MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION

2017
MARYLAND
State Highway Mobility Report

2017 MARYLAND State Highway Mobility Report

Sixth Edition

AUTHORS Subrat Mahapatra, Kaveh Farokhi Sadabadi, Matthew Wolniak

CONTENT CONTRIBUTORS Tom Costello, Theresa Pyzik Cox, Sepideh Eshragh, Sarah Gary, Masoud Hamedi, Thomas Jacobs, L'Kiesha Markley, Clyde Munz, Ben Myrick, Abhay Nigam (AC)

REVIEW PANEL Eric Beckett, Charlie Gischlar, Karuna Pujara, Lisa Shemer

LEADERSHIP PANEL Greg Slater, Jason Ridgway, Tim Smith, Betty Conners, Scott Pomento, Joseph Sagal, Cedric Ward, Valerie Burnette Edgar, Richard Woo, Glenn McLaughlin, Allison Hardt

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MESSAGE FROM THE ADMINISTRATOR

Supporting the daily lives of Marylanders is a central part of our mission here at the Maryland Department of Transportation State Highway Administration (MDOT SHA). With 60 billion vehicle miles traveled in 2017 and the advent of GPS travel technology (Waze, Google Maps etc.), more and more drivers are out there on the roads. They aren't just on the highways. That travel technology - and the advent of older drivers with more mobility - has created more and more congestion on side roads, smaller corridors and our neighborhoods. The likelihood of sitting in frustrating gridlocks and congested thoroughfares is ever-increasing. Who wants to waste time sitting in traffic when they could be closing the next business deal, going to the gym, walking the dog, or spending quality time with the kids?

MDOT SHA uses a combination of policies, programs and projects to address congestion and reliability challenges to deliver Marylanders to life's opportunities. In 2016, MDOT SHA Congestion Management efforts led to more than $1.63 billion in annual user savings by reducing fuel consumption, emissions, and most importantly, delay.

MDOT SHA is monitoring existing travel trends, identifying accomplishments and challenges and establishing long-term strategies for improvement, relevance and organizational excellence. The 2017 Maryland Mobility Report addresses performance and mobility trends from 2016 and compares the results to how we've done in the past so we can continue to improve the customer experience - your perception of how we serve you.

Welcome to a NEW MDOT SHA. In 2017, we made history with the highest number of active construction projects than ever before. By staying committed to improving the customer experience by reducing congestion along with critical safety improvements and keeping our system in top shape, we are delivering the projects that matter to you - breaking bottlenecks, reducing travel times and making travel more efficient, smoother and safer. Staying focused on infrastructure, volume and regionally specific traffic trends, we are continuing to innovate and modernize our roadways as we look to transportation's ever-approaching horizon.

MDOT SHA has done a lot this year to build on these priorities and implement them in our daily organizational operations. We will do even more in 2018 and for many years to come. Those 'Pardon our Dust' signs are proof of that progress. Our citizens see cones, lane closures and detour signs. They see our dust. But the results behind that dust are making a difference in this state. The people of Maryland depend on us to deliver. We will.

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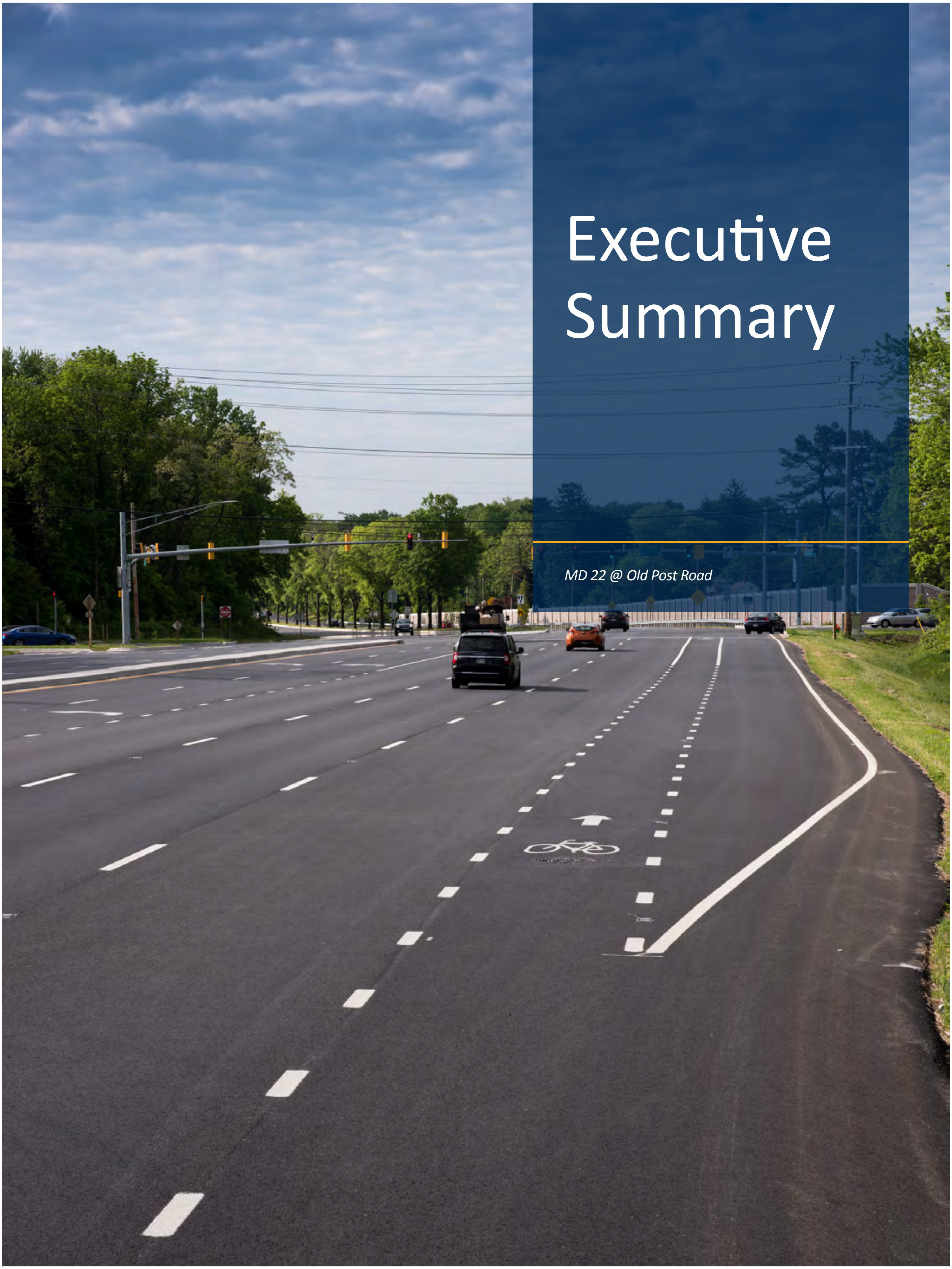
Executive Summary



MD 22 @ Old Post Road

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Executive Summary

The Maryland Department of Transportation State Highway Administration (MDOT SHA) continues to implement the Administration's transportation agenda to deliver safe, sustainable, intelligent, and exceptional transportation solutions with a focus on customer service. In order to address mobility challenges, MDOT SHA focuses on policies, programs, and projects with a performance-based and practical transportation approach that systematically addresses recurring and non-recurring congestion. The 2017 Maryland Mobility Report provides a summary of performance along MDOT facilities and the agency's efforts to improve mobility in calendar year 2016.

CONGESTION AND RELIABILITY TRENDS

The following is a summary of congestion and reliability trends on the Maryland highway system in 2016:

VEHICLE MILES OF TRAVEL (VMT)

- Maryland experienced an all time record number of vehicle miles of travel (VMT) on its roadway systems. This amounted to 59.0 billion which is a 2.9% increase over 2015.
- 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 2015.
- The Baltimore - Washington region VMT increased by approximately 1.3 billion miles to 46.4 billion. The VMT on the Eastern Shore, southern and western Maryland facilities was 12.6 billion, an approximate 0.4 billion mile increase over 2015 levels.

AVERAGE DAILY TRAFFIC (ADT)

- The highest volume roadway locations include:

HIGHEST AVERAGE DAILY TRAFFIC (ADT) SECTIONS

Freeway Section		2016 ADT (Thousands)
I-270	I-270 Split to MD 28	242-261
I-495	I-270 East to I-95	202-248
I-95/I-495	MD 4 to I-95	206-226
I-95	MD 32 to I-895	201-212
I-695	I-95 S to MD 26	186-208
Arterial Section		**2016 ADT (Thousands)**
MD 5	US 301 to MD 223	64-97
MD 3	US 50 to I-97	66-80
MD 650	MD 212 to US 29	46-79
MD 210	Ft. Washington Rd to I-95	68-75
MD 4	MD 223 to Forestville Rd	58-74

CONGESTION & RELIABILITY

- Motorists on the Maryland freeway/expressway system experienced heavy to severe congested conditions on 148 miles (9%) of the network in the AM peak hour. 246 miles (15%) of the network experienced heavy to severe congested conditions in PM peak hour. There was no change in AM and PM peak hour operations over 2015 levels.
- On the freeway/expressway system, 17% of the AM peak hour and 26% of the PM peak hour VMT occurred in congested conditions. This was a 1% decrease in both peak hour operations versus 2015.
- The two worse performing roadways for their entire length were I-695 in the AM peak hour (13 miles) and I-495 in the PM peak hour (19 miles) that operate in severe congestion.
- The cost of congestion to travelers on Maryland freeway/expressway system amounted to more than $2.11 billion dollars annually. This is an increase of approximately $59 million over 2015 levels.
- Highly to extremely unreliable conditions occur on 7% of the freeway/expressway system in the AM peak hour and 12% in the PM peak hour. The 2016 conditions showed an improvement of 1% and 2% respectively.
- Congestion cost on major arterials is estimated to be $1.2 billion in the State.
- A failing level of service (LOS F) occurred at fifty-seven (57) state highway intersections based on traffic count data from the last three years. This included ten intersections that failed in both the AM and PM peak hours.

I-70 @ I-695

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

2016 MOST CONGESTED FREEWAYS/EXPRESSWAY SECTIONS (AVERAGE WEEKDAY)	
AM Peak (8-9 AM)	**PM Peak (5-6 PM)**
I-495 Outer Loop - US 1 to US 29	I-695 Inner Loop - MD 139 to MD 542
I-695 Outer Loop - I-795 to Edmondson Ave	I-270 West Spur Southbound - I-270 to I-495
I-695 Outer Loop - US 1 to MD 41	I-495 Inner Loop - Virginia State Line to I-270 West Spur
I-270 Local Southbound - Shady Grove Rd to Montrose Rd	I-495 Outer Loop - MD 187 to Virginia State Line
I-95/I-495 Inner Loop - MD 5 to I-295	I-495 Inner Loop - MD 355 to MD 97
US 50 Westbound - MD 704 to MD 295	I-495 Inner Loop - MD 650 to MD 201
I-695 Inner Loop - MD 140 to I-83	I-270 Spur Northbound - I-495 to I-270
I-270 Southbound - Montrose Rd to I-270 Spur	MD 100 Westbound - MD 713 to US 1
MD 295 Southbound - MD 32 to MD 197	I-95/I-495 Inner Loop - MD 202 to MD 214
I-95 Southbound - MD 212 to I-495	I-695 Outer Loop - US 1 to MD 170

2016 MOST CONGESTED ARTERIAL SECTIONS (AVERAGE WEEKDAY)	
AM Peak (8-9 AM)	**PM Peak (5-6 PM)**
US 29 Southbound - MD 650 to I-495	MD 210 Southbound - Kerby Hill Rd/Livingston Rd to Palmer Rd
MD 212 Westbound - Beltsville Rd to Riggs Rd	MD 650 Southbound - US 29 to Adelphia Rd
MD 185 Southbound - Jones Bridge Rd to D.C. Line	MD 185 Northbound - MD 410 to I-495
MD 210 Northbound - Swan Creek Rd to Palmer Rd	MD 28 Eastbound - E. Gude Dr to Bel Pre Rd
MD 28 Westbound - MD 97 to E. Gude Dr	MD 410 Eastbound - Adelphia Rd to MD 295
MD 190 Eastbound - MD 188 to MD 614	MD 2 Northbound - US 50 to MD 648/White Rd
MD 3 Southbound - I-97 to Waugh Chapel Rd	MD 187 Northbound - MD 188 to I-495
MD 410 Westbound - MD 650 to US 29	MD 355 Northbound - Gude Dr to Shady Grove Rd
MD 97 Southbound - MD 193 to I-495	MD 3 Southbound - MD 175 to Waugh Chapel Rd
MD 650 Southbound - Venice Dr to I-495	MD 170 Southbound - MD 176 to MD 174

US 40 @ Rossville Blvd

MDOT SHA ACCOMPLISHMENTS

MDOT SHA uses a combination of policies, programs, and projects to address congestion and reliability challenges. In 2016, various MDOT SHA Congestion Management efforts resulted in more than $1.63 billion of annual user savings by reducing delay, fuel consumption and emissions. A summary of the accomplishments associated with these efforts to improve mobility include:

CHART

- 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 43.6 million vehicle hours of delay amounting to over $1.5 billion in user savings.

SIGNALS

- Traffic signal timings were reviewed for 35 signal systems including 306 signals and retiming 202 of those signals. The retiming of traffic signals resulted in $29 million annual user savings.
- MD 24 was the second major corridor where a smart adaptive signal system was implemented.

CAPITAL PROJECTS

- There were eleven mobility projects completed in 2016, mainly at intersections. This included US 220 @ Louise Drive, MD 2 @ MD 255, MD 2 @ Earleigh Heights Road/Magothy Bridge Road, MD 32 @ MD 97, MD 140 @ Pleasant Valley Road South, MD 22 @ Old Post Road and MD 119 @ Orchard Ridge Drive/Kentlands Boulevard. The final two projects included constructing a new interchange on MD 5 to improve access to the Branch Avenue Metro Station and widening along MD 355 between Center Drive and West Cedar Lane. These projects are projected to result in an annual user savings of $50 million.
- Several mobility improvement projects are under construction as part of Governor Hogan's transportation investment program. This includes the widening of I-695 from US 40 to MD 144, widening of US 29 from Seneca Drive to MD 175 and the November 2017 completion of MD 404 in Caroline County.

- The I-270 Innovative Congestion Management Project was initiated in 2016 which provides a unique method to improve operations, faster travel times and maximize vehicle thru-put.

2016 USER SAVINGS DUE TO MDOT CONGESTION MANAGEMENT

CHART	$1,500 Million
Signals	$29 Million
Capital Projects	$50 Million
Park and Ride Program	$55 Million
	$1,634 Million

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 nine miles of new sidewalk and approximately 88 miles of marked bicycle lanes and six miles of marked shared use bike lanes. The number of accessible pedestrian signals increased by 5% statewide and the number of sidewalks now ADA compliant exceeds 80%.
- Park and ride lots allow for more than 6,700 motorists on a given weekday to connect to transit or ride with other commuters at 106 locations operated in 20 counties. This provided a savings of more than 101 million annual VMT and user savings of $55 million.
- HOV lanes are provided on the I-270 and US 50 corridors to encourage ridesharing and increased person throughput. The I-270 HOV lanes provide as much as 20 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

- Several commercial vehicle related projects were completed in 2016 including four new virtual weigh stations and improvements to eight at-grade railroad crossings. In addition, design is underway to provide up to ten additional truck parking spaces on I-70 westbound at South Mountain.
- Various other commercial vehicle initiatives started in 2016 that were completed in 2017 included a new National Highway Freight Network with critical Rural and Urban Freight Corridor designations, Maryland Strategic Goods Movement Plan - 2017 update and development of a Maryland Freight Story Map.

TSM&O IMPLEMENTATION

- The Transportation Systems Management and Operations (TSM&O) 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 TSM&O into projects, developing a list of sample corridors for TSM&O, and developing a data supported system for performance reporting.
- MDOT is at the forefront of several nationwide research initiatives. Since 2014, MDOT SHA has received more than $2 Million in FHWA Strategic Highway Research Program (SHRP-2) implementation assistance. 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.
- Committees have been established and research is being performed related to the implementation of policies for connected vehicles/automated vehicles.

US 1 near Halethorpe Station

What is in the MARYLAND State Highway Mobility Report?

Monkton Road (MD 138)

Introduction

The Maryland Department of Transportation (MDOT) aspires to support Maryland's economy and communities with the reliable movement of people and goods thru a well connected transportation system. MDOT State Highway Administration (MDOT SHA) is the transportation business unit (TBU) that owns, operates, and maintains the interstate, US and non-tolled MD routes in Maryland. In order to serve the citizens of Maryland and the travelling public, MDOT SHA has developed data driven methodologies to identify and address congestion issues. The Maryland State Highway Mobility Report showcases MDOT SHA's data driven transportation investments for safe, efficient, and reliable and 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 MDOT SHA 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, 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 vehicles and automated vehicles.

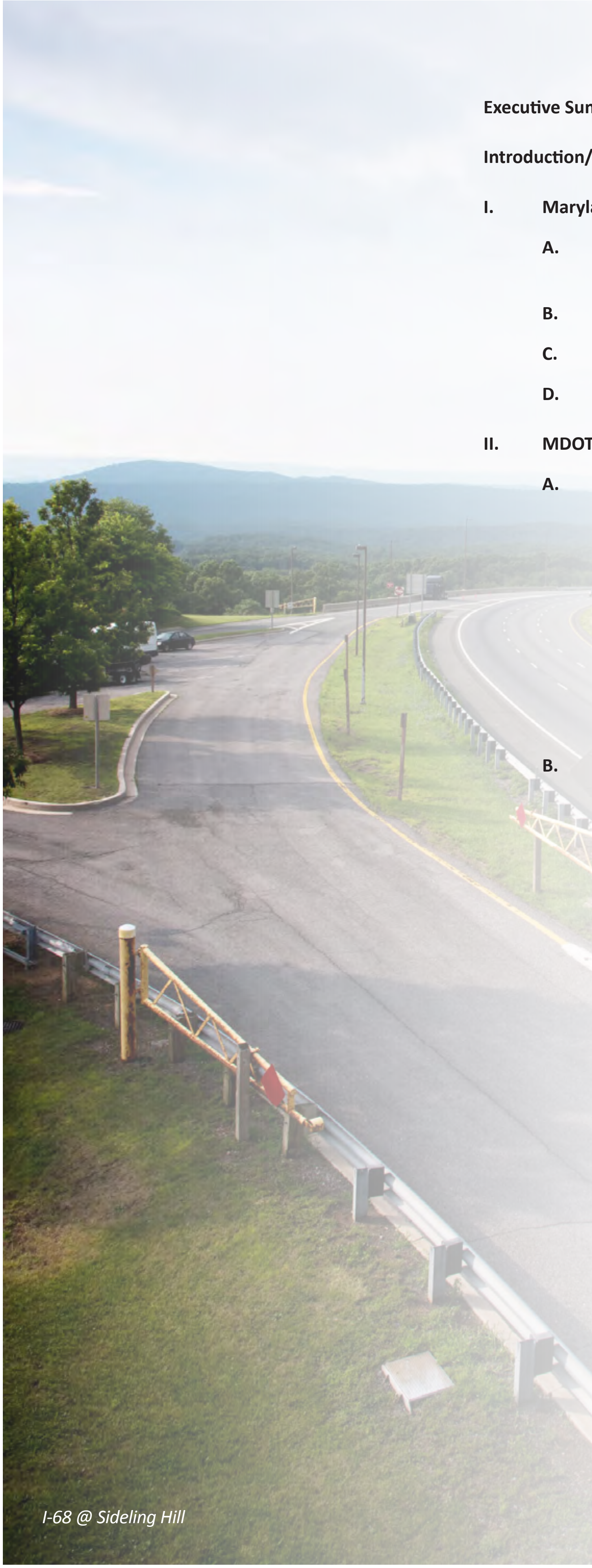
The 2017 Maryland Mobility Report describes performance and mobility trends in 2016 and compares the results to past years and identifies accomplishments. This follows a general theme of "What is Happening" and "What is MDOT SHA Doing and What are the Outcomes." Key elements reviewed include Transportation Systems Management and Operations (TSM&O), freight, multi-modalism, and major capital projects that were undertaken in the past year.

