	AM	PM	AM	PM	AM	PM	AM	PM
Number of Roadway Miles	139	232	111	200	101	200	-10	0
Percent of Roadway Miles	8	14	7	12	6	12	-1	0
Percent of Peak Hour VMT Impacted	17	26	13	22	13	23	0	+1

Figure I-16



Maryland Reliability Map: 2017 AM Peak Hour (8-9) AM
AM Peak
- 6% of the freeway/expressway system is unreliable
- 13% of the VMT on the freeway/expressway system occurs in unreliable conditions
Baltimore-Washington Region
Based on Planning Time Index (PTI)
Reliable (PTI < 1.5)
Moderately Unreliable (PTI 1.5 - 2.5)
Highly to Extremely Unreliable (PTI > 2.5)

Figure I-17


Maryland Reliability Map: 2017 PM Peak Hour (5-6) PM
PM Peak
- 12% of the freeway/expressway system is unreliable
- 23% of the VMT on the freeway/expressway system occurs in unreliable conditions
Baltimore-Washington Region
Based on Planning Time Index (PTI)
Reliable (PTI < 1.5)
Moderately Unreliable (PTI 1.5 - 2.5)
Highly to Extremely Unreliable (PTI > 2.5)
N

I-695 @ I-83

CONGESTION AND RELIABILITY CORRELATION TRENDS

Most roadway segments that have high TTI values also experience high PTI values. This strong correlation normally exists because these roadway segments are more likely to be impacted by minor incidents. Incidents on those segments can produce severe back-ups and system level unreliable conditions for hours. Roadways with lower TTI have some reserve capacity to absorb the disruption caused by non-recurring congestion and show higher reliability. The TTI values representing average congestion (Figures I-7 and I-8) and PTI values for reliability (Figures I-16 and I-17) in many areas are closely correlated. The Top 15 congested segments (segments are part of a section) and their unreliability values for 2016 and 2017 are shown In Tables I-11 and I-12.

Table I-11

2017 TOP 15 CONGESTED SEGMENTS & ASSOCIATED RELIABILITY VALUES - AM PEAK						
Roadway	Location	Direction	2017 Rank (TTI)	2016 Rank (TTI)	2017 Rank (PTI)	2016 Rank (PTI)
I-495	MD 650 to MD 193	Outer Loop	1 (5.1)	1 (4.8)	2 (8.3)	2 (8.0)
I-495	@ MD 650	Outer Loop	2 (4.6)	2 (4.5)	1 (8.9)	1 (8.7)
I-495	MD 193 to US 29	Outer Loop	3 (4.1)	3 (3.9)	11 (6.2)	12 (6.2)
I-695	@ MD 147	Outer Loop	4 (3.8)	4 (3.7)	6 (7.0)	9 (6.3)
I-495	I-95 to Prince George's County Line	Outer Loop	5 (3.6)	6 (3.5)	3 (8.2)	3 (8.0)
I-695	@ I-70	Outer Loop	6 (3.5)	5 (3.7)	10 (6.2)	10 (6.3)
MD 295	US 50 to Washington, DC Line	Southbound	7 (3.0)	8 (3.1)	13 (5.2)	16 (5.4)
I-695	MD 147 to MD 41	Outer Loop	8 (3.0)	16 (2.6)	18 (4.9)	50 (3.9)
I-495	US 29 to MD 97	Outer Loop	9 (2.9)	9 (3.0)	38 (4.0)	33 (4.2)
I-95	MD 210 to I-295	Inner Loop	10 (2.9)	14 (2.7)	8 (6.3)	14 (5.5)
US 50	MD 202 to MD 459	Westbound	11 (2.9)	10 (3.0)	27 (4.5)	25 (4.8)
I-695	@ MD 122	Outer Loop	12 (2.8)	11 (2.9)	21 (4.8)	20 (5.1)
MD 295	Anne Arundel County Line to MD 197	Southbound	13 (2.8)	15 (2.7)	39 (4.0)	43 (4.0)
I-695	US 1 to MD 43	Outer Loop	14 (2.8)	13 (2.7)	5 (7.4)	4 (7.4)
I-695	I-70 to US 40	Outer Loop	15 (2.7)	12 (2.8)	48 (3.8)	39 (4.0)

Table I-12

2016 TOP 15 CONGESTED SEGMENTS & ASSOCIATED RELIABILITY VALUES - PM PEAK						
Roadway	Location	Direction	2017 Rank (TTI)	2016 Rank (TTI)	2017 Rank (PTI)	2016 Rank (PTI)
I-495	@ Cabin John Pkwy	Inner Loop	1 (4.5)	3 (4.2)	5 (7.5)	7 (6.9)
I-695	@ MD 45	Inner Loop	2 (4.0)	4 (4.2)	7 (7.1)	5 (7.2)
MD 32	@ MD 108	Westbound	3 (3.9)	6 (3.9)	8 (7.0)	8 (6.9)
I-695	@ MD 146	Inner Loop	4 (3.9)	2 (4.4)	12 (6.4)	10 (6.7)
I-695	MD 139 to MD 45	Inner Loop	5 (3.8)	7 (3.7)	4 (7.9)	4 (7.8)
I-495	Clara Barton Pkway to Cabin John Pkwy	Inner Loop	6 (3.8)	9 (3.5)	14 (6.0)	16 (5.8)
I-270	I-270 Split to Democracy Blvd	Southbound	7 (3.5)	1 (4.7)	1 (10.4)	2 (11.6)
I-695	MD 146 to Providence Rd	Inner Loop	8 (3.5)	5 (4.0)	21 (5.5)	18 (5.6)
I-495	MD 355 to MD 185	Inner Loop	9 (3.4)	14 (3.0)	19 (5.7)	25 (5.1)
I-495	@ MD 185	Inner Loop	10 (3.4)	19 (2.9)	20 (5.6)	28 (5.0)
I-495	@ MD 355	Inner Loop	11 (3.3)	24 (2.7)	6 (7.2)	6 (7.1)
I-495	MD 190 to I-270 West Spur	Inner Loop	12 (3.3)	13 (3.2)	43 (4.4)	38 (4.4)
I-270	MD 124 to N of MD 124 CD Lanes	Northbound	13 (3.3)	12 (3.3)	30 (5.0)	24 (5.1)
I-495	@ MD 190	Outer Loop	14 (3.2)	11 (3.4)	33 (4.8)	30 (4.9)
I-495	MD 190 to Clara Barton Pkwy	Outer Loop	15 (3.1)	8 (3.5)	23 (5.4)	17 (5.7)

Although there is a strong correlation between the most congested and the unreliable segments, there are a few exceptions. Several of these occur on the border of the worst congested segments. On most days these locations experience some congestion but on certain days when an incident occurs further downstream these locations are more impacted as queues extend further than normal. Table I-13 identifies the top 5 locations where PTI values are high and the corresponding TTI value is much lower:

Table I-13

HIGHEST PTI LOCATIONS WITH LOWER TTI VALUES				
2017 AM Peak Hour				
Location	PTI Value	Statewide Rank	TTI Value	Statewide Rank
I-695 @ US 1 Outer Loop	6.2	9	1.9	64
I-270 - Father Hurley Blvd. to MD 118 Southbound	4.9	16	2.0	54
US 50 - MD 202 to MD 459 Westbound	4.6	26	1.9	69
I-95/I-495 - MD 210 to I-295 Inner Loop	4.5	28	2.0	56
I-95/I-495 @ MD 202 Outer Loop	4.4	29	2.1	50
2017 PM Peak Hour				
Location	PTI Value	Statewide Rank	TTI Value	Statewide Rank
I-270 @ Democracy Blvd. Southbound	10.0	2	2.1	81
I-495 @ I-270 Spur Inner Loop	8.0	3	1.8	119
US 50 @ MD 450 Eastbound	6.8	9	1.4	124
I-495 - I-270 to MD 187 Outer Loop	6.7	10	1.8	124
US 340 @ MD 67 Westbound	5.8	17	1.3	280

C.

TRUCK TRENDS

I-95 @ Susquehanna River

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Truck Trends

The successful movement of freight and goods is vital to the economy of Maryland. In order to support freight movement, Maryland has an excellent system of highways, ports, infrastructure, rails, and airport access to support the movement of freight. The majority of freight is moved by trucks, particularly for short distance freight movement. It is estimated that freight originating and terminating in Maryland amounts to approximately 287 million tons of which 219 million is linked by the roadway system. The total value of freight is estimated to be valued at $432 billion annually with $324 billion hauled on the roadway system. Over 1.5 million jobs in Maryland are associated with freight movement. Among the leading products that are shipped along the roadways include food and nonmetallic minerals.

The second area where freight movement in Maryland is very strong is the numerous warehouses/distribution centers that are constructed along the I-95 and I-81 corridors. The trend toward leaner supply chains and changes to on-line retailing require efficient roadway networks, warehouses, and intermodal facilities to ensure timely and cost-effective deliveries. This increases the demand for warehouse and distribution facilities in those high volume corridors. Examples include the one million square foot Amazon distribution center in southeast Baltimore. In addition, growth in intermodal traffic is further expected to increase following completion of the Panama Canal expansion project in June 2016. Besides freight that originates or is destined to Maryland, the State also acts as a "through" State with I-68, I-70, I-95, and I-81 as the primary routes. Many sections of interstate roadways in Maryland exceed 20,000 trucks per day as depicted in Table I-14A. Table I-14B highlights the highest truck percentage routes on Interstate and US Routes.

Table I-14A

HIGHEST TRUCK VOLUME		
	Location	Average Daily Truck Volume
1	I-95 North of I-695	28,900
2	I-95/I-495 South of US 50	22,700
3	I-95 North of MD 24	22,500
4	I-95 North of MD 100	22,300
5	I-95 North of MD 200	22,200

Table I-14B

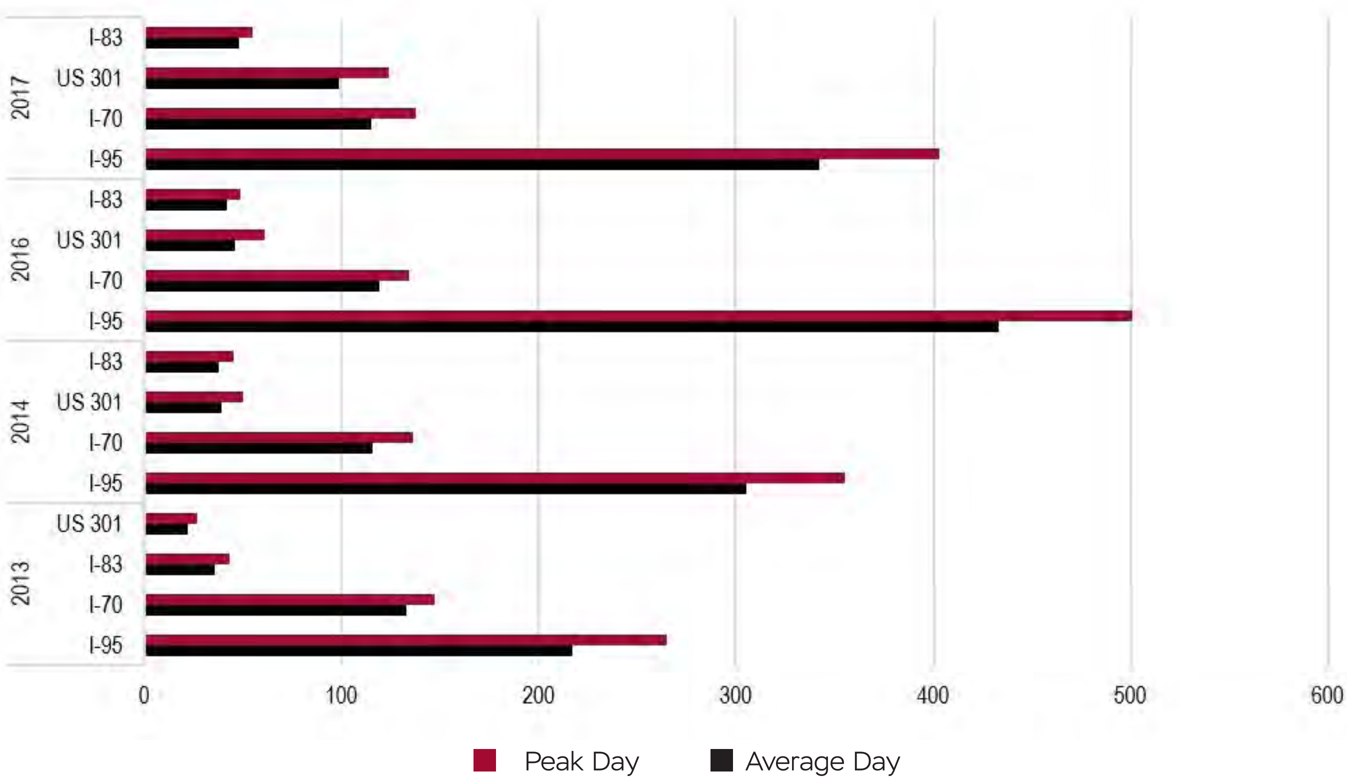
HIGHEST TRUCK PERCENTAGE LOCATIONS		
	Location	Truck %
1	I-81 – I-70 to Pennsylvania State Line	22-28%
2	I-81 – West Virginia State Line to I-70	28%
3	I-68 West of US 219	24%
4	I-70 East of Pennsylvania State Line	23%
5	US 301 South of MD 304	23%

Freight movement includes many large size loads. The largest loads over 102 inches in width or over 70 feet in length require a permit. MDOT SHA processed more than 136,000 oversize/overweight truckload permits last year for the movement of goods in or around Maryland to support economic viability.

With the number of trucks on the roadways, it is important to create a safe environment as much as possible both for the truck drivers and other motorists using these roadways. This is especially true when truck drivers need to rest at night. Jason's Law was established to address required rest hours for drivers of commercial motor vehicles and parking shortages at public and private facilities. In Maryland, a yearly program was established by MDOT SHA to monitor overnight truck parking to better identify parking issues. Truck parking at rest areas and other commercial trucks stops provide for safe locations to reduce the potential for crashes between parked trucks and moving vehicles. Parking along shoulders of highways and at entrance/exit ramps can create a hazard. A survey is performed twice a night for three nights at 11 PM and 4 AM on the major routes mainly along the National Highway Freight Network to identify locations where overnight truck parking is occurring. The results identified 700 trucks parked along the system in public areas during the peak time period. The trucks parked in private lots were counted, but not included in the results for this survey. The highest number of trucks were parked along I-95 with an average of approximately 350 trucks parked at night. Similar to last year the I-95 Northbound and Southbound Welcome Centers in Howard County and the Maryland House Travel Plaza northbound were the highest recorded locations for overnight truck parking with these locations averaging over 50 trucks parked each survey time. A comparison of truck parking along four routes (I-70, I-95, I-68 and US 301) which have the highest number of trucks parking during the survey are shown in Figure I-19. Overall, truck parking was approximately 10% lower than 2016 with a similar reduction being seen at private lots.

Figure I-19

TOP 4 ROUTES FOR OVERNIGHT TRUCK PARKING



Note: Overnight truck parking data was not collected in 2015.

Approximately

350

trucks overnight are parked along I-95. Congestion cost truckers $286 million in 2017 along the freeway/ expressway system.

The Federal Highway Administration (FHWA) Office of Freight Management and Operations monitors interstate highways as part of the Freight Performance Measures (FPM) Initiative. A major monitoring effort is the identification of bottlenecks on the nations interstate system. The American Transportation Research Institute (ATRI) developed "The Nations Top Truck Bottlenecks". The ATRI analysis to determine the worse bottlenecks identifies a "total freight congestion value" in a four- step process which includes determining free flow speed, the average truck speed deviation from the free flow speed, a hourly freight congestion based on speed and on volume, and the cumulative 24 hour freight congestion values.

The analysis identified that five of the top 100 bottlenecks at the junction of two access controlled facilities nationwide were located in Maryland. This included the seventh worse bottleneck location at the junction of I-695 and I-70. The following is the list of locations and their nationwide rank:

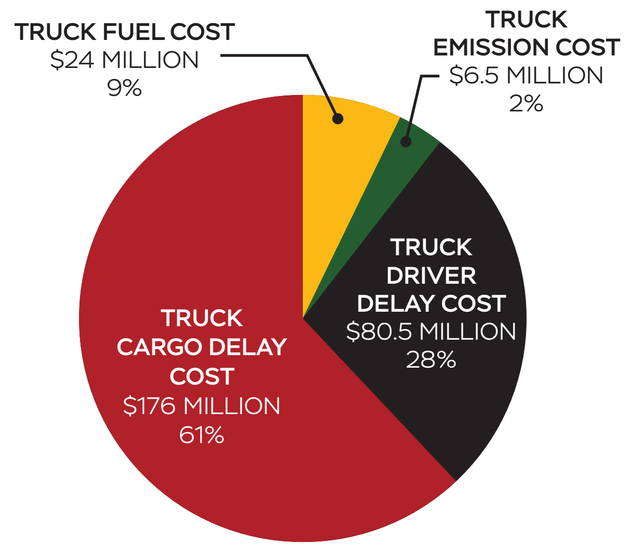
- I-695 @ I-70 (7th)
- I-695 @ I-83 (30th)
- I-95 @ MD 100 (50th)
- I-95/I-495 @ US 50 (I-595) (52nd)
- I-95 @ I-495 (86th)

The estimated cost of congestion to freight operators due to truck driver delay, truck cargo delay, additional fuel cost, and emission cost along the freeway/ expressway system is $287 million. This is shown in Figure I-20.

Figure I-20

2017 FREIGHT CONGESTION COSTS ON MARYLAND'S FREEWAY/EXPRESSWAY SYSTEM

$287 million



ATRI developed a report on the "Cost of Congestion to the Trucking Industry in 2016." This congestion cost is based on the total cost and cost per mile in each state that are part of National Highway System (NHS). Maryland was rated 3rd highest among all states in congestion costs per NHS segment mile and 15th in overall total congestion cost. The Baltimore Metropolitan Area experienced the 9th largest increase in congestion costs and specifically, Baltimore County ranks 9th nationally in congestion cost by county. The Washington D.C. Metropolitan Area was ranked the 6th highest total cost of congestion for highway freight movement.

Among the locations where truckers experience the greatest amount of delay not related to the intersection of two access controlled facilities include:

- I-495 Outer Loop @ MD 97
- I-495 Inner Loop @ Clara Barton Parkway
- I-695 Outer Loop @ US 40/Edmondson Ave
- I-270 Southbound @ MD 109

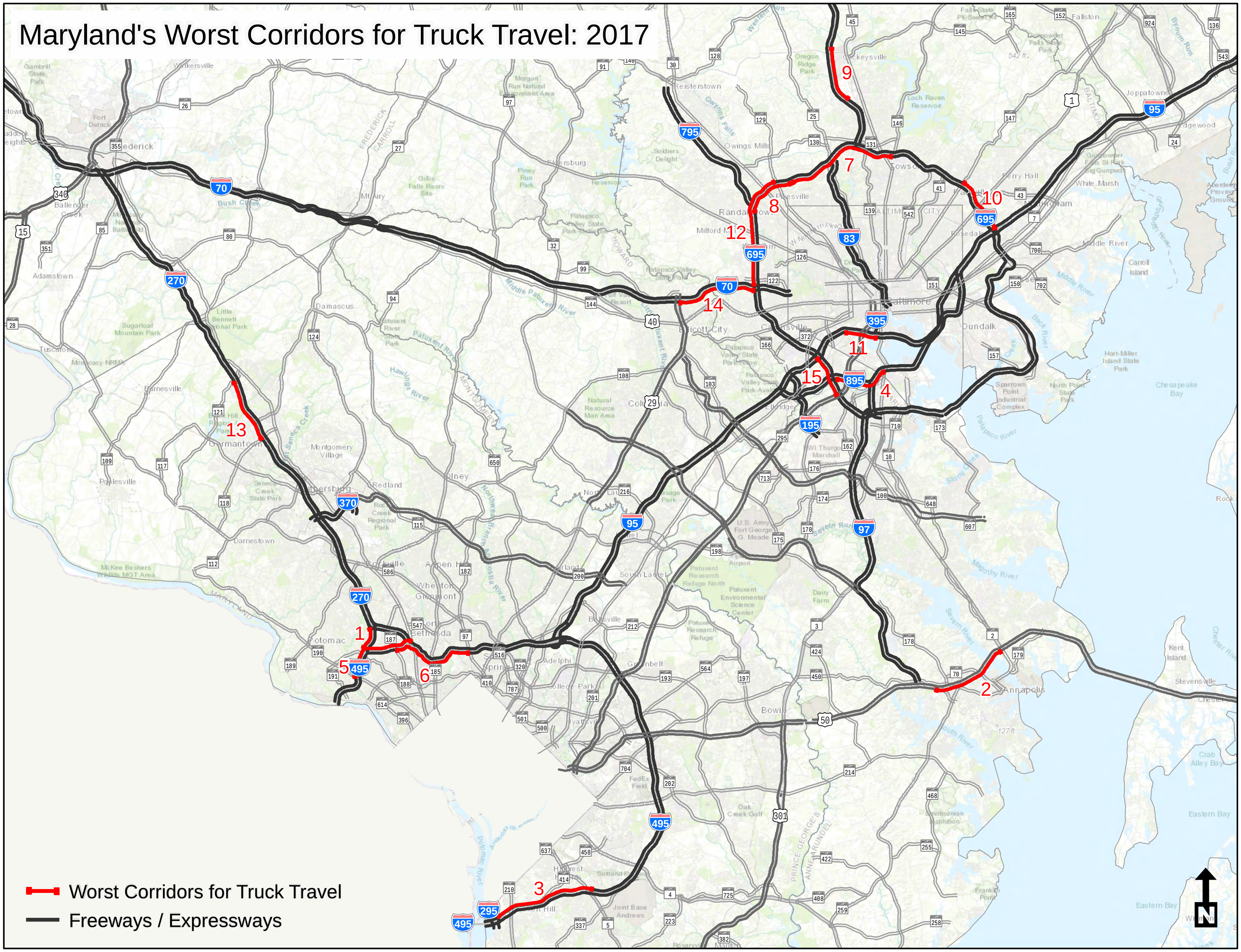
increases the cost of the products we buy due to increased fuel consumption and more time spent on the roadways. Many companies rely on just "in time" arrival of goods to minimize their inventories. This requires the trucking industry to match their needs. In order to accomplish this, a systematic approach must be provided. This included consideration of the maximum amount of time a trucker can drive and the reliability of the roadway system.

Analysis was performed along the Interstate system in Maryland to determine the reliability for truckers. The Truck Travel Time Reliability Index (TTTR) represents the 95th percentile travel time divided by the 50th percentile travel time for each segment. The TTTR is calculated for five-time periods with the maximum value used to determine the final system performance. Each individual segments TTTR value was combined to develop the Top 15 most unreliable corridors on the Interstate system for trucks. These 2017 locations are shown in Table I-15 and Figure I-21.

Table I-15

2017 TOP 15 WORST CORRIDORS FOR TRUCK TRAVEL				
Rank	Road/Direction	Limits	TTTR Max Value	Mileage
1	I-270 Spur (west) Southbound	I-270 Spur West to I-495	5.6	1.9
2	US 50 Eastbound	MD 665 to MD 2	4.6	5.7
3	I-495 Inner Loop	MD 5 to I-295	4.4	5.6
4	I-895 Northbound	I-695 to MD 2	4.0	3.4
5	I-495 Outer Loop	MD 355 to MD 190	4.0	3.9
6	I-495 Inner Loop	MD 187 to MD 97	3.8	4.9
7	I-695 Inner Loop	Stevenson Road to MD 146	3.8	6.3
8	I-695 Inner Loop	I-795 to Stevenson Road	3.5	3.1
9	I-83 Northbound	Padonia Road to Shawan Road	3.5	3.3
10	I-695 Outer Loop	I-95 to MD 147	3.5	4.3
11	I-95 Northbound	US 1 Alt to MD 2	3.5	3.2
12	I-695 Outer Loop	MD 129 to I-70	3.4	4.0
13	I-270 Southbound	MD 121 to MD 118	3.4	4.8
14	I-70 Eastbound	US 29 to I-695	3.4	4.8
15	I-695 Outer Loop	I-95 to MD 295	3.3	3.4

Figure I-21



Maryland's Worst Corridors for Truck Travel: 2017
Worst Corridors for Truck Travel
Freeways / Expressways

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D.