Organization Of The Report:

- **What is Happening? (Trends and Needs Identification - Chapter I)**
  - Chapter I identifies Mobility Trends in calendar year 2016. 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 2016 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 2017 Report:

- Arterial Corridor Metrics
- Connected and Automated Vehicles (CAV) Efforts
- Countywide Congestion Maps



I-68 @ Sideling Hill

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I. Maryland

Mobility Trends and Needs

I-95 Managed Lanes

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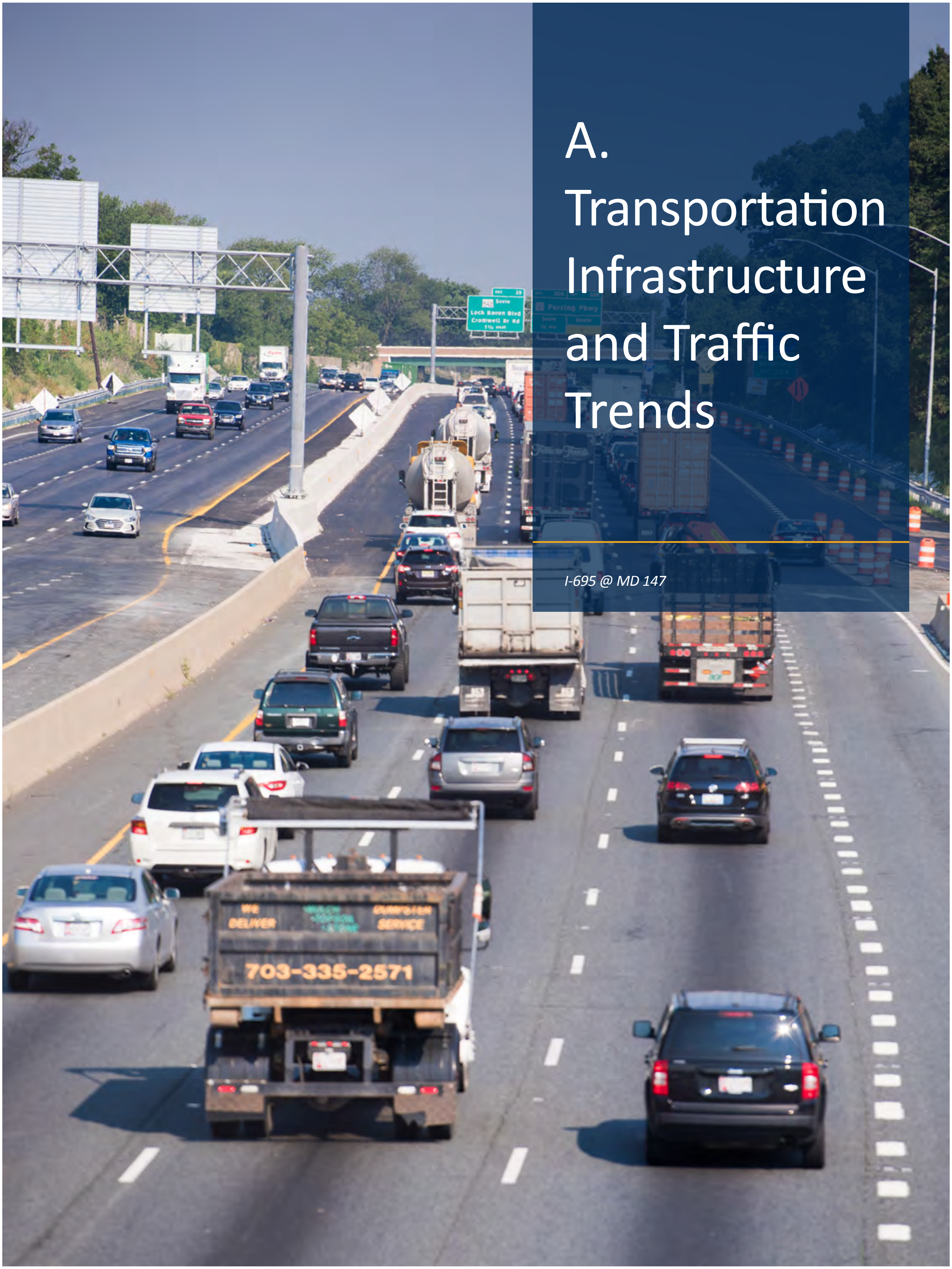

A. Transportation Infrastructure and Traffic Trends

I-695 @ MD 147

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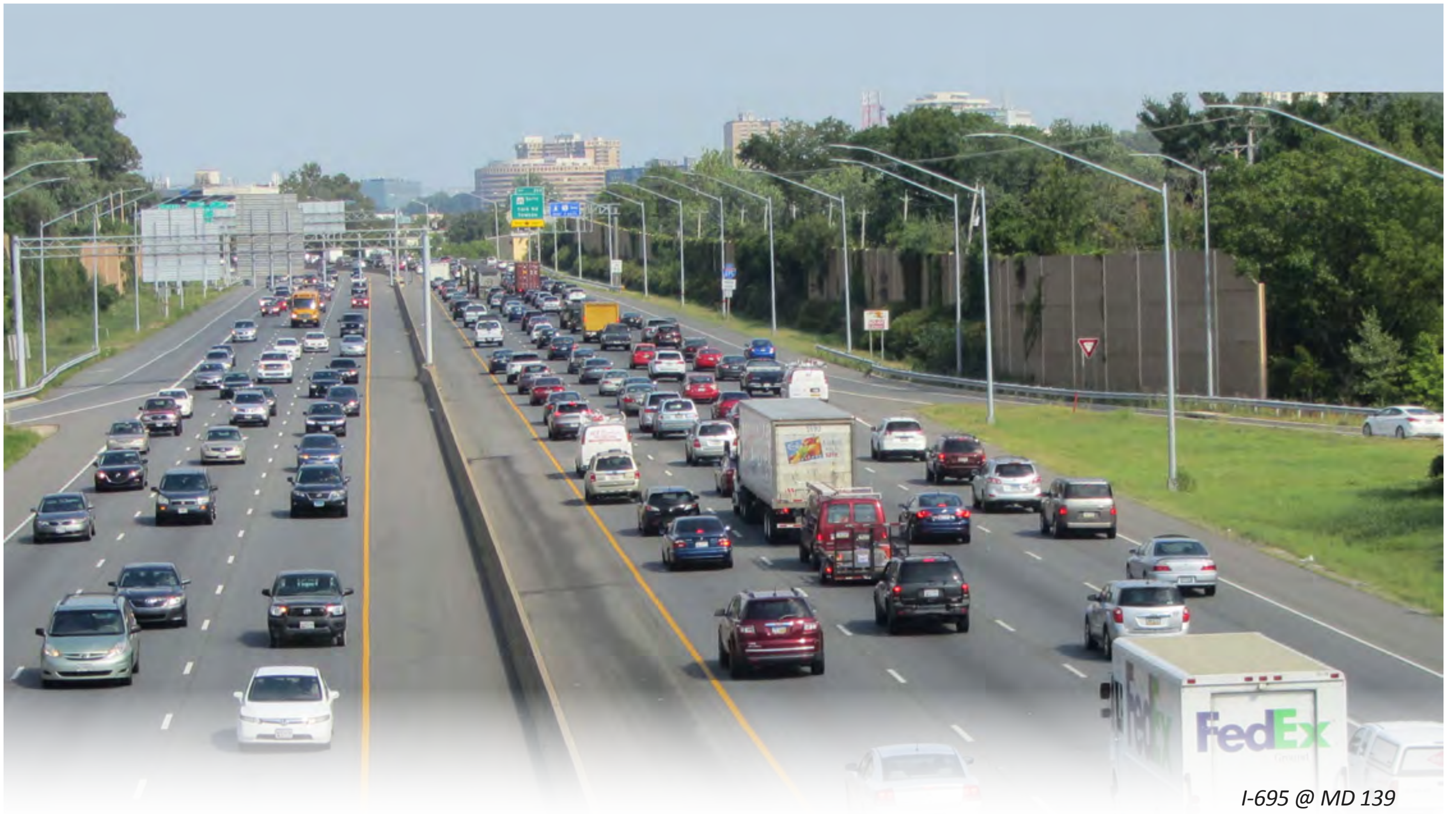


I-695 @ MD 139

Maryland and MDOT Transportation Infrastructure

MDOT SHA is responsible for 17,764 lane miles of roadway and 2,567 bridges.

Interstate highways pass through 12 of Maryland 23 counties.

Infrastructure

Today there are over 4.3 million licensed drivers in Maryland or about 71% of the population. The ability for them to move throughout the State is based on having a strong roadway infrastructure.

Roadways throughout the State are owned and maintained by various agencies. This includes cities and towns, private entities, counties, State, and federal agencies. MDOT SHA operates the numbered, non-toll routes in Maryland's 23 counties, a total of 17,764 lane-miles which includes all ramps, spurs, and service roads. These roadways are the highest type facilities and form the majority of the National Highway System (NHS) which includes interstate highways, freeways and major arterial roadways.

Chesapeake Bay Bridge

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.

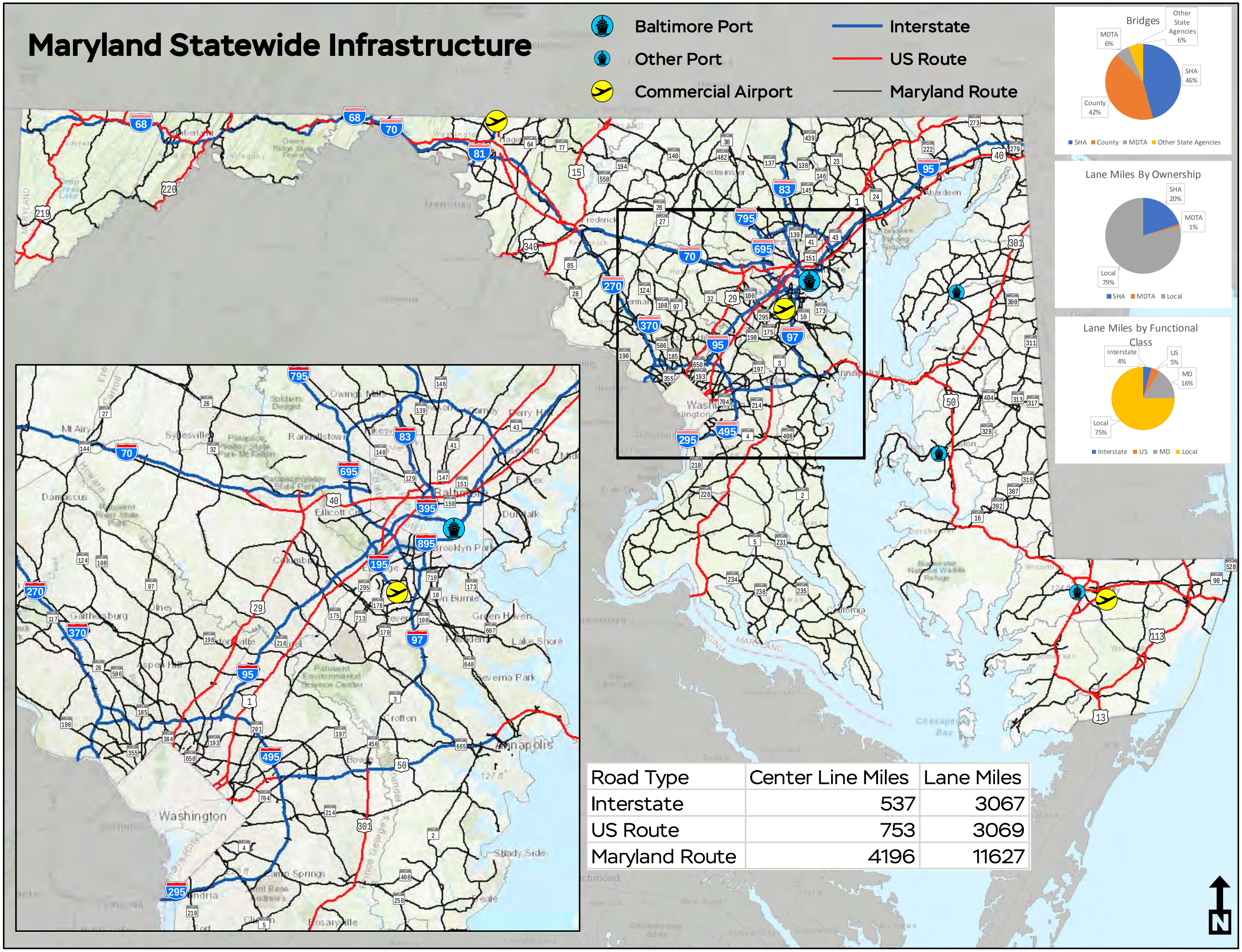
These roadways provide for both long distance travel and for access to major commercial, office and residential centers. The State transportation network not only provides roadway connections but also multi-modal connectivity to airports, railroads, mass transit, and the Port of Baltimore. Figure I-1 identifies Maryland's transportation infrastructures.

Maryland's' roadway network commenced in 1908 under the direction of the Maryland Roads Commission. Some of the earliest constructed roads include MD 2, MD 3, MD 4, MD 313, MD 404 and 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 Kennedys dedication of the opening of I-95 in 1963 through the completion of I-97 which uniquely traverses through only one county and I-68 in western Maryland. Among the last segments of the initial interstate system to be completed include the I-95 Ft. McHenry Tunnel and I-70 through Frederick.

The quality of Maryland's roadway network is shown through various measures from a consumer and maintenance standpoint. Consumer surveys showed that Maryland roadways were rated the equivalent of 4 out of 5 stars. A measure of roadway quality based on the International Roughness Index identified that 87% of Maryland state roads were acceptable. Also, 79% of the roads were identified to be in preferred maintenance condition.

The MDOT SHA roadway network includes 2,567 bridges. These include some of the most distinctive structures such as the Chesapeake Bay Bridge which opened the ability to access points on the Atlantic Ocean and is recognizable worldwide. Bridges require constant maintenance and inspection. When bridges become structurally deficient, they need to be programmed for repairs. Less than 3% of the bridges in Maryland are considered structurally deficient. There has been a reduction of 56 deficient bridges between MDOT SHA and MDOT MDTA in the last eight years. In 2016, contracts were let or construction was taking place on 20 bridges with 14 more planned for repairs starting in 2017.

Figure I-1



Road Type	Center Line Miles	Lane Miles
Interstate	537	3067
US Route	753	3069
Maryland Route	4196	11627

MD 213 Chestertown

Traffic Trends

Traffic volumes continue to grow across the country. Nationally, this was the fifth straight year with an increase in travel with volumes growing approximately 2.8% over 2015. The trends in Maryland replicate the nationwide pattern.

The following facts highlight trip patterns in Maryland:

- Maryland is second in the nation in terms of longest commuting times according to the American Community Survey with an average of 32.3 minutes. The District of Columbia which includes many Maryland commuters is fourth in the nation with commuting times averaging 29.7 minutes each way. Baltimore commuters have the highest percentage of extreme commutes (greater than 90 minutes) in the country.
- Approximately 240,000 people commute from Maryland into Washington D.C based on AirSage data analysis. An additional 120,000 people commute to Montgomery and Prince George's Counties from out of state.
- There are almost 140,000 people commuting into Baltimore City each day, mainly from Baltimore, Anne Arundel, Howard and Harford counties.
- The 2016 INRIX Traffic Scorecard that analyses congestion in 240 cities ranked Washington D.C. 6^{th}, Columbia, Maryland 27^{th} and Baltimore 33^{rd} worst in peak hours spent in congestion.
- Maryland's population in 2016 was approximately 6.02 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.
- The 2015 Urban Mobility Scorecard developed by Texas A&M Transportation Institute has cited the Washington, DC region as number one (1) in the nation in terms of annual delay per auto commuter, excess fuel consumed due to travel in congested conditions, and congestion cost per auto commuter.
- The Baltimore Metropolitan area is ranked #14 in truck congestion costs, #18 in excess fuel consumed and #18 in total congestion costs in the nation based on the Urban Mobility Scorecard. The annual delay experienced by Baltimore area commuters, ranks 23^{rd} nationwide. Higher delays indicate increased levels of congestion.

US 29 @ I-70

Maryland VMT grew by 2.9% exceeding the national average.

Maryland has been fortunate from an economic standpoint to experience substantial growth in the last 25 years. This is reflected in changes in traffic volumes over that period. Especially along interstate freeways, major arterials, and roadways in suburban areas volumes have increased greatly. Table I-1 illustrates the growth in traffic volumes along selected roadways over the last twenty-five years:

Table I-1

HISTORIC GROWTH ON MAJOR ROADWAYS			
Location	**1991 Average Daily Traffic (ADT)**	**2016 Average Daily Traffic**	**Average Annual Growth**
US 50 East of MD 313	14,000	23,500	2.1%
I-95 @ Susquehanna River Bridge	54,700	85,200	1.8%
I-70 North of MD 27	61,200	104,300	2.2%
MD 24 North of MD 924	25,800	42,400	2.0%
MD 235 West of MD 237	35,100	60,000	2.2%
I-70 East of US 40	40,900	72,800	2.3%
US 29 South of I-70	45,200	113,200	3.7%

MD 43

The highest volume MDOT SHA freeway, arterial and MDOT MDTA toll facilities based on the MDOT SHA Traffic Volume maps are depicted in Table I-2:

Table I-2

HIGHEST AVERAGE DAILY TRAFFIC (ADT) VOLUMES	
Freeway Section	**2016 ADT**
I-270 N of I-270 Split	261,000
I-270 N of Montrose Road	256,000
I-495 W of MD 650	248,000
I-495 N of MD 190	243,000
I-270 N of MD 189	242,000
Arterial Section	
US 301/MD 5 S of McKendree Rd	97,000
MD 5 S of MD 223	84,000
MD 3 N of MD 424	79,000
MD 3 N of Prince George’s Co Line	79,000
MD 650 S of I-495	79,000
MDTA Toll Facility Crossings	
I-95 Ft. McHenry Tunnel	123,000
I-95 Tydings Bridge	85,000
I-895 Harbor Tunnel	77,000
US 50/301 Bay Bridge	73,000

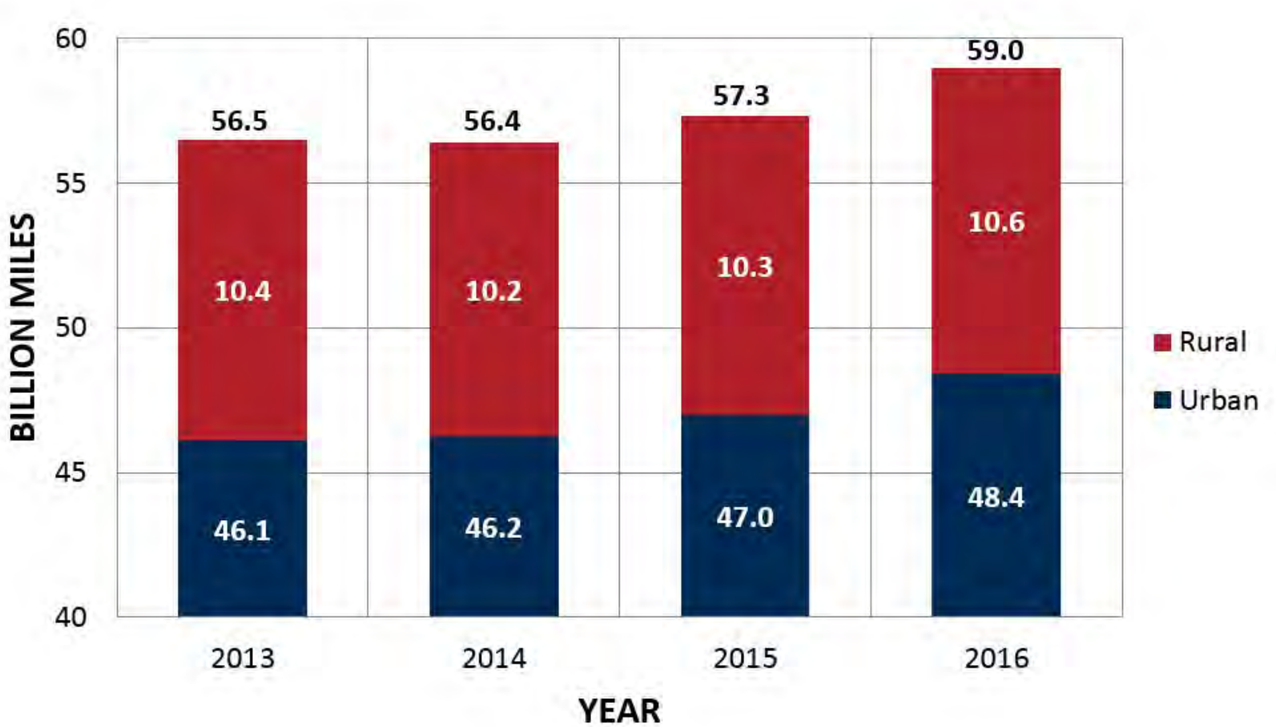
Despite overall growth, some areas such as rural roadways and in the center of cities have seen negative or flat growth over the last several years. In cities, possibly contributing to this is the number of multi-modal options such as bicycling.

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 last two years have seen record growth in VMT compared to the previous ten years where VMT was relatively flat. In 2016, the statewide VMT climbed to an all-time record of 59.0 billion vehicle miles, a 2.9% increase over 2015 VMT. Travel along and through urban area roadways was the major reason for the increase in VMT. Urban area VMT was approximately 48.4 billion, an increase of 1.4 million miles from 2015. The increase in urban VMT could be attributed to the strong job and population growth in the Baltimore-Washington area. A smaller increase of 0.3 million vehicle miles occurred in rural VMT. Figure I-2 shows statewide VMT in the last 4 years.

Figure I-2

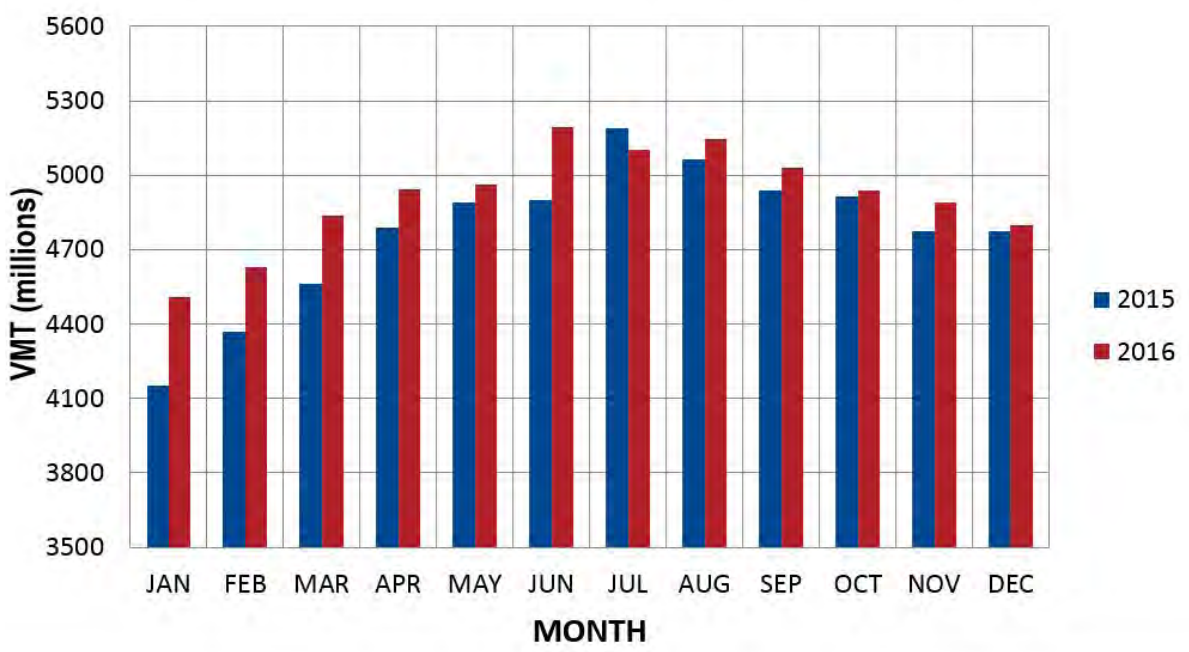
MARYLAND VEHICLE MILES OF TRAVEL (BILLIONS)



The monthly distribution of VMT is shown in Figure I-3 which depicts that 11 of the 12 months saw an increase in travel over the previous year.

Figure I-3

MONTHLY DISTRIBUTION OF ANNUAL VEHICLE MILES OF TRAVEL



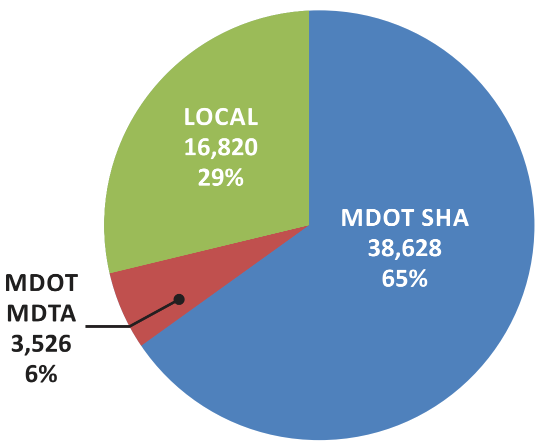
MDOT facilities account for 21% of state lane-miles but 71% of VMT occurred on these roadways.

The majority of VMT occurs on state and toll maintained roadways. MDOT facilities account for only 21% of the states lane miles, but 71% of the VMT occurs on these roadways. In 2016, the VMT on these roadways was 42.1 billion, an increase of 985 million miles (2.4%). The 2016 VMT along all other roadways increased to 16.8 billion from 16.1 billion (4.2%) in 2015. Figure I-4 shows VMT by ownership and the type of roadway.