REGIONALLY SIGNIFICANT CORRIDORS

I-695 @ Stevenson Road

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Freeway/Expressway Corridor Summary

I-81 @ Halfway Boulevard

The highest classification of roadways are freeways and expressways. These are high speed facilities that provide the maximum capacity/ mobility. Access along these roadways is limited to interchanges and these highways are termed controlled access facilities. Analysis was performed on these roadways to evaluate various attributes such as mobility and reliability including the travel time index, planning time index, daily variability, speed, and the location of the top bottlenecks. The freeways/expressways evaluated include:

- I-70 (Pennsylvania Border to US 40 in Frederick)
- I-70 (US 40 in Frederick to I-695)
- I-81
- I-83
- I-95 (Capital Beltway to I-695 North)
- I-95 (I-695 North to Delaware State Line)
- I-97
- I-270
- I-495 Capital Beltway
- I-695 Baltimore Beltway
- I-795
- I-895
- US-50 (D.C Line to William Preston Lane Bridge (Bay Bridge))
- MD 32
- MD 100
- MD 295

A summary of major freeway/expressway corridors' performance including average TTI, average PTI, number of miles, average daily traffic and number of lanes is shown in Table I-16.

Appendix A provides additional in-depth information about the mobility performance of these corridors.

Table I-16

2017 FREEWAY/EXPRESSWAY FACILITY PERFORMANCE SUMMARY							
FREEWAY/EXPRESSWAY	NO. OF MILES	AVG TTI		AVG PTI		AVERAGE DAILY TRAFFIC (IN THOUSANDS)	NO. OF LANES
		AM	PM	AM	PM		
I-70 - Pa. State Line to US 40 (Frederick)	48	1.00	1.00	1.00	1.00	22-74	4
I-70 - US 40 (Frederick) to I-695	43	1.00	1.01	1.04	1.05	17-107	6
I-81	12	1.00	1.00	1.00	1.08	57-80	4
I-83	26	1.01	1.06	1.14	1.17	46-147	4-6
I-95 -I-495 to I-695	40	1.16	1.20	1.27	1.37	144-254	8
I-95 - I-695 to Del. State Line	45	1.00	1.00	1.01	1.04	62-166	6-12
I-97	17	1.07	1.11	1.20	1.36	24-160	4-6
I-270	41	1.21	1.20	1.36	1.38	84-267	4-12
I-495	42	1.27	1.58	1.44	1.91	112-254	6-8
I-695	35	1.23	1.37	1.44	1.63	125-227	6-8
I-795	8	1.02	1.06	1.14	1.17	56-117	4-6
I-895	15	1.09	1.08	1.20	1.21	18-86	4
US 50 - Washington DC Line to Chesapeake Bay Bridge	33	1.02	1.06	1.08	1.18	73-168	4-10
MD 32 - MD 108 to I-97	22	1.02	1.09	1.11	1.20	49-100	4
MD 100 - US 29 to MD 177	22	1.03	1.17	1.11	1.31	29-112	4-8
MD 295 - MD 201 to Waterview Ave	29	1.14	1.38	1.26	1.60	81-118	4-6

These numbers represent the average values for the entire roadway. Several segments of these freeways/expressways as identified in Table I-16 have much higher TTI and PTIs. The variation between the segments is shown in the Peak Hour Statewide Congestion and Reliability Maps.

Major Arterial Corridor Summary

A. 2017 CONDITIONS

The next highest classification of roadways after freeways/expressways is arterials. These roadways provide a vital connection between the freeway/expressway system and the local roadways. These roadways normally have multi-lanes, traffic signals, and access points either from cross streets or driveways. Arterial roadways carry the next highest volumes of traffic in comparison to freeways/expressways.

Thirty-four corridors were selected based on observed traffic operations, traffic volumes, regional significance, and availability of data to analyze in further detail. Traffic analysis was performed to identify the most congested intersections and segments and the accompanying levels of service, TTI, and PTI on a segment basis. Various roadway characteristics such as the number of lanes, speed limits, signalized intersections, and traffic/transit ridership data were analyzed. The following corridors were analyzed:

- MD 2 - US 50/301 to MD 10
- MD 3 - US 50/301 to I-97
- MD 4 - Washington DC Line to Dower House Road
- MD 5 - I-95 to Washington D.C. Line
- MD 5 - US 301 to MD 223
- MD 24 - US 40 to US 1
- MD 26 - MD 32 to Baltimore City Line
- MD 28 - Riffle Ford Road to MD 97
- MD 32 - MD 108 to MD 26
- MD 43 - I-695 to US 40
- MD 45 - Baltimore City Line to Shawan Rd
- MD 97 - Washington DC Line to MD 108
- MD 124 - MD 28 to MD 108
- MD 140 - MD 97 to Baltimore City Line
- MD 175 - MD 32 to US 29
- MD 185 - Washington DC Line to MD 97
- MD 193 - MD 201 to MD 650
- MD 197 - US 301 to MD 450
- MD 201 - MD 450 to MD 212
- MD 210 - MD 228 to I-95
- MD 228 - MD 210 to US 301
- MD 355 - Washington DC Line to MD 27
- MD 355 - MD 85 to MD 26
- MD 410 - MD 650 to Pennsy Drive
- MD 410 - MD 355 to US 29
- MD 450 - MD 202 to MD 704
- MD 450 - Housley Rd to MD 2
- MD 650 - Washington DC Line to US 29
- US 1 - MD 410 to MD 198
- US 1 - Baltimore City Line to Honeygo Blvd
- US 29 - MD 97 to MD 650
- US 29 - Industrial Parkway to MD 198
- US 40 - I-70 to Cleveland Ave
- US 301 - Billingsley Rd to MD 5

A summary of the operational characteristics of each of these corridors is shown in Table I-17.

Appendix A contains additional information related to various characteristics and performance measures of these arterial roadways.

Table I-17

2017 ARTERIAL FACILITY PERFORMANCE SUMMARY						
ARTERIAL	NO. OF MILES	AVERAGE DAILY TRAFFIC (THOUSANDS)	CONGESTED MILEAGE			
			HEAVY TO SEVERE CONGESTION			
			AM EB/NB	AM WB/SB	PM EB/NB	PM WB/SB
MD 2 - US 50/301 to MD 10	8.4	48-66	0.9	0.5	6.5	3.7
MD 3 - US 50/301 to I-97	8.8	68-81	1.7	4.2	5.8	1.8
MD 4 - DC Line to Dower House Rd.	6.6	22-76	0.0	0.9	0.4	1.5
MD 5 - I-95 to DC Line	3.1	31-62	0.6	0.0	0.0	0.0
MD 5 - US 301 to MD 223	5.4	65-82	4.1	0.0	0.0	5.4
MD 24 - US 40 to US 1	7.9	23-70	0.0	0.0	2.7	1.8
MD 26 - MD 32 to Balt. City Line	14.1	9-47	0.5	0.0	2.7	1.2
MD 28 - Riffle Ford Rd to MD 97	11.9	26-50	1.6	4.4	4.1	0.6
MD 32 - MD 108 to MD 26	16.3	21-29	0.0	5.4	8.8	0.0
MD 43 - I-695 to US 40	6.0	27-55	0.7	1.0	1.1	0.9
MD 45 - Balt. City Line to Shawan Rd.	9.3	23-41	0.4	0.0	6.5	4.6
MD 97 - DC Line to MD 108	12.7	28-63	0.5	2.9	3.7	1.8
MD 124 - MD 28 to MD 108	16.7	11-74	0.0	1.3	1.2	0.7
MD 140 - MD 97 to Balt. City Line	20.4	25-50	0.0	0.4	3.2	4.5
MD 175 - MD 32 to US 29	12.2	19-76	0.0	0.0	4.4	0.0
MD 185 - DC Line to MD 97	8.3	35-72	0.0	3.4	3.4	1.6
MD 193 - MD 201 to MD 650	5.5	32-48	0.0	1.0	3.5	1.3

EB: Eastbound NB: Northbound
WB: Westbound SB: Southbound

Table I-17 (Continued)

2017 ARTERIAL FACILITY PERFORMANCE SUMMARY						
ARTERIAL	NO. OF MILES	AVERAGE DAILY TRAFFIC (THOUSANDS)	CONGESTED MILEAGE			
			HEAVY TO SEVERE CONGESTION			
			AM EB/NB	AM WB/SB	PM EB/NB	PM WB/SB
MD 197 - US 301 to MD 450	3.2	19-35	0.0	0.0	1.7	0.2
MD 198 - MD 197 to Russett Green	2.2	35-40	0.0	0.0	0.0	0.0
MD 201 - MD 450 to MD 212	7.4	24-41	0.0	0.6	3.4	1.5
MD 210 - MD 228 to I-95	10.3	27-75	3.7	0.0	0.0	2.5
MD 228 - MD 210 to US 301	6.8	39-40	0.0	0.0	1.5	0.0
MD 355 - DC Line to MD 27	19.7	33-64	1.5	4.0	6.8	7.8
MD 410 - MD 355 to US 29	3.8	15-27	0.0	1.1	1.4	0.0
MD 410 - MD 650 to Pennsy Dr.	7.7	21-48	0.0	1.5	4.7	1.2
MD 450 - MD 202 to MD 704	6.3	26-66	0.0	0.0	0.6	0.0
MD 450 - Housley Rd. to MD 2	1.2	33-48	0.0	0.5	0.6	0.5
MD 650 - DC Line to US 29	6.0	36-62	1.3	2.2	2.3	2.8
US 1 - MD 410 to MD 198	10.7	20-47	0.0	0.0	5.9	5.1
US 1 - Balt. City Line to Honeygo Blvd.	5.6	27-47	0.0	0.0	1.0	0.6
US 29 - MD 97 to MD 650	3.8	35-67	1.0	2.0	1.3	1.0
US 29 - Industrial Pkwy. to MD 198	4.4	62-68	0.0	2.0	0.2	0.0
US 40 - I-70 to Cleveland Ave.	3.4	26-39	0.0	0.0	0.0	0.3
US 301 - Billingsley Rd to MD 5	7.8	38-97	0.0	0.0	1.3	1.9

EB: Eastbound **NB: Northbound**
WB: Westbound **SB: Southbound**

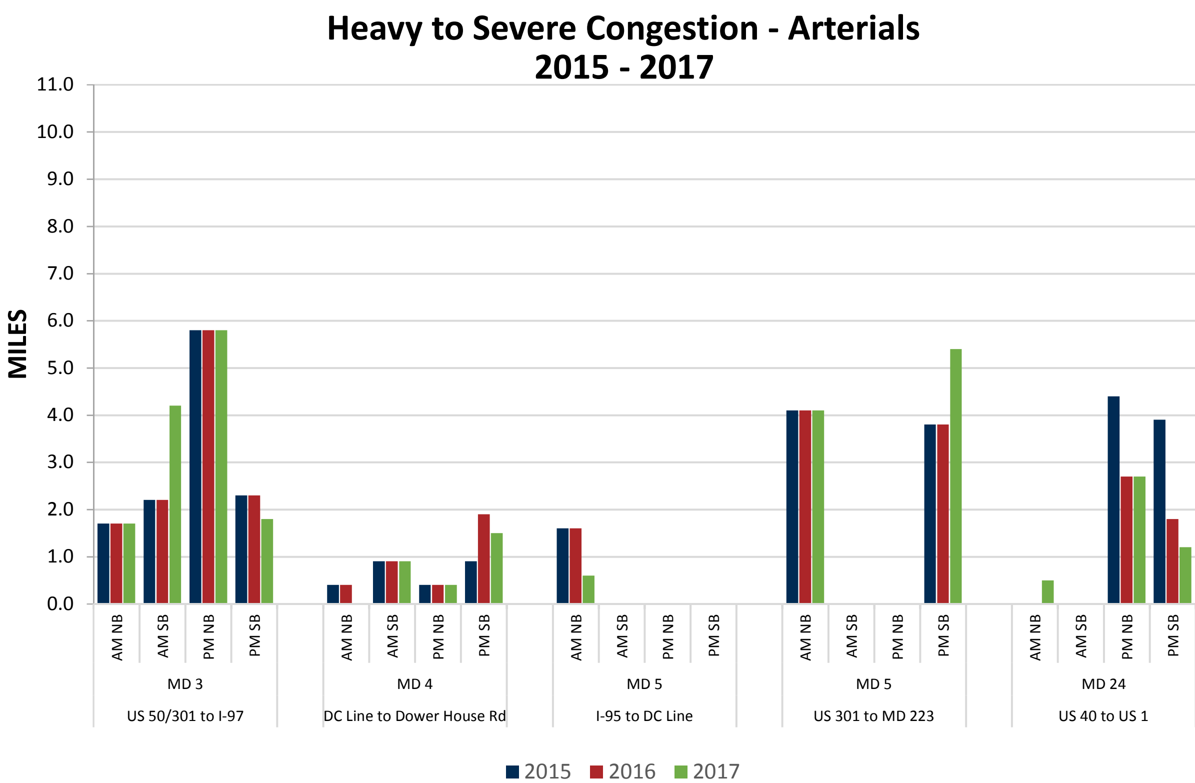
B. ARTERIAL ROADWAY TRENDS

A comparison was conducted of the operations of the major arterial corridors over the last three years. Presently, 34 corridors are analyzed. Over the three year period each year some corridors are added or dropped to expand locations throughout different regions of the State and select roadways that have operational issues. Twenty-one (21) of the arterial corridors have been evaluated throughout all three years for the levels of congestion based on the TTI. A comparison was made between operations at the highest level of congestion (TTI > 1.3).

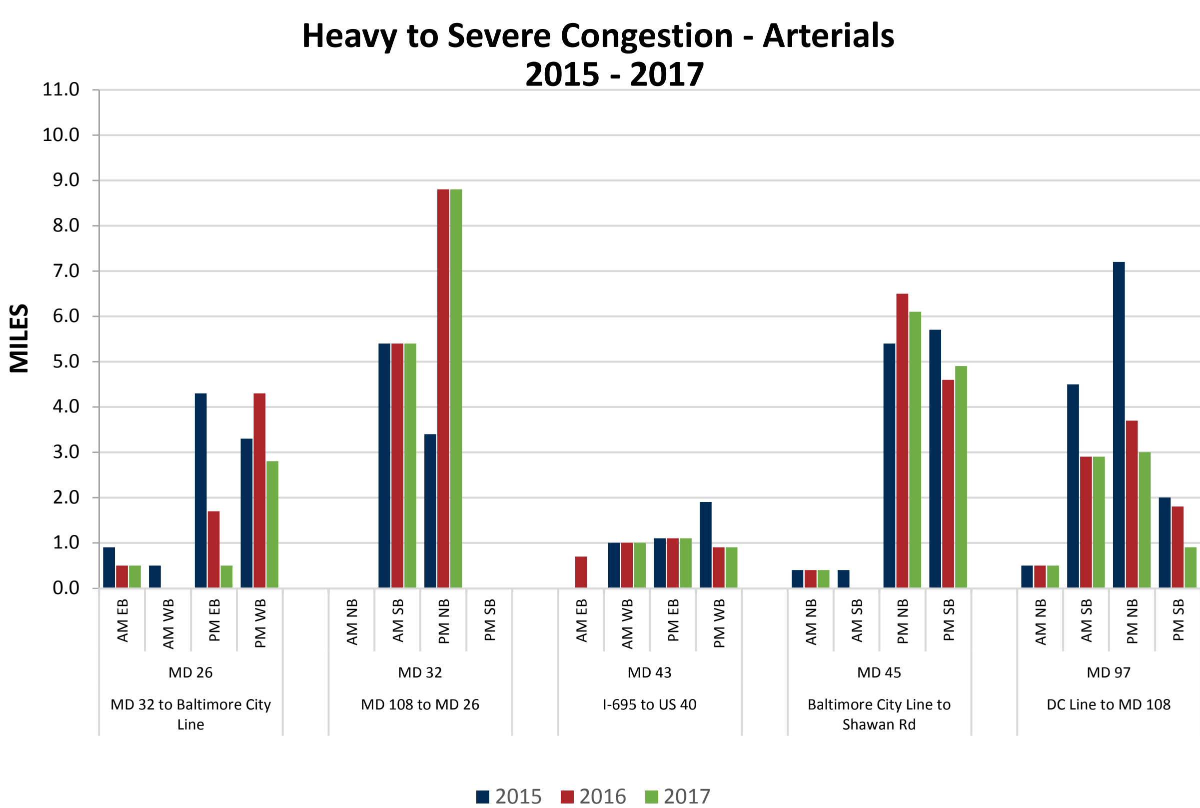
In general, there has been a slight improvement in congestion. Maryland 355 southbound, MD 26 eastbound and westbound, and US 1 southbound all show reductions of greater than a mile of heavy to severe congestion in the PM peak. Only MD 5 southbound from MD 223 to US 301 and MD 175 northbound in the PM peak hour experienced over a 1 mile increase in the highest levels of congestion. The AM heavy to severe congestion remained relatively the same in all corridors. This is shown in Figure I-21.

MD 41 @ Putty Hill Avenue

Figure I-21

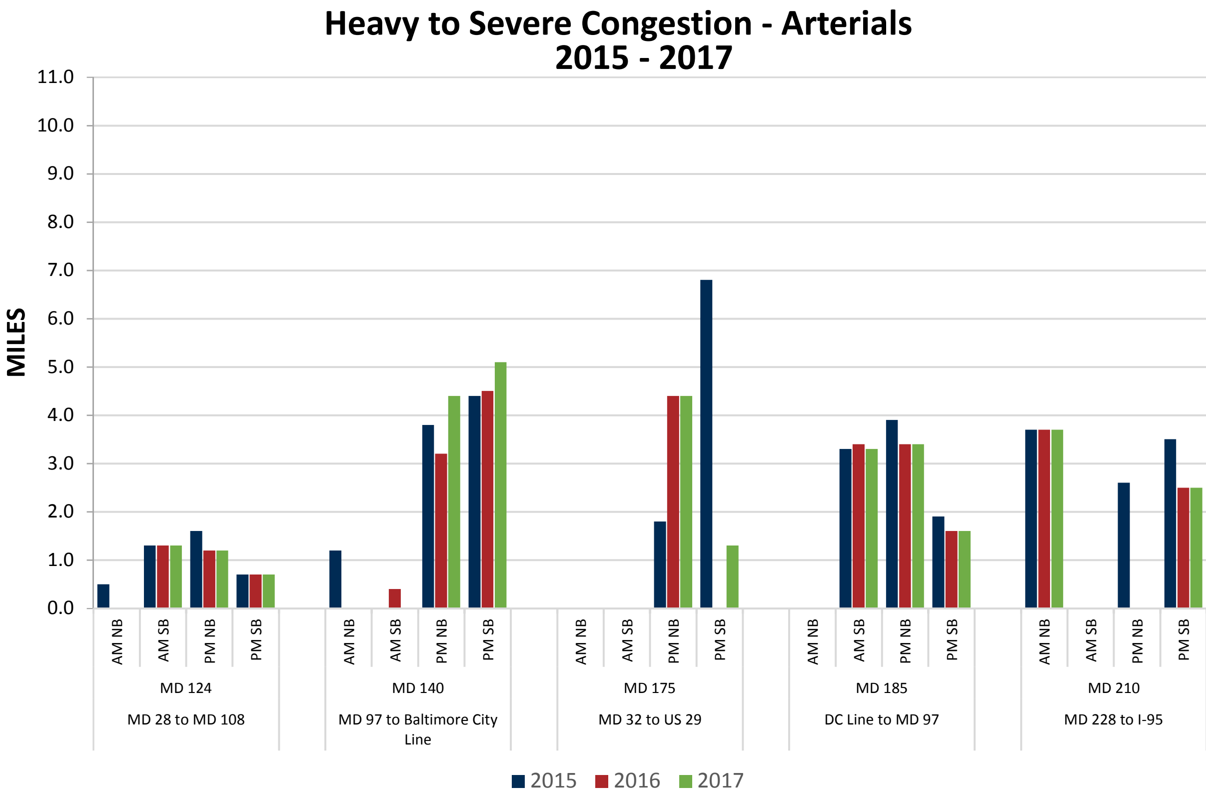


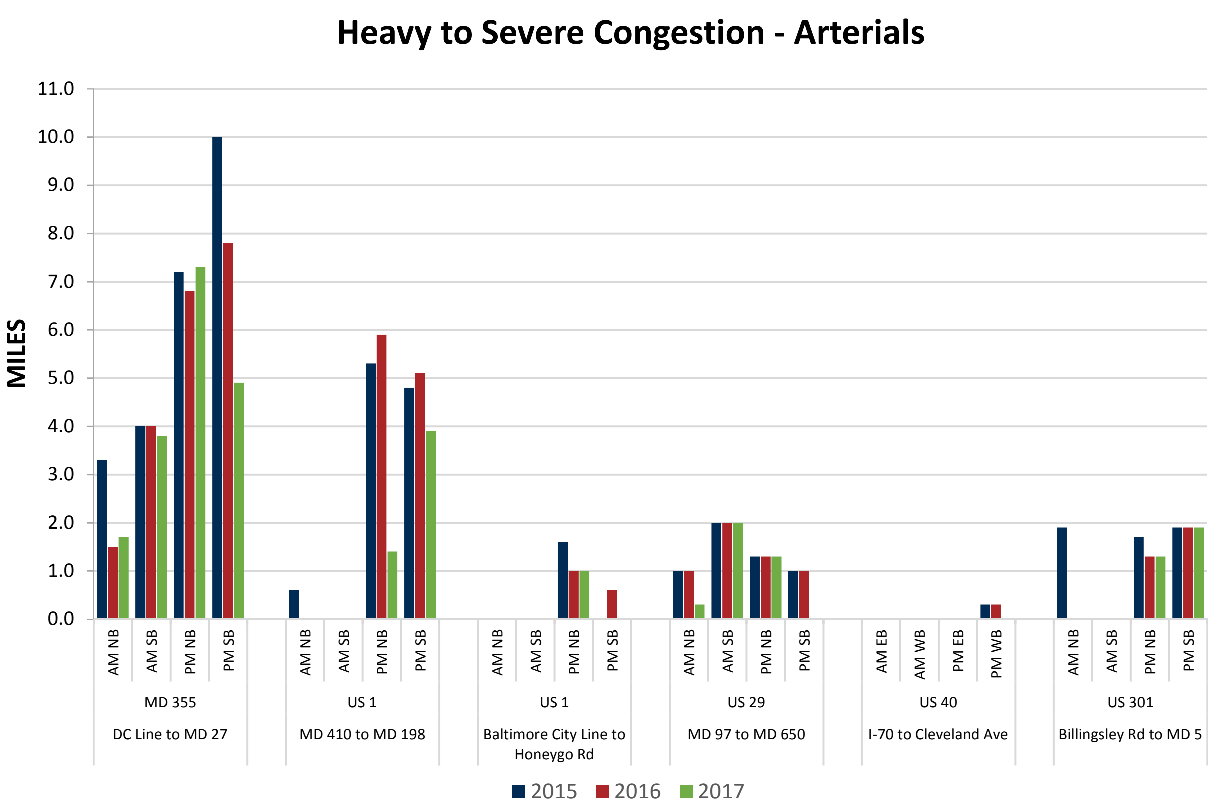
Heavy to Severe Congestion - Arterials
2015 - 2017
MILES
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
AM NB
AM SB
PM NB
PM SB
MD 3
US 50/301 to I-97
MD 4
DC Line to Dower House Rd
MD 5
I-95 to DC Line
MD 5
US 301 to MD 223
MD 24
US 40 to US 1
2015
2016
2017



Heavy to Severe Congestion - Arterials
2015 - 2017
MILES
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
AM EB
AM WB
PM EB
PM WB
AM NB
AM SB
PM NB
PM SB
MD 26
MD 32 to Baltimore City Line
MD 32
MD 108 to MD 26
MD 43
I-695 to US 40
MD 45
Baltimore City Line to Shawan Rd
MD 97
DC Line to MD 108
2015
2016
2017

Figure I-21 (Continued)





A key consideration as to the mobility along arterial and collector roadways is traffic operations at intersections. These intersections where motorists experience long wait times including more than one green cycle to cross the intersections are considered to operate at level of service (LOS) “F” and are identified for improvements.