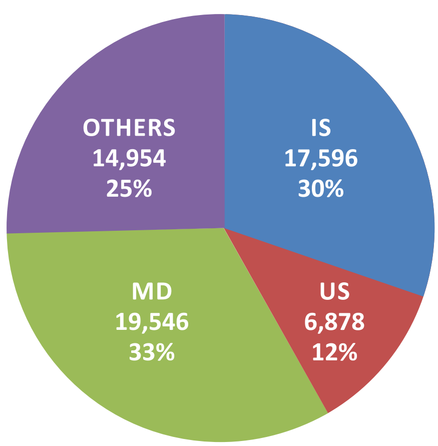
On a county-wide basis, the change in VMT varies with all counties showing an increase over 2015. The largest VMT increase occurred in Anne Arundel and Prince George's Counties. On a percentage basis Worcester and Harford County experienced growth of over 4% while six other counties grew at greater than 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

2016 VMT BY OWNERSHIP (MILLION)

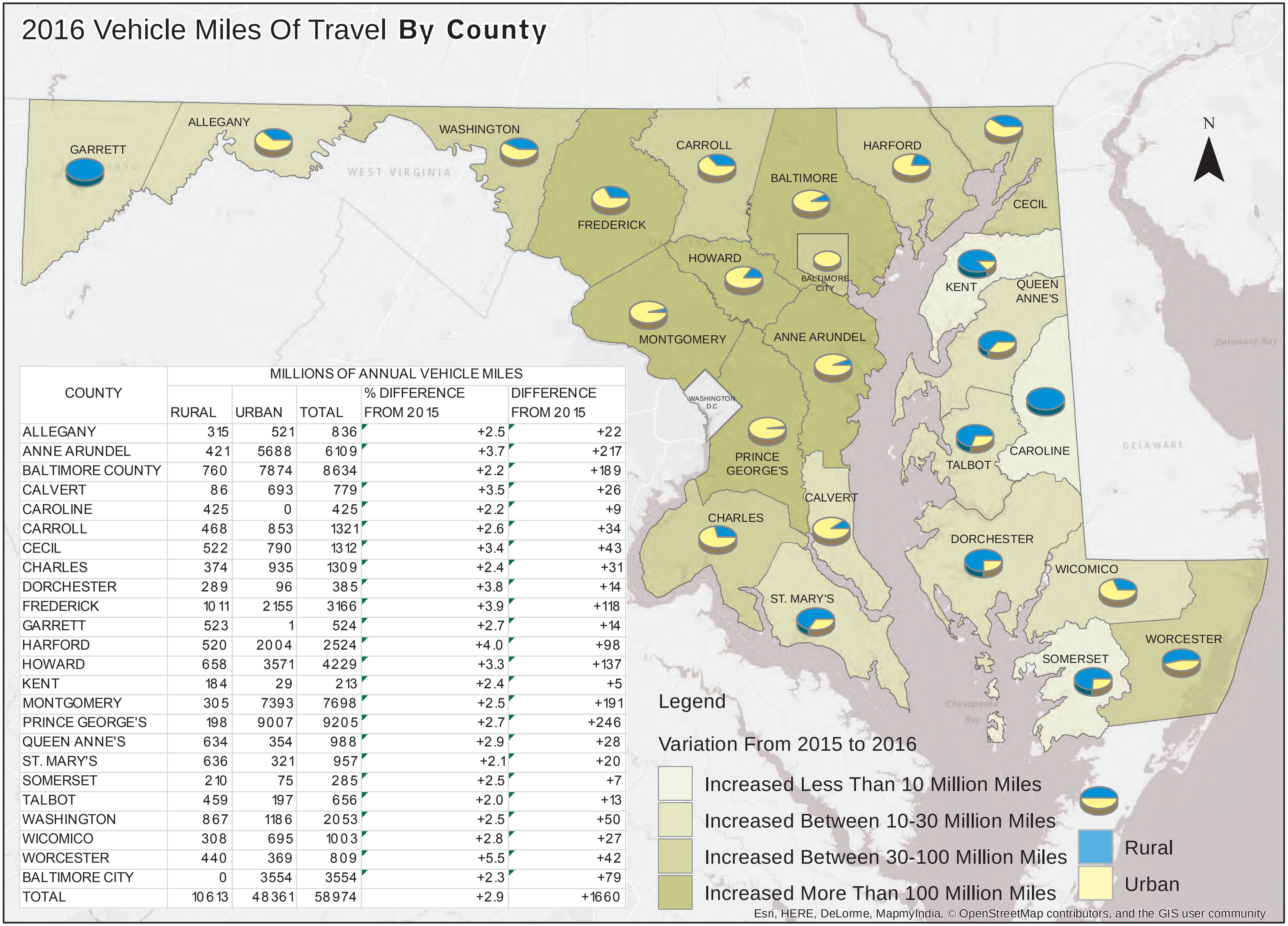


2016 VMT BY ROADWAY TYPE (MILLION)

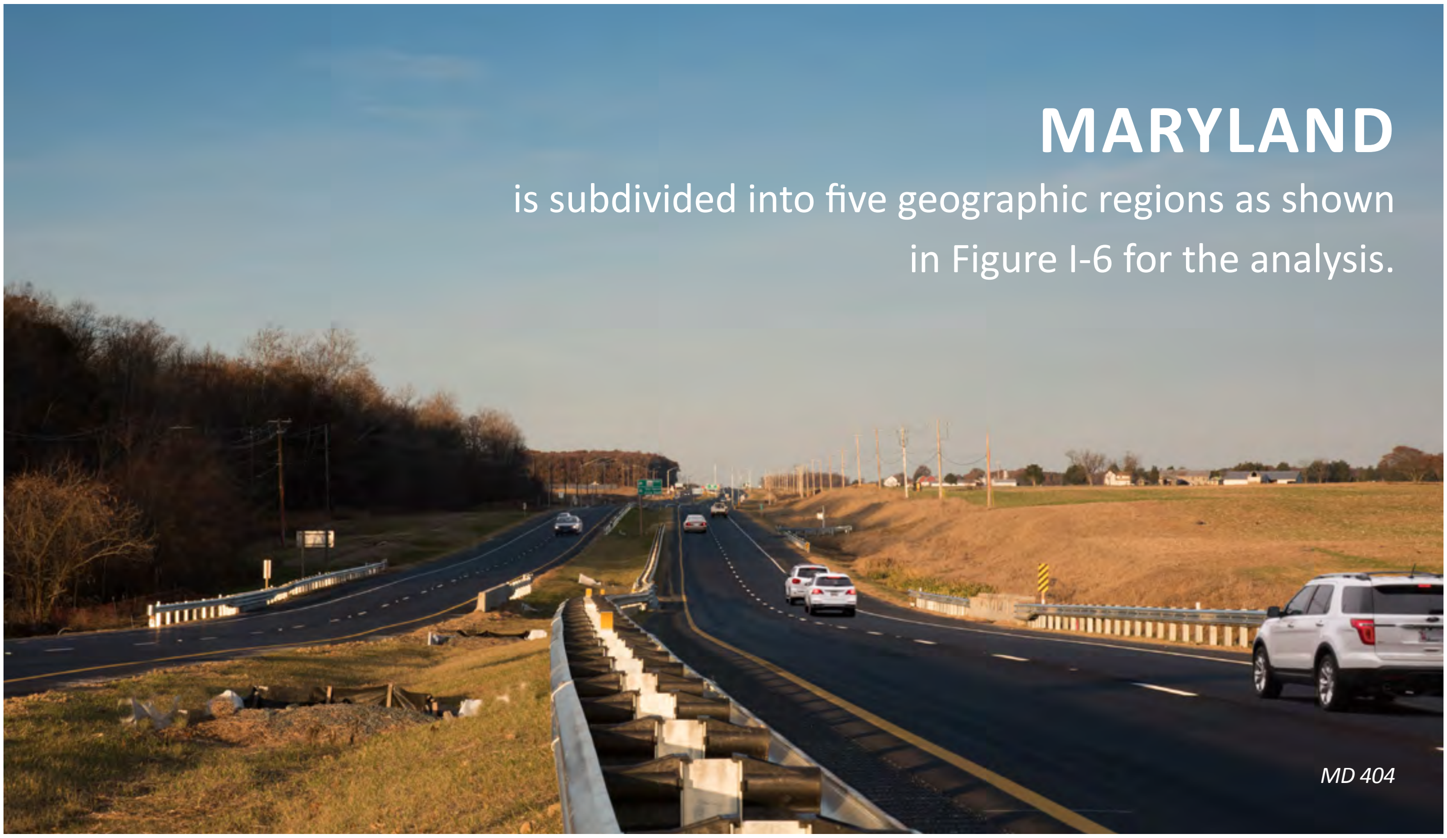


I-695 @ Wilkens Ave

Figure I-5



COUNTY	MILLIONS OF ANNUAL VEHICLE MILES				
	RURAL	URBAN	TOTAL	% DIFFERENCE FROM 2015	DIFFERENCE FROM 2015
ALLEGANY	315	521	836	+2.5	+22
ANNE ARUNDEL	421	5688	6109	+3.7	+217
BALTIMORE COUNTY	760	7874	8634	+2.2	+189
CALVERT	86	693	779	+3.5	+26
CAROLINE	425	0	425	+2.2	+9
CARROLL	468	853	1321	+2.6	+34
CECIL	522	790	1312	+3.4	+43
CHARLES	374	935	1309	+2.4	+31
DORCHESTER	289	96	385	+3.8	+14
FREDERICK	1011	2155	3166	+3.9	+118
GARRETT	523	1	524	+2.7	+14
HARFORD	520	2004	2524	+4.0	+98
HOWARD	658	3571	4229	+3.3	+137
KENT	184	29	213	+2.4	+5
MONTGOMERY	305	7393	7698	+2.5	+191
PRINCE GEORGE'S	198	9007	9205	+2.7	+246
QUEEN ANNE'S	634	354	988	+2.9	+28
ST. MARY'S	636	321	957	+2.1	+20
SOMERSET	210	75	285	+2.5	+7
TALBOT	459	197	656	+2.0	+13
WASHINGTON	867	1186	2053	+2.5	+50
WICOMICO	308	695	1003	+2.8	+27
WORCESTER	440	369	809	+5.5	+42
BALTIMORE CITY	0	3554	3554	+2.3	+79
TOTAL	10613	48361	58974	+2.9	+1660



These are: Baltimore Metropolitan; Washington Metropolitan; Southern Maryland; Eastern Shore; and Western Maryland.

BALTIMORE METROPOLITAN REGION

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

WASHINGTON METROPOLITAN REGION (MARYLAND COUNTIES)

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

SOUTHERN MARYLAND

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

EASTERN SHORE

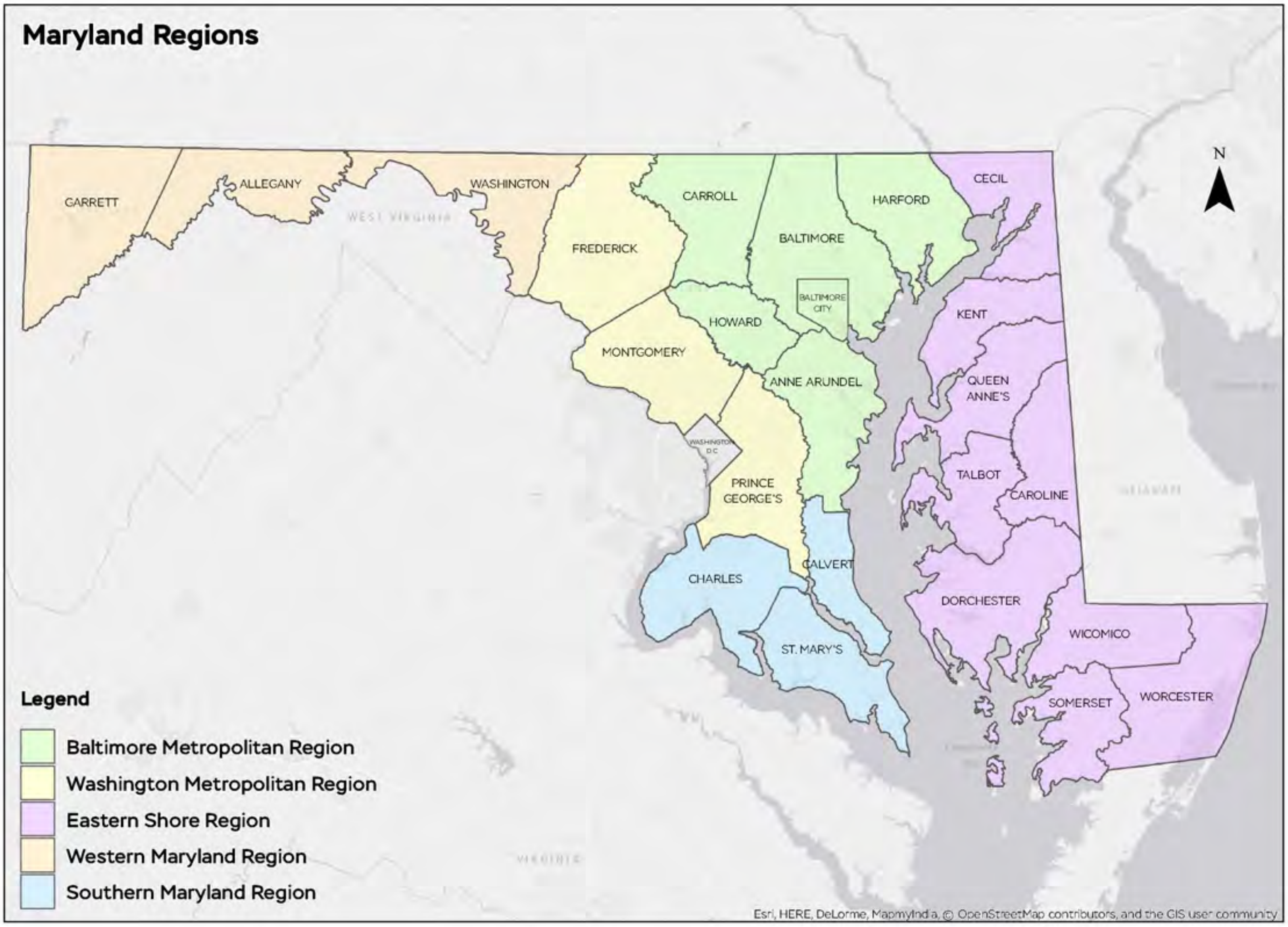
- Caroline (CO) County
- Cecil (CE) County
- Dorchester (DO) County
- Kent (KE) County
- Queen Anne's (QA) County
- Somerset (SO) County
- Talbot (TA) County
- Wicomico (WI) County
- Worcester (WO) County

WESTERN MARYLAND

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

The MDOT SHA county abbreviation is in parenthesis.

Figure I-6



In 2016, each of the five regions experienced an increase in VMT compared with 2015 as depicted in Table I-3.

Table I-3

VMT BY REGION (BILLIONS)

VMT	2012	2013	2014	2015	2016
Baltimore Region	25.2	25.2	25.2	25.6	26.4
Washington Region	19.1	19.2	19.2	19.5	20.0
Southern Region	2.8	2.9	2.9	3.0	3.1
Eastern Shore Region	5.9	5.8	5.8	5.9	6.1
Western Region	3.4	3.4	3.3	3.3	3.4
Total	**56.4**	**56.5**	**56.4**	**57.3**	**59.0**

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B. Congestion and Reliability Trends

I-83

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Congestion Trends

Various factors influence congestion, which can be broadly defined in two categories. 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. 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 recurring congestion. Similarly, traffic that backs up from a signal, traffic trying to enter the mainline from the side streets are instances of recurring congestion on arterials. Factors that influence the level of congestion include high automobile and truck traffic volumes, restricted geometrics or narrow lane widths and shoulder widths.

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 methods used to measure congestion have changed dramatically over past several years as vehicle probe speed data is 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 detailed snapshot of mobility for travelers using the highway system in Maryland. The private 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. In addition, public 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.


I-495


I-270 Spur


I-95 @ MD 200

The freeway/expressway system analysis of vehicle probe speed data involves 1,672 directional miles. This encompasses approximately 95% of these types of roadways in Maryland. The major location for the freeway/expressway system is in the Baltimore - Washington region with approximately 1,136 directional miles. The remaining directional miles are located on the Eastern Shore, Southern Maryland and Western Maryland. 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 of a trip 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 in congested conditions.

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)

The TTI for each highway segment is calculated to provide an understanding of the statewide freeway/expressway system for average weekday peak hour conditions. The analysis was conducted on a statewide basis and for the five major geographic regions. The congestion and reliability measures are further analyzed for the combined Baltimore - Washington region, where the majority of weekday congestion occurs.

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

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 148 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 246 road miles, which is 15% of the statewide freeway/expressway system.

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, I-495 Outer Loop and MD 295 southbound are the worse operating roadways with about five miles or more of severe congestion in the AM peak hour. The PM analysis showed that I-495 Inner Loop, I-695 Inner Loop, MD 295 northbound and I-495 Outer Loop all have over five miles of severe congestion. 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-270

Figure I-7

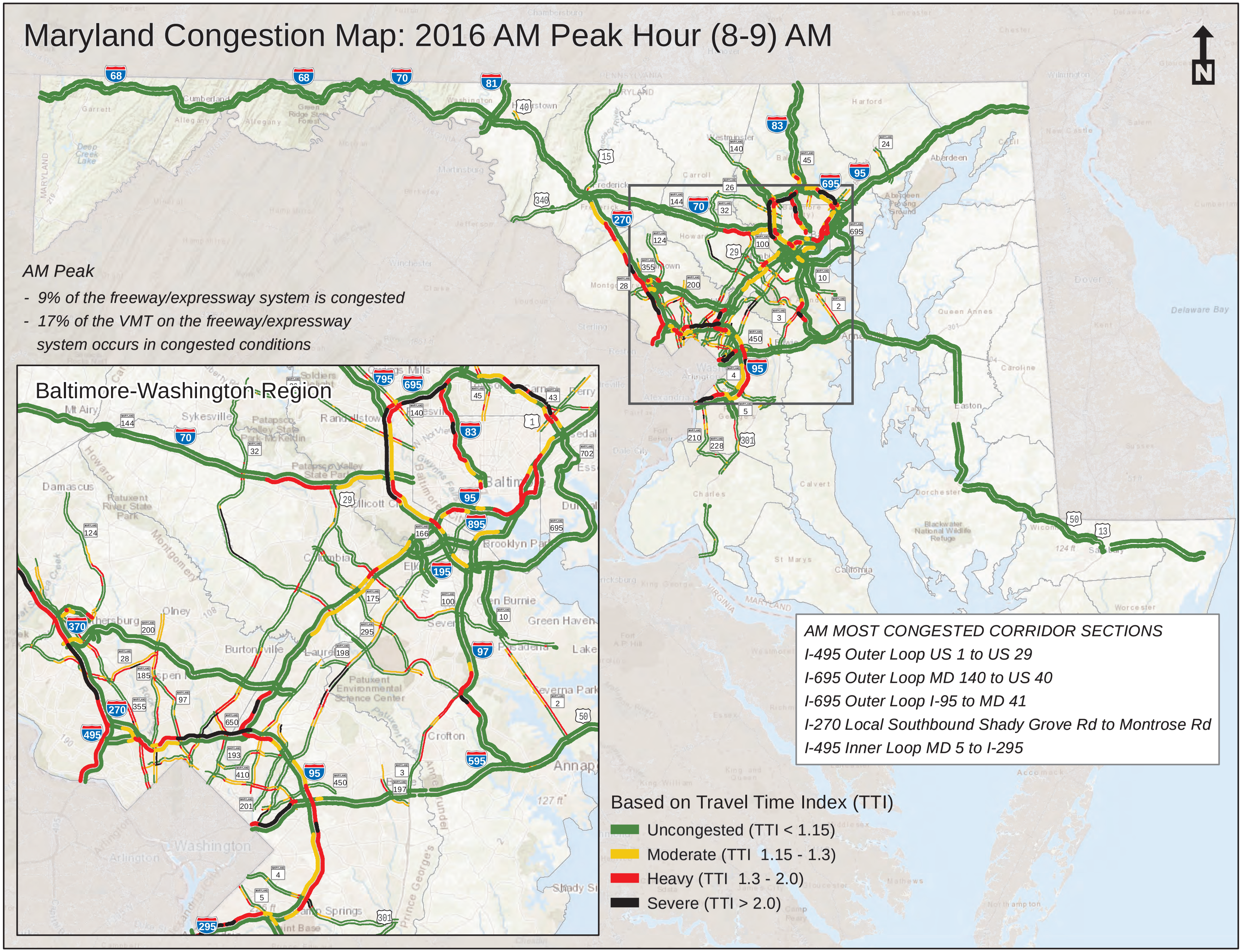

Maryland Congestion Map: 2016 AM Peak Hour (8-9) AM
AM Peak
- 9% of the freeway/expressway system is congested
- 17% of the VMT on the freeway/expressway system occurs in congested conditions
Baltimore-Washington Region
AM MOST CONGESTED CORRIDOR SECTIONS
I-495 Outer Loop US 1 to US 29
I-695 Outer Loop MD 140 to US 40
I-695 Outer Loop I-95 to MD 41
I-270 Local Southbound Shady Grove Rd to Montrose Rd
I-495 Inner Loop MD 5 to I-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-8

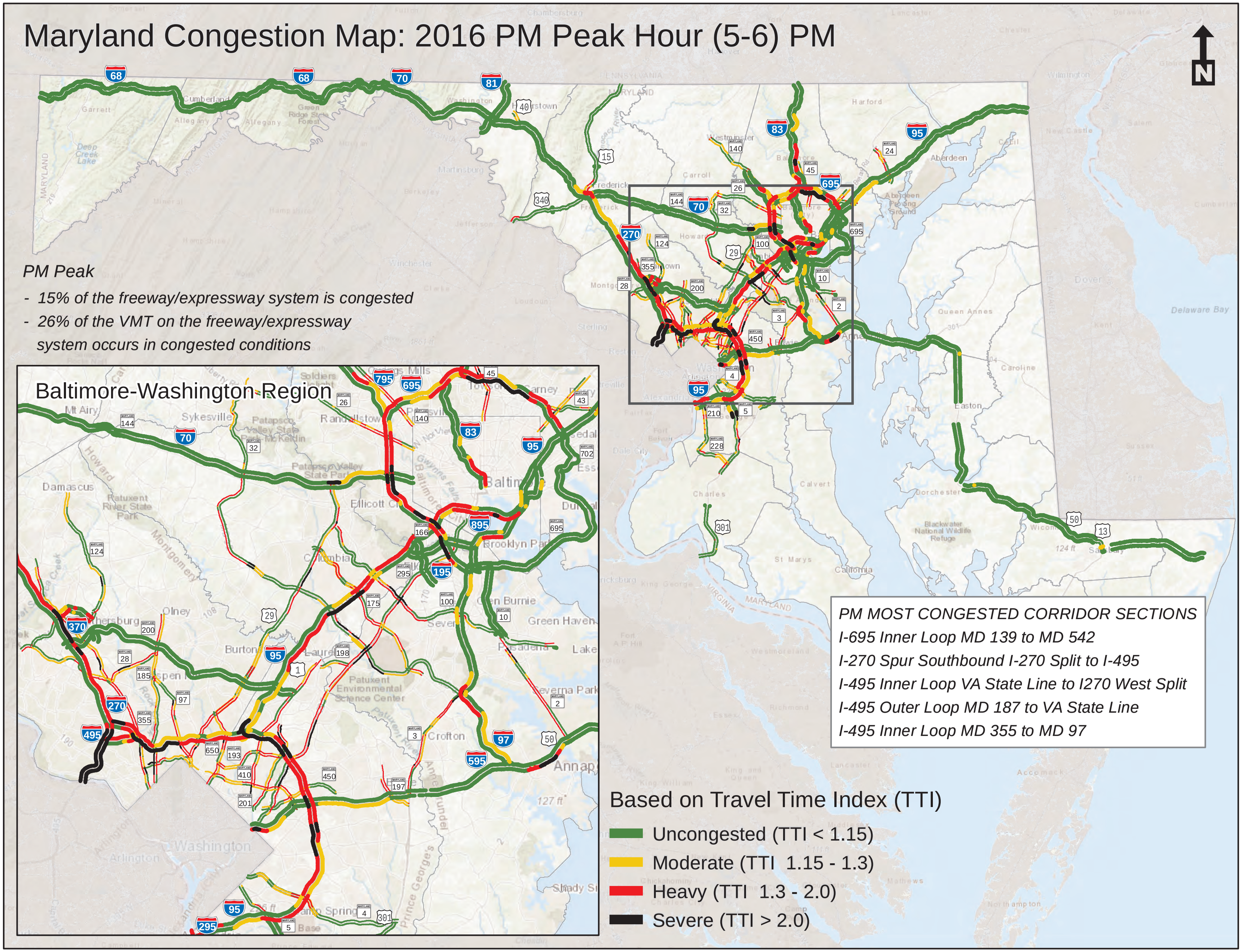
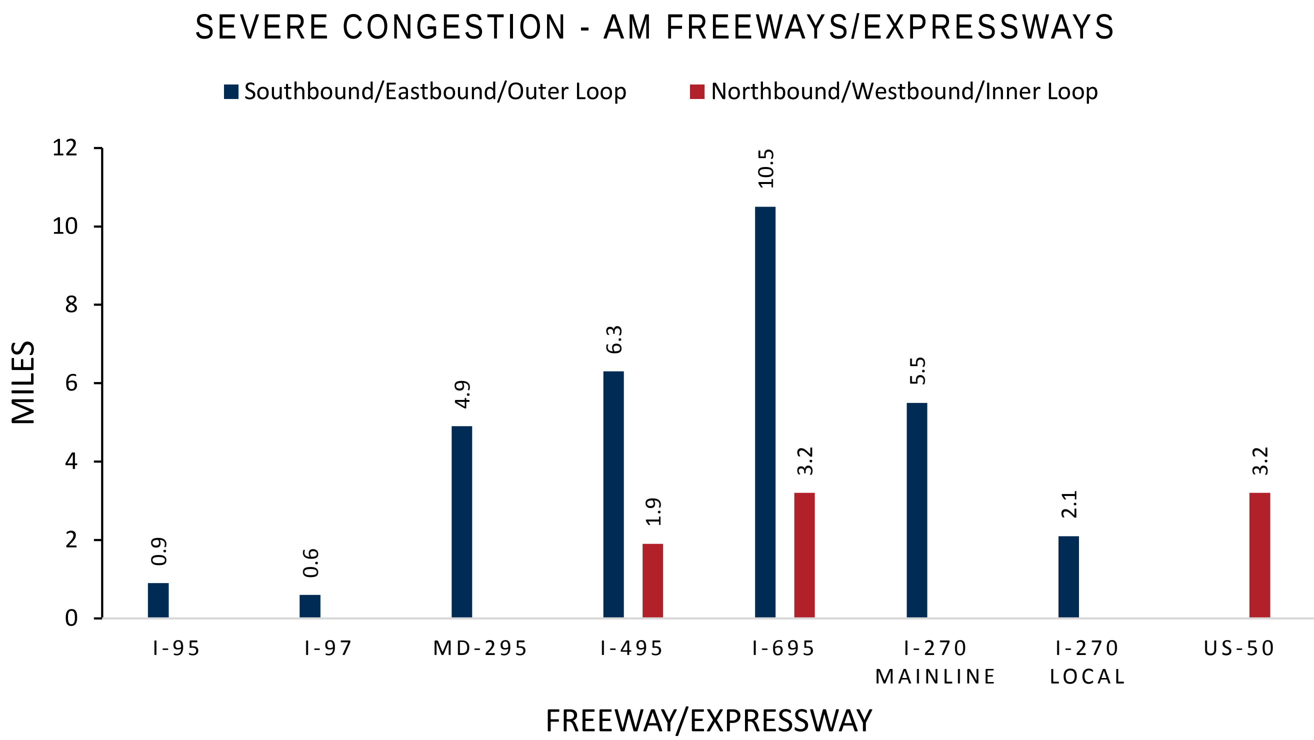
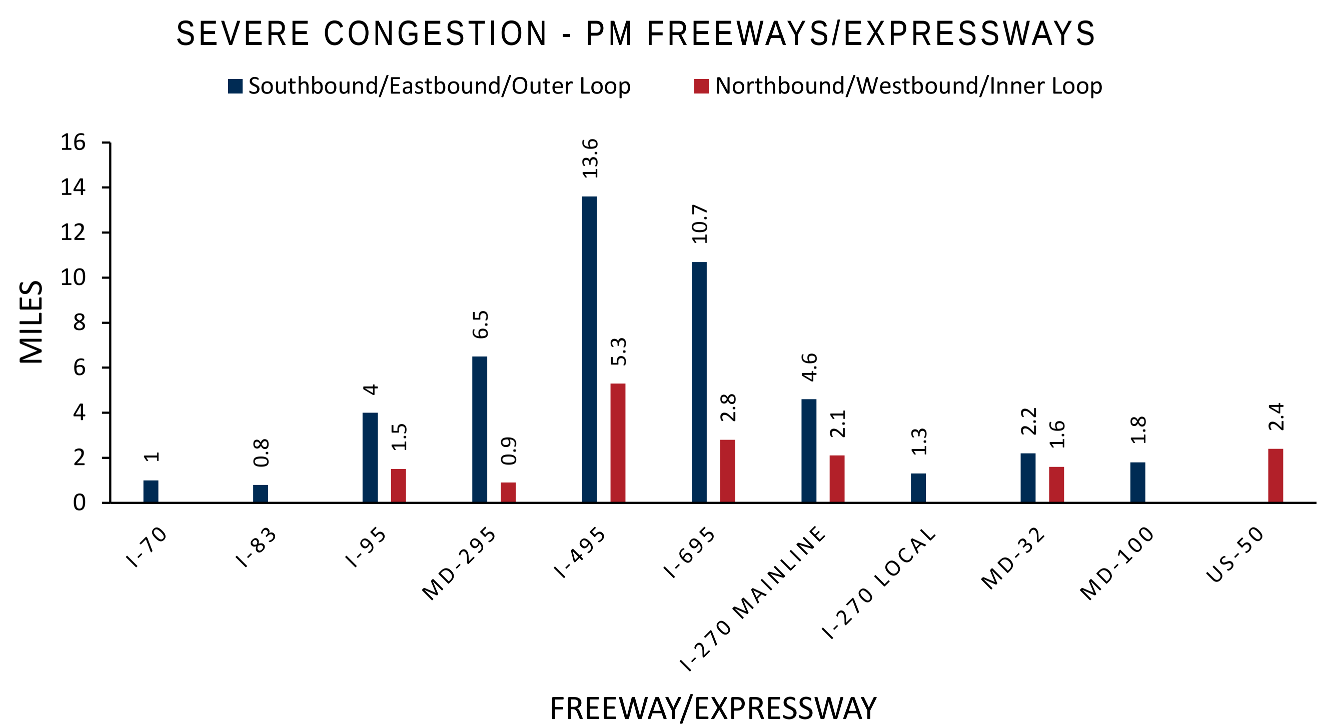

Maryland Congestion Map: 2016 PM Peak Hour (5-6) PM
PM Peak
- 15% of the freeway/expressway system is congested
- 26% of the VMT on the freeway/expressway system occurs in congested conditions
Baltimore-Washington Region
PM MOST CONGESTED CORRIDOR SECTIONS
I-695 Inner Loop MD 139 to MD 542
I-270 Spur Southbound I-270 Split to I-495
I-495 Inner Loop VA State Line to I270 West Split
I-495 Outer Loop MD 187 to VA State Line
I-495 Inner Loop MD 355 to MD 97
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)

Figure I-9


SEVERE CONGESTION - AM FREEWAYS/EXPRESSWAYS
Southbound/Eastbound/Outer Loop
Northbound/Westbound/Inner Loop
MILES
0
2
4
6
8
10
12
0.9
0.6
4.9
6.3
1.9
10.5
3.2
5.5
2.1
3.2
I-95
I-97
MD-295
I-495
I-695
I-270 MAINLINE
I-270 LOCAL
US-50
FREEWAY/EXPRESSWAY


SEVERE CONGESTION - PM FREEWAYS/EXPRESSWAYS
Southbound/Eastbound/Outer Loop
Northbound/Westbound/Inner Loop
MILES
0
2
4
6
8
10
12
14
16
1
0.8
4
1.5
6.5
0.9
13.6
5.3
10.7
2.8
4.6
2.1
1.3
2.2
1.6
1.8
2.4
I-70
I-83
I-95
MD-295
I-495
I-695
I-270 MAINLINE
I-270 LOCAL
MD-32
MD-100
US-50
FREEWAY/EXPRESSWAY

I-695 @ MD 26

The majority of the average weekday congestion occurs in the Baltimore - Washington region. The roadways in this region carry 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.

Congestion on roadways on the Eastern Shore, Southern Maryland and Western Maryland is more limited to select locations. 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 Lexington Park area with the Naval Air Station-Patuxent River and associated support services encounter congestion along MD 4, MD 5 and MD 235 in peak periods. The worse areas of congestion in Western Maryland occur near the Hagerstown area. With the junction of two major interstates (I-70 and I-81), high truck volumes contribute to reduced speeds and increased congestion.

Congestion occurs at three major bridge structures which 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

Another measure that identifies the overall impacts of congestion is the amount of VMT that travel in heavy to severe conditions. The higher the number the more motorists are affected.

Seventeen (17)% of the AM peak hour VMT and 26% of the PM peak hour VMT occur in heavy to severe congested conditions.

A comparison was performed between 2016 and 2015 metrics which shows that roadway performance statewide has improved slightly over the past year. The AM peak hour mileage in heavy to severe congestion decreased by 1 road mile, while the PM peak hour showed a decrease of 6 roadway miles on the freeway/expressway system. The percent of peak hour VMT occurring in these conditions decreased by 1% in the AM peak hour and PM peak hour versus 2015.

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	**2014**		**2015**		**2016**		**CHANGE 2015 TO 2016**	
	AM	PM	AM	PM	AM	PM	AM	PM
Roadway Miles	136	224	149	252	148	246	-1	-6
Percent of Roadway Miles	8	13	9	15	9	15	0	0
Percent of Peak Hour VMT Impacted	16	24	18	27	17	26	-1	-1

3. Statewide Annual Cost of Congestion of the Freeway/Expressway System

Freeway/expressway congestion cost motorists $2.11 billion in 2016.

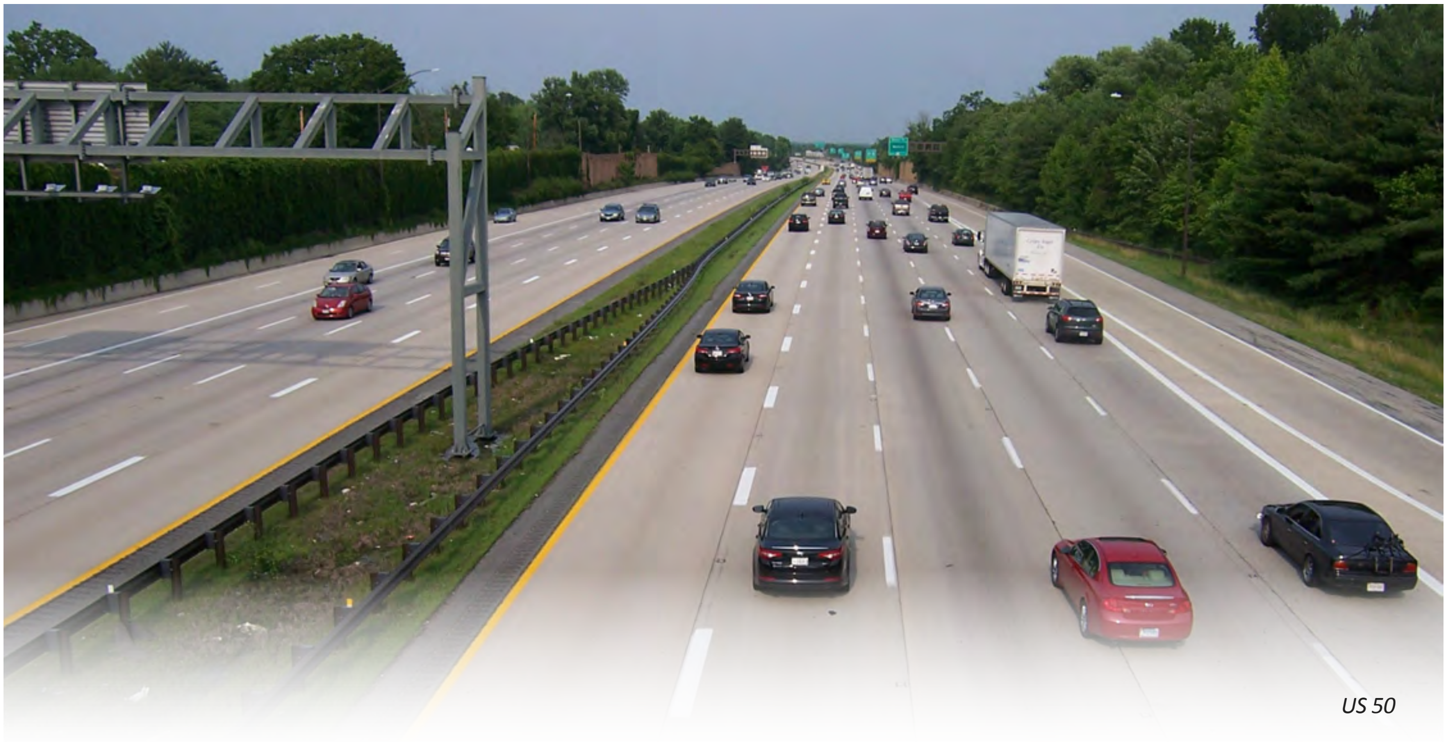
The statewide cost of congestion was estimated based on the auto delay, truck delay, and wasted fuel and emissions that occurs on the freeway/expressway system on a statewide and region-wide basis. The statewide cost for 2016 is estimated to be $2.11 billion which includes:

- Auto Delay Cost: $1.83 billion
- Truck Delay Cost: $165 million
- Wasted Fuel Cost: $57 million
- Air Emissions Cost: $59 million

The cost of congestion was broken down by region. The highest congestion cost occurs in the Washington region which accounts for approximately 60% statewide. This was about 2.7% greater than last year which is the largest increase in the State. The Baltimore region experienced a 2.6% increase in congestion cost to a total of $827 million. The cost associated with congestion for the Eastern Shore, Southern and Western Maryland regions is estimated at $19 million, which is $5 million lower 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	**2014**	**2015**	**2016**	**CHANGE 2015 TO 2016**
Statewide	1,698	2,052	2,111	+59
Baltimore Region	686	806	827	+21
Washington Region	954	1,222	1,265	+43
Eastern Shore Region	47	20	14	-6
Southern Region	5	1	2	+1
Western Region	6	3	3	+0



The delay experienced by auto and truck drivers account for the majority of the cost associated with congestion. Figures I-10 and I-11 identify the percentage breakdown of the congestion costs by source and by different regions for the freeway/expressway system:

Figure I-10

PERCENT OF STATEWIDE CONGESTION COST BY SOURCE

(TOTAL CONGESTION COST = $2.11 BILLION)

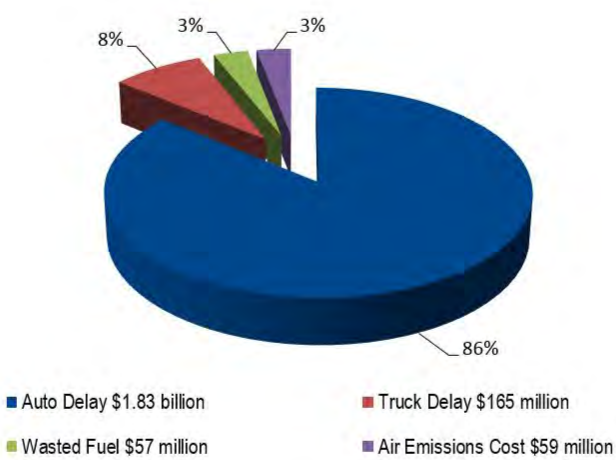
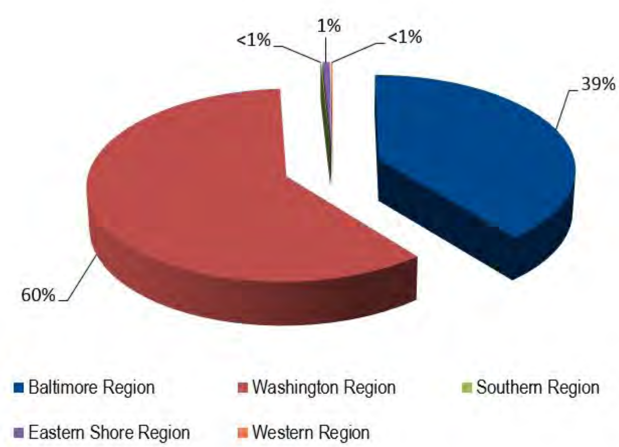


Figure I-11

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

(TOTAL CONGESTION COST = $2.11 BILLION)



TOP 15 FREEWAY/EXPRESSWAY CONGESTED CORRIDOR SECTIONS

Analysis was performed 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 travel conditions. These corridors range from approximately three (3) miles to eight (8) miles. 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.

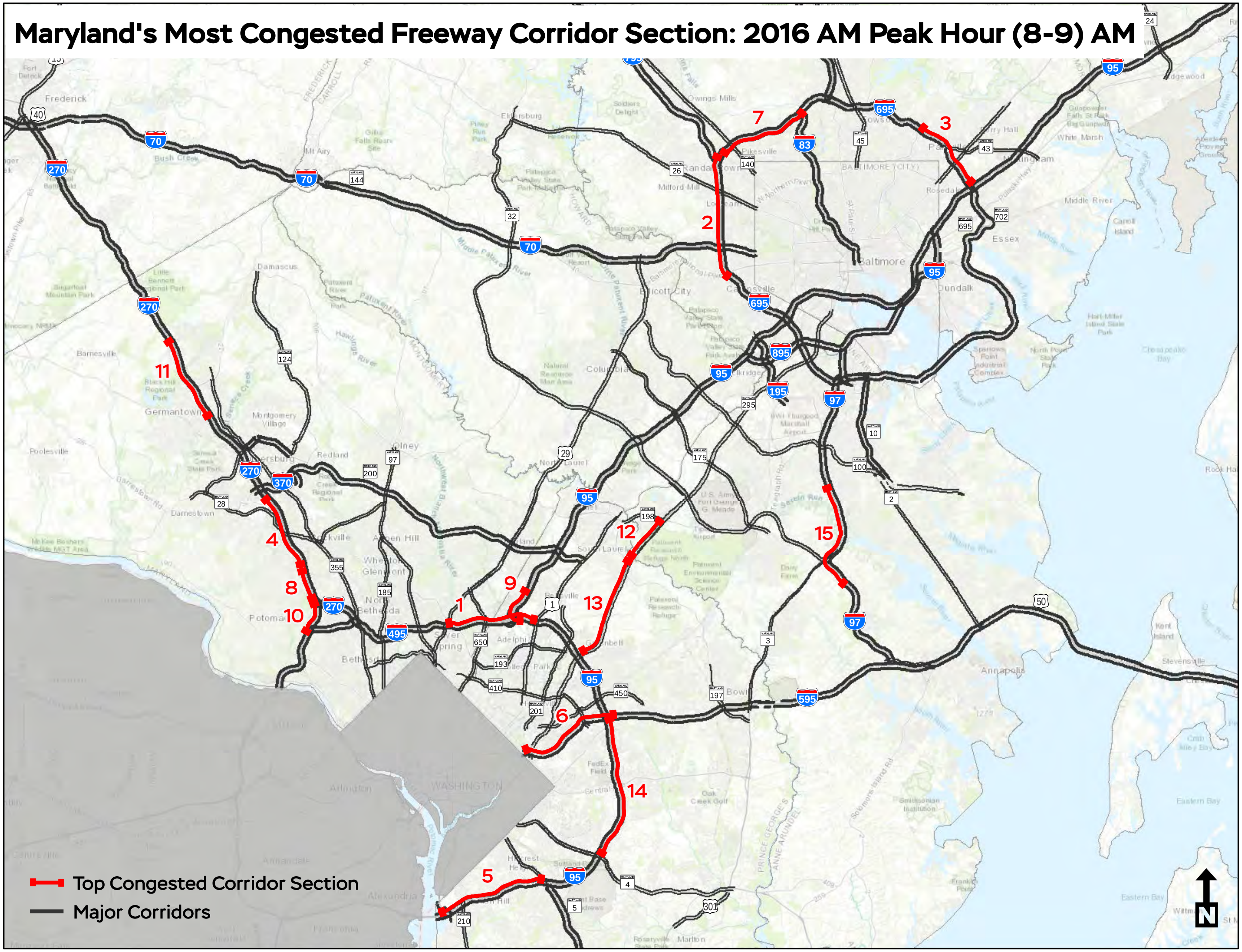
The Top 15 sections for the freeway and expressways corridors are shown in the following Tables I-6 and I-7 and in Figures I-12 and I-13.