MDOT SHA continues to monitor operations at intersections that operate poorly through its traffic data collection program. This data is collected with equipment and personnel at numerous intersections throughout the State. As part of the traffic counts, analysis is performed to determine levels of service. Table I-18 and I-19 show a list of failing intersections (LOS F); however, this list is limited to locations counted over the past three years. MDOT SHA continues to expand on its data collection program and work with locals to obtain additional information on intersection performance at other locations.

These locations are depicted in Figures I-22 and I-23.

Table I-18

LOS “F” INTERSECTIONS

AM PEAK HOUR

Intersection	County	Volume/ Capacity
MD 3 at Millersville Rd	AA	1.21
MD 140 at Dede Rd	CL	1.18
MD 210 at Livingston Rd/ Kerby Hill Rd	PG	1.18
MD 41 at Putty Hill Ave	BA	1.13
MD 175 at MD 170/ Piney Orchard Pkwy	AA	1.09
MD 27 at Skylark Rd	MO	1.08
MD 28 at MD 97	MO	1.05
MD 4 at MD 337/Presidential Pkwy	PG	1.04
MD 5 at Auth Way/Simpson Rd	PG	1.03
MD 185 at Aspen Hill Rd	MO	1.02
MD 187 at Ryland Dr	MO	1.01
MD 201 at MD 410	PG	1.01
MD 650 at Ramps 2 & 7 from I-495 WB	MO	1.00

Table I-19

LOS “F” INTERSECTIONS

PM PEAK HOUR

Intersection	County	Volume/ Capacity
MD 2 at MD 524 (Old Town Rd)/Cox Rd	CA	1.20
MD 458 at Swann Rd	PG	1.11
MD 586 at Twinbrook Pkwy	MO	1.11
MD 500 at MD 410/Adelphi Rd	PG	1.10
US 301 at MD 725/ Marlboro Pike	PG	1.10
MD 201 at MD 410	PG	1.09
MD 28 at Riffle Ford Rd/ Seurat Dr	MO	1.08
MD 4 at MD 337/ Presidential Pkwy	PG	1.07
MD 193 at Metzerott Rd/ Paint Branch Dr	PG	1.07
US 301 at Cedarville Rd/ McKendree Rd	PG	1.06
MD 41 at Putty Hill Ave	BA	1.05
MD 175 at Tamar Dr	HO	1.05
MD 193 at Cherrywood La/ 60th Ave	PG	1.05
MD 410 at MD 450	PG	1.05
US 301 at Clymer Dr/ Matapeake Business Dr	PG	1.05
US 40 at Rossville Blvd	BA	1.05
MD 2 at College Pkwy	AA	1.04
MD 210 at Old Fort Rd (North)	PG	1.04
MD 191 at Seven Locks Rd	MO	1.03
MD 212 at MD 410	PG	1.03
MD 175 at Morgan Rd/Town Center Blvd	AA	1.02
MD 210 at Livingston Rd/ Kerby Hill Rd	PG	1.02
MD 97 at MD 650	MO	1.01
US 301 at MD 5 Bus./MD 228	CH	1.01
MD 355 at Tuckerman Lane (North Intersection)	MO	1.00

Figure I-22

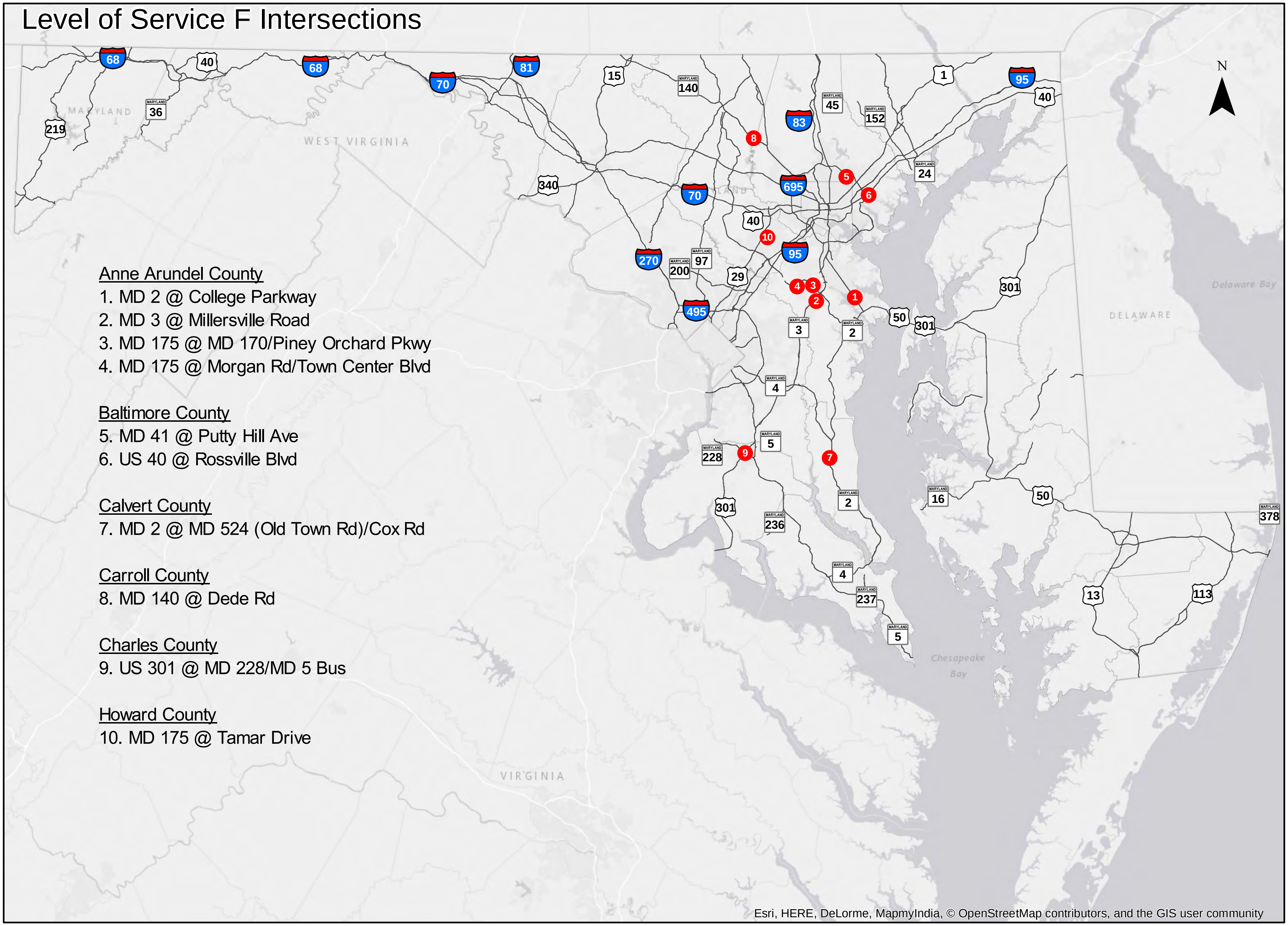

Level of Service F Intersections
Anne Arundel County
1. MD 2 @ College Parkway
2. MD 3 @ Millersville Road
3. MD 175 @ MD 170/Piney Orchard Pkwy
4. MD 175 @ Morgan Rd/Town Center Blvd
Baltimore County
5. MD 41 @ Putty Hill Ave
6. US 40 @ Rossville Blvd
Calvert County
7. MD 2 @ MD 524 (Old Town Rd)/Cox Rd
Carroll County
8. MD 140 @ Dede Rd
Charles County
9. US 301 @ MD 228/MD 5 Bus
Howard County
10. MD 175 @ Tamar Drive
MARYLAND
WEST VIRGINIA
VIRGINIA
DELAWARE
Delaware Bay
Chesapeake Bay
N
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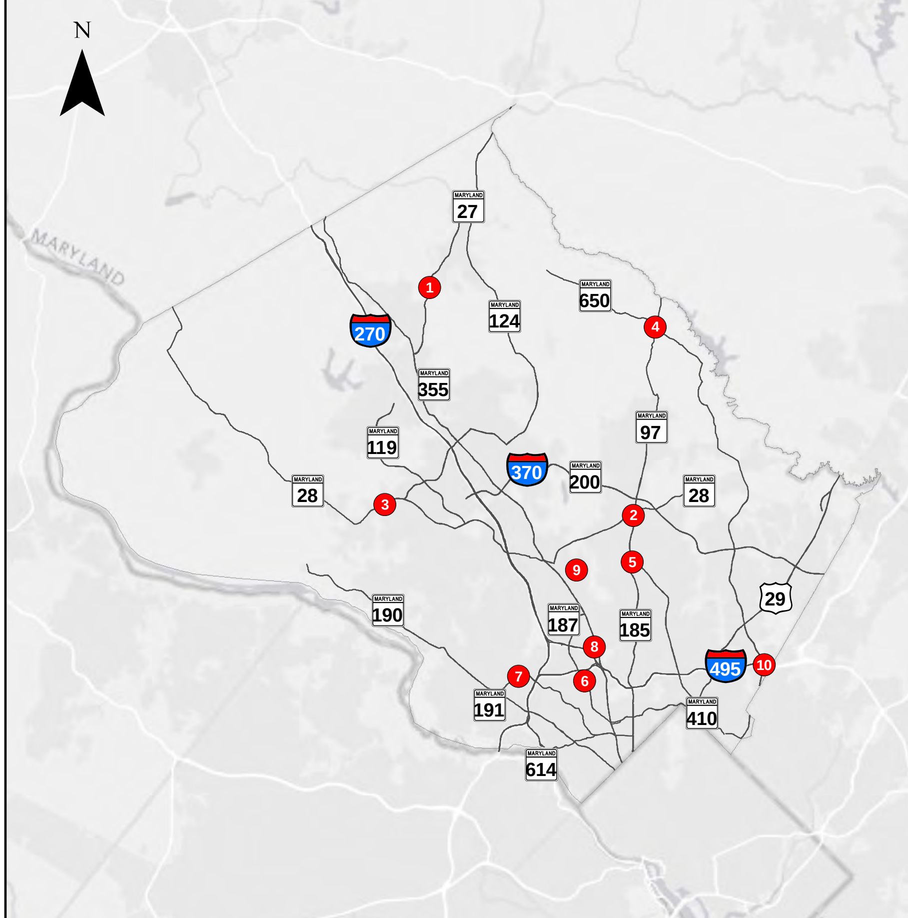
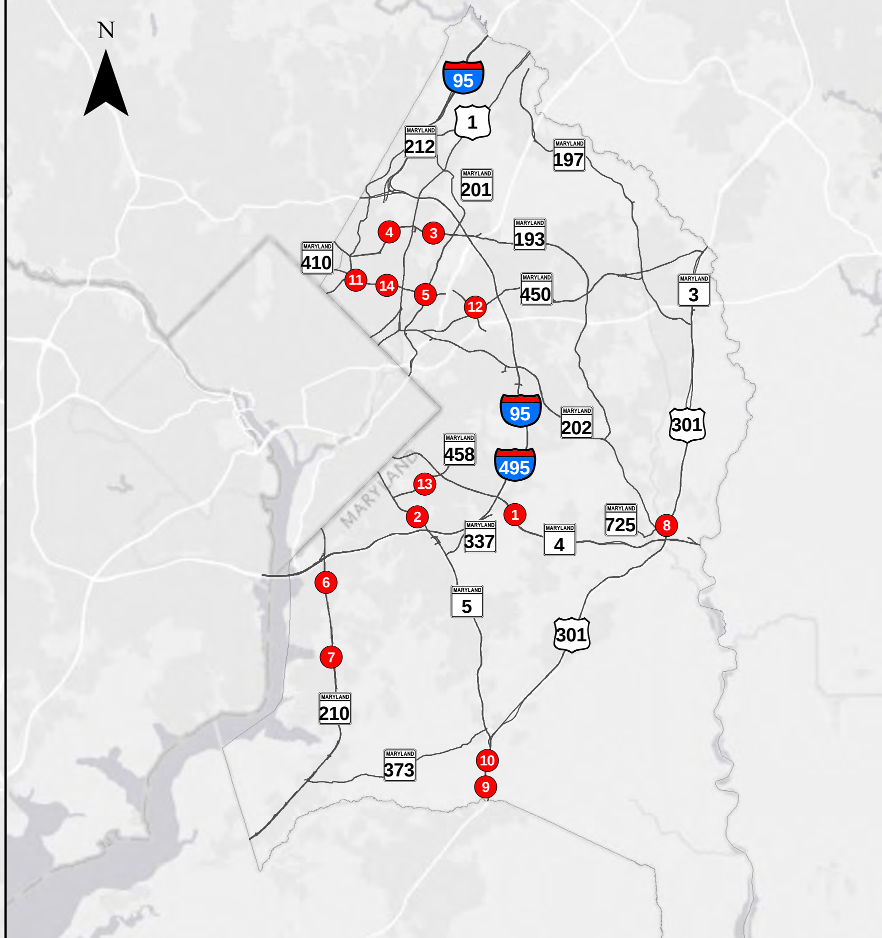
Figure I-23

Level of Service F Intersections
Montgomery County



1. MD 27 @ Skylark Road
2. MD 28 @ MD 97
3. MD 28 @ Riffle Ford Road
4. MD 97 @ MD 650
5. MD 185 @ Aspen Hill Road
6. MD 187 @ Ryland Drive
7. MD 191 @ Seven Locks RD
8. MD 355 @ Tuckerman Lane (North Intersection)
9. MD 586 @ Twinbrook Pkwy
10. MD 650 @ Ramps 2 & 7 From I-495

Level of Service F Intersections
Prince George's County



1. MD 4 @ MD 337
2. MD 5 @ Auth Way/Simpson Road
3. MD 193 @ Cherrywood Lane/60th Ave
4. MD 193 @ Metzerott Road/Paint Branch Drive
5. MD 201 @ MD 410
6. MD 210 @ Livingston Road/Kerby Hill Road
7. MD 210 @ Old Fort Road (North)
8. US 301 @ MD 725 / Marlboro Pike
9. US 301 @ Cedarville Road/McKendree Road
10. US 301 @ Clymer Drive
11. MD 410 @ MD 212
12. MD 410 @ MD 450
13. MD 458 @ Swann Road
14. MD 500 @ MD 410/Adelphi Road

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II. MDOT'S Mobility Solutions and Strategies

US 29 @ Seneca Drive

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A.

CAPITAL PROJECTS

I-695 @ MD 147

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Capital Projects

To address congestion and reliability challenges due to increased traffic volumes, MDOT SHA employs a variety of projects and programs to meet the needs of the traveling public. This is completed through a performance-based approach to identify and plan, design and implement congestion mitigation solutions with a practical design standpoint. These projects and programs identify both short and long-term solutions to address transportation issues. The MDOT Consolidated Transportation Program (CTP) identifies the projected six-year outlay of funds to address capital investments, system upgrades and maintenance. There are many challenges involved in developing major capital projects including funding, right-of-way and utility impacts, environmental constraints, time to complete the Federal requirements, and permitting. To overcome the fiscal challenges that hinder MDOT's ability to develop and implement major corridor projects, the agency is looking at Private – Public Partnerships (P3) opportunities. P3 projects allow for the private sector to invest on roadway infrastructure and then collect revenue through tolls. Governor Hogan announced a $7 Billion Traffic Relief Plan to improve I-270 and I-495 corridors as part of a P3 initiative by adding express toll lanes. This is a win-win situation for everyone as motorists travelling in the free general-purpose lanes will also experience mobility improvements due to the additional capacity offered by the free-flowing toll lanes.

MDOT SHA is also incorporating Transportation System Management and Operations (TSMO) projects and strategies to maximize operations. The $100 Million I-270 Innovative Congestion Management Progressive design-build project aims to maximize vehicle and person throughput using methods such as ramp metering, variable speed limits and geometric improvements to improve operations. The $151 Million I-695 TSMO project announced as part of the Baltimore Traffic Relief Plan project will utilize hard shoulder running and other active traffic management strategies to improve traffic operations. In addition to above major projects, MDOT SHA continues to focus on alleviating congestion hotspots through a variety of low cost geometric improvements such as turn lanes and roundabouts. Other projects include upgrades to the freight network and new pedestrian and bicycle facilities.

Eighteen (18) mobility improvement projects were opened to traffic in 2017. These projects provide for congestion relief, improve safety, and enhance traffic operations. All projects are reviewed from a practical design standpoint to insure the proposed project is addressing just the defined purpose and need.

1. MOBILITY IMPROVEMENT PROJECTS

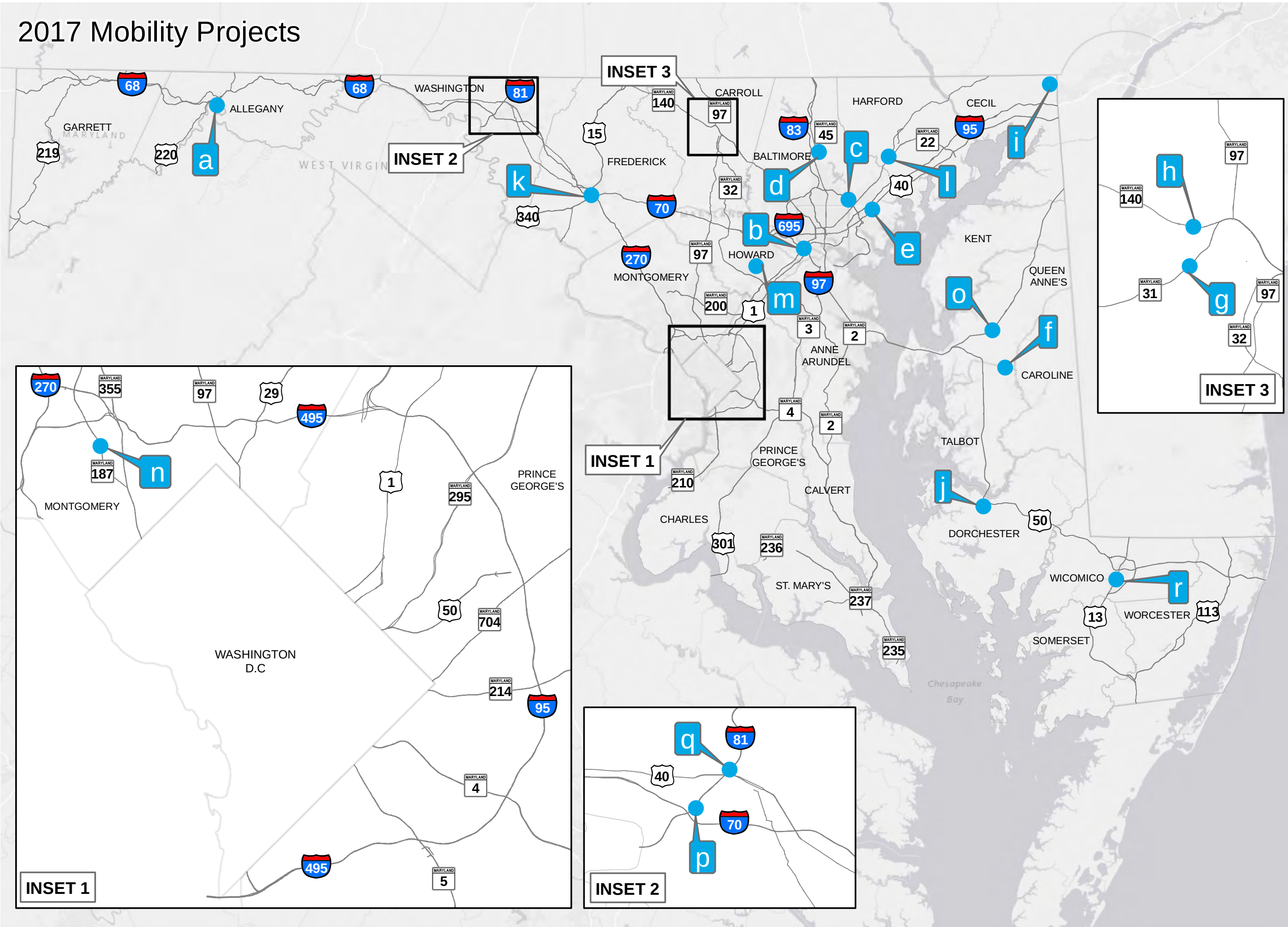
There were eighteen mobility improvement projects completed in 2017. The location of these projects is shown in Figure II-1.

2017 mobility projects provide

$67.2 million

in annual user savings in the opening year.

Figure II-1



MOBILITY PROJECT LOCATIONS:

a. MD 51 @ Virginia Ave.
b. I-695 over Leeds Ave/Benson Ave. & Amtrak Railroad
c. I-695 @ MD 41 to MD 147
d. MD 45 @ Corbett Rd/Piney Hill Rd.
e. US 40 @ Campbell Blvd/Mohrs Ln.
f. MD 404 from US 50 to Holly Rd.
g. MD 31 @ Tahoma Farm Rd.
h. MD 140 from WMC Dr. to Royer Rd.
i. MD 273 @ Appleton Rd.
j. MD 16 @ Woods Rd.
k. MD 180 @ Solarex Ct/US 340 Ramp
l. MD 147 @ Connelly Dr.
m. US 29 Northbound from Seneca Dr. to MD 175
n. MD 187 @ Oakmont Ave./W. Cedar Lane
o. US 301 @ MD 304
p. I-81 Northbound from I-70 to Halfway Blvd.
q. I-81 Southbound from MD 58 to US 40
r. US 13 Business from Dogwood Dr. to College Ave.

The following describes in detail the improvement at each location.

MD 51 @ VIRGINIA AVENUE (ALLEGANY COUNTY)

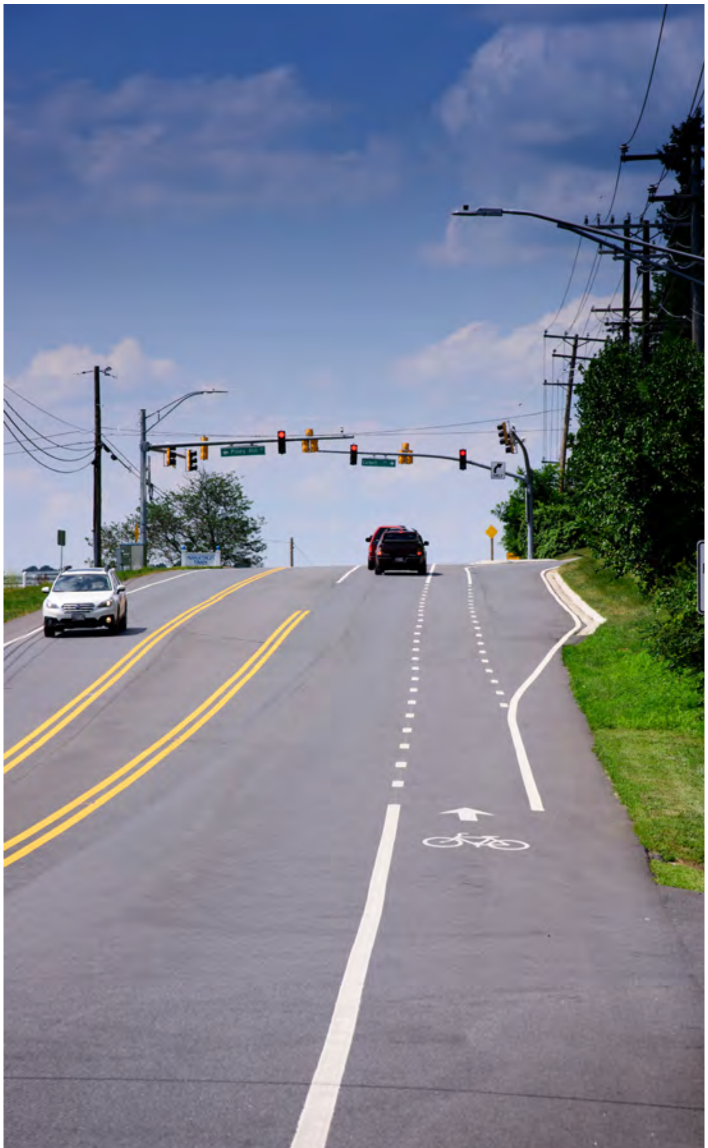
MD 51 at Virginia Avenue in Cumberland was modified to a Michigan left type intersection to reduce delay and improve mobility. Various improvements were constructed at this location including a median crossover to the west. Southbound motorists on Virginia Avenue will turn right and utilize the median crossover to go eastbound on MD 51. The median area between the MD 51 eastbound and westbound was converted to allow for only northbound traffic. The traffic signal was modified at the intersection to reflect the changes.