Table I-6

2016 MOST CONGESTED FREEWAY/EXPRESSWAY CORRIDORS - AM PEAK HOUR

AM Rank	Route/Direction	Limits	TTI Value	County	Mileage
1	I-495 Outer Loop	US 1 to US 29	3.30	Montgomery/ Prince George's	5.0
2	I-695 Outer Loop	MD 140 to US 40	2.49	Baltimore	7.5
3	I-695 Outer Loop	I-95 to MD 41	2.37	Baltimore	4.1
4	I-270 (Local) Southbound	Shady Grove Road to Montrose Road	2.04	Montgomery	4.6
5	I-95/I-495 Inner Loop	MD 5 to I-295	2.00	Prince George's	5.7
6	US 50 Westbound	MD 704 to MD 295	1.95	Prince George's	6.6
7	I-695 Inner Loop	MD 140 to I-83	1.90	Baltimore	5.4
8	I-270 Southbound	Montrose Road to I-270 Spur	1.86	Montgomery	3.1
9	I-95 Southbound	South of MD 200 to I-495	1.82	Prince George's	4.3
10	I-270 Spur Southbound	I-270 Split to I-495	1.76	Montgomery	2.1
11	I-270 Southbound	MD 121 to Middlebrook Road	1.75	Montgomery	4.7
12	MD 295 Southbound	MD 32 to AA/PG County Line	1.63	Anne Arundel	4.7
13	MD 295 Southbound	AA/PG County Line to MD 193	1.61	Prince George's	4.9
14	I-95/I-495 Outer Loop	MD 4 to US 50	1.56	Prince George's	8.0
15	I-97 Southbound	MD 3 to MD 178	1.43	Anne Arundel	6.4

Figure I-12

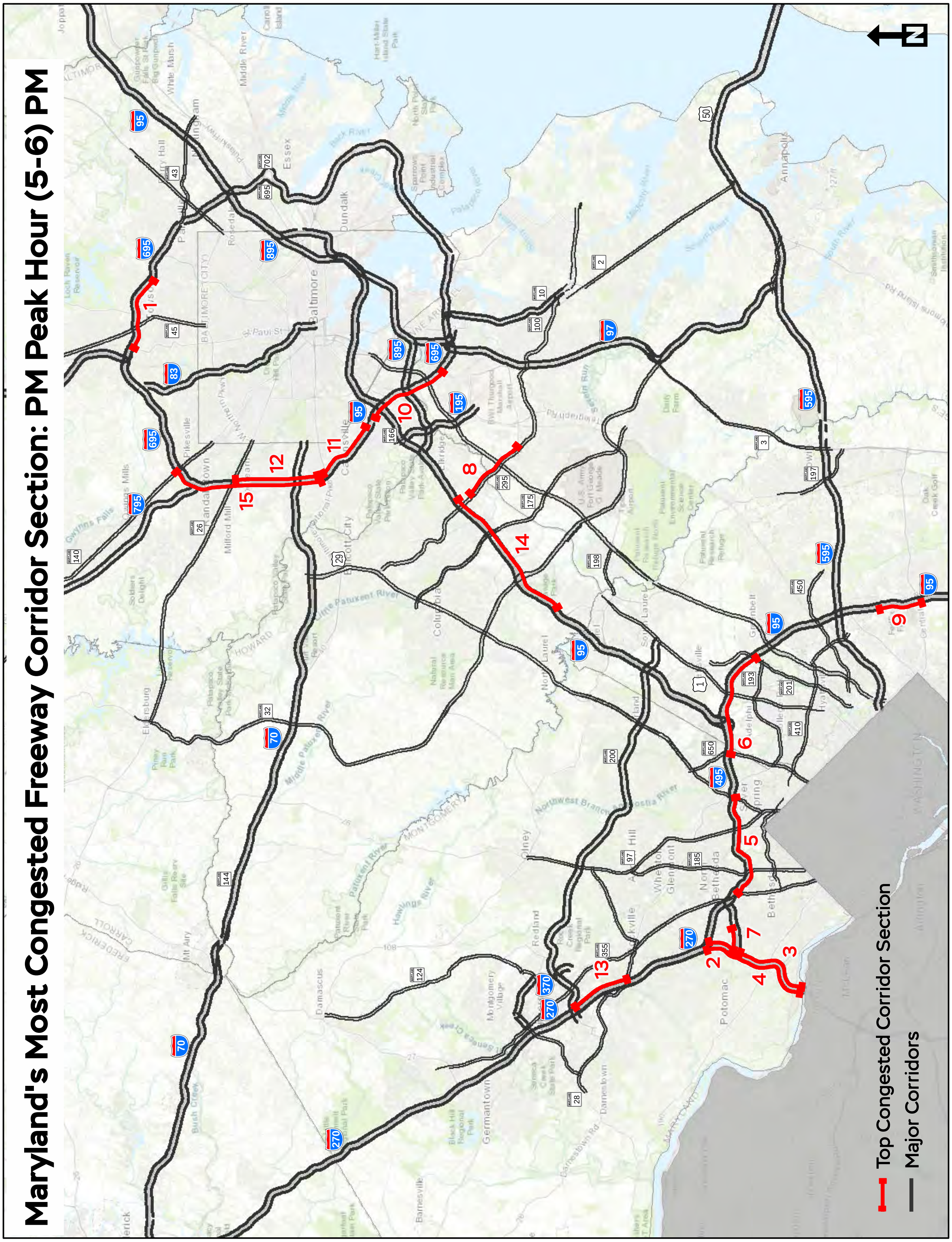


Maryland's Most Congested Freeway Corridor Section: 2016 AM Peak Hour (8-9) AM
Top Congested Corridor Section
Major Corridors
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Frederick
Baltimore
Germantown
Annapolis

Table I-7

2016 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	3.52	Baltimore	4.6
2	I-270 Spur Southbound	I-270 Split to I-495	3.25	Montgomery	2.1
3	I-495 Inner Loop	VA State line to I-270 Spur (West)	3.22	Montgomery	4.0
4	I-495 Outer Loop	MD 187 to VA State Line	2.72	Montgomery	5.3
5	I-495 Inner Loop	MD 355 to MD 97	2.43	Montgomery	4.1
6	I-495 Inner Loop	MD 650 to MD 201	2.22	Prince George's	5.1
7	I-270 Spur Northbound	I-495 to I-270	2.19	Montgomery	2.3
8	MD 100 Westbound	MD 713 to US 1	2.14	Anne Arundel/ Howard	2.8
9	I-95/I-495 Inner Loop	MD 202 to MD 214	2.07	Prince George's	3.7
10	I-695 Outer Loop	US 1 to MD 170	2.06	Baltimore/ Anne Arundel	3.4
11	I-695 Inner Loop	US 1 to US 40	2.05	Baltimore	4.9
12	I-695 Inner Loop	US 40 to MD 26	1.87	Baltimore	5.8
13	I-270 (Local) Northbound	Shady Grove Road to MD 124	1.86	Montgomery	5.4
14	I-95 Northbound	MD 216 to MD 100	1.86	Howard	7.1
15	I-695 Outer Loop	MD 140 to US 40	1.86	Baltimore	7.5

Figure I-13



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

MD 45

CONGESTION MEASURES ON THE MARYLAND ARTERIAL SYSTEM

The arterial system provides the vital linkage between the freeway/expressway system and the local system. These roadways 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 four categories based on the TTI. These are the same measures as the freeway/expressway system and 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

The TTI values were calculated for the arterial system for each segment on an average weekday. This was accomplished 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 553 miles of which 496 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.

Motorists on 82 miles (15%) of the arterial system in the AM peak hour experience heavy to severe congestion. Congestion levels are higher in the PM peak hour with 33% of the system or 182 miles experiencing heavy to severe congestion.

2. Statewide Annual Cost of Congestion of the Arterial System

Congestion costs were developed for the roadways analyzed as part of the arterial system. The congest cost statewide were estimated to be $1.23 billion. This consisted of:

- Auto Delay Cost: $1.06 billion
- Truck Delay Cost: $91 million
- Wasted Fuel Cost: $41 million
- Air Emission Cost: $35 million

TOP 15 ARTERIAL CONGESTED CORRIDORS

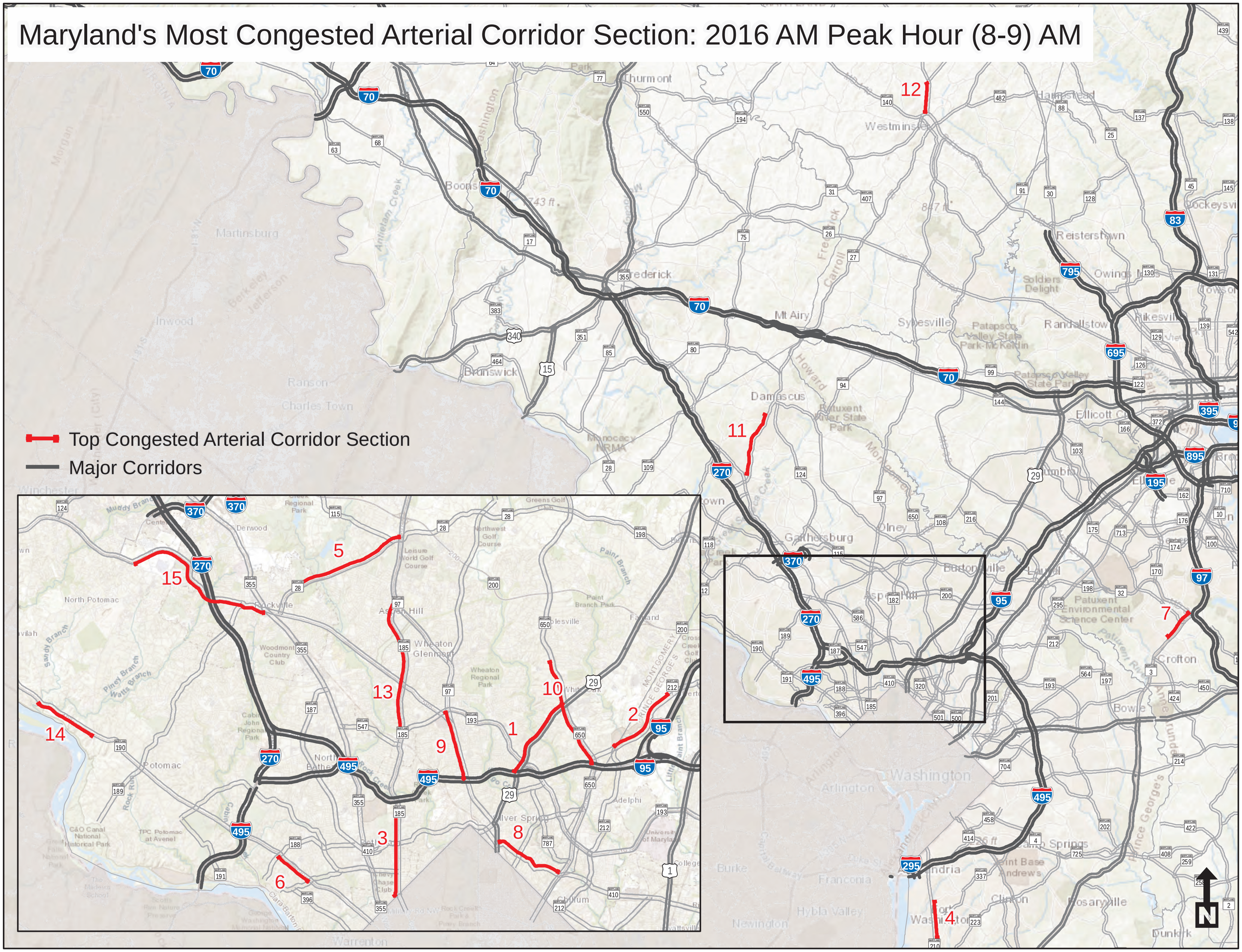
The TTI values were determined for each individual segment. These individual segments were combined together in approximately two (2) to five (5) mile sections. The length of the section was based on the analysis of the individual segment TTI and engineering judgement. The section TTI was determined multiplying the individual segment TTI by the segment length, adding those individual segments and dividing by the total length. The Top 15 congested corridors for the arterials are shown in Table I-8 and I-9 and Figures I-14 and I-15.

Congestion cost for the freeway/expressway and arterial system is $3.34 Billion.

Table I-8

2016 MOST CONGESTED ARTERIAL CORRIDORS - AM PEAK HOUR					
AM Rank	Route/Direction	Limits	TTI Value	County	Mileage
1	US 29 Southbound	MD 650 to I-495	2.25	Montgomery	2.3
2	MD 212 Westbound	Beltsville Dr to Riggs Rd	1.73	Prince George's	2.5
3	MD 185 Southbound	Jones Bridge Rd to Washington D.C. Line	1.71	Montgomery	2.2
4	MD 210 Northbound	Swan Creek Rd to Palmer Rd	1.62	Prince George's	2.9
5	MD 28 Westbound	MD 97 to E Gude Dr	1.60	Montgomery	3.2
6	MD 190 Eastbound	MD 188 to MD 614	1.58	Montgomery	2.1
7	MD 3 Southbound	I-97 to Waugh Chapel Rd	1.56	Anne Arundel	2.0
8	MD 410 Westbound	MD 650 to US 29	1.56	Montgomery	2.1
9	MD 97 Southbound	MD 193 to I-495	1.53	Montgomery	2.1
10	MD 650 Southbound	Venice Dr to I-495	1.53	Montgomery	3.4
11	MD 27 Southbound	Oak Dr to Brink Rd	1.48	Montgomery	4.9
12	MD 97 Southbound	MD 496 to MD 140	1.47	Carroll	2.5
13	MD 185 Southbound	MD 97 to MD 193	1.46	Montgomery	3.6
14	MD 190 Eastbound	Stoney Creek Rd to Piney Meetinghouse Rd	1.45	Montgomery	2.5
15	MD 28 Eastbound	Darnestown Rd to MD 355	1.45	Montgomery	2.3

Figure I-14

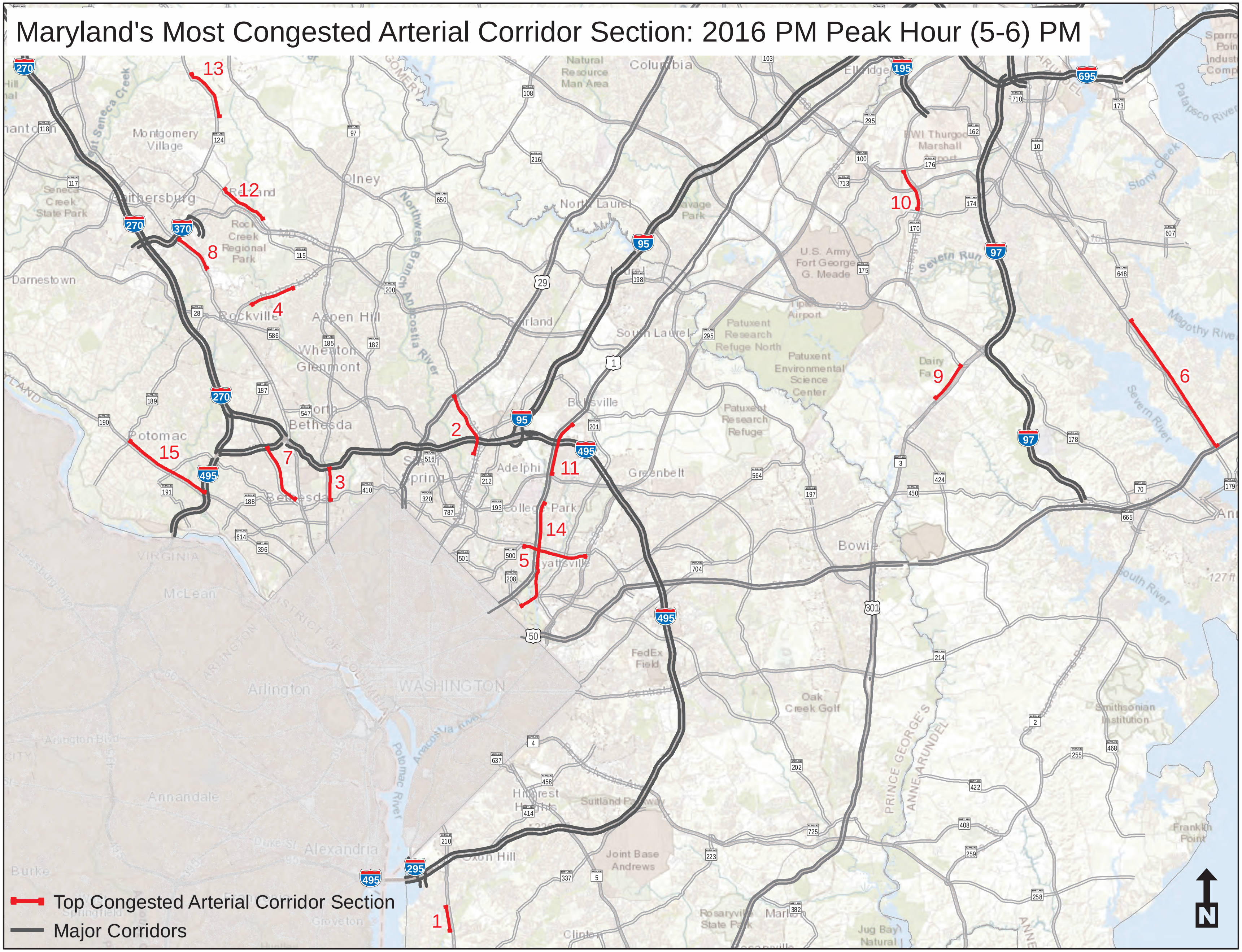


Maryland's Most Congested Arterial Corridor Section: 2016 AM Peak Hour (8-9) AM
Top Congested Arterial Corridor Section
Major Corridors

Table I-9

2016 MOST CONGESTED ARTERIAL CORRIDORS - PM PEAK HOUR					
PM Rank	**Route/Direction**	**Limits**	**TTI Value**	**County**	**Mileage**
1	MD 210 Southbound	Kerby Hill Rd/Livingston Rd to Palmer Rd	2.04	Prince George's	2.0
2	MD 650 Southbound	US 29 to Adelphi Rd	1.87	Montgomery	2.3
3	MD 185 Northbound	MD 410 to I-495	1.83	Montgomery	2.1
4	MD 28 Eastbound	E Gude Dr to Bel Pre Rd	1.78	Montgomery	2.6
5	MD 410 Eastbound	Adelphi Rd to MD 295	1.68	Prince George's	2.4
6	MD 2 Northbound	US 50 to MD 648/Whites Rd	1.59	Anne Arundel	5.8
7	MD 187 Northbound	MD 188 to I-495	1.59	Montgomery	2.5
8	MD 355 Northbound	Gude Dr to Shady Grove Rd	1.57	Montgomery	2.6
9	MD 3 Southbound	MD 175 to Waugh Chapel Rd	1.57	Anne Arundel	2.0
10	MD 170 Southbound	MD 176 to MD 174	1.56	Anne Arundel	2.9
11	US 1 Northbound	MD 193 to Rhode Island Ave	1.55	Prince George's	2.1
12	MD 115 Westbound	Needwood Rd to Shady Grove Rd	1.53	Montgomery	3.6
13	MD 124 Northbound	Fieldcrest Rd to Brink Rd	1.50	Montgomery	2.0
14	US 1 Northbound	38^{th} St to Campus Dr/Paint Branch Dr	1.50	Prince George's	2.3
15	MD 190 Westbound	I-495 to MD 189	1.49	Montgomery	3.3

Figure I-15


Maryland's Most Congested Arterial Corridor Section: 2016 PM Peak Hour (5-6) PM
Top Congested Arterial Corridor Section
Major Corridors

Reliability Trends

Travel time varies due to many factors and motorists plan and adjust their departure times to make sure they make it to their destination on time. It is the variability in travel times from day to day that shows unreliability of the system and frustrates the motorist. The unreliability or variability of travel time on any road is caused by incidents, vehicular breakdowns, crashes, weather, and lane reductions through work zones. This non-recurring congestion 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. There is a cost associated with the additional travel time due to the unreliability of the network and motorists having to add a buffer to reach their destination on time. An unreliable system causes an undesirable customer experience whether it is a motorist or a rider. The cost of any trip varies by purpose and 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 costs 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 understands its significance and continues to deliver feasible transportation options.

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 95th 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 30 minutes to ensure arriving on time when the PTI is 3.0. 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

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.

Highly to extremely unreliable conditions (PTI > 2.5) are defined by MDOT SHA as having the poorest operations. This occurs on a total of 111 road miles (7% of the statewide freeway/expressway system) in the AM peak hour.

In the PM peak hour, 12% of the statewide freeway/expressway system operates under highly to extremely unreliable condition (200 road miles). 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 22% of the afternoon peak hour VMT occurs in these travel conditions.

Compared to 2015, reliability trends statewide over the past year have improved slightly. There was a 4% decrease in the VMT that occurred under highly or extremely unreliable conditions in the AM peak hour. In the PM peak hour, operations were similar with a 4% decrease 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	2014		2015		2016		CHANGE 2015 to 2016	
	AM	PM	AM	PM	AM	PM	AM	PM
Number of Roadway Miles	141	211	139	232	111	200	-28	-32
Percent of Roadway Miles	9	13	8	14	7	12	-1	-2
Percent of Peak Hour VMT Impacted	16	23	17	26	13	22	-4	-4

Figure I-16

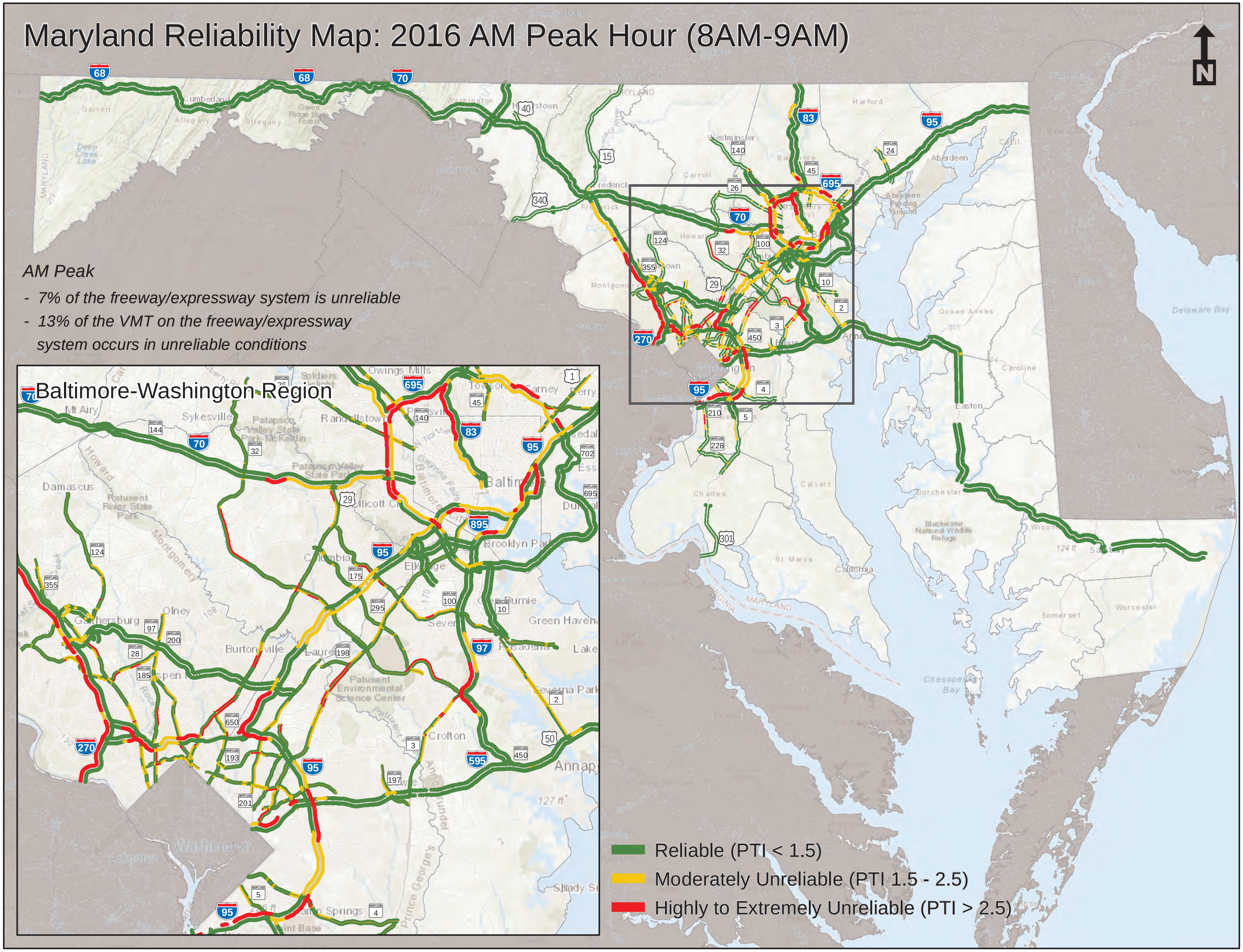
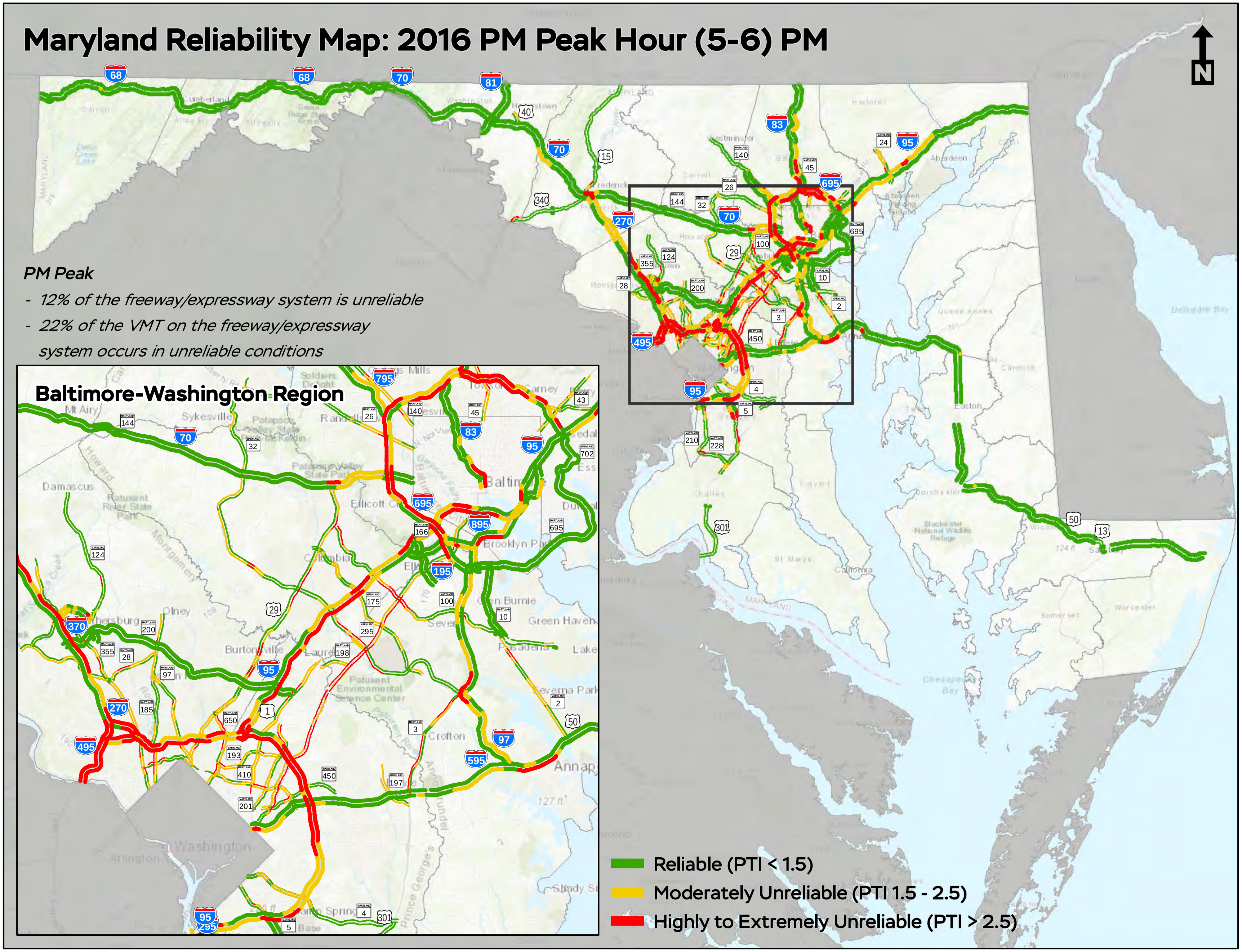

Maryland Reliability Map: 2016 AM Peak Hour (8AM-9AM)
AM Peak
- 7% of the freeway/expressway system is unreliable
- 13% of the VMT on the freeway/expressway system occurs in unreliable conditions
Baltimore-Washington Region
Reliable (PTI < 1.5)
Moderately Unreliable (PTI 1.5 - 2.5)
Highly to Extremely Unreliable (PTI > 2.5)

Figure I-17


Maryland Reliability Map: 2016 PM Peak Hour (5-6) PM
PM Peak
- 12% of the freeway/expressway system is unreliable
- 22% of the VMT on the freeway/expressway system occurs in unreliable conditions
Baltimore-Washington Region
Reliable (PTI < 1.5)
Moderately Unreliable (PTI 1.5 - 2.5)
Highly to Extremely Unreliable (PTI > 2.5)
N

I-495

CONGESTION AND RELIABILITY CORRELATION TRENDS

In general, there is a strong correlation between congestion and reliability, segments of roadways with high TTI values are likely to have high PTI values. 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 average congestion (TTI based maps shown in Figures I-7 and I-8) and reliability (PTI based maps in 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 2015 are shown In Tables I-11 and I-12.

Table I-11

2016 TOP 15 CONGESTED SEGMENTS & ASSOCIATED RELIABILITY VALUES - AM PEAK						
Roadway	**Location**	**Direction**	**2016 Rank (TTI)**	**2015 Rank (TTI)**	**2016 Rank (PTI)**	**2015 Rank (PTI)**
I-495	MD 650 to MD 193	Outer Loop	1 (4.8)	1 (4.4)	2 (8.0)	6 (8.5)
I-495	@ MD 650	Outer Loop	2 (4.5)	2 (4.4)	1 (8.7)	1 (9.2)
I-495	MD 193 to US 29	Outer Loop	3 (3.9)	4 (3.6)	12 (6.2)	15 (6.3)
I-695	@ MD 147	Outer Loop	4 (3.7)	5 (3.5)	9 (6.3)	9 (7.5)
I-695	@ I-70	Outer Loop	5 (3.7)	11 (2.6)	10 (6.3)	12 (6.5)
I-495	I-95 to Prince George's County Line	Outer Loop	6 (3.5)	3 (3.7)	3 (8.0)	2 (9.1)
I-695	MD 43 to MD 147	Outer Loop	7 (3.5)	6 (3.4)	6 (6.9)	7 (8.3)
MD 295	US 50 to Washington DC Line	Southbound	8 (3.1)	9 (2.8)	16 (5.4)	24 (5.3)
I-495	US 29 to MD 97	Outer Loop	9 (3.0)	8 (2.8)	33 (4.2)	45 (4.4)
US 50	MD 202 to MD 459	Westbound	10 (3.0)	10 (2.6)	25 (4.8)	37 (4.8)
I-695	@ MD 122	Outer Loop	11 (2.9)	28 (2.2)	20 (5.1)	26 (5.3)
I-695	I-70 to US 40	Outer Loop	12 (2.8)	24 (2.2)	40 (4.0)	53 (4.1)
I-695	US 1 to MD 43	Outer Loop	13 (2.7)	7 (3.0)	4 (7.4)	3 (9.1)
I-95	MD 210 to I-295	Inner Loop	14 (2.7)	27 (2.2)	14 (5.5)	28 (5.2)
MD 295	Anne Arundel County Line to MD 197	Southbound	15 (2.7)	18 (2.4)	43(4.0)	61 (3.90)

Table I-12

2016 TOP 15 CONGESTED SEGMENTS & ASSOCIATED RELIABILITY VALUES - PM PEAK						
Roadway	**Location**	**Direction**	**2016 Rank (TTI)**	**2015 Rank (TTI)**	**2016 Rank (PTI)**	**2015 Rank (PTI)**
I-270 Spur	I-270 Split to Democracy Blvd.	Southbound	1 (4.7)	130 (1.6)	2 (11.6)	10 (7.0)
I-695	@ MD 146	Inner Loop	2 (4.4)	2 (4.0)	10 (6.7)	6 (8.3)
I-495	@ Cabin John Pkwy	Inner Loop	3 (4.2)	4 (3.7)	7 (6.9)	9 (7.4)
I-695	@ MD 45	Inner Loop	4 (4.2)	1 (4.0)	5 (7.2)	4 (9.1)
I-695	MD 146 to Providence Rd	Inner Loop	5 (4.0)	6 (3.6)	18 (5.6)	13 (6.7)
MD 32	@ MD 108	Westbound	6 (3.9)	7 (3.4)	8 (6.9)	14 (6.6)
I-695	MD 139 to MD 45	Inner Loop	7 (3.7)	3 (3.9)	4 (7.8)	3 (10.4)
I-495	I-270 West Spur to MD 190	Outer Loop	8 (3.5)	13 (2.9)	17 (5.7)	19 (6.2)
I-495	Clara Barton Pkwy to Cabin John Pkwy	Inner Loop	9 (3.5)	8 (3.2)	16 (5.8)	17 (6.3)
I-270 Spur	@ Democracy Blvd	Southbound	10 (3.4)	12 (2.9)	1 (14.5)	1 (15.0)
I-495	@ MD 190	Outer Loop	11 (3.4)	16 (2.8)	30 (4.9)	40 (5.0)
I-270	MD 124 to N of MD 124 CD Lanes	Northbound	12 (3.3)	10 (3.0)	24 (5.1)	43 (4.8)
I-495	MD 190 to I-270 West Spur	Inner Loop	13 (3.2)	9 (3.0)	37 (4.4)	37 (5.0)
I-495	MD 355 to MD 185	Inner Loop	14 (3.0)	25 (2.5)	25 (5.1)	32 (5.2)
MD 100	@ Coca Cola Dr	Westbound	15 (3.0)	18 (2.7)	36 (4.5)	63 (4.2)

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. Table I-13 identifies the top 4 locations for PTI values that do not correlate closely with TTI values:

Table I-13

HIGHEST PTI LOCATIONS WITH LOWER TTI VALUES				
2016 AM Peak Hour				
Location	PTI Value	Statewide Rank	TTI Value	Statewide Rank
I-695 @ US 1 Outer Loop	6.25	11	1.92	59
I-95/I-495 - MD 5 to MD 414 Inner Loop	4.47	26	1.68	84
I-95/I-495 @ MD 414 Inner Loop	4.43	27	1.47	115
MD 295 - MD 202 to US 50 Southbound	4.36	29	1.95	54

2016 PM Peak Hour				
Location	PTI Value	Statewide Rank	TTI Value	Statewide Rank
I-495 - MD 187 to I-270 Inner Loop	7.80	3	1.84	94
US 50 @ MD 450 Eastbound	6.80	9	1.42	228
I-495 - I-270 to MD 187 Outer Loop	6.15	12	1.98	83
I-495 @ MD 187 Outer Loop	6.08	13	1.32	276

C. Truck Trends

I-95 @ NB Welcome Center

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I-95 @ I-495

Truck Trends

A key indicator of economic growth is the movement of freight and goods. This ranges from transporting raw materials from Western Maryland to developing products in Cecil County to distribution centers in the Hagerstown area. It is estimated that freight originating and terminating in Maryland amounts to approximately 275 million tons valued at $410 billion annually. Over 1 million jobs in Maryland are associated with freight movement.

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, carrying items such as food products, machinery, and consumer products. Approximately 78% of the freight tonnage in Maryland moves on highways. In order to support the economic vitality, MDOT SHA processed more than 136,000 oversize/overweight truckload permits last year for the movement of goods in or around Maryland.

In addition to goods movement that originates or is destined to Maryland, the State also acts as a "through" State with I-95 and I-81 as the primary routes. Many sections of interstate roadways in Maryland exceed 25,000 trucks per day as depicted in Table I-14A. Table I-14B highlights Interstate and US Routes exceeding 30% trucks.

Table I-14A

HIGHEST TRUCK VOLUME		
	Location	Average Daily Truck Volume
1	I-95 South of MD 175	28,400
2	I-95 North of MD 24	27,200
3	I-95 North of MD 100	27,200
4	I-95/I-495 South of US 50	26,700
5	I-95 South of MD 24	26,500

Table I-14B

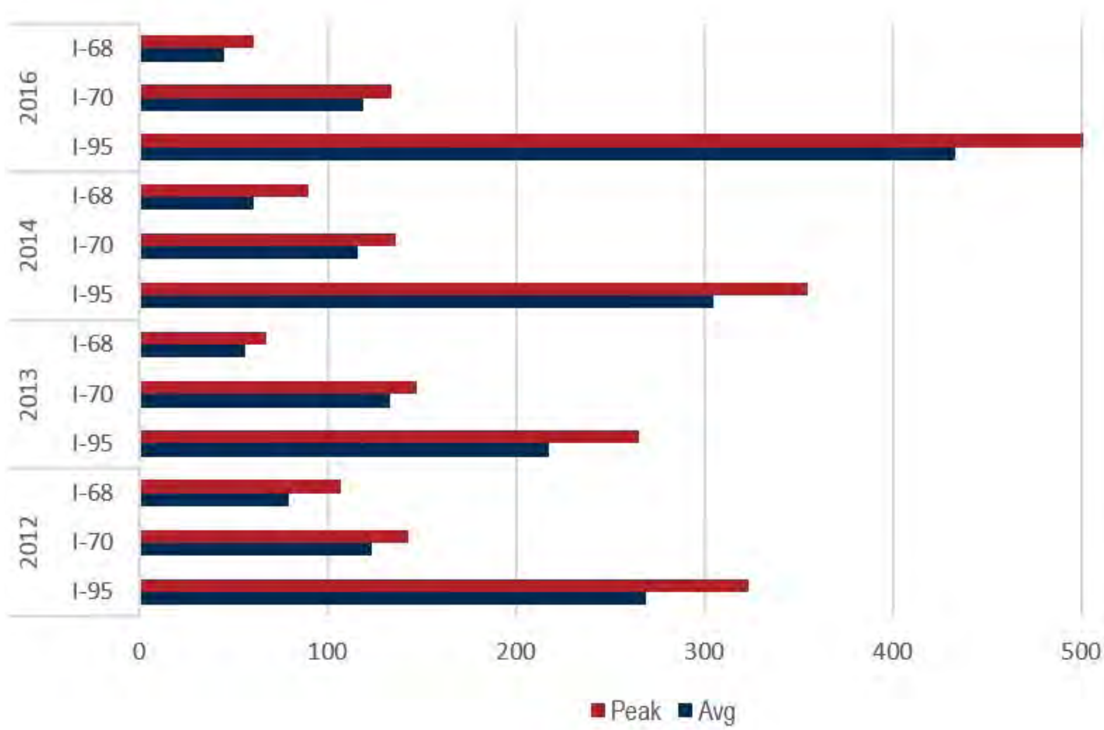
HIGHEST TRUCK PERCENTAGE LOCATIONS		
	Location	Truck %
1	US 301 South of Kent County Line	32%
2	I-81 South of PA Line	32%
3	I-81 South of US 11	32%
4	I-70 South of PA Line	31%
5	I-68 West of US 219	30%

Freight and goods movement depends on a system that provides mobility and reliability. 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 high volume corridors. Numerous warehouse developments have occurred along the I-95 corridor including distribution giant Amazon opening a one million square foot distribution center in southeast Baltimore in 2015. In addition, growth in intermodal traffic is further expected to increase following completion of the Panama Canal expansion project in June 2016.

An important consideration for truck operations is to create a safe environment for truck drivers when they need to rest. Jason's Law was established to address commercial motor vehicle 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 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 on the major routes along the Maryland Truck Route System to identify locations where overnight truck parking is occurring. The results identified more than 800 trucks parked along the system not including private lots during the peak time period. This represents an increase of approximately 17% from 2014. The highest number of trucks were parked along I-95 with an average of 400 trucks parked at night. 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. Truck parking along the highest interstate routes is shown in Figure I-19.

Figure I-19

TOP 3 ROUTES FOR OVERNIGHT TRUCK PARKING



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

Over 400 trucks per night are parked along I-95.

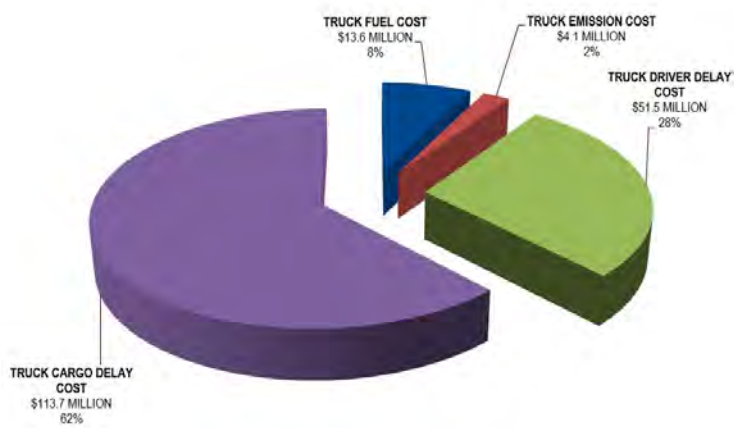
Congestion cost truckers $183 million in 2016 along the freeway/expressway system.

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 $183 million. This is shown in Figure I-20.

Figure I-20

2016 FREIGHT CONGESTION COSTS ON MARYLAND'S FREEWAY/EXPRESSWAY SYSTEM

$183 million



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. Nationally, four of the top 100 locations at the junction of two interstates were in Maryland including:

- I-95 @ I-495
- I-95 @ I-695 (South)
- I-495 @ I-270
- I-95 @ I-395

ATRI develops a report on the "Cost of Congestion to the Trucking Industry." 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.

The impact of congestion on trucks increases the cost of the products we buy due to increased fuel consumption and more time spent on the roadways. Among the locations where truckers experience the greatest amount of delay not at the junction of an arterial and an interstate highways include:

- I-495 Outer Loop @ MD 97
- I-495 Inner Loop @ Clara Barton Parkway
- I-695 Outer Loop @ Edmondson Avenue
- I-695 Inner Loop @ MD 41

Companies relay 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 considering the maximum amount of time a trucker can drive and the reliability of the roadway system.

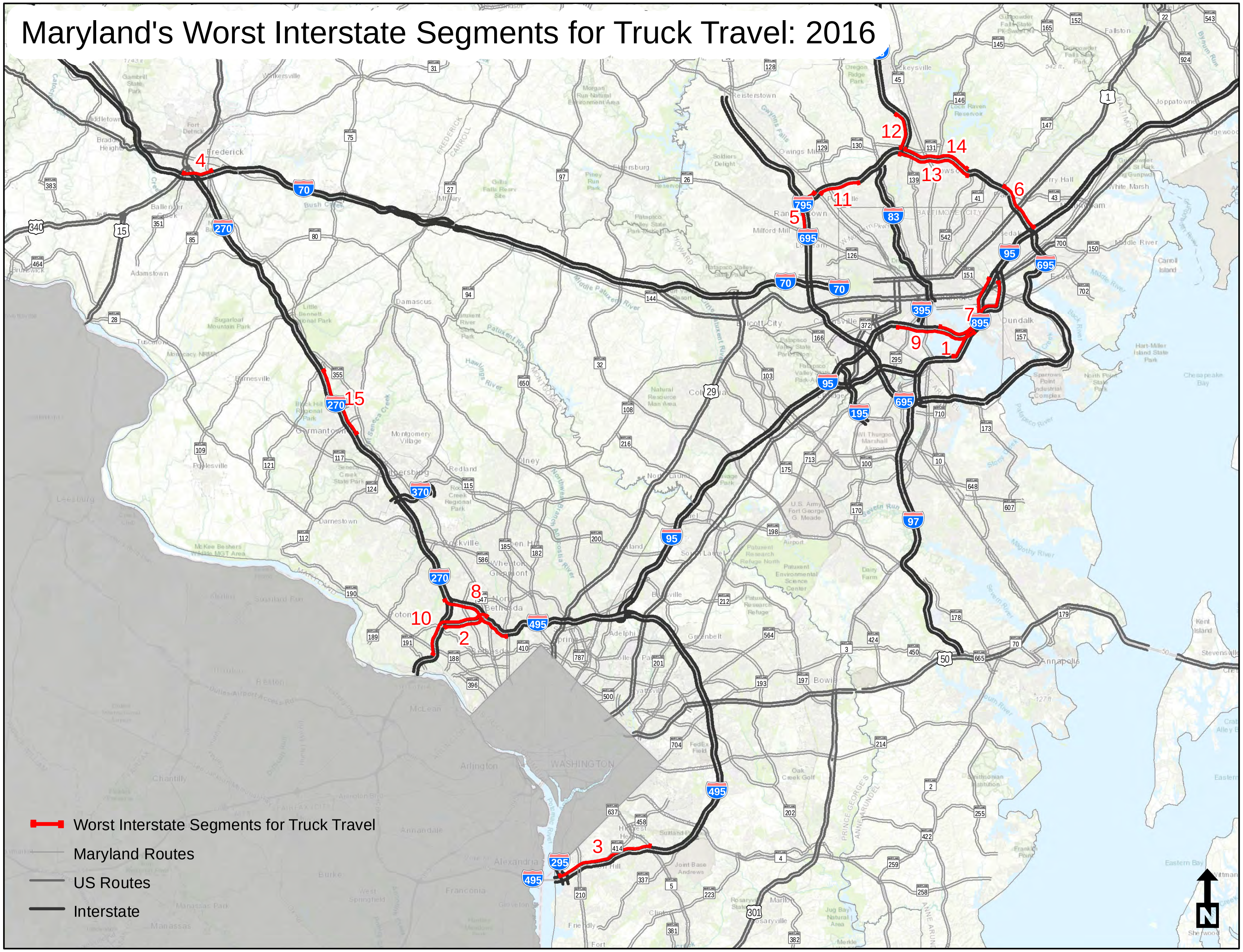
Analysis was performed along the Interstate system in Maryland to determine the reliability for truckers. The Truck Travel Time Reliability Index (TTTR) represents the 95th percentile travel time divided by the 50th percentile travel time for each segment. The TTTR is calculated for five-time periods 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 locations are shown in Table I-15 and Figure I-21.