I-695 OVER LEEDS AVENUE, BENSON AVENUE AND AMTRAK RAILROAD (BALTIMORE COUNTY)

The I-695 bridges over Leeds Avenue, Benson Avenue and the Amtrak Railroad located in the southwest portion of the Baltimore Beltway near I-95 were reconstructed during this project. On I-695 (Inner Loop) the roadway was reduced from three lanes to two lanes between the I-695 Inner Loop off-ramp to I-95 northbound and the I-95 southbound to I-695 Inner Loop on-ramp. At the merge point, long queues would occur. This project, in addition to repairing the bridges, eliminated the merge condition by carrying three lanes past the merge point of the I-695 on-ramp. The three lanes plus the two lanes from the ramp merge into five lanes on the Inner Loop and then the left-most lane drops which substantially reduced the queuing along the I-695 Inner Loop.

I-695 @ MD 147 (BALTIMORE COUNTY)

Motorists along I-695 (Baltimore Beltway) experience severe congestion along the Outer Loop in the AM peak and the Inner Loop in the PM peak period. The section between MD 41 (Perring Parkway) and MD 147 (Harford Rd) is constantly rated as one of the worse sections in the state during the AM peak hour (rated #3 in 2016). I-695 is three lanes in each direction in this section. This project replaced the Old Harford Road Bridge over I-695 and widened I-695 to four lanes by providing an auxiliary lane between the two interchanges. In addition, to improve safety and mobility the I-695 eastbound (Inner Loop) ramp to MD 147 northbound was removed and replaced with a signalized left turn from the outer directional ramp to MD 147 southbound. This eliminated the weave section along I-695.



MD 45 @ CORBETT ROAD/PINEY HILL ROAD (BALTIMORE COUNTY)

The intersection of MD 45 (York Rd) and Corbett Road/Piney Hill Road is located in the Hereford area of Baltimore County. The northbound approach consisted of a through lane and a 200 foot right turn lane. The southbound approach was a single lane. This project provided for a left turn lane on both MD 45 approaches and a channelizing island for the northbound right turn lane onto Corbett Road. The signal was modified as part of the project. Corbett Road provides access to Hereford Middle School.

US 40 @ CAMPBELL BLVD/MOHRS LANE (BALTIMORE COUNTY)

US 40 in eastern Baltimore County is mainly a four-lane divided roadway. Campbell Boulevard on the east leg was recently extended from just east of US 40 to Bird River Road. On Mohrs Lane just to the west of the intersection originally there was a single lane bridge over the CSX Railroad. Ultimately a new bridge and roadway will be constructed to tie into MD 7. This project provided for additional capacity in both the short and long term. US 40 was widened from a four-lane divided highway to a six lane roadway.

MD 404 FROM US 50 TO HOLLY ROAD (CAROLINE, QUEEN ANNE'S AND TALBOT COUNTIES)

MD 404 is utilized as alternative route to reach Denton and locations on the Atlantic Ocean. During the summer, traffic volumes substantially increase causing congestion. Over the years there were severe collisions from motorists trying to pass or cross the centerline on the two-lane roadway. MDOT SHA decided to widen approximately 9 miles of MD 404, providing for a four-lane section. This improvement will reduce delays and improve safety.

MD 31 @ TAHOMA FARM ROAD (CARROLL COUNTY)

The intersection of MD 31 and Tahoma Farm Road is located in Carroll County southwest of Westminster. This signalized T-intersection has two lanes on all approaches except for MD 31 westbound. This project provided a right turn lane to be constructed on MD 31 westbound. Bike lanes were added with the improvement along MD 31.

MD 140 FROM WMC DRIVE TO ROYER ROAD (CARROLL COUNTY)

MD 140 is a multi-lane divided highway through the City of Westminster. Along MD 140 to the west of the city the number of lanes is reduced until in front of McDaniel College where only a two-lane undivided roadway existed. As developments have continued to the west side of the city, this has caused capacity issues in the eastbound direction. In order to address this issue, MD 140 eastbound was widened to two lanes. The second through lane commences at Royer Road and continues more than ½ mile to the signalized intersection at WMC Drive.

MD 273 @ APPLETON ROAD (CECIL COUNTY)

The intersection of MD 273 and Appleton Road is located just south of the Pennsylvania border and just east of the Delaware State Line in the most northeastern portion of the state. Motorists previously stopped on the Appleton Road approach to the intersection. With the rural character along MD 273, speeds along this section of roadway were fairly high increasing the risk for severe crashes. A single lane roundabout was constructed to improve safety and reduce delay along Appleton Road.

MD 16 @ WOODS ROAD (DORCHESTER COUNTY)

The intersection of MD 16 (Church Creek Road) and Woods Road lies at the southern edge of the City of Cambridge. Originally, Woods Road was stop controlled for both approaches while MD 16 free flowed through the intersection. There were single lane approaches to the intersection along Woods Road and right and through/left lanes along MD 16. One of the high volume movements at this intersection was the left turn from MD 16 eastbound to Woods Road northbound with about 1,500 motorists per day making that movement. In order to improve operations and safety especially for that movement a single lane roundabout was constructed.

MD 180 @ SOLAREX COURT (BALLENGER CENTER DRIVE) (FREDERICK COUNTY)

MD 180 in Frederick is experiencing congestion due to the number of retail, residential, and office developments in the area. Various improvement projects have taken place and others are being studied. MD 180 intersects with Solarex Court to the east and the on ramps to and from US 15/340 to the west. Solarex Court has been renamed Ballenger Center Drive. This project included a second northbound left turn lane on MD 180 to the ramp to US 15/340, a second southbound lane on MD 180 and removes the median at Solarex Court to provide a two lane approach to the intersection. The westbound approach from Solarex Court was also widened to provide a new shared left/through lane.

MD 147 @ CONNELLY ROAD (HARFORD COUNTY)

The MD 147/Connelly Road intersection is located just to the south of the Town of Bel Air. MD 147 is a two lane divided roadway. Left turn lanes were not provided on MD 147. This meant that along MD 147 left turning motorists would queue in the through lane. This project constructed left turn lanes on both northbound and southbound MD 147 and signalized the intersection.

US 29 NORTHBOUND FROM SENECA DRIVE TO MD 175 (HOWARD COUNTY)

US 29 in Howard County serves as a parallel facility to roadways such as I-95, US 1 and MD 295. Traffic volumes are substantial in the area with US 29 carrying approximately 93,000 vehicles per day. The high volumes along this section causes congestion with stop and go traffic occurring from south of the MD 32 interchange. This project widened US 29 northbound from two to three lanes. Also, the US 29 northbound ramp to MD 175 eastbound has been realigned and reconstructed. The entrances to Old Colombia Road and Gale Lane from US 29 northbound were closed to improve safety.

MD 187 AT OAKMONT AVENUE/WEST CEDAR LANE (MONTGOMERY COUNTY)

A project completed to support the BRAC Act employment growth at the Walter Reed National Medical Center and National Institutes of Health was along MD 187 in the Bethesda area of Montgomery County. At the West Cedar Lane intersection with MD 187, several modifications occurred. This included constructing a right turn lane on both West Cedar Lane westbound and on MD 187 northbound. Lane usage was modified on West Cedar Lane westbound to provide a through/left from a separate through and left turn lane. The signal was also modified at this location. This project also expanded the North Bethesda Trail.

US 301 AT MD 304 (QUEEN ANNE'S COUNTY)

US 301 on the Eastern Shore is a four lane limited access controlled facility with some interchanges and some at-grade intersections. Speeds along US 301 are high due to the rural nature of the land use surrounding the roadway. Trucks are a large proportion of the vehicles along the roadway with most sections having almost 25%. MDOT SHA has been eliminating many of these at-grade intersections to improve safety due to the severe nature when a collision occurs at these locations. A diamond interchange was constructed with roundabouts along MD 304 at the ramp termini to improve safety and mobility. A two lane bridge was built to carry MD 304 over US 301. A park and ride lot was relocated from near the intersection to just to the west of the interchange of Tidewater Drive. Approximately 1.6 miles to the north, at MD 305, the intersection had been modified to a median u-turn design which limited some of the left turn and the through movements to further improve safety.

I-81 NORTHBOUND FROM I-70 TO HALFWAY BOULEVARD (WASHINGTON COUNTY)

I-81 and I-70 intersect in Hagerstown. These two major facilities have a high percentage of trucks accessing from one interstate to the other. In addition, there are several warehouse type developments located off of Halfway Boulevard to the north of I-70 that have a high number of trucks exiting at this location. Traffic operations were impacted along the mainline of I-81 northbound with truck drivers trying to get up to speed to merge on to I-81 and the other drivers trying to reduce speeds to diverge to Halfway Blvd. This project provided for a continuous auxiliary lane between I-70 and Halfway Boulevard instead of separate acceleration and deceleration lanes by completing the missing approximately 200’ gap.

I-81 SOUTHBOUND FROM MD 58 TO US 40 (WASHINGTON COUNTY)

I-81 in Hagerstown was configured with a separate acceleration lane for the ramp from MD 58 to I-81 southbound and a separate deceleration lane to US 40. These were approximately 2,100 feet apart. This project consisted of providing a continuous lane to tie in the MD 58 on ramp acceleration lane with the US 40 off ramp deceleration lane.

US 13 BUSINESS FROM DOGWOOD DRIVE TO WEST COLLEGE AVENUE (WICOMICO COUNTY)

Various improvements were constructed along US 13 Business to improve mobility. The major emphasis of these improvements was to extend left turn lanes on US 13 Business northbound at West College Avenue by 475 feet, southbound at Bateman Street by 525 feet and provide a 325 foot northbound left lane for the future Salisbury University library entrance. Left turning motorists along US 13 Business were at times unable to access the left turn lane or would block through motorists. In order to alleviate this congestion, the project improved the storage for these movements.

a. Mobility Improvement Project Benefits

Each of the mobility improvement projects were analyzed to determine the benefits they provide to the traveling public. This included before and after safety and traffic analysis to determine the annual user cost benefits of the completed mobility projects. The benefits are related to the reduction in delay incurred by motorists and commercial vehicles, fuel savings, the safety benefit resulting from the improvement, and the benefit provided by increased reliability of the system.

The benefits from the eighteen projects are shown in Table II-1. Detailed information is included in Appendix C.

2017 Mobility Projects provided

560,000 hours of delay reduction and 313,000 gallons of fuel savings in opening year of operation.

Table II-1

MOBILITY PROJECTS OPENING YEAR BENEFITS			
Location	County Name	Safety Savings	Annual Cost Savings
		$ Savings (Thousands)	$ Savings (Thousands)
MD 51 @ Virginia Avenue	AL	1,700	422
I-695 over Leeds Road/Benson Avenue and Amtrak Railroad	BA	1	838
I-695 @ MD 41 to MD 147	BA	253	16,349
MD 45 @ Corbett Road/Piney Hill Road	BA	7	42
US 40 @ Campbell Blvd/Mohrs Lane	BA	17	67
MD 404 from US 50 to Holly Road	CO, QA, TA	6,059	1,418
MD 31 @ Tahoma Farm Road	CL	2	15
MD 140 from WMC Drive to Royer Road	CL	326	411
MD 273 @ Appleton Road	CE	390	11
MD 16 at Woods Road	DO	5,000	-30
MD 180 @ Solarex Court/US 340 Ramp	FR	94	10,932
MD 147 @ Connelly Drive	HA	-600	477
US 29 Northbound from Seneca Drive to MD 175	HO	163	13,238
MD 187 @ Oakmont Avenue/ West Cedar Lane	MO	28	1,527
US 301 at MD 304	QA	7,200	31
I-81 Northbound from I-70 to Halfway Boulevard	WA	208	75
I-81 Southbound from MD 58 to US 40	WA	317	17
US 13 Business from Dogwood Dr. to College Ave.	WI	0	12
Total		**21,258**	**45,852**

It should be noted that the projected mobility savings for future years would be higher then opening year savings shown in Table II-1. (Compared to no-build condition.)

MD 65 @ I-70 Ramps

2. DEVELOPER PROJECTS

Traditional roadway improvements are funded by State/County/local agencies. In addition to these improvements, often developers will be required to construct projects to mitigate the impacts caused by the additional volume of traffic that is generated from these new residential, commercial, office and warehouse developments. The improvements funded by developers range from acceleration and deceleration lanes, to new traffic signals, to minor/major intersection enhancements, to interchange modifications. Without these improvements, operational issues can result including failing intersections or traffic from turn lanes queuing into through lanes. The proposed improvements are a joint process between MDOT SHA and developers to determine the upgrades required to offset the traffic the development will generate. Some of the mobility improvement projects completed by developers in 2017 include:

- MD 85 @ Conestoga Trail (Frederick County)
- MD 22 @ Thomas Run Rd (Harford County)
- US 29 @ MD 99 (Howard County)
- MD 65 @ I-70 Ramps (Washington County)

The benefits of these projects are corridor wide and are not limited to motorists going to/from the development. These projects improve conditions for motorists that pass through the intersection daily by decreasing travel times and reducing delays along the corridor.

3. FREIGHT PROJECTS

Freight projects present the challenge of balancing the mobility of truckers with providing safe facilities for all users. These projects can be divided into two types. The first are roadway projects that enhance overall mobility which provide improvements for freight operators. The second includes the projects directed specifically at improving trucking operations. These enhancements aim to keep truckers and other users of the network including autos/ bicyclists/ pedestrians safe.

Virtual Weigh Station @ US 40
(Cecil County)

There are several programs established to move freight more efficiently. One of the programs managed by MDOT SHAs' Motor Carrier Division is the Virtual Weigh Station (VWS) program. This program uses technology to protect the reliability of the pavement and keep trucks moving smoothly. Maryland's VWS promotes the goals of safety, freight mobility and infrastructure preservation through an automated system of sensors and cameras that record activity of Commercial Motor Vehicles (CMV) traveling at highway speeds. The VWS can record the speed, height, weight and every axle of a commercial vehicle without requiring the vehicle to stop, which increases mobility for compliant vehicles. Overweight vehicles which damage roads and bridges can be identified for possible educational contact or enforcement action.

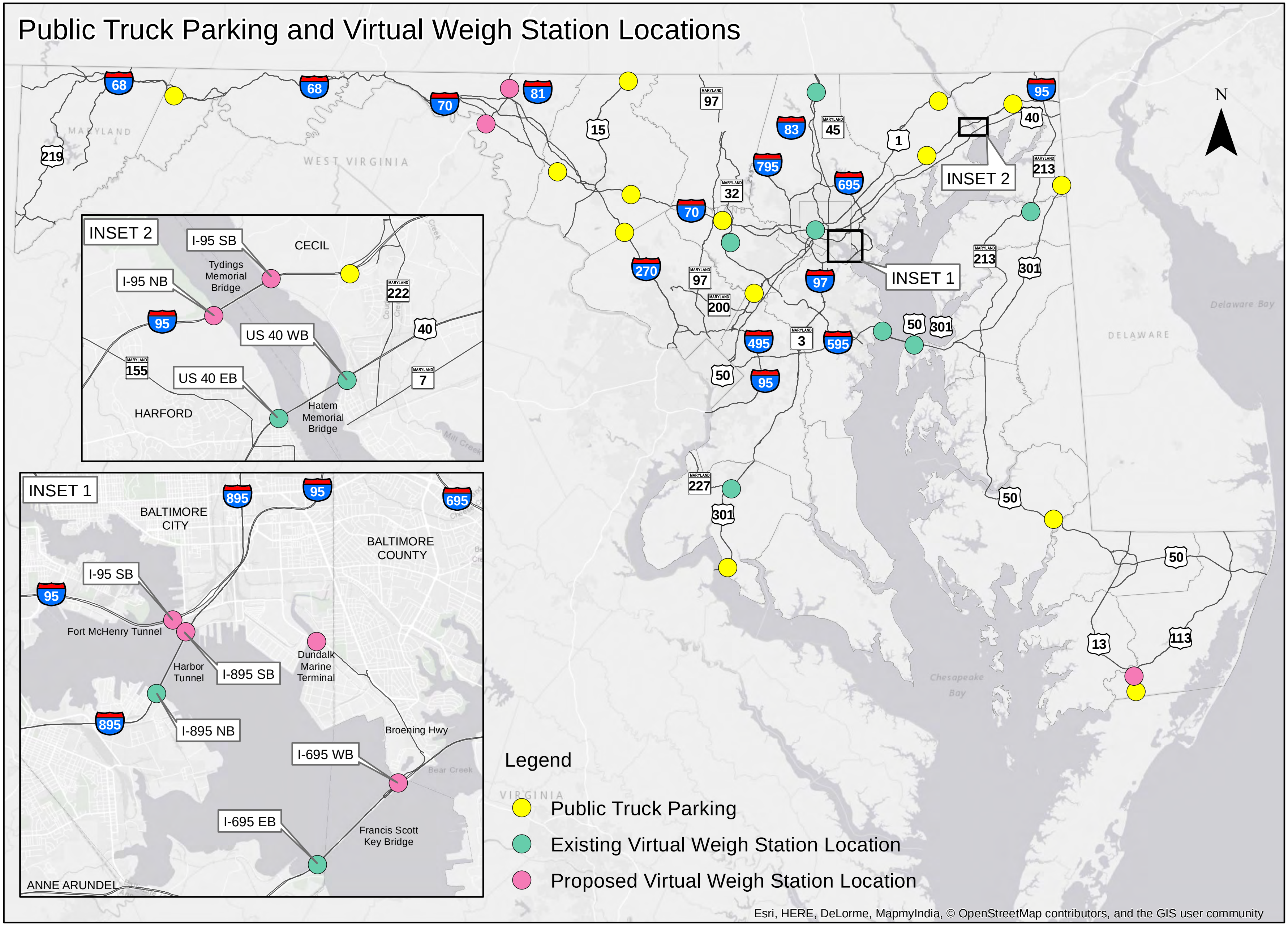
In addition, each VWS provides a volume and classified count including the image of the vehicle. By the end of 2017 there were eleven active VWS sites across the state. Nine more sites are anticipated to be constructed by the end of 2018, two years ahead of schedule. Statewide, ten of these sites will monitor Maryland Transportation Authority's bridges and tunnels. Once complete, this will allow for a system that electronically checks a majority of CMV's, intercepts the ones that are unsafe or overweight, and minimizes delay to others operating legally.

In 2016, the new automated MDOT SHA's Maryland One permit system became operational. Maryland One permit system program allows the state to process applications more efficiently for large shipments. Shipments that exceed the legal size and weight limits require special hauling permits. Previously, permit approval could take hours or days depending upon the request.

By the end of 2017 approximately 84% of permit applications submitted with this system were processed in a matter of minutes and without error. Most permits for superloads up to 200,000 pounds can be issued within two (2) days. The only lengthy process is permitting for megaloads which can exceed 1,000,000 pounds due to the coordination needed by numerous agencies/participants.

Overnight truck parking is a national and statewide concern and is monitored through a MDOT SHA's Freight Planning Program. Truck parking at Rest Areas and Welcome Centers provide for safe locations to reduce the potential for crashes between parked trucks and moving vehicles as parking along shoulders of highways and at entrance/exit ramps can create a safety hazard. Overnight truck parking is maintained through MDOT SHA's Freight Planning Program. Truck parking expansion projects were completed at the I-95 Southbound Welcome Center in Howard County and the US 301 Bay County facility in 2015. Design is underway for the expansion of up to 10 spaces at the I-70 Westbound and Eastbound Welcome Centers at South Mountain in Frederick County. Public truck parking locations and the location of VMS are shown in Figure II-2.

By the end of 2018, nine new virtual weigh stations are anticipated to be constructed.


Public Truck Parking and Virtual Weigh Station Locations
INSET 1
INSET 2
BALTIMORE CITY
BALTIMORE COUNTY
ANNE ARUNDEL
I-95 SB
Fort McHenry Tunnel
Harbor Tunnel
I-895 SB
I-895 NB
Dundalk Marine Terminal
Broening Hwy
I-695 WB
I-695 EB
Francis Scott Key Bridge
CECIL
HARFORD
I-95 SB
I-95 NB
Tydings Memorial Bridge
US 40 WB
US 40 EB
Hatem Memorial Bridge
MARYLAND
WEST VIRGINIA
DELAWARE
VIRGINIA
Delaware Bay
Chesapeake Bay
N
Legend
Public Truck Parking
Existing Virtual Weigh Station Location
Proposed Virtual Weigh Station Location
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

4. RAILROAD CROSSING PROJECTS

Highway rail-at-grade crossings can present a safety issue for all transportation users. Each year approximately 8 of the 633 public at-grade crossings and 22 separate pedestrian crossings in Maryland are updated to either eliminate hazards or improve traffic control devices. These improvements can include a wide range of possible solutions such as installing new flashing light signals (with or without gates), updating the components at existing active warning devices and improving crossing surfaces. Public highway-rail grade crossings that were modified in 2017 included MD 31 and Church Street in the Town of New Windsor; Lawndale Road in Carroll County; Carey Road in Worcester County; Jordan Road, Rench Road and College Road in Washington County and US 1 Alternate and Decatur Street in the City of Hyattsville.

5. PEDESTRIAN AND BICYCLE PROJECTS

There are two approaches through which MDOT SHA improves pedestrian and bicycle facilities in Maryland. In appropriate projects where the emphasis is on roadway improvements, pedestrian and bicycle facilities are incorporated to provide a multi-modal project. This could include bike lanes, pedestrian signals, ADA ramps, crosswalks and sidewalks. Other projects are stand-alone pedestrian and bicycle facilities. It is anticipated that between fiscal year 2018 and fiscal year 2023 MDOT will provide over $75 million for reconstruction and new sidewalks, over $16 million for bikeway projects and administer over $65 million in grants for programs such as the Maryland Bikeways Program.

Sections of sidewalk where gaps occur or sidewalks that are in poor shape are major candidates for sidewalk improvement projects. There were 7.55 miles of new sidewalk constructed in 2017 including:

- MD 355 - Hyattstown (Montgomery County)
- MD 4 - Forestville Road to MD 458 (Prince George's County)
- MD 201 - Kenilworth Towers to Riverdale Road (Prince George's County)

Sidewalk improvements include upgrading intersections to be ADA compliant. Statewide approximately 68% of the crosswalks meet guidelines.

MD 187 @ Cedar Lane

Bike projects could include on-street bike lanes or off street facilities to encourage safe bicycle use. MDOT SHA projects in 2017 incorporated upgrades of more than $2 million for bicycle retrofit programs. This included 60.1 miles of marked bike lanes and 2.4 miles of marked shared use lanes. In addition, there was an increase of 4% in the number of bike facilities within 3 miles of transit. Among the locations of new bicycle facilities were:

- MD 258 at MD 794 (Anne Arundel County)
- MD 755 - Willoughby Beach Road to Edgewood MARC Station (Harford County)
- MD 4 - MD 458 to Forestville Road (Prince George's County)

6. PAST PROJECT BENEFITS

The use of probe data has allowed for comparisons to be created between segment operations before and after a major construction project has been completed. This shows the operational benefits these projects provide for years after their construction. For such projects that provided capacity improvements over that period and their year completed were:

- I-95 - Express Toll Lanes - I-895 to MD 43 (2015)
- MD 295 - I-195 to I-695 (2012)
- I-95 - MD 212 to MD 198 (2015)
- US 15 - Motter Ave to MD 26 (2016)

Several other projects on the freeway/expressway system have just been completed (eg. I-695 from MD 147 to MD 41) but data is not available yet for one year of operation with the capacity improvement. Other projects such as the I-695/MD 144 bridge and interchange reconstruction project now have another on-going construction that is impacting operations in the area where the first project was completed (eg. I-695 widening from US 40 to MD 144).