Table I-15

2016 TOP 15 WORST CORRIDORS FOR TRUCK TRAVEL

Rank	Road/Direction	Limits	TTTR Max Value	Mileage
1	I-895 Southbound	Moravia Road to Harbor Tunnel Toll Plaza	15.13	5.3
2	I-495 Inner Loop	I-270 - West Spur to MD 185	5.74	5.5
3	I-95/I-495 Inner Loop	MD 5 to I-295	5.38	5.7
4	I-70 Westbound	South Street to US 15/US 340	5.33	3.0
5	I-695 Outer Loop	MD 140 to MD 26	5.12	3.6
6	I-695 Outer Loop	I-95 to MD 147	5.02	4.3
7	I-95 Southbound	US 40 to Key Highway	4.97	6.2
8	I-270 East Spur Southbound	I-270 Split to I-495/MD 355	4.94	3.1
9	I-95 Northbound	Washington Boulevard to Fort McHenry Tunnel Toll Plaza	4.40	7.1
10	I-495 Outer Loop	MD 355 to Cabin John Parkway	4.12	6.0
11	I-695 Inner Loop	MD 140 to Greenspring Avenue	3.98	3.4
12	I-83 Southbound	Padonia Road to I-695	3.93	3.6
13	I-695 Inner Loop	I-83/MD 25 to MD 542	3.90	7.5
14	I-695 Outer Loop	Cromwell Bridge Road to I-83	3.85	4.5
15	I-270 Northbound	Middlebrook Road to MD 121	3.84	4.4

Figure I-21


Maryland's Worst Interstate Segments for Truck Travel: 2016
Worst Interstate Segments for Truck Travel
Maryland Routes
US Routes
Interstate
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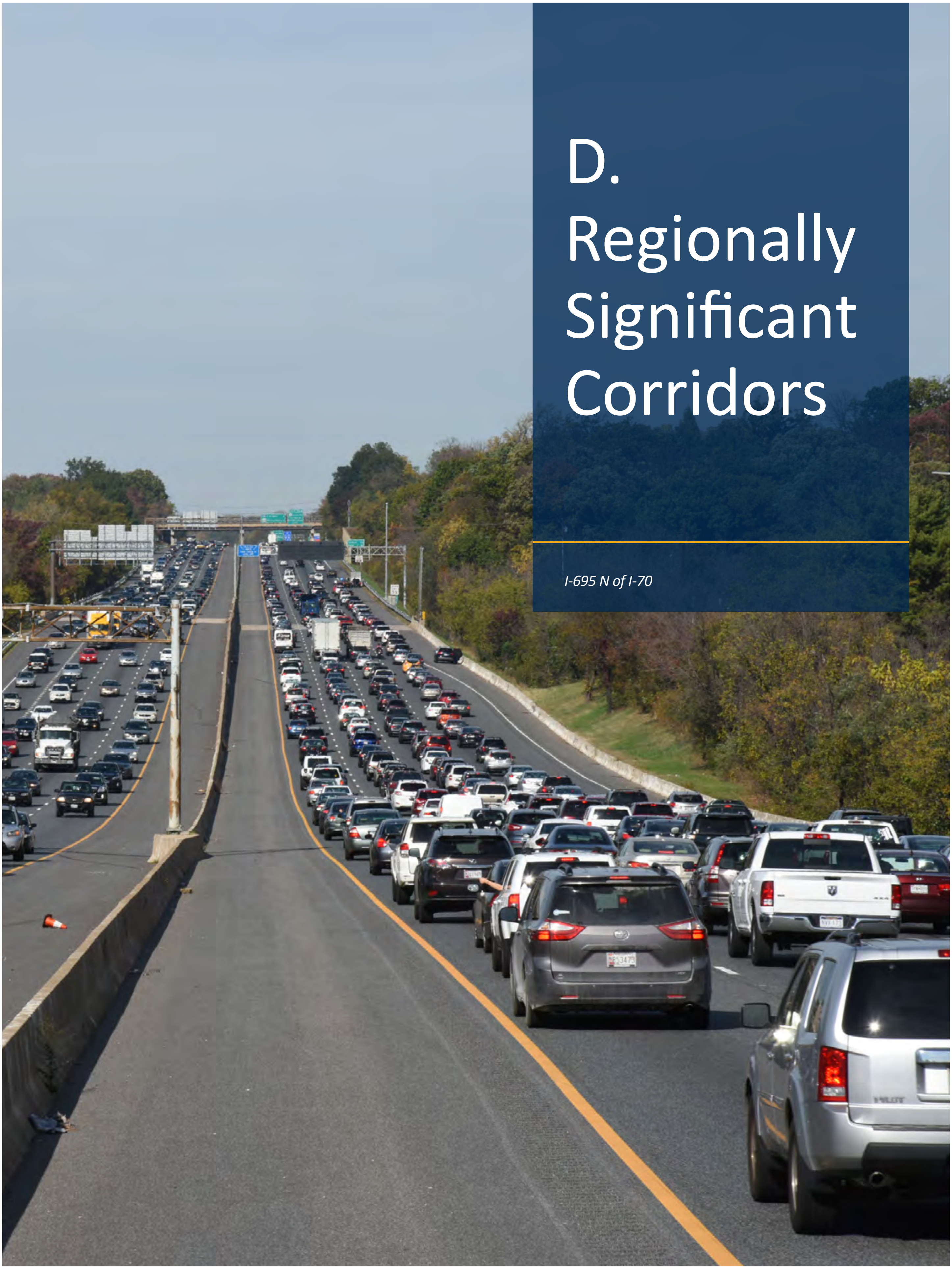

D. Regionally Significant Corridors

I-695 N of I-70

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Major Freeway/Expressway Corridor Summary

Roadways where access is limited to interchanges are termed controlled access facilities. Controlled access facilities which include freeways and expressways are the highest functional classification of roadways in the state. In most instances, they are high speed facilities that provide the maximum capacity/ mobility. 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 facilities evaluated include:

- I-70 (Pennsylvania Border to US 40 (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.

Additional in-depth information about the mobility performance of these corridors is included in Appendix A.

Arterial roadways provide a vital connection between the freeway/expressway system and the local roadways.

Table I-16

2016 CONTROLLED ACCESS FACILITY PERFORMANCE SUMMARY							
FREEWAY/EXPRESSWAY	NO. OF MILES	AVG TTI		AVG PTI		AVERAGE DAILY TRAFFIC	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	50,000	4
I-70 - US 40 (Frederick) to I-695	43	1.00	1.00	1.03	1.04	66,000	6
I-81	12	1.00	1.00	1.00	1.06	65,000	4
I-83	26	1.02	1.06	1.15	1.19	88,000	4-6
I-95 -I-495 to I-695	40	1.15	1.19	1.34	1.38	162,000	8
I-95 - I-695 to Del. State Line	45	1.00	1.00	1.02	1.05	104,000	6-12
I-97	17	1.07	1.10	1.27	1.32	118,000	4-6
I-270	41	1.22	1.20	1.40	1.34	172,000	4-12
I-495	42	1.27	1.56	1.52	1.99	202,000	6-8
I-695	35	1.24	1.37	1.50	1.65	157,000	6-8
I-795	8	1.01	1.04	1.11	1.17	83,000	4-6
I-895	15	1.06	1.04	1.18	1.17	59,000	4
US 50 - Washington DC Line to Chesapeake Bay Bridge	33	1.01	1.05	1.07	1.14	103,000	4-10
MD 32 - MD 108 to I-97	23	1.03	1.08	1.14	1.21	71,000	4
MD 100 - US 29 to MD 177	22	1.03	1.15	1.14	1.35	75,000	4-8
MD 295 - MD 201 to Waterview Ave	29	1.14	1.35	1.33	1.62	108,000	4-6

It should be noted that several segments of corridors shown in Table I-16 have much higher TTI and PTIs, as shown in the Peak Hour Statewide Congestion and Reliability Maps.

Arterial Facilities

These roadways normally have multi-lanes, traffic signals, and carry the next highest volumes of traffic in comparison to freeways/expressways.

An evaluation was performed to determine the major arterial corridors based on traffic volumes, regional significance, operations and availability of data. 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 198 - MD 197 to Russett Green
- 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 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.

Additional information related to various characteristics and performance measures of the above 34 major arterials are shown in Appendix A.

Table I-17

2016 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	50-65	0.0	0.5	5.6	3.7
MD 3 - US 50/301 to I-97	8.8	67-79	1.7	2.2	5.8	2.3
MD 4 - DC Line to Dower House Road	6.6	22-74	0.4	0.9	0.4	1.9
MD 5 - I-95 to DC Line	3.1	31-60	1.6	0.0	0.0	0.0
MD 5 - US 301 to MD 223	5.4	64-84	4.1	0.0	0.0	3.8
MD 24 - US 40 to US 1	7.9	22-69	0.0	0.0	2.7	1.8
MD 26 - MD 32 to Balt. City Line	14.1	9-46	0.5	0.0	1.7	4.3
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

Table I-17 (Continued)

2016 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

US 40 @ Rossville Boulevard

INTERSECTIONS

Mobility along arterial and collector roadways is impacted by waiting at traffic signals through multiple cycles. These intersections are considered to operate at level of service (LOS) "F". These locations 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 shows 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.

Table I-18

LOS "F" INTERSECTIONS

AM PEAK HOUR

Intersection	County	Volume/ Capacity
MD 5 at Brandywine Rd	PG	1.27
MD 210 at Livingston Rd/Palmer Rd	PG	1.22
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
US 29 at Rivers Edge Rd	HO	1.17
MD 637 at Suitland Pkwy	PG	1.17
MD 355 at Shady Grove Rd	MO	1.13
US 29 at Greencastle Rd	MO	1.13
MD 45 at Shawan Rd	BA	1.12
MD 175 at MD 170/Piney Orchard Pkwy	AA	1.09
MD 2 at Arnold Rd	AA	1.08
MD 27 at Skylark Rd	MO	1.08
MD 355 at Cedar La	MO	1.07
MD 97 at Ramp 6 from I-495 EB	MO	1.06
MD 185 at MD 410	MO	1.05
MD 28 at MD 97	MO	1.05
US 29 at Blackburn Rd	MO	1.04
MD 4 at MD 337/Presidential Pkwy	PG	1.04
MD 355 at E&W Gude Dr	MO	1.02
MD 5 at MD 373	PG	1.02
MD 187 at Ryland Dr	MO	1.01
MD 201 at MD 410	MO	1.01
MD 4 at MD 235	SM	1.01
MD 650 at Ramps 2 & 7 from I-495 WB	MO	1.00
MD 210 at MD 373/Livingston Rd	PG	1.00

Table I-19

LOS "F" INTERSECTIONS

PM PEAK HOUR

Intersection	County	Volume/ Capacity
MD 202 at Brightseat Rd/MD 202E	PG	1.32
MD 197 at Montpelier Dr/Brock Bridge Rd	PG	1.24
US 50 at MD 378/N. Division St	WO	1.21
MD 2 at MD 524 (Old Town Rd)/Cox Rd	CA	1.20
MD 637 at Suitland Pkwy	PG	1.15
MD 5 at MD 5BU/St. Charles Pkwy	CH	1.15
MD 210 at Livingston Rd/Palmer Rd	PG	1.14
MD 190 at MD 614	MO	1.13
MD 97 at Ramp 6 from I-495 EB	MO	1.12
MD 586 at Twinbrook Pkwy	MO	1.11
MD 458 at Swann Rd	PG	1.11
MD 355 at Cedar La	MO	1.10
MD 500 at MD 410/Adelphi Rd	PG	1.10
US 301 at MD 725/Marlboro Pike	PG	1.10
US 29 at Greencastle Rd	MO	1.09
MD 201 at MD 410	PG	1.09
MD 185 at MD 191/Bradley La	MO	1.09
MD 28 at Riffle Ford Rd/Seurat Dr	MO	1.08
MD 4 at MD 337/Presidential Pkwy	PG	1.07
MD 4 at MD 235	SM	1.07
MD 193 at Metzerott Rd/Paint Branch Dr	PG	1.07
MD 2 at Arnold Rd	AA	1.06
US 301 at Cedarville Rd/McKendree Rd	PG	1.06
US 40 at Rossville Blvd	BA	1.05

LOS "F" INTERSECTIONS

PM PEAK HOUR

Intersection	County	Volume/ Capacity
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
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
US 40AL at MD 36 (Mt. Savage Rd)	AL	1.03
MD 210 at Livingston Rd/ Kerby Hill Rd	PG	1.02
MD 45 at MD 131/Seminary Ave	BA	1.02
MD 175 at Morgan Rd/ Town Center Blvd	AA	1.02
US 301 at MD 5BU/MD 228	CH	1.01
MD 97 at MD 650	MO	1.01
US 40 at Rolling Rd	BA	1.00
MD 355 at Tuckerman La (North Intersection)	MO	1.00
US 1 at Edgewood Rd	PG	1.00

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

Figure I-22

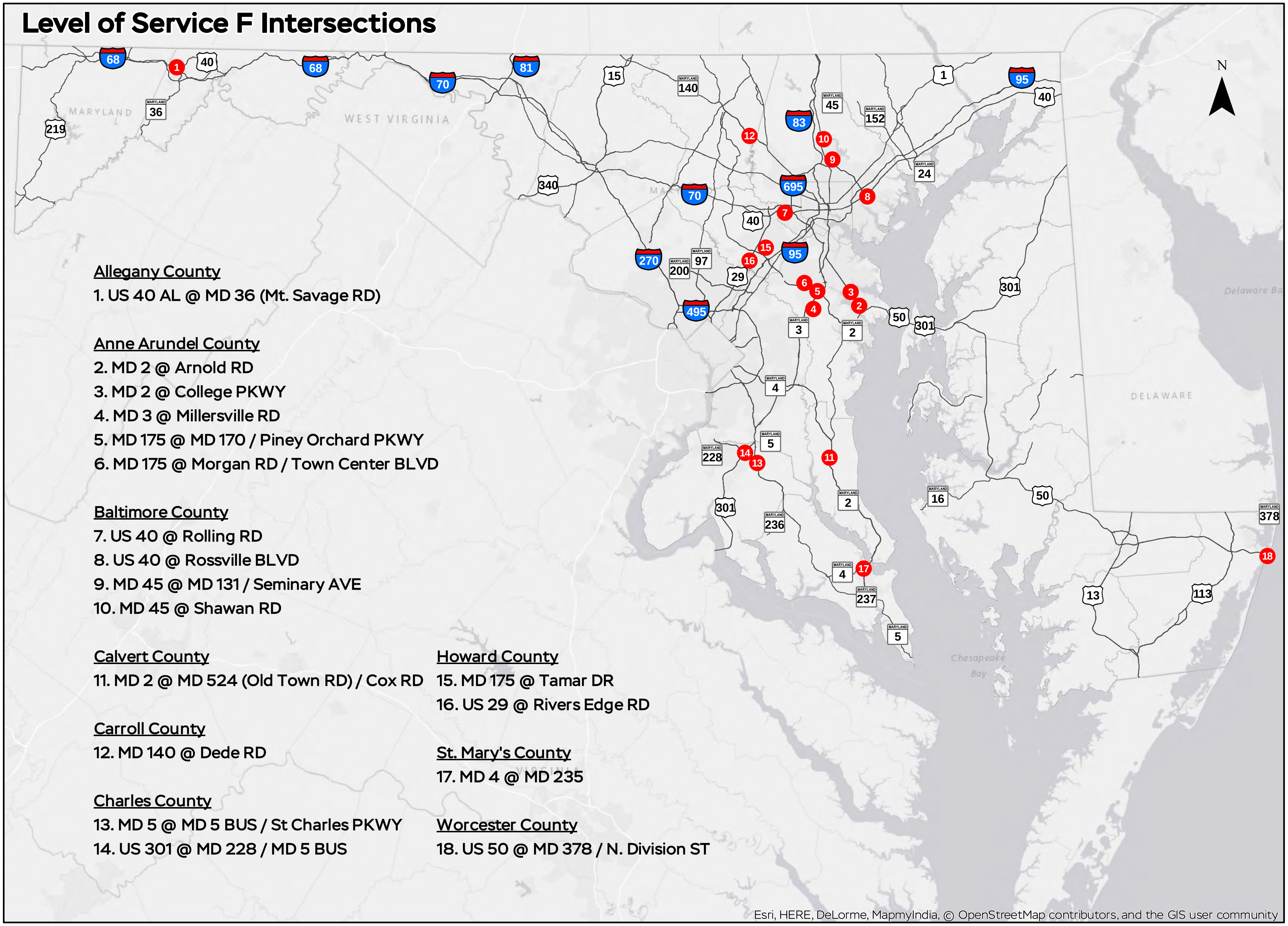
Level of Service F Intersections
Allegany County
1. US 40 AL @ MD 36 (Mt. Savage RD)
Anne Arundel County
2. MD 2 @ Arnold RD
3. MD 2 @ College PKWY
4. MD 3 @ Millersville RD
5. MD 175 @ MD 170 / Piney Orchard PKWY
6. MD 175 @ Morgan RD / Town Center BLVD
Baltimore County
7. US 40 @ Rolling RD
8. US 40 @ Rossville BLVD
9. MD 45 @ MD 131 / Seminary AVE
10. MD 45 @ Shawan RD
Calvert County
11. MD 2 @ MD 524 (Old Town RD) / Cox RD
Carroll County
12. MD 140 @ Dede RD
Charles County
13. MD 5 @ MD 5 BUS / St Charles PKWY
14. US 301 @ MD 228 / MD 5 BUS
Howard County
15. MD 175 @ Tamar DR
16. US 29 @ Rivers Edge RD
St. Mary's County
17. MD 4 @ MD 235
Worcester County
18. US 50 @ MD 378 / N. Division ST
MARYLAND
WEST VIRGINIA
DELAWARE
Chesapeake Bay
N
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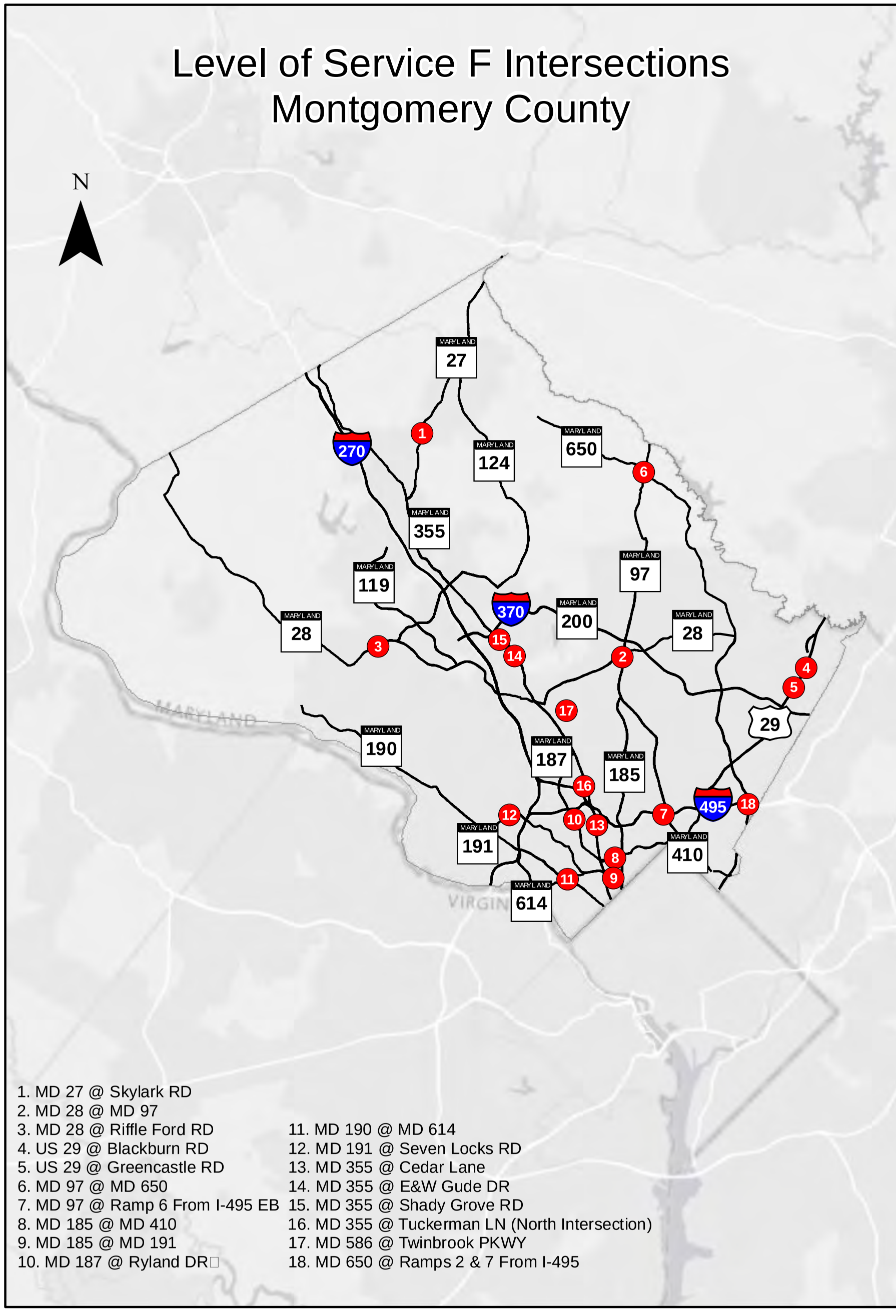
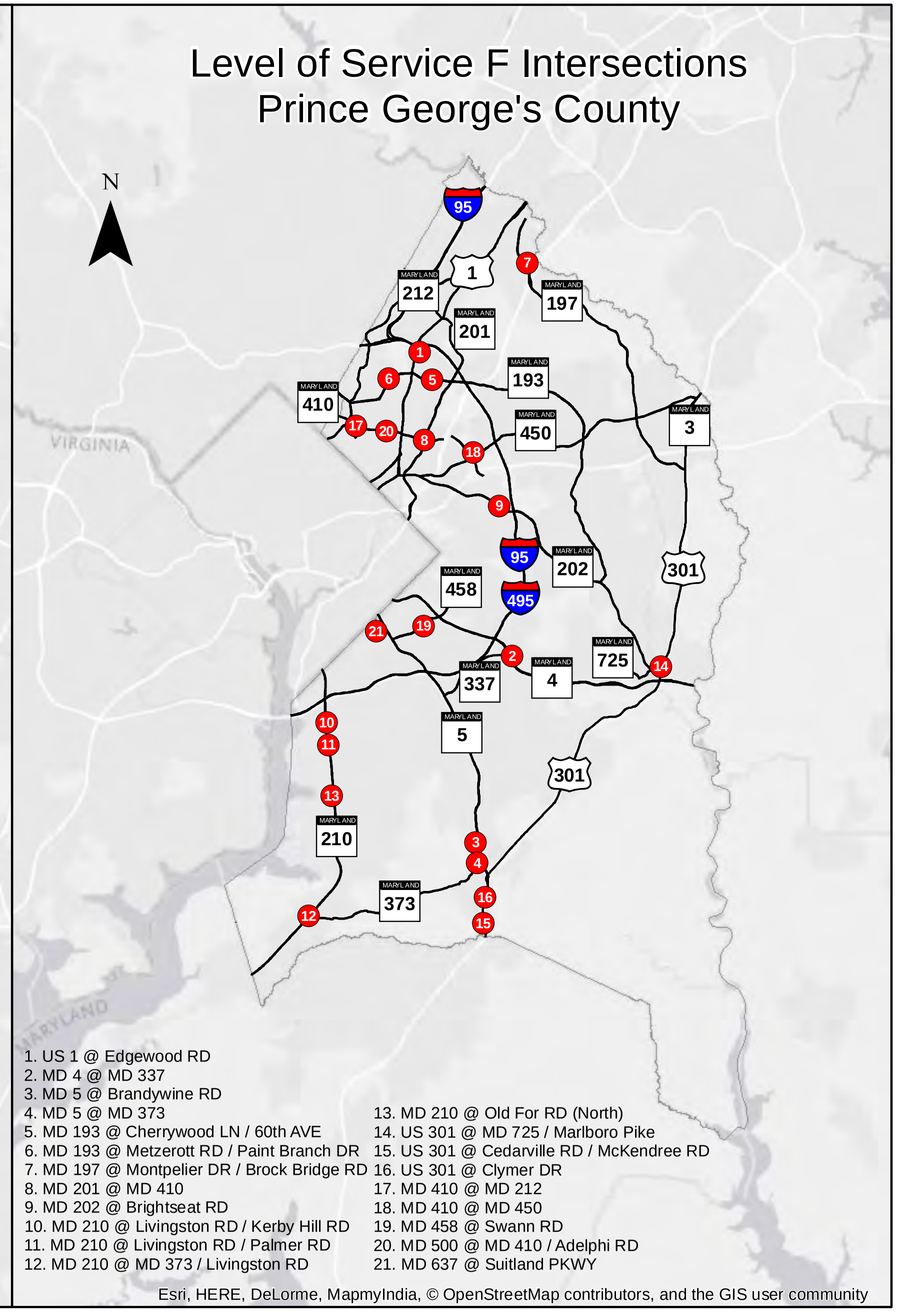
Figure I-23


Level of Service F Intersections
Montgomery County
N
1. MD 27 @ Skylark RD
2. MD 28 @ MD 97
3. MD 28 @ Riffle Ford RD
4. US 29 @ Blackburn RD
5. US 29 @ Greencastle RD
6. MD 97 @ MD 650
7. MD 97 @ Ramp 6 From I-495 EB
8. MD 185 @ MD 410
9. MD 185 @ MD 191
10. MD 187 @ Ryland DR
11. MD 190 @ MD 614
12. MD 191 @ Seven Locks RD
13. MD 355 @ Cedar Lane
14. MD 355 @ E&W Gude DR
15. MD 355 @ Shady Grove RD
16. MD 355 @ Tuckerman LN (North Intersection)
17. MD 586 @ Twinbrook PKWY
18. MD 650 @ Ramps 2 & 7 From I-495