A comparison was made between traffic operations before the projects were constructed and 2017 operations to determine the mobility benefits of these improvements. The Travel Time Index (TTI) was used as a basis for the evaluation. Data from the years 2011 and 2017 were utilized for the comparison. The year 2011 represented the oldest year that INRIX data was analyzed for travel time index. A comparison was made between the peak direction TTI for 2011 and 2017 data which identified the following changes as shown in Table II-2:

Table II-2

CONGESTION IMPROVEMENT BY COMPLETED PROJECTS

LOCATION	COUNTY	LENGTH (MILES)	2011 TTI	2017 TTI	% REDUCTION
I-95 AM SB MD 43 to I-695	BA	2.0	1.59	1.04	+35
I-95 AM SB I-895 to US 40	BC	0.6	1.50	1.05	+30
I-95 PM NB US 40 to I-895	BC	0.6	1.72	1.04	+40
I-95 PM NB I-895 to I-695	BA	1.9	1.33	1.06	+20
MD 295 AM SB I-695 to W. Nursery Rd	AA	0.7	1.43	1.09	+24
MD 295 PM NB I-695 to W. Nursery Rd	AA	0.5	1.86	1.02	+42
MD 295 PM NB @ W. Nursery Rd Interchange	AA	0.5	2.24	1.21	+46
I-95 NB PM @ MD 212 Interchange	PG	1.1	1.47	1.03	+30
I-95 SB AM @ MD 212 Interchange	PG	1.3	1.32	1.00	+24
US 15 NB PM Motter Avenue to MD 26	FR	0.5	1.05	1.01	+4

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B.

PROGRAMS AND POLICIES

MD 139 @ I-695

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1. CHART TRANSPORTATION SYSTEM MANAGEMENT AND OPERATIONS (TSMO)

It is critical to operate the roadway network at its fullest potential to minimize the impacts of incidents and other events which in turn will increase the reliability of the system. This is accomplished through the MDOT SHA Transportation Systems Management and Operations (TSMO) program. This program maximizes performance to preserve capacity and improve mobility. In Maryland, the efforts are led by the Coordinated Highways Action Response Team (CHART). CHART is a multi-agency effort to improve mobility for Maryland's highway system through its Advanced Traffic Management System (ATMS), service patrols, communication, system integration, and incident response and management. CHART's mission is to improve mobility and safety using intelligent transportation systems (ITS) devices and interagency teamwork to address non-recurring congestion. Non-recurring congestion includes crashes, vehicle breakdowns, work zones, special events, and weather events. Non-recurring congestion is estimated to account for more than 50 percent of all delays on roadways. The Statewide Operations Center (SOC) in Hanover near BWI Airport is the main coordination hub. The SOC is supported by three strategically located Traffic Operations Centers (TOCs) using ATMS to support CHART's critical functions, including traffic monitoring and incident management. Traffic is monitored using a series of ITS devices. The information is used in conjunction with reports provided by radio communications, local government communications, and traffic signal systems to both detect and respond to incidents. In addition, CHART is one of 26 agencies from Maine to Florida that are part of the I-95 Corridor Coalition working cooperatively to improve inter-regional travel throughout the East Coast through consensus, cooperation, coordination, and communication. CHART is involved in:

- Emergency Preparedness - Redundant Power and Communication, Decentralized Communications and Emergency Operations Center (EOC) Activation and coordination with the Maryland Emergency Management Agency (MEMA).
- Emergency Weather Operations - Automatic Vehicle Location Fleet Management System and Resource Tracking System.
- Incident Management - CHART Operations Centers, Emergency Traffic Patrols, and Emergency Response Units.
- Traffic Management - Special Event and Work Zone Management.
- Traffic and Roadway Monitoring - CCTV Cameras, Traffic Detectors, and Cell phone #77.
- Traveler Information - Maryland 511 Traveler Information System - High-quality and Timely Travel Information to Motorists, CCTV Camera Video Sharing with First Responders, and Internet (www.traffic.maryland.gov).
- Public/Private Partnerships

I-95 SB @ Bouchelle Road

In 2017, the CHART program responded to and cleared more than 30,000 incidents and assisted over 42,000 stranded motorists.

I-695 @ Windsor Mill Road

a. CHART Incident Management

CHART has many functions to keep traffic moving along Maryland roadways. One of the key areas is incident management. Traffic incidents require a multi-disciplinary effort to detect, respond to, and clear collisions or other traffic impacting incidents so operations can be restored as quickly and safely as possible. Traffic is monitored by Emergency Traffic Patrols (ETPs). These ETPs assist drivers when their vehicles become disabled or when involved in a crash. These ETPs are assigned to high volume/high-incident routes and locations to boost the efficiency of the emergency response program. There are currently 46 full-time ETPs in the Baltimore, Washington, Frederick and Annapolis regions that offer various types of motorist assistance on the freeways. These ETPs operate 24 hours a day/seven days a week in the metro areas. In addition, from May through September, extra patrols are assigned to respond to the increased traffic volume traveling to and from Atlantic Ocean Beaches and locations on the Eastern Shore. Traffic is monitored using closed-circuit television (CCTV) cameras, speed sensors, and weather stations at the SOC and the regional Traffic Operations Centers (TOCs) located in College Park, Essex and Frederick. The location of the SOC and TOCs along with their coverage areas are shown on page II-3. At the time an incident is detected, the necessary information is communicated to emergency service personnel. From the SOC, motorists are then alerted to the incident through the use of Dynamic Message Signs (DMS) which identify the location of the incident or the travel time along that section of roadway. This allows motorists to make better real-time decisions. The use of incident management and traveler information system initiatives result in roadway users saving billions of dollars from minimizing delay, reducing fuel consumption and causing less harmful emissions.

The expansion of ETPs has greatly increased the number of responses to incidents and stranded motorists. Each year over the last three years ETPs have responded to over 70,000 events, up from 40,000 just five years ago. The total number of CHART responses on a yearly basis is identified in the Figure II-4.

Figure II-3

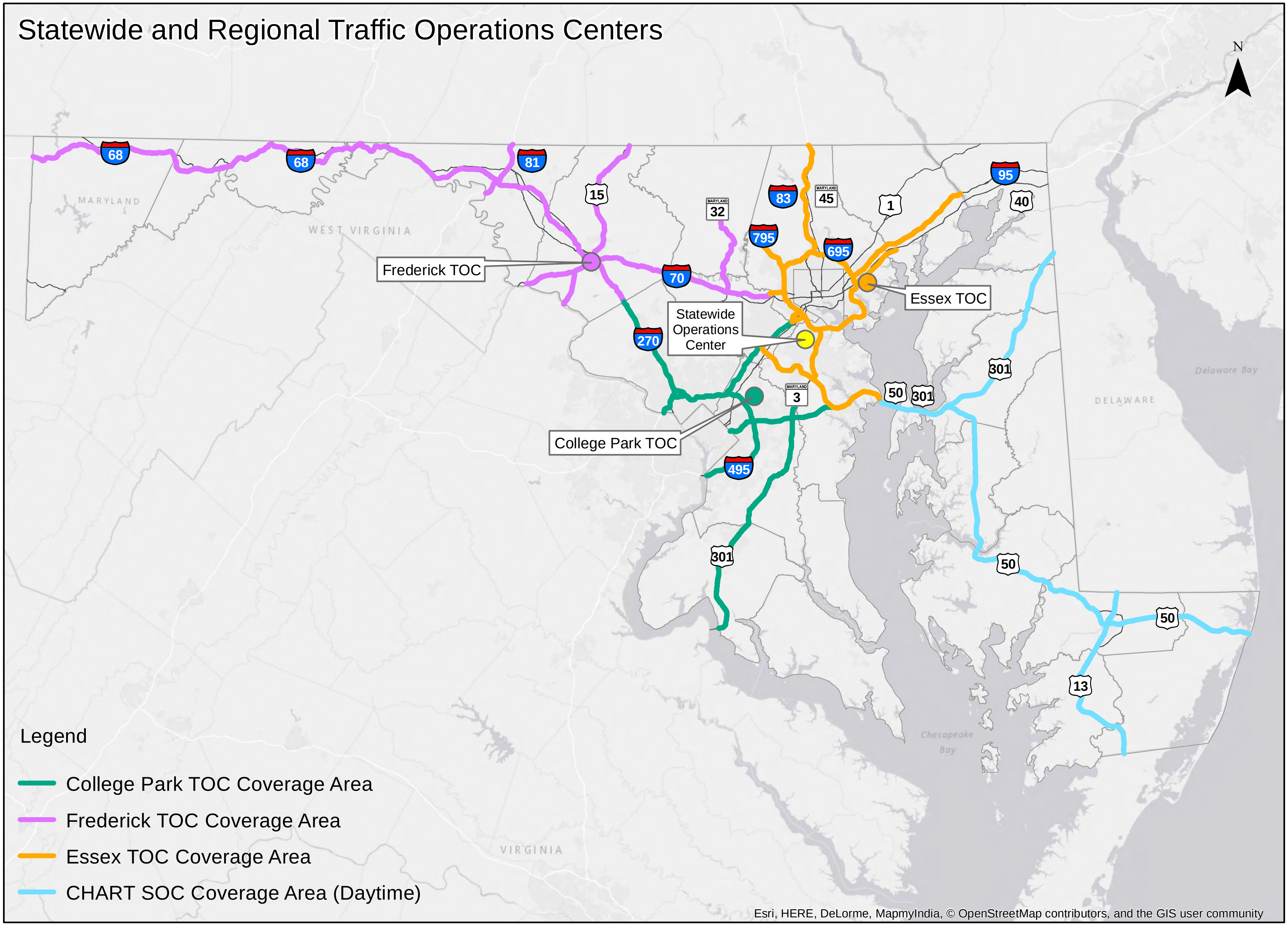
Statewide and Regional Traffic Operations Centers
N
MARYLAND
WEST VIRGINIA
VIRGINIA
DELAWARE
Delaware Bay
Chesapeake Bay
68
68
81
15
32
83
45
1
95
40
795
695
70
270
495
3
50
301
301
50
50
13
301
Frederick TOC
Essex TOC
Statewide Operations Center
College Park TOC
Legend
College Park TOC Coverage Area
Frederick TOC Coverage Area
Essex TOC Coverage Area
CHART SOC Coverage Area (Daytime)
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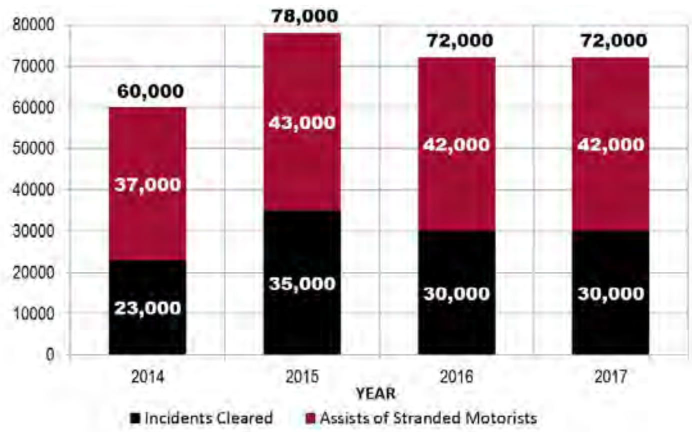
Figure II-4
CHART SERVICE PATROL RESPONSES



A broken-down vehicle on the shoulder late at night may not impact traffic operations while a car fire on an Interstate roadway in the Baltimore-Washington region during the peak period would cause major congestion. The more severe the incident, the more important it is for the cooperation of numerous agencies involved with CHART working together to achieve the goal of improving mobility and safety. In order to improve mobility, incidents need to be cleared quickly so that lanes can be reopened as soon as possible. The faster an incident is cleared from the roadway the greater the benefits (reducing delay to the travelling public and minimizing the chance for secondary incidents). Safety is of the utmost importance in protecting those involved in the incident, the emergency personnel responding, and other motorists on the roadway. This is accomplished using detailed incident management plans and procedures to address different situations. Reviews take place regularly to learn from past incidents and put in place new or revised procedures to improve for next time.

CHART has many different resources dedicated to traffic management that include:

- Emergency Traffic Patrols (ETPs), which are used to provide emergency motorist assistance and to clear disabled vehicles from the travel lanes.
- Emergency Response Units (ERUs), which establish overall traffic control at crash locations.
- Freeway Incident Traffic Management (FITM) plans and response trailers, which are pre-stocked with traffic control tools including detour signs, cones, and trailblazer signs that are used to quickly set up pre-planned detour routes when incidents require full roadway closure.

> The average response time to an incident in 2017 was 11.4 minutes and the average incident took 24 minutes to clear.

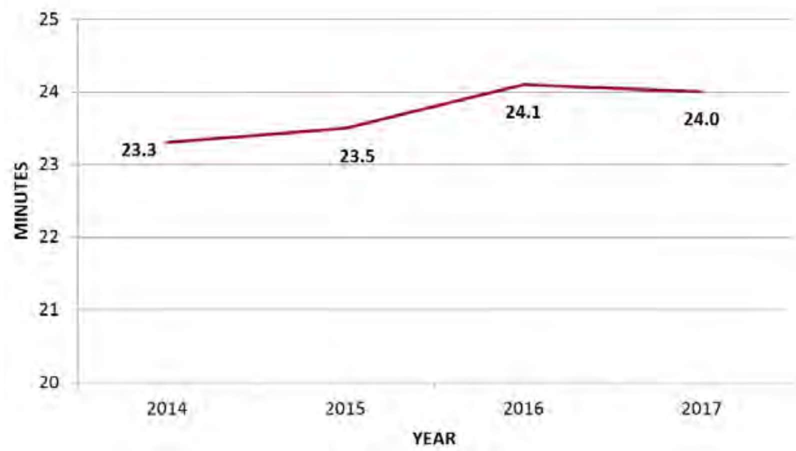
- Maryland "Clear the Road" policy, provides direction for the rapid removal of vehicles from the travel lanes rather than waiting for law enforcement or private towing services to remove disabled vehicles that block travel lanes. This in combination with the "Move It" law directs motorists in property damage collisions to move the vehicle off the roadway to minimize incident delays.
- An Information Exchange Network (IEN) Clearinghouse, provided through the I-95 Corridor Coalition workstation at the SOC, which shares regional incident and traveler information to member agencies.

The heavily congested conditions on many roadways in Maryland means the longer an incident remains on a roadway the greater the cost associated with the delay experienced by motorists. The delay includes the amount of time it takes to respond to an incident and the length of time to clear that incident. By providing CHART services, this reduces the amount of delay, and ultimately provides for an annual user cost savings. These factors are evaluated each year by CHART. Figure II-5 depicts the trends of average incident duration reduction in delay and annual user cost savings provided by CHART over the last four years. In 2017, the annual user cost savings amounted to $1.46 billion. This is approximately the same amount of savings as in 2016. Annual user cost includes reduction in delay, savings in fuel, and emissions.

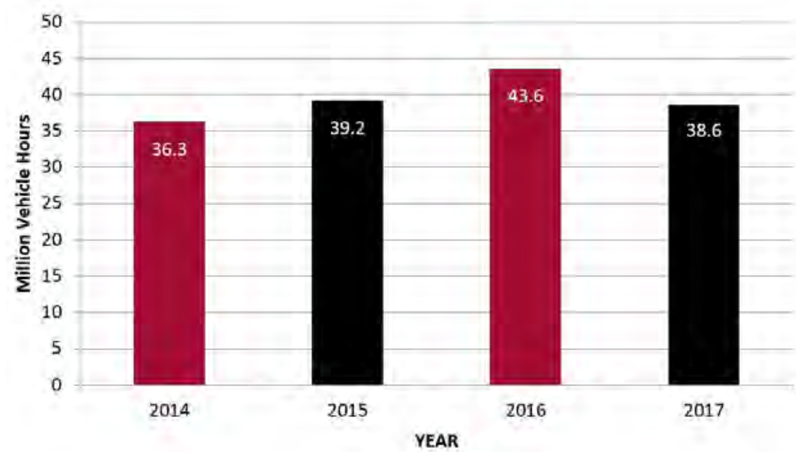
CHART achieved a $1.46 Billion savings to motorists and reduced delay by approximately 38.6 million vehicle hours. This was the second highest savings to motorists by CHART in their history just slightly below last year.

Figure II-5

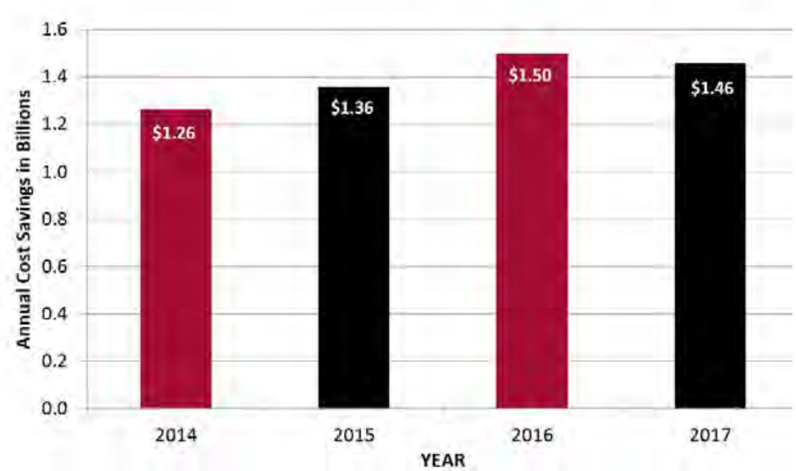
AVERAGE INCIDENT DURATION



REDUCTION IN DELAY



ANNUAL USER COST SAVINGS



b. ITS/511

Data is collected from a wide variety of ITS devices that are strategically located throughout the State and is disseminated to motorists to allow them to make better decisions, thereby reducing congestion and increasing mobility. Travel time information is made available based on the analysis of INRIX probe speed data and displayed on more than 200 DMS. The Maryland 511 Travel Information System continues to provide useful, high-quality, and timely travel information. These devices are evaluated each year and, based on funding availability, new features are introduced to the system or expansions made in the number of devices. Presently CHART and MDTA have access to:

- 800+ CCTV Cameras which include video feeds from other agencies.
- 300+ Speed Detectors (including those shared through public/private partnerships).
- 200+ Dynamic Message Signs (DMS).
- 60+ Roadway Weather Information Systems (RWIS).
- 50+ Traveler Advisory Radios.
- 15+ Variable Toll Rate Signs.

2. SIGNAL OPERATIONS

Along arterial roadways, the major constraint to mobility is at the junction of two higher volume roadways. Traffic flows need to allow for all movements to take place. Traffic signals provide control for conflicting movements at these intersections. This allows for roadway users to pass through the locations safely and efficiently. When signals are not properly timed or new traffic patterns emerge as a result of development they can result in longer travel time and delay. One of the most cost-effective ways to reduce delay and improve mobility is to optimize traffic signals to provide better progression. Signal retiming projects provide improved safety and increased person throughput on corridors by being more responsive to traffic flows. This reduces delay to motorists, lowers the amount of fuel consumed and decreases emissions. Other benefits include a more walkable environment and the potential decrease in rear end crashes by reducing the number of stopped vehicles. The benefit cost ratio of improving signal timings based on nationwide studies can range up to 40:1.

MDOT SHA maintains 1,571 traffic signals

in 259 signal systems in Maryland's 23 Counties.

MD 140

In 2017, MDOT SHA's Signal Retiming Program reduced delay by 1,000,000 hours and saved 370,000 gallons of fuel. This resulted in $34.9 annual user savings.

Most of the traffic signals in Maryland are owned and operated by MDOT SHA. These signal systems are often in need of timing upgrades due to changes in traffic volumes. The process of upgrading signal timing includes gathering new traffic volume data, performing traffic modeling, developing adjustments to the timing patterns, and conducting travel time analysis to evaluate the before and after results and performing final iterations to the signal timings. In 2017 a total of 317 signals were reviewed for retiming. New timings were installed on 41 systems involving 242 signals throughout the State. The signal systems that were reviewed are shown in Table II-3 and in Figure II-6.

The highest benefits associated with any signal system upgrade from a reduction in the number of vehicle hours of delay are as follows:

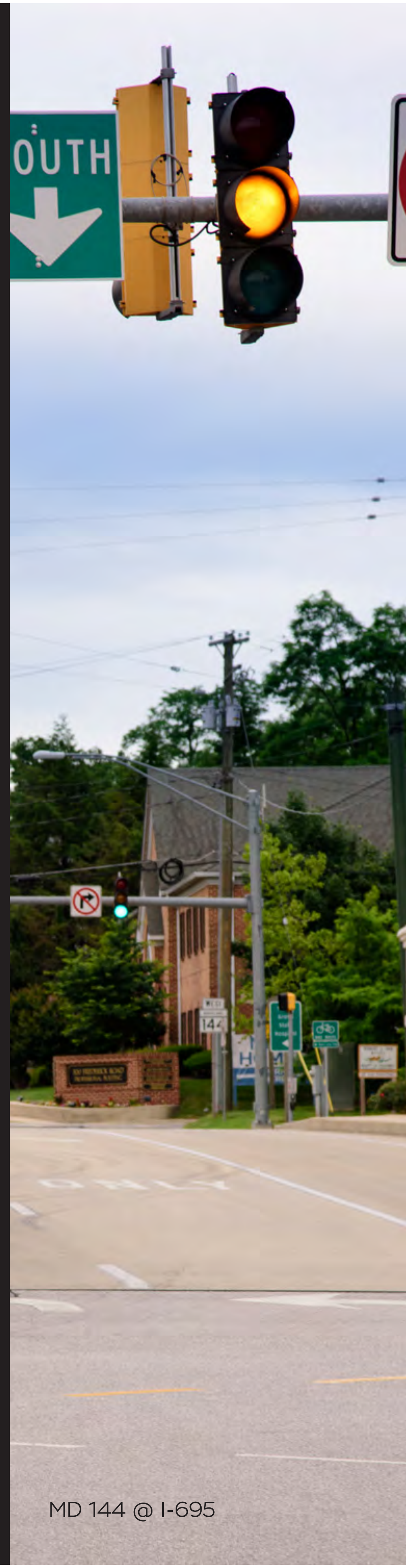
- US 40 - Coleridge Rd. to Nuwood Dr.
- MD 202 - McCormick Dr. to Arena Dr.
- MD 235 - Airport View Dr to Pegg Rd.
- MD 26 - MD 355 to MD 194/Antietam Dr.
- US 40 - Old Camp Rd. to US 15 Ramps
- MD 202 - Kenmoor Dr. to I-95 S/B Off Ramp

Each of these systems provide a reduction of more than 50,000 vehicle hours of delay annually. In addition, the following systems provided more than a 20% reduction in delay:

- MD 80 - MD 355 to Singleton Dr.
- MD 177 - Long Point Rd. to Forest Glen Dr.

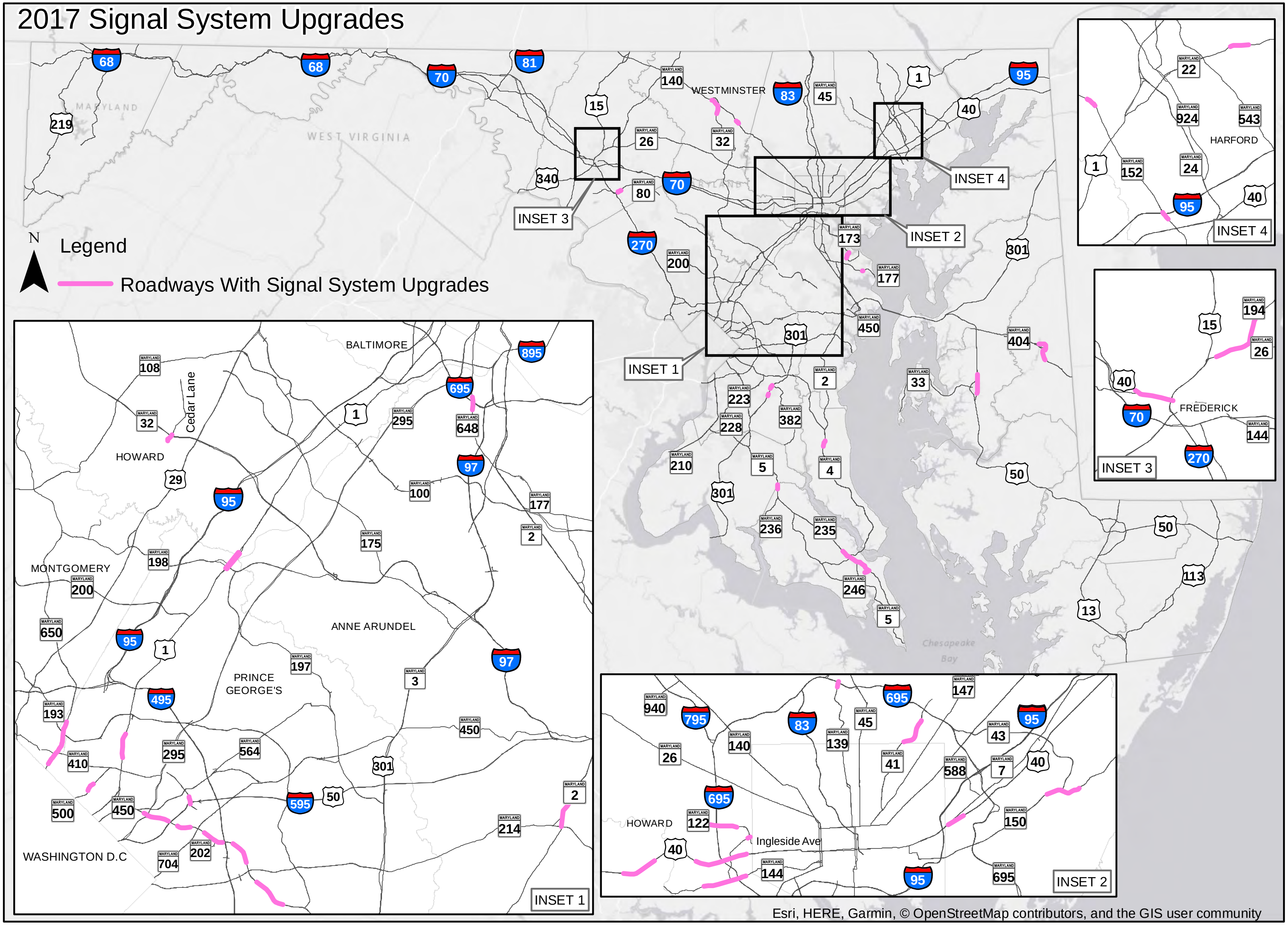
Statewide signal retiming and optimization modifications provided an estimated reduction of 1,000,000 hours of delay for motorists and saved nearly 370,000 gallons of gasoline.

Retimed signals in 2017 reduced delay by 9% compared to 2016 levels.



MD 144 @ I-695

Figure II-6



2017 Signal System Upgrades
Legend
N
Roadways With Signal System Upgrades
MARYLAND
WEST VIRGINIA
WESTMINSTER
INSET 1
INSET 2
INSET 3
INSET 4
BALTIMORE
HOWARD
Cedar Lane
MONTGOMERY
ANNE ARUNDEL
PRINCE GEORGE'S
WASHINGTON D.C
Ingleside Ave
HARFORD
FREDERICK
Chesapeake Bay
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Table II-3

2017 NETWORK DELAY SAVINGS FOR SIGNAL SYSTEM UPGRADES		
LOCATION	NO. OF SIGNALS	DELAY SAVINGS (VEH-HRS)
US 40 - Coleridge Rd. to Nuwood Dr.	11	139,000
MD 202 - McCormick Dr. to Arena Dr.	4	124,000
MD 235 - Airport View Dr. to Pegg Rd.	14	106,000
MD 26 - MD 355 to MD 194/Antietam Dr.	7	71,000
US 40 - Old Camp Rd. to US 15 Ramps	11	66,000
MD 202 - Kenmoor Dr. to I-95/I-495 S/B Off Ramp	5	54,000
MD 202 - 57th Ave. to US 50 Ramp	7	46,000
US 301 - MD 382 to Heathermore Blvd.	3	46,000
MD 80 - MD 355 to Singleton Dr.	4	41,000
MD 650 - Sheridan St. to Quebec St.	16	39,000
MD 5 - Mohawk Dr. to Golden Beach Rd.	3	31,000
MD 32 - Town of Westminster	10	29,000
US 50 - Dutchmans Ln. to MD 309	7	29,000
MD 202 - Campus Way to White House Rd.	5	27,000
MD 122 - Rolling Rd. to Perimeter Dr.	13	24,000
US 1 - Campus Dr. to MD 500/Queens Chapel Rd.	9	23,000
MD 22 - Prospect Mill Rd. to Campus Hills Shopping Center	4	21,000
MD 202 - Pennsy Dr. to Fire House Rd.	5	20,000
Ingleside Ave. - MD 122 to Parallel Dr.	2	16,000
MD 41 - Hillsway Ave. to Putty Hill Ave.	4	15,000
MD 223 - Pine View Ln. to Mike Shapiro Dr.	4	13,000
US 40 - Normandy Dr. to Chatham Rd.	5	13,000
MD 152 - Watervale Rd. to Carrs Mill Rd.	2	12,000
US 1 - Bowie Rd. to N Laurel Rd.	15	9,000
MD 2/4 - Cox Rd. to Ponds Wood Rd.	3	8,000
MD 140 - Sandymount Rd. to Suffolk Rd.	2	5,000
MD 648 - Furnace Branch Rd. to Hammonds Ln.	5	2,000
MD 144 - Rolling Rd. North to Paradise Ave.	10	2,000
MD 177 - Long Point Rd. to Forest Glen Dr.	2	2,000
MD 139 - I-695 Ramps to Kenilworth Dr.	3	N/A
MD 150 - Chesapeake Park Dr. to Carroll Island Rd.	5	N/A
MD 152 - MD 7 to I-95 Ramps	4	N/A
MD 173 - Bar Harbor Rd. to Edwin Raynor Blvd.	5	N/A
MD 2 - Virginia Ave. to MD 214	7	N/A
MD 235 - Corporate Dr. to MD 246, MD 246 - MD 235 to St. Mary's SC	8	N/A
MD 32 - Ramps @ Cedar Ln; Pindell School Ln.	3	N/A
MD 410 - Ellin Rd. to US 50 Ramps	3	N/A
MD 500 - MD 501/Chillum Rd. to MD 208/Hamilton St.	3	N/A
US 301 - Fairhaven Ave. to Rosaryville Rd	2	N/A
US 40E - Chesaco Ave. to 66th St.	3	N/A
MD 404 - MD 328 to MD 16	4	N/A
Total	**242**	**1,033,000**

The MDOT SHA is investing $50 million to upgrade 14 major corridor signal systems with cutting edge technology to improve mobility. These Smart Traffic Signals allow for adjustments to be made to the timings based on real time traffic conditions. Also termed adaptive signals, the computer software allows for more green time for the major road when necessary. By better synchronizing the entire corridor, this reduce delays to motorists and improves progression along the major road due to the changing traffic conditions and volumes. The 14 corridors where the Smart Signals are being implemented are shown in Table II-4.

Another program that is a joint state/county effort to implement transit signal priority (TSP). TSP allows transit vehicles to either pre-empt a signal to provide a queue jump or to extend the green to improve travel time and reliability. The first project is on MD 355 in Montgomery County. Initial deployment was completed in the fall of 2017 for the Ride On extRa express bus service on MD 355 between Lakeforest Mall and Medical Center METRO Station. TSP was installed at 30 traffic signals along the route and all Ride On extRa buses are taking advantage of the technology to put in requests for signal priority. The joint state/county policy and criteria for location identification was used to determine the most beneficial locations for TSP implementation.

With the initial success of the Ride On extRa TSP service, planning and engineering are underway in 2017 for Montgomery County's proposed Bus Rapid Transit (BRT) service on US 29. This will feature TSP at approximately 15 traffic signals and all Ride On BRT service buses. It is anticipated that BRT service with TSP will commence in early 2020.

Table II-4

SMART TRAFFIC SIGNAL CORRIDORS		
ROUTE	**COUNTY**	**LIMITS**
MD 2	Anne Arundel	Annapolis Harbor Center to Tarragon Lane
MD 2	Anne Arundel	Hammonds Lane to 11th Avenue
MD 3	Anne Arundel	MD 450 to St. Stephens Church Road
MD 139	Baltimore	Kenilworth Avenue to I-695 Outer Loop
US 40	Baltimore	Coleridge Road to Nuwood Drive
MD 5 Business	Charles	Post Office Drive to US 301
MD 228	Charles	Western Parkway to US 301
US 301	Charles	Chadds Ford Drive to MD 227
US 1 Business	Harford	Tollgate Road to Atwood Road
MD 22	Harford	Technology Way to North Rogers Street/US 40 ramp
US 1	Howard	Montgomery Road to MD 175
US 301	Prince George's	Excalibur Road to Governor's Bridge Road
MD 202	Prince George's	McCormick Drive to Arena Drive
MD 108	Montgomery	MD 182 to Volunteer Drive

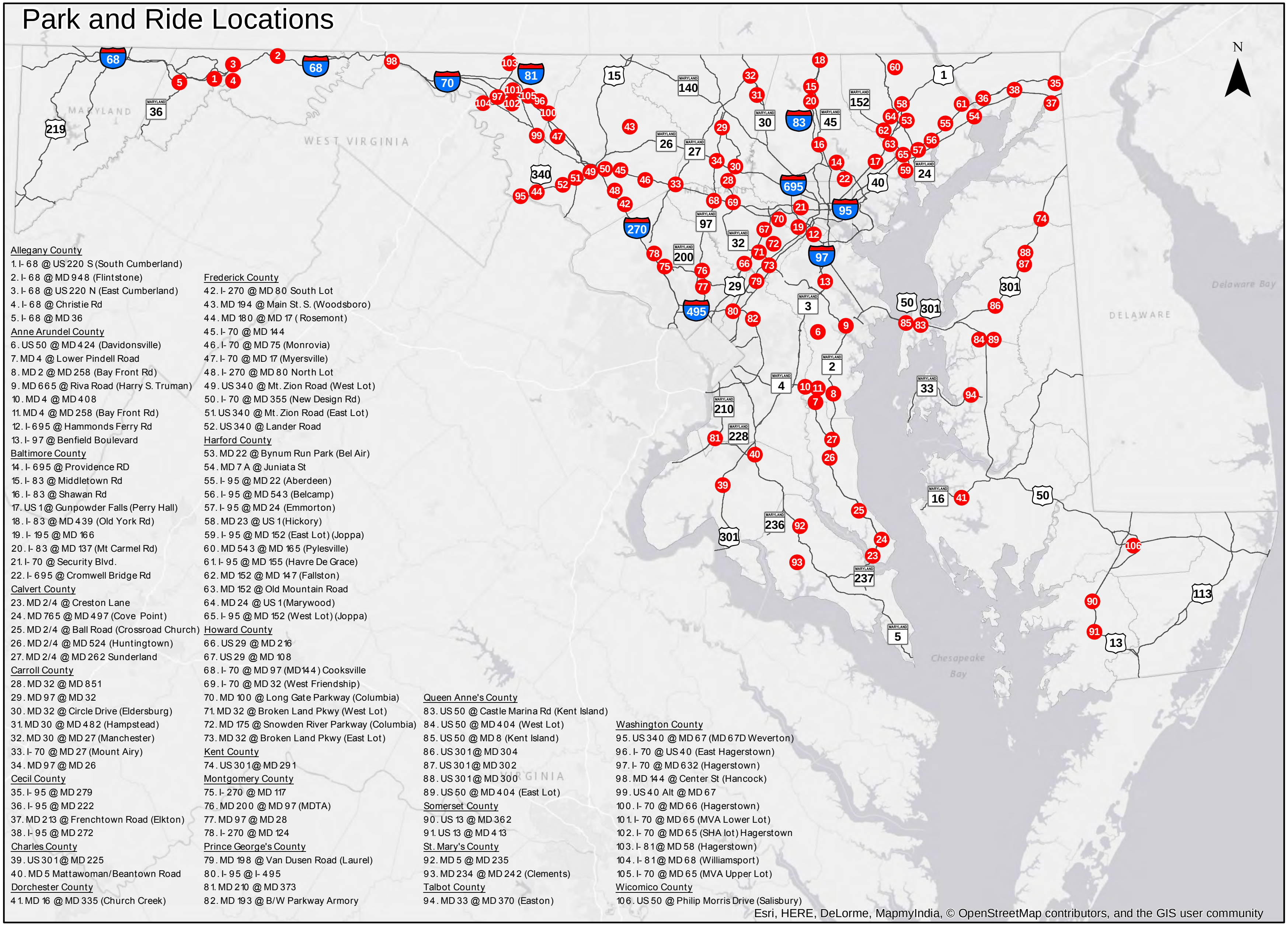
3. MULTI-MODAL STRATEGIES

a. Park and Ride

MDOT SHA and MDOT MDTA have established a network of park and ride lots throughout the State. This provides a means to connect motorists to multi-modal transit connections. MDOT has established and maintains 106 locations in 20 counties providing over 13,300 parking spaces. Motorists that park at these lots reduce single occupant vehicles and increase ride-sharing. MDOT SHA partners with the MDOT MTA and local transit agencies to encourage transit connections to the lots. The mutually beneficial relationship boosts transit trips and reduces congestion. The number of spaces at the park and ride lots range from less than 10 spaces to more than 800 spaces. The two largest lots are along MD 5 in the Waldorf area of Charles County and MD 665 at Riva Road in the Annapolis area of Anne Arundel County. Over 600 motorists park at the MD 5 lot along Mattawoman -Beantown Rd. In 2017, a new park and ride lot was opened at US 301/MD 304. This replaced the former lot that needed to be relocated due to construction of the US 301/ MD 304 interchange.

Figure II-7 shows the location of all the Park and Ride lots operated by MDOT SHA and MDOT MDTA in Maryland.

Figure II-7


Park and Ride Locations
Allegany County
1. I-68 @ US 220 S (South Cumberland)
2. I-68 @ MD 948 (Flintstone)
3. I-68 @ US 220 N (East Cumberland)
4. I-68 @ Christie Rd
5. I-68 @ MD 36
Anne Arundel County
6. US 50 @ MD 424 (Davidsonville)
7. MD 4 @ Lower Pindell Road
8. MD 2 @ MD 258 (Bay Front Rd)
9. MD 665 @ Riva Road (Harry S. Truman)
10. MD 4 @ MD 408
11. MD 4 @ MD 258 (Bay Front Rd)
12. I-695 @ Hammonds Ferry Rd
13. I-97 @ Benfield Boulevard
Baltimore County
14. I-695 @ Providence RD
15. I-83 @ Middletown Rd
16. I-83 @ Shawan Rd
17. US 1 @ Gunpowder Falls (Perry Hall)
18. I-83 @ MD 439 (Old York Rd)
19. I-195 @ MD 166
20. I-83 @ MD 137 (Mt Carmel Rd)
21. I-70 @ Security Blvd.
22. I-695 @ Cromwell Bridge Rd
Calvert County
23. MD 2/4 @ Creston Lane
24. MD 765 @ MD 497 (Cove Point)
25. MD 2/4 @ Ball Road (Crossroad Church)
26. MD 2/4 @ MD 524 (Huntingtown)
27. MD 2/4 @ MD 262 Sunderland
Carroll County
28. MD 32 @ MD 851
29. MD 97 @ MD 32
30. MD 32 @ Circle Drive (Eldersburg)
31. MD 30 @ MD 482 (Hampstead)
32. MD 30 @ MD 27 (Manchester)
33. I-70 @ MD 27 (Mount Airy)
34. MD 97 @ MD 26
Cecil County
35. I-95 @ MD 279
36. I-95 @ MD 222
37. MD 213 @ Frenchtown Road (Elkton)
38. I-95 @ MD 272
Charles County
39. US 301 @ MD 225
40. MD 5 Mattawoman/Beantown Road
Dorchester County
41. MD 16 @ MD 335 (Church Creek)
Frederick County
42. I-270 @ MD 80 South Lot
43. MD 194 @ Main St. S. (Woodsboro)
44. MD 180 @ MD 17 (Rosemont)
45. I-70 @ MD 144
46. I-70 @ MD 75 (Monrovia)
47. I-70 @ MD 17 (Myersville)
48. I-270 @ MD 80 North Lot
49. US 340 @ Mt. Zion Road (West Lot)
50. I-70 @ MD 355 (New Design Rd)
51. US 340 @ Mt. Zion Road (East Lot)
52. US 340 @ Lander Road
Harford County
53. MD 22 @ Bynum Run Park (Bel Air)
54. MD 7A @ Juniata St
55. I-95 @ MD 22 (Aberdeen)
56. I-95 @ MD 543 (Belcamp)
57. I-95 @ MD 24 (Emmorton)
58. MD 23 @ US 1 (Hickory)
59. I-95 @ MD 152 (East Lot) (Joppa)
60. MD 543 @ MD 165 (Pylesville)
61. I-95 @ MD 155 (Havre De Grace)
62. MD 152 @ MD 147 (Fallston)
63. MD 152 @ Old Mountain Road
64. MD 24 @ US 1 (Marywood)
65. I-95 @ MD 152 (West Lot) (Joppa)
Howard County
66. US 29 @ MD 216
67. US 29 @ MD 108
68. I-70 @ MD 97 (MD144) Cooksville
69. I-70 @ MD 32 (West Friendship)
70. MD 100 @ Long Gate Parkway (Columbia)
71. MD 32 @ Broken Land Pkwy (West Lot)
72. MD 175 @ Snowden River Parkway (Columbia)
73. MD 32 @ Broken Land Pkwy (East Lot)
Kent County
74. US 301 @ MD 291
Montgomery County
75. I-270 @ MD 117
76. MD 200 @ MD 97 (MDTA)
77. MD 97 @ MD 28
78. I-270 @ MD 124
Prince George's County
79. MD 198 @ Van Dusen Road (Laurel)
80. I-95 @ I-495
81. MD 210 @ MD 373
82. MD 193 @ B/W Parkway Armory
Queen Anne's County
83. US 50 @ Castle Marina Rd (Kent Island)
84. US 50 @ MD 404 (West Lot)
85. US 50 @ MD 8 (Kent Island)
86. US 301 @ MD 304
87. US 301 @ MD 302
88. US 301 @ MD 300
89. US 50 @ MD 404 (East Lot)
Somerset County
90. US 13 @ MD 362
91. US 13 @ MD 413
St. Mary's County
92. MD 5 @ MD 235
93. MD 234 @ MD 242 (Clements)
Talbot County
94. MD 33 @ MD 370 (Easton)
Washington County
95. US 340 @ MD 67 (MD 67D Weverton)
96. I-70 @ US 40 (East Hagerstown)
97. I-70 @ MD 632 (Hagerstown)
98. MD 144 @ Center St (Hancock)
99. US 40 Alt @ MD 67
100. I-70 @ MD 66 (Hagerstown)
101. I-70 @ MD 65 (MVA Lower Lot)
102. I-70 @ MD 65 (SHA lot) Hagerstown
103. I-81 @ MD 58 (Hagerstown)
104. I-81 @ MD 68 (Williamsport)
105. I-70 @ MD 65 (MVA Upper Lot)
Wicomico County
106. US 50 @ Philip Morris Drive (Salisbury)
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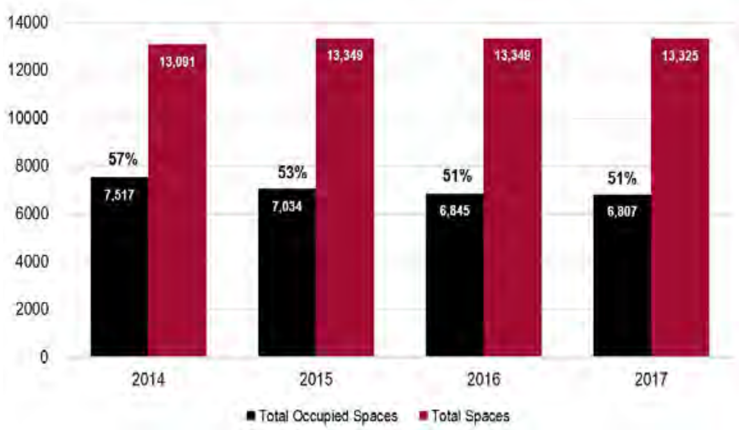
MDOT SHA performs a survey twice a year (spring and fall) at each park and ride lot to determine trends in usage. Over 6,800 spaces were utilized on a given day accounting for about 51% of the total spaces. Overall usage of the lots in 2017 were approximately the same as 2016 as shown in Figure II-8.

Figure II-8

MDOT SHA/MDTA PARK AND RIDE LOT SPACES AND OCCUPANCY



The largest increase in usage at a park and ride lot was at:

- MD 210 @ MD 373
- I-270 @ MD 124

Several lots experienced capacity constrained conditions with motorists parking on the grass or in unmarked spaces during one of the surveys. The following locations were at or exceeded capacity during one of the surveys:

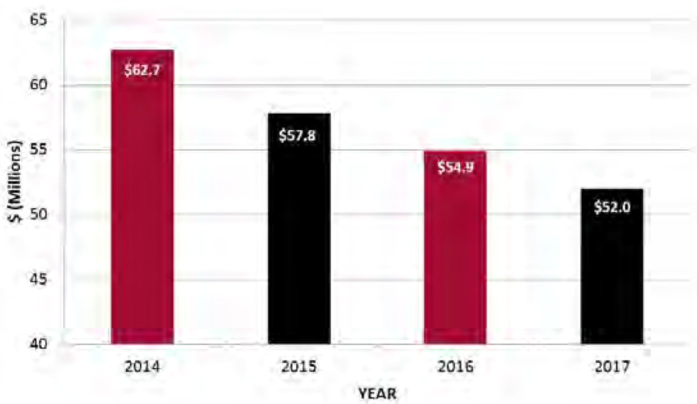
- MD 2/4 @ MD 262 (Calvert County)
- MD 2/4 @ Ball Road (Calvert County)
- MD 32 @ MD 851 (Carroll County)
- I-70 @ New Design Road (Frederick County)
- I-270 @ MD 80 South Lot (Frederick County)
- US 340 @ Mt. Zion Road East Lot (Frederick County)

The estimated annual user savings over the past four years is shown in Figure II-9. The savings has decreased in that period due to the strong economy slightly decreasing the demand and the reduction in gasoline prices.

Although MDOT SHA and MDOT MDTA provide the majority of park and ride lots, other agencies have similar goals to encourage multi-occupant vehicles or increase transit ridership. This includes MDOT MTA which provides lots for the MARC commuter trains and bus service, the Washington Metropolitan Area Transit Authority for METRO service, and various counties.

Figure II-9

MDOT SHA/MDTA PARK AND RIDE SAVINGS TO MOTORISTS (MILLIONS)



Over 6,800 motorists park at MDOT SHA/MDTA Park and Ride lots on a given day. This reduces VMT by 97.2 million miles and provides for a $52 million annual user savings.

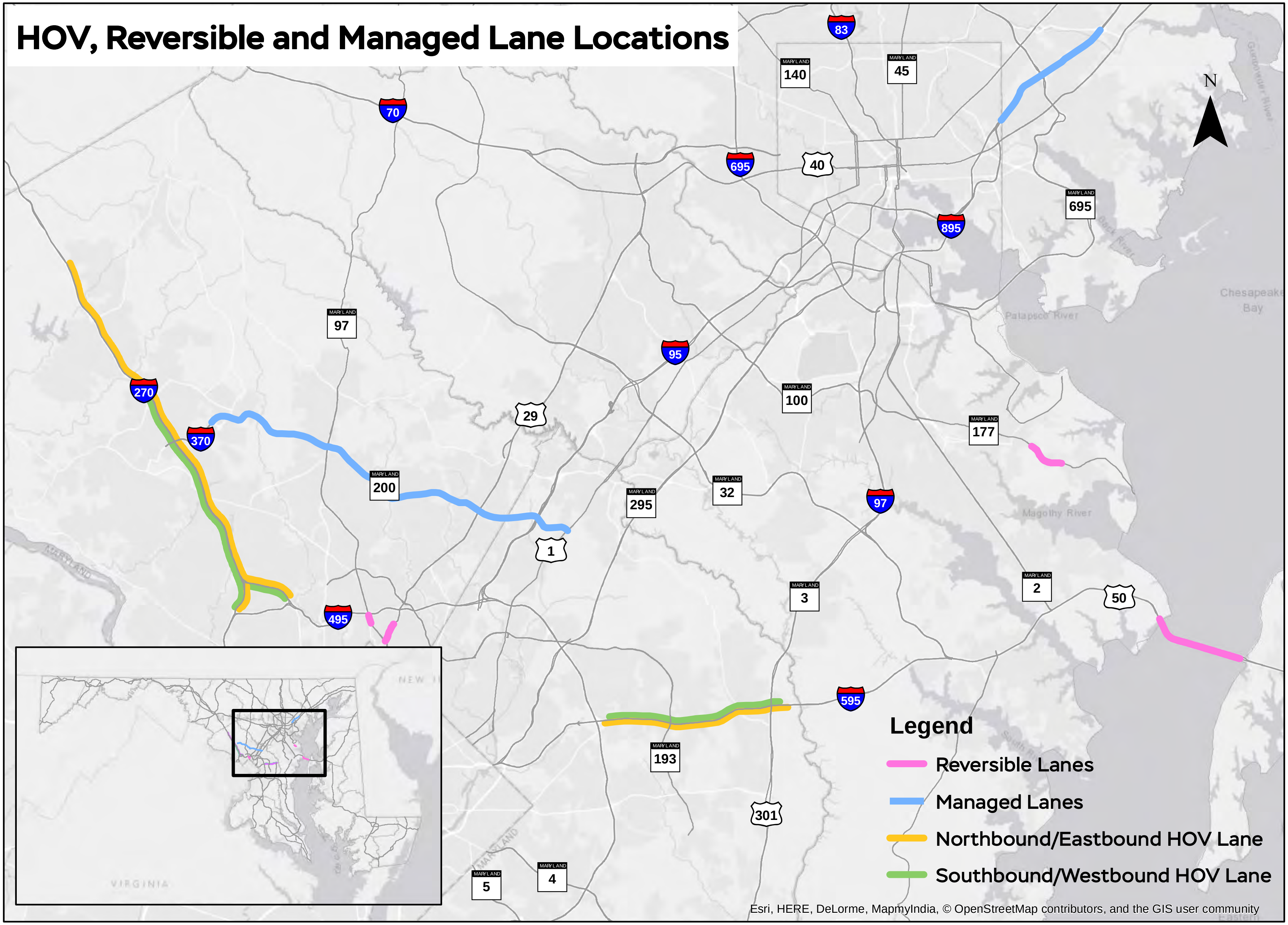
b. HOV Lane Operation (HOV)

There are various strategies to improve upon the number of persons that use a roadway without expanding the number of lanes. These strategies are commonly called Travel Demand Management (TDM). One of the most commonly utilized is high occupancy vehicle (HOV) lanes. HOV lanes encourage carpooling and reduce the number of single occupant vehicles. A travel time savings is achieved for multiple occupant vehicles over single occupant vehicles with the HOV lanes operating at near free flow speeds while the general purpose lanes usually experience congestion and lower travel speeds. HOV lanes, in combination with park and ride lots and transit service, increase person throughput and provide a viable alternative method for commuters in Maryland to reach their destination quicker and improve overall mobility. In Maryland, vehicles in HOV lanes must have two or more occupants; transit vehicles, motorcycles, or plug-in electric vehicles (permits required) are exempt. There are two HOV locations in Maryland. See Figure II-10. These are along I-270 in Montgomery County and US 50 in Prince Georges County.

The I-270 and US 50 HOV lanes are mostly separated by pavement markings from the general purpose lanes although, a few sections along I-270 have a physical separation between the lanes. The I-270 HOV lanes operate southbound from 6:00 to 9:00 AM and northbound from 3:30 to 6:30 PM while the US 50 HOV lanes function the entire day.

Studies were performed along I-270 and US 50 to evaluate the performance of the HOV lanes relative to the general purpose lanes. This was accomplished by conducting vehicle occupancy counts at multiple sites and performing travel time studies using GPS data. Person throughput evaluates the total number of people moved in each lane versus the total number of vehicles. On I-270, the HOV lanes transported approximately 400 to 600 additional people compared to an average general purpose lane.

Figure II-10


HOV, Reversible and Managed Lane Locations
Legend
Reversible Lanes
Managed Lanes
Northbound/Eastbound HOV Lane
Southbound/Westbound HOV Lane
N
83
140
45
70
695
40
695
895
97
95
100
177
270
29
370
200
32
295
97
1
2
3
50
495
595
193
301
5
4
Patapsco River
Magothy River
Chesapeake Bay
Back River
VIRGINIA
NEW
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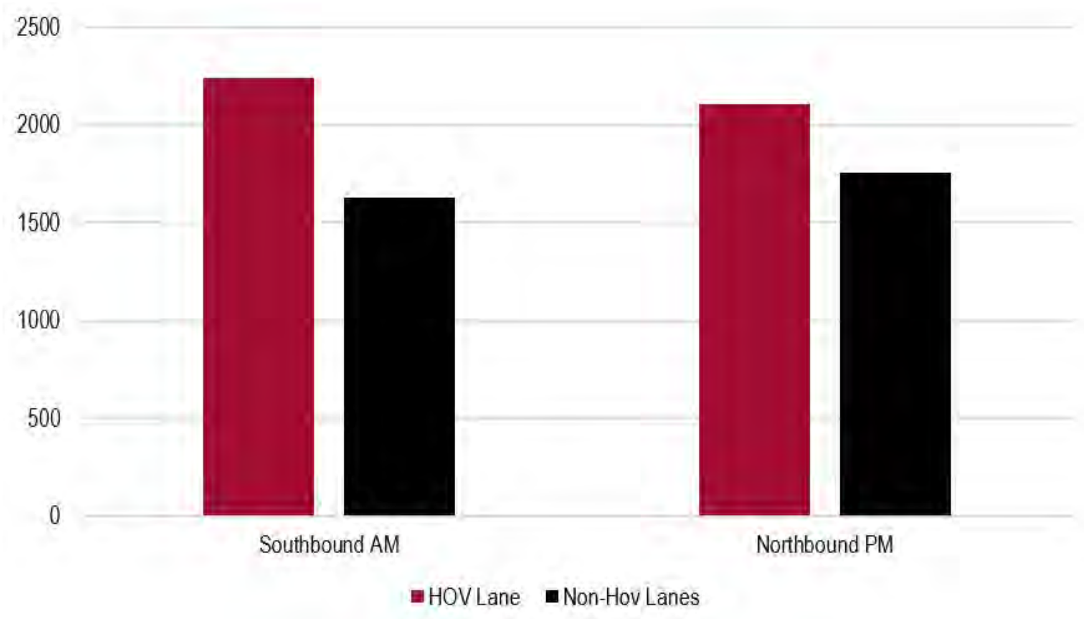
The HOV lane carries as many as 2,200 persons per lane per hour based on an average of all surveyed sites. This is shown in Figure II-11:

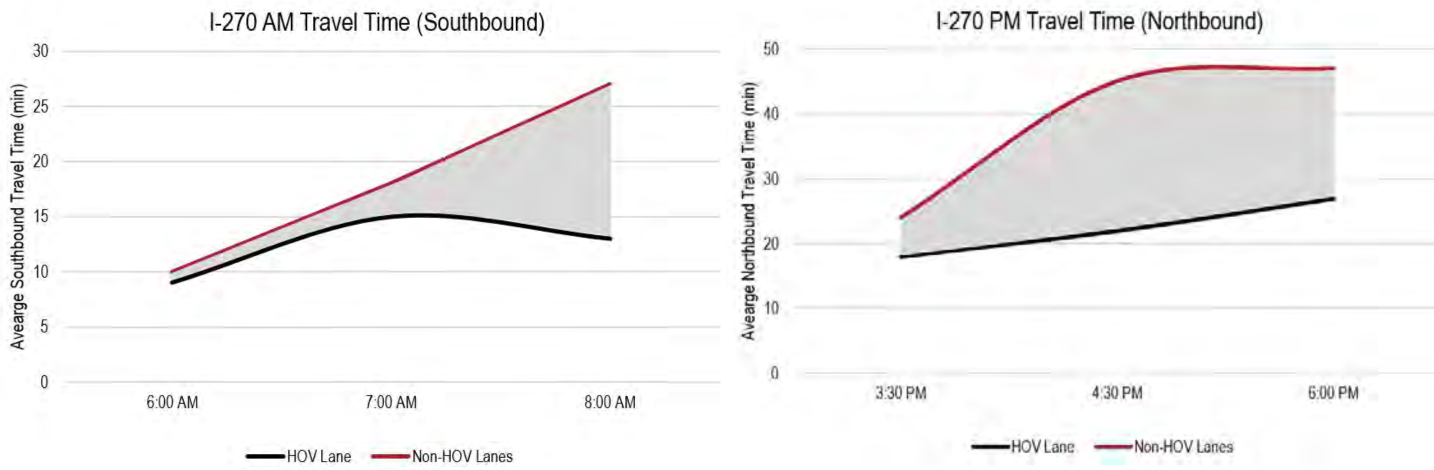
Figure II-11

I-270 AVERAGE PERSON THROUGHPUT PER LANE PER HOUR



Multi-occupant vehicles using the HOV lanes experienced a significant travel time savings over motorists in the general purpose lanes. Along I-270 in the morning peak period, the travel time savings was as much as 15 minutes with an average of 6 minutes. The afternoon peak period provided even greater travel time savings with a maximum of almost 25 minutes and an average of approximately 16 minutes. An average time savings of 1 minute occurs on US 50 for the HOV users versus those motorists using the non-HOV lanes for the AM peak period eastbound. A 4 minute maximum travel time savings occurred during the survey. The average travel time savings on the I-270 HOV lanes versus the general purpose lanes during the AM and PM peak period of operation are depicted in Figure II-12.

Figure II-12

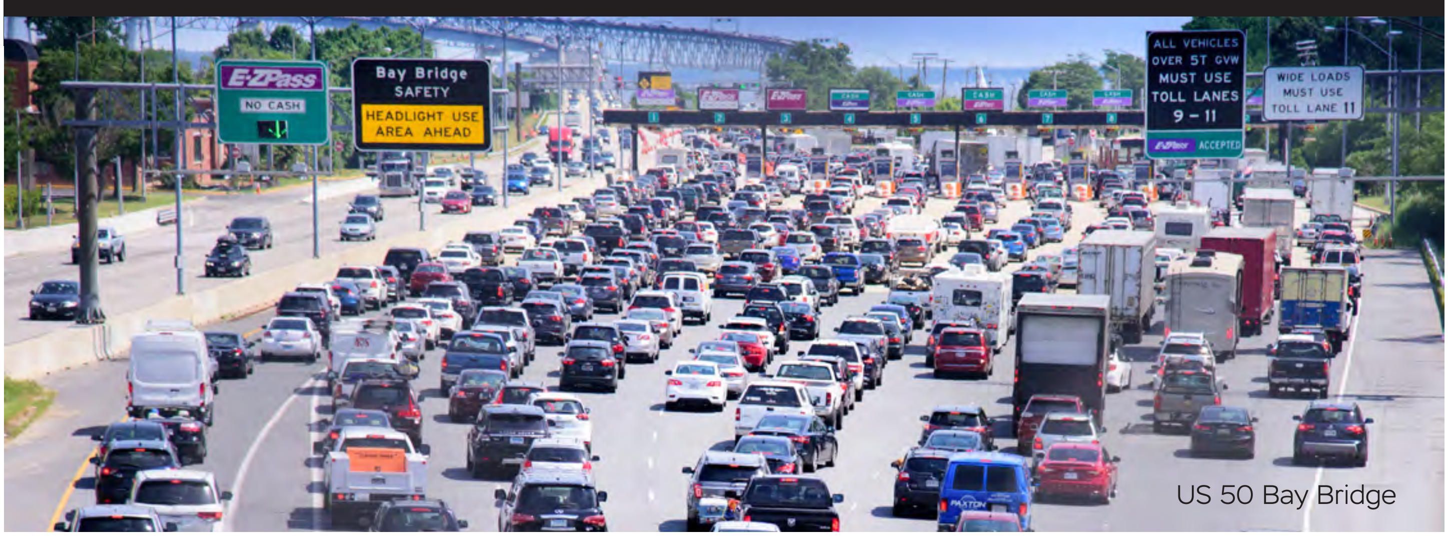


c. Reversible Traffic Lane Operation

An Active Transportation and Demand Management (ATDM) strategy is the use of reversible lanes. Reversible lanes are utilized where traffic volumes are very high in one direction and much lower in the other direction. The peak direction traffic without the reversible lane would experience major delays. These lanes operate through the use of overhead lane control signals designating the middle lane(s) to alternate with the peak flow of traffic. Reversible lanes reduce delay and congestion causing crashes while minimizing investment. By utilizing reversible lanes instead of widening a roadway reduces the impact to surrounding residents, businesses and environmental resources. Reversible lanes are usually limited to certain hours of the day.

Reversible lane operations along MDOT roadways include:

- US 29 from Sligo Creek Parkway to MD 97 (Georgia Ave) (Montgomery County) - 1.0 miles
- US 50/US 301 Chesapeake Bay Bridge (Anne Arundel/Queen Anne's County) - 4.5 miles
- MD 97 from I-495 to MD 390 (16th Street) (Montgomery County) - 0.5 miles
- MD 177 from MD 100 to West of South Carolina Avenue (Anne Arundel County) - 1.6 miles



US 50 Bay Bridge

US 29 S of Sligo Creek Parkway

Three of the four reversible lane locations are operated to improve the standard AM and PM peak period commuting traffic flows. These are along US 29, MD 97 and MD 177. The US 29 and MD 97 reversible lane operations occur inside the Washington DC Beltway (I-495). These locations provide access to the downtown Silver Spring employment center and to the WMATA Metro Red Line for commuters into Washington DC. The lanes operate southbound in the AM peak period and northbound in the PM peak period. MD 177 (Mountain Rd.) is a three lane roadway in Anne Arundel County that is converted from two lanes westbound in the AM peak period to two lanes eastbound in the PM peak period to respond to the directionality of the traffic between Lake Shore and Gibson Island to Pasadena.

The final location is the five lane Chesapeake Bay Bridge (US 50/US 301). In addition to the traditional PM peak commuter patterns, travel periods such as Saturday mornings and Friday evenings the lanes are reversed through the use of overhead lane signing. This allows for the two eastbound and three westbound lanes to be converted to three eastbound lanes and two westbound lanes. This reduces congestion and improves mobility for the numerous families traveling to the Eastern Shore and locations such as Ocean City.

The number of motorists utilizing the reversible lanes varies per facility. The highest volumes occur on the Chesapeake Bay Bridge and US 29 with over 1,600 motorists in the peak direction as shown in Table II-5.

Table II-5

Location	AM (PM) Volume Traveling in General Lanes (Vehicles Per Hour)	AM (PM) Volume Traveling in Reversible Lane(s) in Peak Direction (Vehicles Per Hour)
US 29	1,625 (1,300)	1,375 (1,400)
US 50/301	N/A (3,200)	N/A (1,600)
MD 97	2,500 (2,500)	700 (725)
MD 177	925 (1,075)	275 (150)

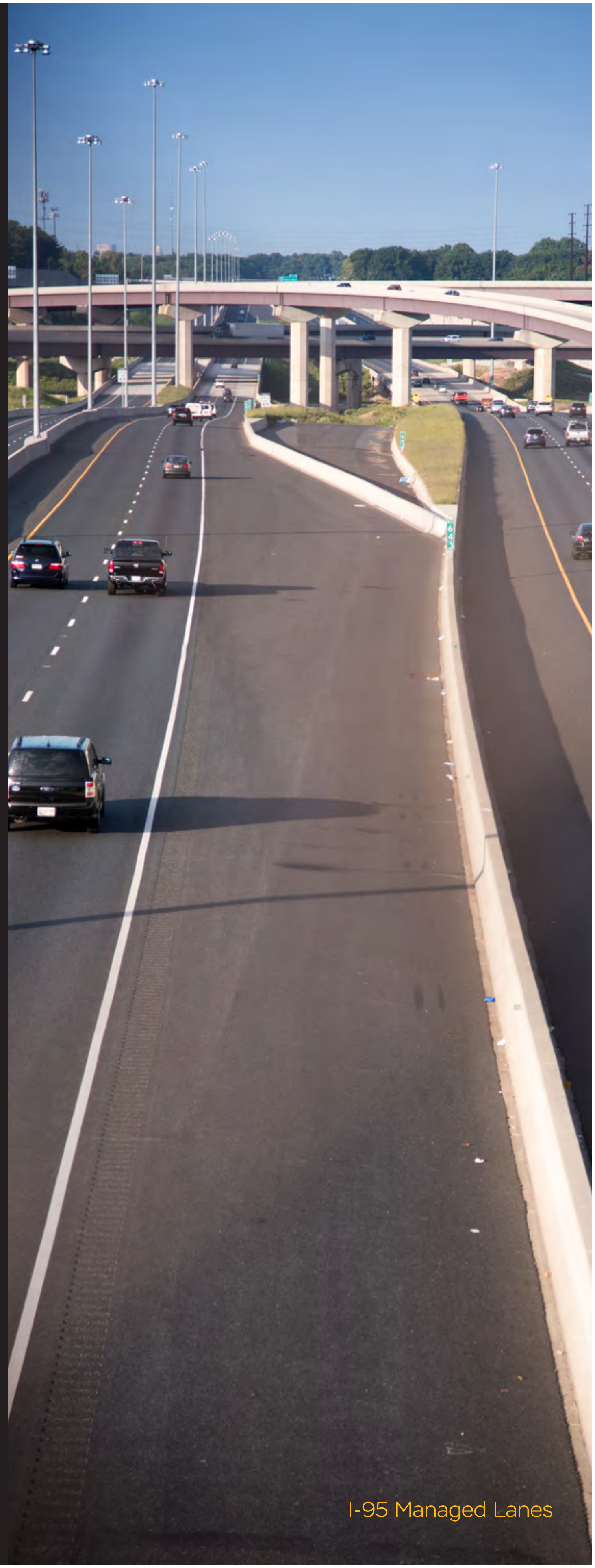
There are several other facilities throughout the State where reversible lanes are utilized on non-MDOT roadways. This includes on Brightseat Road and Arena Drive near FedEx Field in Prince George’s County, Clara Barton Parkway in Montgomery County and MD 2 (Hanover Street) over the Patapsco River in Baltimore City. The reversible lane locations for MDOT facilities are shown in Figure II-10.

d. Managed Lane Operation

The need to provide for transportation improvements in limited funding environments has required agencies to develop creative methods to upgrade facilities. An innovative approach was utilized on the I-95 north of I-895 and MD 200 corridors. This involved the use of managed lanes. Managed lanes can involve numerous different strategies to handle the flow of traffic. These two projects involved utilizing tolls to insure traffic in toll lanes operate at acceptable travel speeds without experiencing delays. The MD 200 project was the first all-electronic toll collection managed lane facility. This roadway extends from I-370 in Montgomery County to US 1 in Prince George's County a distance of 19 miles. Volumes along MD 200 have grown by 44% over the last 4 years including over 6% last year to nearly 55,000 vehicles per day on sections west of I-95. This growth in traffic volumes is illustrated in Figure II-13.

I-95 from I-895 to north of MD 43 in Baltimore County/City is an eight-mile section of roadway where motorists have the option of utilizing the four free general purpose lanes or paying a toll using E-Z Pass to travel in free flow express toll lanes. In addition to auto and commercial vehicles, transit vehicles are provided free passage. This improves transit time reliability to better meet schedules for routes in the corridor. In 2017 over 25,000 per day on average used the express toll lanes. See Figure II-14 for the existing and historic volumes for this area. The highest volume on any day was greater than 44,000 vehicles. The highest volume hours during the year exceeded 2,600 vehicles in one direction using the express toll lanes. This has substantially reduced the congestion on the highest volume section of I-95 north of Baltimore.

Over 25,000 persons per day use the I-95 managed lanes.



I-95 Managed Lanes

Figure II-13

MD 200 AVERAGE DAILY TRAFFIC VOLUMES BETWEEN I-370 AND I-95

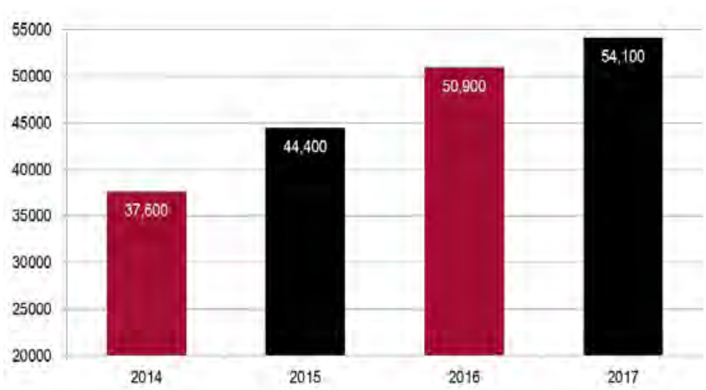
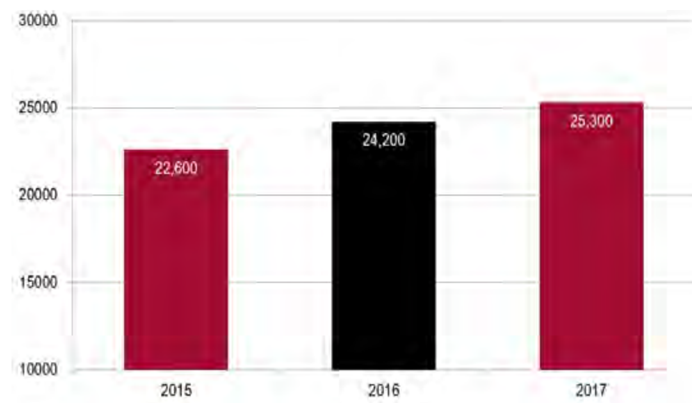


Figure II-14

I-95 EXPRESS TOLL LANE VOLUMES



e. Bicycles and Pedestrians

A transportation system needs to provide multi-modal options to all users of the facilities. This includes a strong network of facilities to support bicyclists and pedestrians. MDOT SHA does this through a series of strategic investments to improve accessibility, safety, and convenience. In November 2017 the award of $20 million dollars in grants for 43 projects was announced for pedestrian and bicycle projects. In addition, bicycle and pedestrian facilities are incorporated into MDOT SHA roadway projects to provide better multi-modal connections. This is through a Complete Streets policy. The basis for this insures that the transportation system balances all users of the roadway, including pedestrians, transit, bicyclists, and motorists. This could involve providing new sidewalks, reconstructing existing sidewalks, providing ADA facilities such as ramps and audible pedestrian signals, bike lanes, and upgrades to signing/pavement markings to alert motorists to all users of the facility.

Either as individual projects or as part of a roadway improvement these facilities provide numerous benefits including reducing auto emissions, improving public health, and enhancing community vitality to encourage more sustainable and livable places.

Various other initiatives are on-going to provide resources and improve user safety. This includes the Cycle Maryland Interactive Bicycle Map, the Pedestrian and Bicycle advisory committee made up of State representatives and private citizens, the Bicycle Safety Task Force which is working toward the goals of Toward Zero Deaths and the start of the work on an update to the Bicycle and Pedestrian Master Plan in 2019 which provides for a 20-year vision to support biking and walking.

Several funding programs are available through MDOT SHA to implement the planning, design, and construction of bicycle and pedestrian facilities throughout the State. These programs include:

MD 187

- Bicycle Retrofit - Bicycle improvements including signing and marking upgrades, modifying typical sections and creating off road trails to facilitate bicycle mobility. (MD 187 Shared Use Path)
- Bicycle and Pedestrian Priority Areas (BPPA) - Collaborative approach that designates areas to improve multi-modal options by better aligning state and local bicycle and pedestrian facilities in areas with high potential for bicycling and walking. (Prince George's Plaza METRO)
- Maryland Bikeways Program - Funding for improvements ranging from low cost bicycle treatments to shared/use paths, cycle tracks and trails. (WB&A Spur Trail)
- New Sidewalk Construction for Pedestrian Access - Sidewalk program to fill in gaps or construct key pieces of the pedestrian network (MD 245 from MD 5 to Baldridge Street)
- Recreational Trails Program - Construction of new trails or maintenance/rehabilitation of existing trails. (Three Notch Trail)
- Safe Routes to School Program - Program for infrastructure, education, or enforcement for bicycle and pedestrian routes to school for children in grades K-8.
- Sidewalk Reconstruction for Pedestrian Access - Upgrades of sidewalks, curb ramps, intersections and driveway entrances to comply with ADA guidelines. (MD 108 @ Maple Knoll Dr.)
- Transportation Alternatives Program (TAP) - Pedestrian and bicycle improvement program for transportation related community projects to strengthen the intermodal transportation system. (Anacostia River Tributaries Trail)
- Urban Reconstruction Program - Projects to promote safety and economic developments such as including sidewalks in priority funding areas.
- Federal Lands Access Program - Scenic easements and bicycle/pedestrian facilities that provide access to Federal Lands.

There are several other pedestrian/bicycle programs administered by other State and Federal agencies such as Maryland Highway Safety Office Grant, Eastern Federal Lands, Department of Housing and Community Development, and the Office of Tourism.

f. Transit Oriented Development

The State of Maryland has developed a policy to encourage transit oriented development (TODs) since legislation passed in 2008. TODs provide for a vibrant, sustainable mixed-use community around transit stations that encourage alternatives to automobile travel. There are many economic and environmental benefits associated with TODs. These benefits range from linking residents and jobs at one location, reducing auto dependency, increasing pedestrian and bicycle trips, fostering safer station areas, offering attractive public spaces, enhancing public transportation ridership, and encouraging new development or revitalization around the TOD area. TODs increase the mobility of citizens by providing more convenient access to mass transit while reducing fuel consumption, air pollution, greenhouse gas emissions, and local infrastructure costs. State designated TOD projects allow for funds and resources, financing assistance, tax credits, prioritization for the location of State offices, and support from MDOT on access improvements. There are 16 TOD sites located in six (6) counties (Harford, Baltimore, Anne Arundel, Howard, Montgomery, and Prince George's) and Baltimore City as shown in Figure II-15. The level of development at the 16 sites varies throughout the State. Certain locations are much more active with on-going construction while other locations are waiting for the right opportunities. Table II-6 shows the most active TOD sites. These sites are developed either in coordination with MDOT TSO, MDOT MTA or through a partnership between MDOT and the Washington Metropolitan Area Transit Authority (WMATA). The joint MDOT/WMATA projects are located at New Carrollton, Twinbrook, White Flint, and Branch Avenue Metro stations.

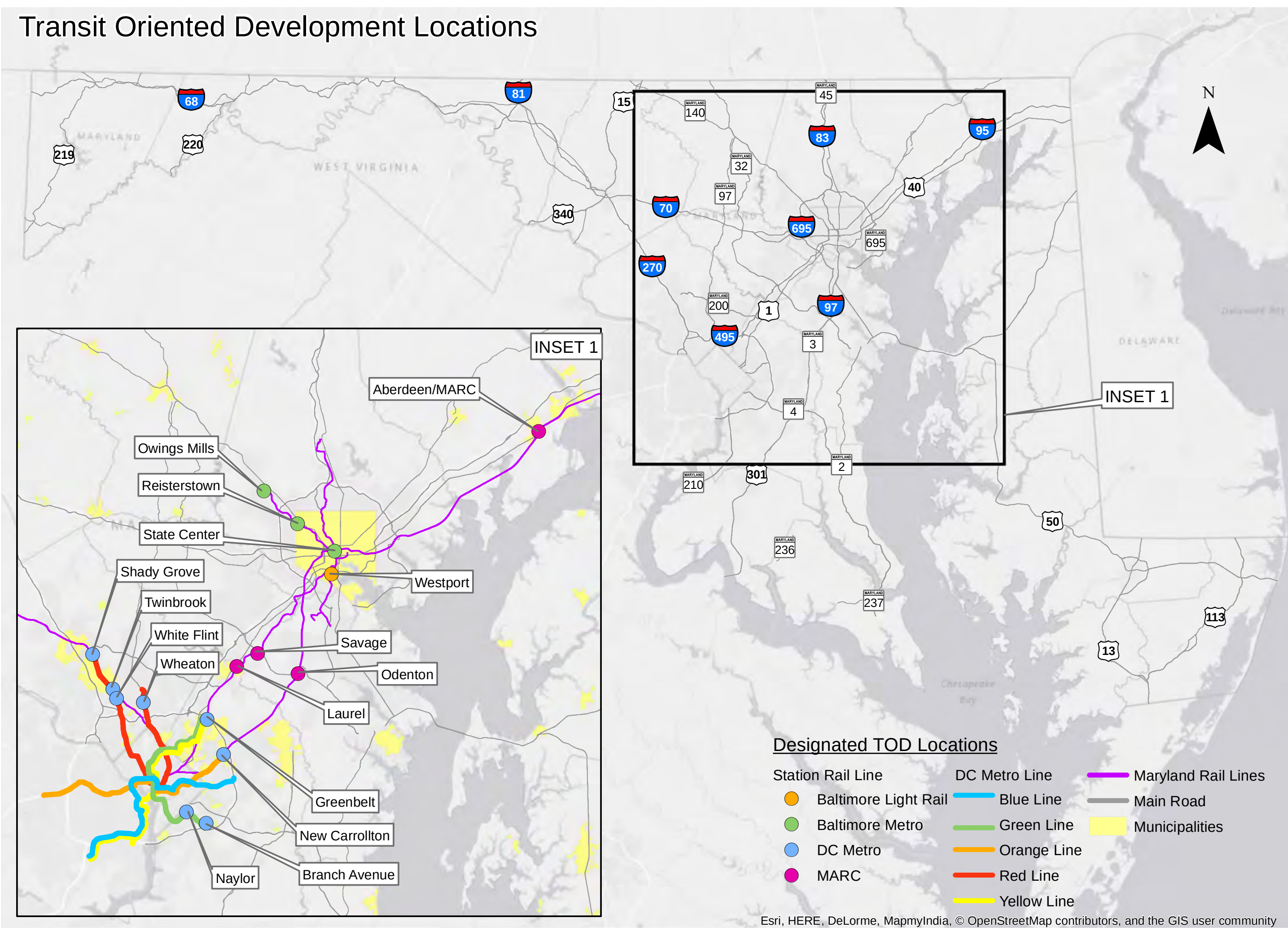
There are 16 established TOD sites in six counties and Baltimore City.

Metro Centre @ Owings Mills

Table II-6

ACTIVE DEVELOPMENT AT TODs		
TOD Location	**MULTI-MODAL CONNECTION**	**ON-GOING DEVELOPMENT**
Metro Centre @ Owings Mills	MDOT MTA-METRO	4,500 SF retail 114 residential units
Annapolis Junction/ Savage	MARC	14,000 SF retail (leasing) 416 residential units (leasing)
New Carrollton	WMATA-METRO	200,000 SF office
White Flint	WMATA-METRO	340,000 SF retail 2,000 residential apartments

Figure II-15



4. FREIGHT

The movement of freight requires a designated system to allow for truck traffic to move on roadways that are conducive to larger vehicles and minimize the interaction between long distance truck trips and local traffic/pedestrians. The National Highway Freight Network was designated as the new federal truck highway network under the FAST Act, which replaced the National Freight Network (NFN) from MAP-21 legislation. Under the FAST Act, the National Highway Freight Network included the Primary Highway Freight System, other interstates not on the Primary Highway Freight System and the Critical Rural and Urban Freight Corridors. The National Highway Freight Network includes all interstate routes (481 miles) plus MD 695 and portions of US 50/301.The Fast Act also required state DOTs to establish and designate critical urban and rural freight corridors. Maryland was allocated 75 Critical Urban miles and 150 Critical Rural miles. The state designated 73 Critical Urban miles and approximately 149 Critical Rural miles after routes were analyzed to meet the federal criteria. In addition to the National Highway Freight Network the Maryland Multi-Modal Freight Network was established which includes all of the other federal and state freight routes including the intermodal freight facilities in Maryland. These networks were established to improve intermodal movements and improve freight mobility and connections. The three freight networks are shown in Figure II-16.

Over the years, a series of programs and policies have been established to improve mobility and safety.

US 50/US 301

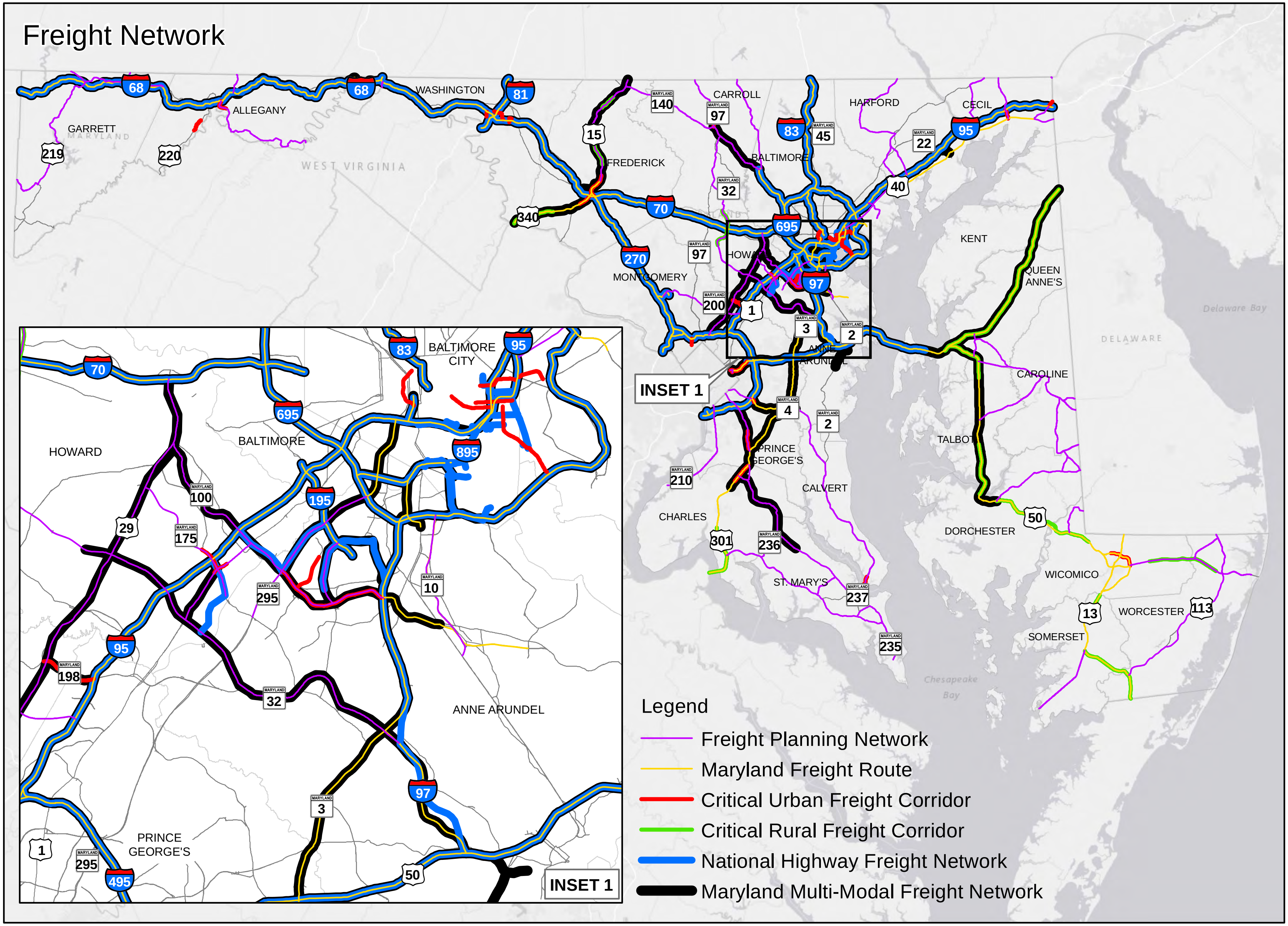
These include upgrades to at-grade railroad crossings through the Highway-Rail Crossing Program, programs to construct virtual weigh stations, Commercial Vehicle Information Systems and Networks (CVISN) facilities, implementation of the Maryland One Hauling Permit System, and the continual monitoring and expansion of truck parking to address requirements from Jason's Law. Jason's Law provides federal funding toward the construction of safe roadside parking lots for truck drivers. This includes assessing truck volumes, developing metrics to measure truck parking, and evaluating the capacity to provide adequate truck parking in each state.

On-going projects to address Jason's Law include the design of up to ten additional spaces at the Westbound and Eastbound Welcome Centers at South Mountain. In addition, the concept for expanding existing I-95/I-495 Park and Ride/Weigh Station site is transitioning into the design phase. MDOT SHA is working with the University of Maryland – Maryland Transportation Institute to conduct truck driver surveys in late summer/early fall to understand their behavior on the road that contributes to where they chose to park overnight. Other methods to provide more information and develop more truck parking include:

- Identifying areas along freight corridors that have sizable right-of-way that can serve as a possible truck holding area.
- Investigating P3 truck parking opportunities with developers.
- Implementing the use of Truck Weigh in Motion Stations for overnight truck parking when the stations are closed from 7 PM to 7 AM.
- Reviewing possible expansion of park and ride facilities to include truck parking.
- Coordinating with WAZE and other private sector partners to identify locations of available spots.
- Updated truck map that identifies size and weight restrictions.
- Utilizing crowd sourcing data analysis for freight program/ project decision-making.

I-95 @ I-495

Additional freight planning efforts include implementing the updated 2017 Strategic Goods Movement Plan (Maryland's State Freight Plan) which identifies performance metrics for Truck Travel Time Reliability (TTTR), designated Critical Urban and Rural Freight Corridors and a Freight Financial Plan to show where freight investments will be allocated statewide. A Maryland Freight Story Map was developed to compliment and provide a visual overview of the updated Strategic Goods Movement Plan. The Maryland Freight Story Map serves as an interactive geospatial dashboard which includes areas such as infrastructure access, mobility, and asset management. An Advanced Data Viewer is under development to allow engineers and planners to overlay available freight data layers for planning purposes. The updated 2017 Strategic Goods Movement Plan provides direction for future transportation investments to enhance the safe and efficient movement of commercial vehicle freight. Next steps include the incorporation of freight tools to screen, identify and prioritize freight related projects into the highway project planning process.


Freight Network
GARRETT
ALLEGANY
WASHINGTON
FREDERICK
CARROLL
BALTIMORE
HARFORD
CECIL
HOWARD
MONTGOMERY
KENT
QUEEN ANNE'S
ANNE ARUNDEL
PRINCE GEORGE'S
CALVERT
CHARLES
ST. MARY'S
CAROLINE
TALBOT
DORCHESTER
WICOMICO
WORCESTER
SOMERSET
WEST VIRGINIA
DELAWARE
Delaware Bay
Chesapeake Bay
INSET 1
BALTIMORE CITY
Legend
Freight Planning Network
Maryland Freight Route
Critical Urban Freight Corridor
Critical Rural Freight Corridor
National Highway Freight Network
Maryland Multi-Modal Freight Network

TSMO
MARYLAND TRANSPORTATION SYSTEMS MANAGEMENT & OPERATIONS

MDOT SHA recognizes that an approach that balances adding capacity and maximizing the existing system is needed to improve operations on Maryland's roadways. Heightened demands on the transportation infrastructure due to population and job growth, additional freight deliveries, etc., has led to record levels of vehicle miles traveled. MDOT SHA is incorporating methods to make better use of the existing transportation system. This method is identified as Transportation Systems Management and Operations (TSMO). The intent of TSMO is to effectively manage and operate existing facilities and systems to maximize their full-service potential. TSMO strategies aim to optimize capacity that is limited by recurring and non-recurring congestion.

Today, MDOT SHA deploys various TSMO strategies to actively manage Maryland's multimodal transportation network. The agency has been involved in many TSMO Strategies such as:

- Traffic Incident Management
- Work Zone Management
- Traveler Information Services
- Road Weather Management
- Freeway Operations including Managed Lanes and Ramp Management
- Active Traffic Management
- Traffic Signal Coordination
- Special Events Management
- Transit Management
- Freight Management
- Integrated Corridor Management

By utilizing these strategies and focusing on coordinating efforts through the CHART program, which is the highway operations element of MDOT SHA's TSMO program, the following are priorities of the program:

- Employing new technologies to improve coordination during incident management.
- Decreasing incident duration and incident delay.
- Allowing the traveling public to make better informed travel decisions.
- Offering active traffic management and integrated corridor management solutions.
- Enhancing coordination between MDOT SHA and local traffic signal operators to optimize signal timing in response to conditions.
- Enhancing ability to manage traffic and increase safety near and within work zones and special event locations.

The goals of TSMO is to provide for better traffic operations through managing bottlenecks, monitoring performance, implementing quick lower cost solutions, improving reliability, enhancing safety and optimizing capacity through maintenance practices consistent with asset management principles. Technology will be a vital part of this effort by meeting customers' needs for travel information and advancing the ability of MDOT SHA to react quickly to trends and changes in travel patterns.

MDOT SHA adopted its first TSMO Strategic Implementation Plan in August 2016, and has made tremendous progress in the last two years. Accomplishments include:

- The I-270 Innovative Congestion Management project is on-going which includes the use of ramp metering to improve traffic flow along the mainline.
- Fourteen highly congested arterial corridors were identified for the implementation of adaptive signal control (Smart Signals) with three of the corridors.
- MDOT SHA has completed a Connected Automated Vehicle (CAV) Strategic Action Plan, formed a CAV Working Group, and developed plans for a CAV pilot deployment corridor on US 1.
- TSMO Projects have been developed such as I-695 which could incorporate hard shoulder running and ramp metering.
- MDOT SHA is formalizing policies, guidance and developing communications and outreach plans to mainstream TSMO as a culture in the organization.
- The TSMO Executive Committee created a Deputy Director position in the Office of CHART & ITS Development to officially serve as the MDOT SHA TSMO Program Manager and oversee the execution of the TSMO Implementation Plan.
- Governor's Traffic Relief Plan was developed to deliver infrastructure projects and highway improvements on the I-495 and I-270 corridors involving Public-Private Partnerships (P3s) will enable TSMO strategies as managed lanes and other technology solutions.

In addition, MDOT SHA has made progress on the following goals established in the 2016 Strategic Implementation Plan:

GOAL 1: Develop and Implement TSMO Program	GOAL 2: Improve travel time reliability for people & freight	GOAL 3: Develop data and performance driven approaches for TSMO Planning	GOAL 4: Improve traveling public's experience
Created TSMO Steering and Executive Committees	Developing statewide integrated freeway and arterial master plan	Completed Mobility Data Business Plan (in conjunction with Federal Highway Administration (FHWA) pilot)	User cost saving from CHART, signal operations, and multi-modal strategies
In process of developing TSMO website	Developing next-level TSMO communications infrastructure plan	Continued refinement of process collecting, integrating, and analyzing data in support of MDOT SHA's Annual Mobility Report and Mobility Dashboard`	CHART working with MDTA on new 511 app
In process of developing TSMO outreach materials for internal/external outreach	Completed I-95 Corridor Integrated Corridor Management (ICM) Concept of Operations	Developed multiple Transportation Research Board (TRB) papers supported by TSMO program	CHART continues to enhance provision of information to RITIS
Developed methodology for incorporating reliability into TSMO project planning	Completed I-95 Corridor Analysis, Modeling, and Simulation (AMS) Plan	Held multiple FHWA workshops supporting various TSMO initiatives	Developing outreach tools targeted to traveling public

In 2018, a new TSMO Strategic Plan is being developed which will take into account the following four goals:

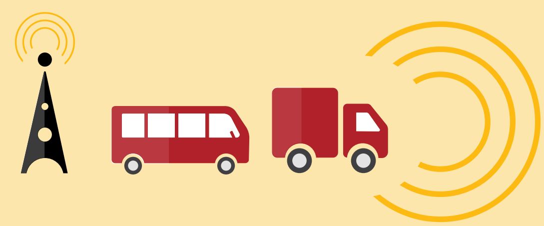
- GOAL 1: Business Processes & Collaboration
- GOAL 2: Systems & Technology
- GOAL 3: Data, Analysis & Performance Management
- GOAL 4: Customer Service & Engagement

In addition, MDOT SHA is also developing a TSMO Master Plan which recommends specific TSMO strategies for all evaluated corridors and applies a ranking system to prioritize strategies across the network.

GOAL 1

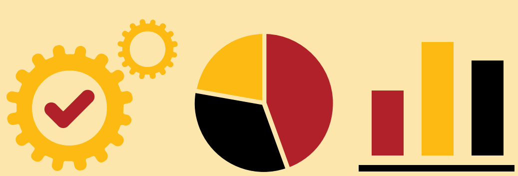
BUSINESS PROCESSES & COLLABORATION

GOAL 2



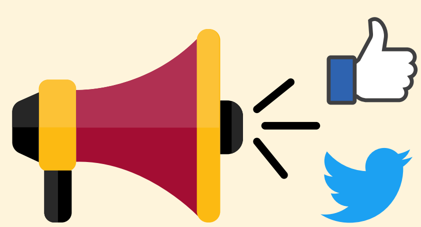
SYSTEMS & TECHNOLOGY

GOAL 3



DATA, ANALYSIS & PERFORMANCE MANAGEMENT

GOAL 4



CUSTOMER EXPERIENCE & ENGAGEMENT

MDOT SHA has developed an organization structure that includes a TSMO Executive Committee, TSMO Working Group, and Task forces to implement the 2018 TSMO Strategic Plan.

CAV ACTIVITIES

- Design and Implementation of Smart Signals in 14 corridors.
- Submitted Entry into National SPaT Challenge.
- Established a Permitting Process and Expression of Interest for Companies interested in Testing CAV in Maryland.
- Developed Web Mapping Application for Maryland locations to Enable Testing Sites for CAV.
- MDOT CAV Working group established a new CAV Freight Subcommittee.
- Developed CAV Strategic Action Plan and Website.
- Applied for Advanced Transportation and Congestion Management Technologies Grant.

6. CONNECTED AND AUTOMATED VEHICLES (CAV)

Technology has rapidly advanced in the area of connected vehicles and automated vehicles through automakers, mobility service providers, and major technology corporations. Connected Vehicles (CV) are vehicles that are capable of interpreting and relaying information over one or more channels of communication. Automated vehicles (AV) are vehicles that can perform at least one aspect of a safety-critical control function without direct driver input. The technology for these vehicles is dependent upon wireless communication between two or more vehicles or between a vehicle and the roadside infrastructure or devices surrounding it. Communication can occur in multiple ways; Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), or Vehicle-to-Everything (V2X). This communication can occur across cellular networks and the Dedicated Short-Range Communications (DSRC) wireless spectrum. Maryland's Connected and Automated Vehicle (CAV) Working Group continues to serve as the central point of coordination for the development and deployment of emerging CAV technologies in Maryland.

In 2017, Gov. Larry Hogan announced a $50 million "Smart Signal" upgrade along 14 corridors to adjust signals to changing traffic conditions in real time, 24 hours per day. In addition, Maryland entered the National SPaT Challenge, with the goal to achieve deployment of DSRC infrastructure with Signal Phase and Timing (SPaT) broadcasts in at least one corridor with 20 or more intersections in each of the 50 states by January 2020. Implementation of SPaT broadcasts is one of the several CAV-related deployment activities planned along MDOT SHA's US 1 Innovative Technology Deployment Corridor, which is located from MD 32 to I-195, and along MD 175 from MD 108 to Brock Bridge Road.

Over the last year, MDOT developed a comprehensive Expression of Interest and Permitting Process for all entities interested in testing Connected and Automated Vehicles in Maryland. This process "facilitates dialogue with potential partner companies – each with their unique circumstances involving CAVs – to better understand the needs of the entity and to help ensure safety is prioritized." Additionally, MDOT released the Maryland Locations to Enable Testing Sites (LETS) for CAV web mapping application – an informational support tool identifying a number of designated locations owned


MDOT State Highway Administration

Connected & Automated Vehicle (CAV) Strategic Action Plan

A Strategic and Operational Outlook on the Impacts of CAV

December 2017

by MDOT and its partners which can be used for CAV technology testing. The MDOT CAV Working Group continues to evaluate the latest research, track federal and state laws, policies and programs, and coordinate with other agencies, organizations and businesses on CAV-related matters. The Working Group announced the establishment of a new CAV Freight Sub-Committee in 2018.

MDOT SHA recently released its CAV Strategic Action Plan and associated website, with a vision to "embrace technology and next generation mobility trends to provide safe and reliable travel for people and goods within Maryland". The following goals are addressed in the MDOT SHA CAV Strategic Action Plan, with associated strategies and recommended actions:

- GOAL 1: Make Maryland an attractive partner for CAV development, testing and production.
- GOAL 2: Begin deploying CAV technology and engaging in national activities.
- GOAL 3: Establish foundational systems to support future CAV deployment.
- GOAL 4: Enable CAV benefits for customers.
- GOAL 5: Explore opportunities to leverage CAV technologies to support MDOT SHA business processes and objectives.

Additionally, MDOT SHA developed several web-based internal and external CAV-related planning tools, including the Connected and Automated Vehicle Public Policy across the US application.

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MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

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