Level of Service F Intersections
Prince George's County
N
1. US 1 @ Edgewood RD
2. MD 4 @ MD 337
3. MD 5 @ Brandywine RD
4. MD 5 @ MD 373
5. MD 193 @ Cherrywood LN / 60th AVE
6. MD 193 @ Metzerott RD / Paint Branch DR
7. MD 197 @ Montpelier DR / Brock Bridge RD
8. MD 201 @ MD 410
9. MD 202 @ Brightseat RD
10. MD 210 @ Livingston RD / Kerby Hill RD
11. MD 210 @ Livingston RD / Palmer RD
12. MD 210 @ MD 373 / Livingston RD
13. MD 210 @ Old For RD (North)
14. US 301 @ MD 725 / Marlboro Pike
15. US 301 @ Cedarville RD / McKendree RD
16. US 301 @ Clymer DR
17. MD 410 @ MD 212
18. MD 410 @ MD 450
19. MD 458 @ Swann RD
20. MD 500 @ MD 410 / Adelphi RD
21. MD 637 @ Suitland PKWY
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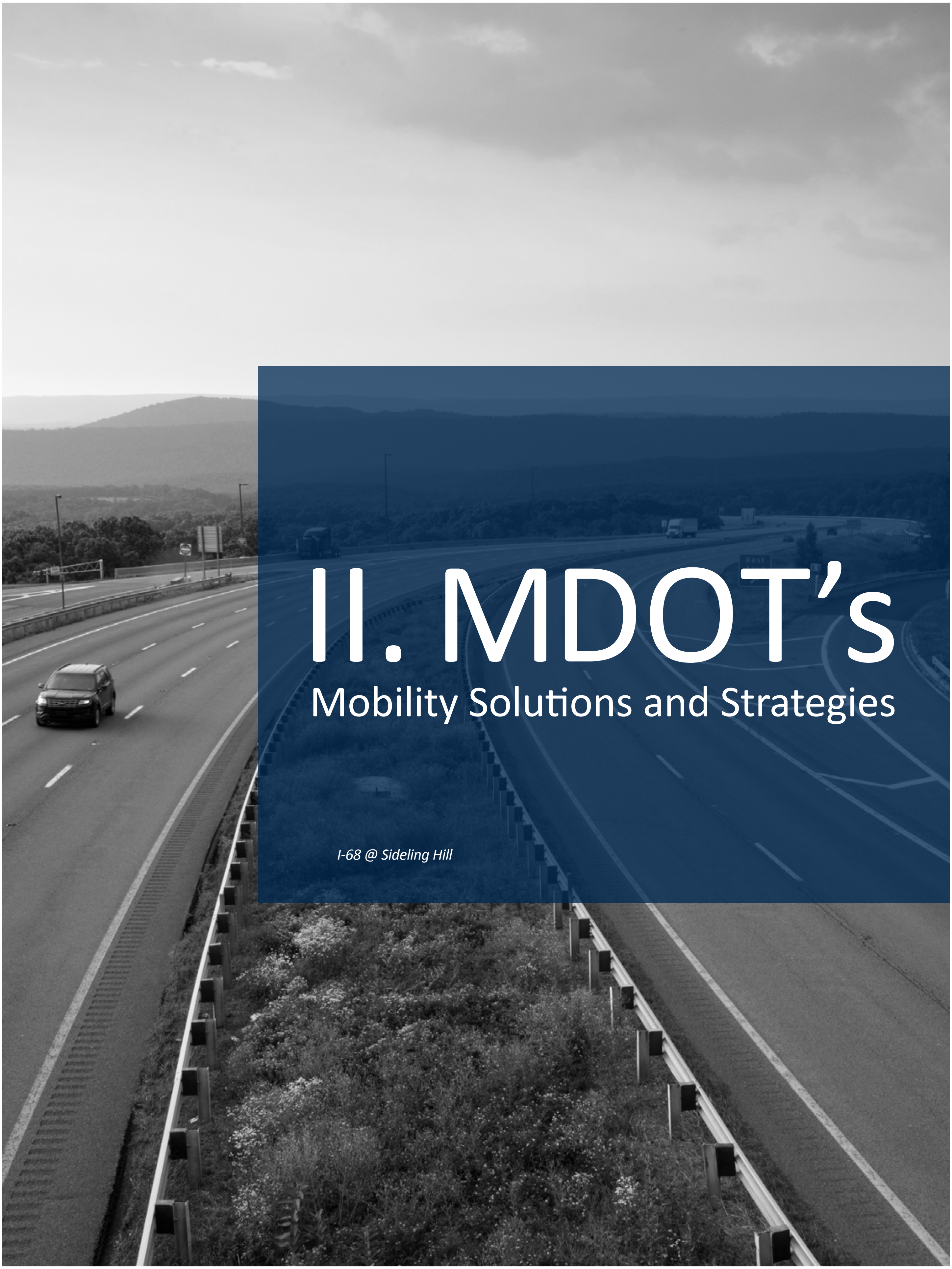

II. MDOT's
Mobility Solutions and Strategies

I-68 @ Sideling Hill

A. Capital Projects

MD 5 North of I-95/495

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I-695 @ MD 144

Capital Projects

The MDOT SHA has established the Consolidated Transportation Program which identifies the projected six-year outlay of funds to address system upgrades and maintenance. There are many challenges involved in developing projects including funding, right-of-way and utility impacts, environmental constraints, time to complete the Federal requirements, and permitting. With increasing volumes and congestion, 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/construct congestion mitigation solutions from a practical design standpoint.

There are a wide range of projects developed by MDOT SHA. These projects and programs identify both short and long-term solutions to address transportation issues. In addition to 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. Transportation System Management and Operations (TSM&O) incorporate methods to maximize operations such as the I-270 Innovative Congestion Management Progressive design-build project which maximizes vehicle and person throughput using methods such as ramp metering and hard shoulder running.

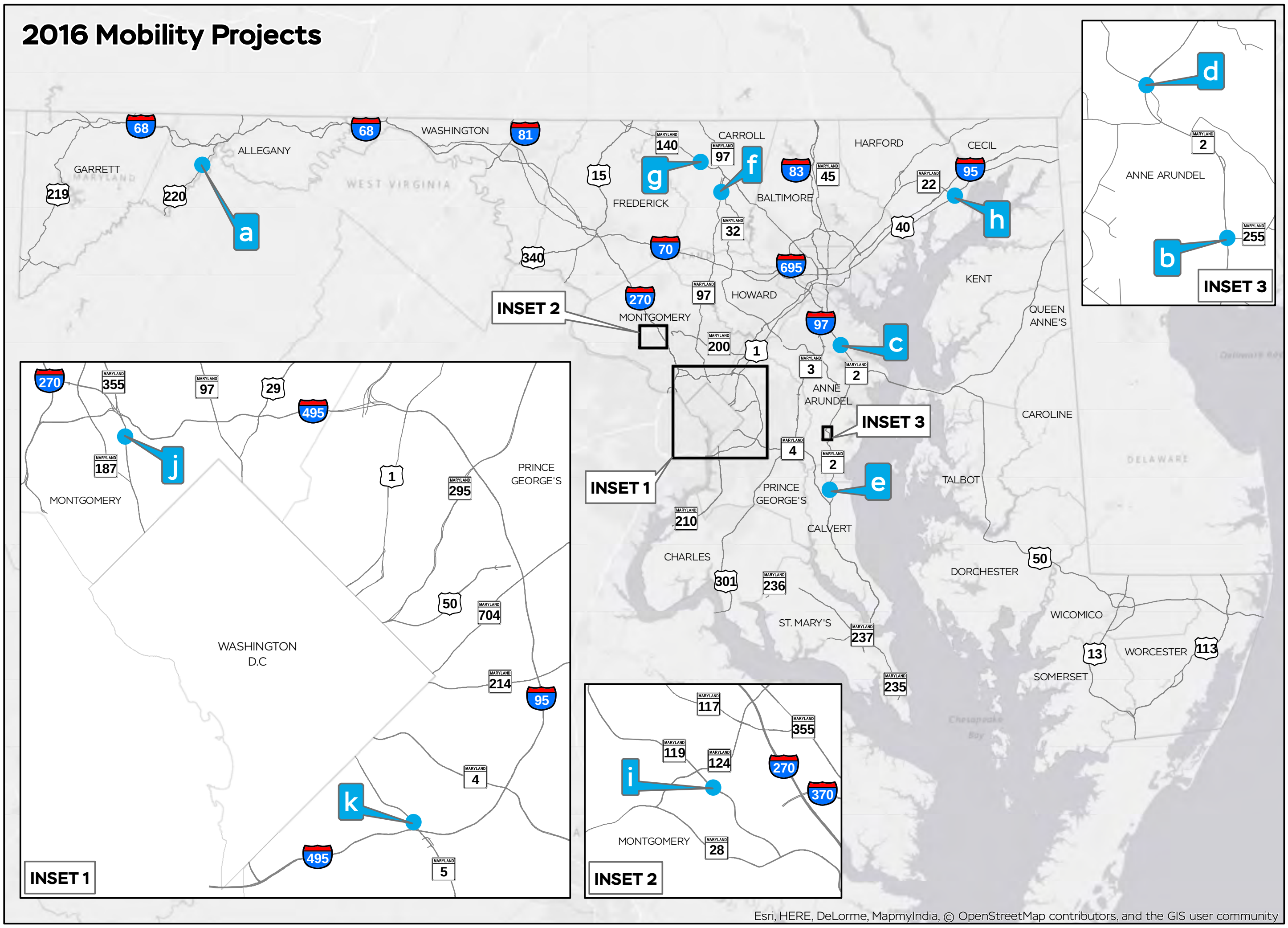
In 2016, to address mobility issues throughout the State, eleven mobility improvement projects were opened to traffic. These projects provide for congestion relief, improve safety, and enhance traffic operations. All projects are reviewed from a practical design standpoint to insure the proposed project is addressing just the defined purpose and need.

1. MOBILITY IMPROVEMENT PROJECTS

There were eleven mobility improvement projects completed in 2016. The location of these projects is shown in Figure II-1.

2016 mobility projects provide $50.1 million in annual user savings in the opening year.

Figure II-1



MOBILITY PROJECT LOCATIONS:

a. US 220 @ Louise Dr.

b. MD 2 @ MD 255

c. MD 2 @ Earleigh Heights Rd./Magothy Bridge Rd.

d. MD 2 @ Harwood Dr.

e. MD 2 @ Mt. Harmony Rd.

f. MD 32 @ MD 97

g. MD 140 @ Pleasant Valley Rd. South

h. MD 22 @ Old Post Rd.

i. MD 119 @ Orchard Ridge Dr./Kentlands Blvd.

j. MD 355 from Center Dr. to W. Cedar Ln.

k. MD 5 from Auth Way to I-95/I-495

The following describes in detail the improvement at each location.

US 220 @ Louise Drive (Allegany County)

US 220 is a two-lane roadway south of Cresaptown. Motorists northbound on US 220 were forced to stop in the through lane to make a left turn into Louise Drive which provides access to numerous residential dwelling units. This project consisted of providing a left turn lane to Louise Drive from US 220 northbound.

MD 2 @ MD 255 (Anne Arundel County)

MD 2 at MD 255 is a T-intersection located just north of Lothian in southern Anne Arundel County. Various improvements were constructed at this location in 2016 including extending the right turn lane from MD 2 northbound, constructing an acceleration lane from MD 255 to MD 2 northbound and modifying MD 2 southbound to provide for a left turn lane instead of a bypass lane. These improvements assisted in reducing delay to motorists especially from MD 255 and along MD 2 southbound.

MD 2 @ Earleigh Heights Road/Magothy Bridge Road (Anne Arundel County)

MD 2 is a four-lane divided north-south roadway. It intersects with Earleigh Heights Road/Magothy Bridge Road in the Pasadena area. Earleigh Heights Road is to the west and Magothy Bridge Road is on the east leg. Left and right turn lanes are provided along MD 2. Earleigh Heights Road has a right turn lane, a through lane and a left turn lane. Magothy Bridge Road has four lanes approaching the intersection including a double left, through and right. This project consisted of providing a third through lane on MD 2 northbound and southbound. The right turn lanes along MD 2 were channelized.

MD 2 @ Harwood Drive (Anne Arundel County)

Another location that improvements were constructed in southern Anne Arundel County was at the intersection of MD 2 and Harwood Drive. MD 2 is a two-lane roadway with Harwood Drive teeing in on the east leg. Harwood Drive is two lanes. This meant that along MD 2 left turning motorists would queue in the through lane forcing through motorists southbound to stop quickly. This project constructed a left turn lane on MD 2 southbound and the right turn lane on MD 2 northbound was extended.

MD 2 @ Mount Harmony Road (Calvert County)

The intersection of MD 2 and Mount Harmony Road is located in Calvert County west of Chesapeake Beach. The eastbound and westbound Mount Harmony Road approaches consisted of a single lane. MD 2 northbound and southbound had one through lane and one right turn lane. This project provided a left turn lane on both MD 2 approaches and channelized the right turn lanes. Bike lanes were added with the improvement along MD 2.

MD 32 @ MD 97 (Carroll County)

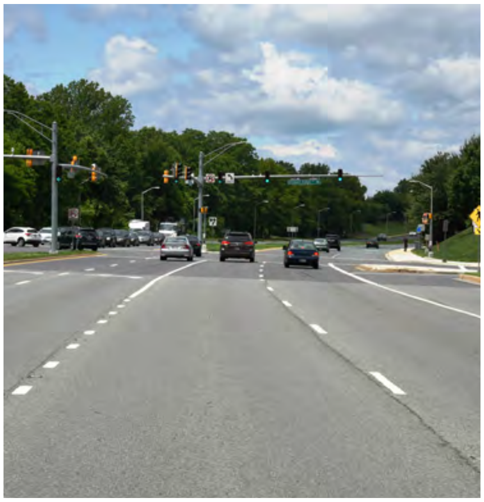
MD 32 intersects with MD 97 just south of Westminster. The MD 32 westbound approach consisted of two unmarked lanes entering the intersection while MD 32 eastbound provided for two lanes with the right most lane merging in immediately following the intersection. MD 97 southbound was a three lane approach to the intersection (left, through, right) while northbound a left turn lane and a through/right lane were provided. Both MD 32 northbound and southbound were widened to provide for three lanes including a right turn lane, a left turn lane and a through lane. The right turn lanes were physically channelized on three approaches.

MD 140 @ Pleasant Valley Road South (Carroll County)

This project improved operations and safety at the MD 140/Pleasant Valley Road South intersection. The unsignalized intersection located between Westminster and Taneytown provided two lanes on each of the MD 140 approaches while single lane approaches occurred on both legs of Pleasant Valley Road South. A third lane was added to provide a separate through, left and right turn lane along both approaches to MD 140 at the intersection. The right turn lanes on MD 140 were extended and bike lanes were added.

MD 22 @ Old Post Road (Harford County)

A major entrance to the Aberdeen Proving Grounds occurs on MD 22 just to the east of Old Post Road. Due to the amount of volume entering the Base in the morning and leaving the Base in the evening, this caused congestion at the intersection. Two through lanes plus a left and a right turn lane were provided along MD 22. Old Post Road southbound has a left, through and a right lane while a two-lane approach occurs on Old Post Road northbound. This project consisted of providing an additional through lane on MD 22 eastbound and westbound and a double left turn from MD 22 eastbound to Old Post Road. This project was directly related to the BRAC (Base Realignment and Closure) Act which increased the number of jobs at Aberdeen Proving Grounds.



MD 119 @ Orchard Ridge Drive/Kentlands Boulevard (Montgomery County)

The MD 119/Orchard Ridge Drive/Kentlands Boulevard intersection is in the Gaithersburg area of Montgomery County. Left turning motorists from Orchard Ridge Drive to MD 119 southbound were at times unable to access the left turn lane or would block through motorists on Orchard Ridge Drive. In order to alleviate this congestion, the project extended the left turn lane to improve the storage for this movement.

MD 355 - Center Drive to West Cedar Lane (Montgomery County)

Another project completed to support the BRAC Act employment growth at the Walter Reed National Medical Center was along MD 355 in the Bethesda area of Montgomery County. At the West Cedar Lane intersection with MD 355 several modifications occurred. This included constructing an additional lane on both West Cedar Lane approaches and eliminating the split phasing of the signal. Along MD 355 northbound a separate right turn lane was added. On MD 355 southbound a fourth through lane is provided through the intersection to Wilson Drive. On MD 355 northbound a left turn lane was provided to the gate entrance for National Institute for Health and the north exit from the gate at Walter Reed National Medical Center was modified.

MD 5 - Auth Way to I-95/I-495 (Prince George's County)

The Branch Avenue Metro Station is located inside the Capital Beltway (I-95/I-495) just off of MD 5. The majority of motorists accessing the Metro Station are destined to MD 5 to the south. There was no direct access to MD 5 from the Metro parking lots with motorists having to use Auth Road and Capitol Gateway Drive from one of the cross streets. In addition, operations on MD 5 were impacted by the proximity of the MD 5/Auth Road signal to the I-95/I-495 ramps. This project provided for a new roadway from the Metro Station to MD 5 bridging over MD 5 northbound. Direct access ramps were provided to and from MD 5 southbound. A pedestrian bridge was constructed across the MD 5 southbound lanes. The existing intersection at MD 5/Auth Road was converted into a right-in/right-out with the traffic signal being eliminated.

a. Mobility Improvement Project Benefits

The eleven 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 eleven projects are shown in Table II-1. Further information is included in Appendix C.

2016 Mobility Projects provided 610,000 hours of delay reduction and 330,000 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)
US 220 @ Louise Drive	AL	6	17
MD 2 @ MD 255	AA	2	18
MD 2 @ Earleigh Heights Road/ Magothy Bridge Road	AA	254	7,891
MD 2 @ Harwood Drive	AA	6	26
MD 2 @ Mt. Harmony Road	AA	105	274
MD 32 @ MD 97	CL	560	3,005
MD 140 @ Pleasant Valley Road South	CL	60	75
MD 22 @ Old Post Road	HA	550	6,047
MD 119 @ Orchard Ridge Drive/ Kentlands Boulevard	MO	0	52
MD 355 - Center Drive to West Cedar Lane	MO	51	10,848
MD 5 - Auth Way to I-95/I-495	PG	460	21,835
Total		**2,054**	**50,088**

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 7 @ Cowenton Avenue

2. DEVELOPER PROJECTS

Mobility improvements are completed by private developers in addition to State/county/local agencies. These are constructed to mitigate the impacts caused by the additional volume of traffic that is generated from these new residential, commercial, office and warehouse developments. Without these improvements, operational issues can result including failing intersections or traffic from turn lanes queuing into through lanes. In order to mitigate these additional traffic volumes, MDOT SHA works with developers to determine the improvements required to offset the traffic the development will generate. The improvements funded by developers range from acceleration and deceleration lanes, to new traffic signals, to minor/major intersection enhancements, to interchange modifications. Developer related capacity improvement projects completed in 2016 include:

- MD 7 @ Cowenton Ave (Baltimore County)
- MD 2 @ Arundel Plaza/MVA Entrance (Anne Arundel County)
- MD 355 @ Urbana Parkway (Frederick County)

The final completed improvements provide a benefit to both motorists accessing the development and drivers that pass through the intersection on a daily basis. These projects improve mobility by decreasing travel times and reducing delays along the corridor.

3. FREIGHT PROJECTS

Improvements in the transportation system for moving freight can be broken down into two types of projects. The first are roadway projects that enhance overall mobility which provide improvements for freight operators. The second includes the programs and projects directed specifically at improving trucking operations. These enhancements aim to keep truckers and other users of the network including autos/bicyclists/pedestrians safe. The challenge is to balance maximizing the mobility of truckers with providing safe facilities for all users.

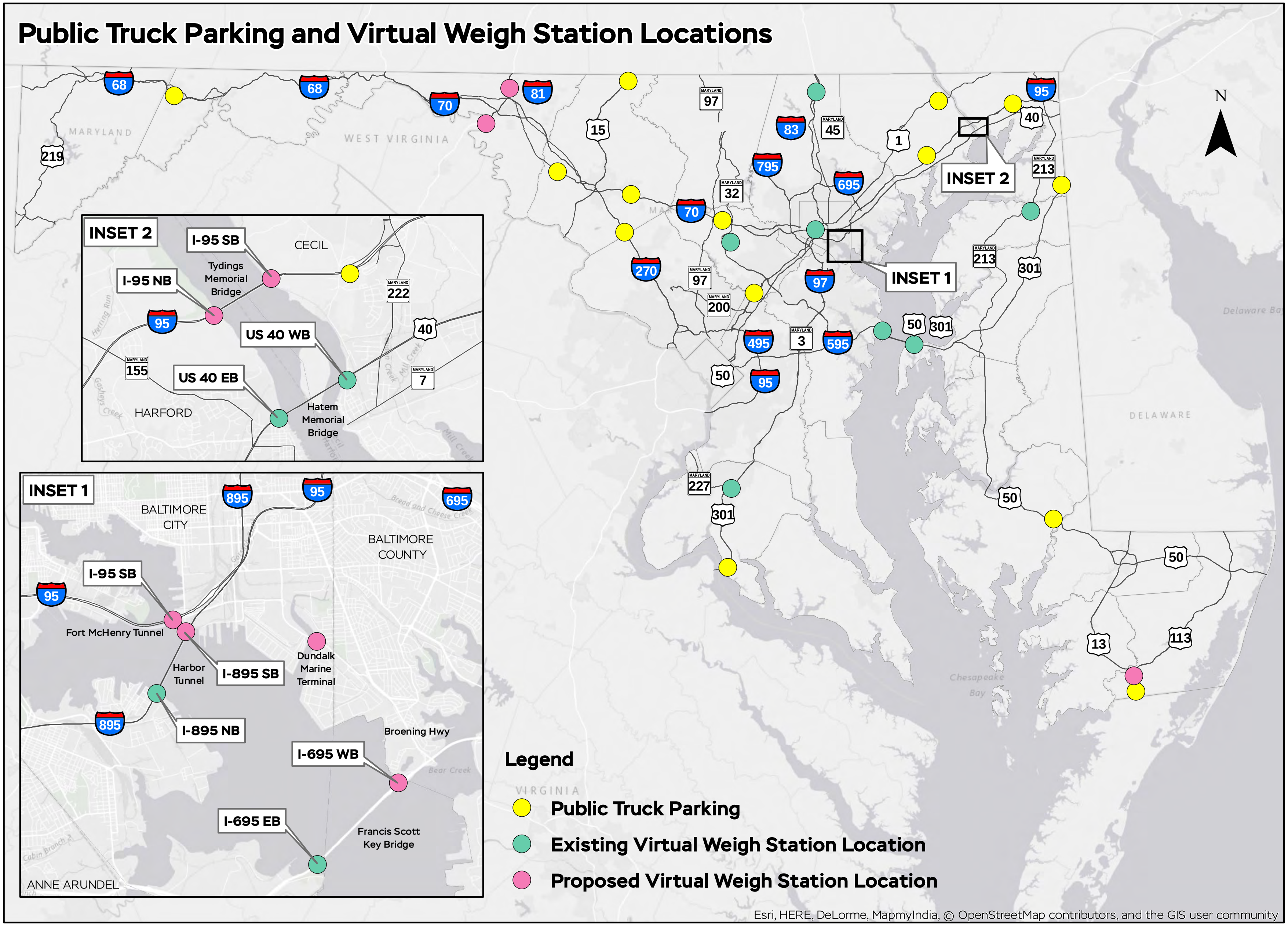
There are several programs established to move freight efficiently. One of the programs managed by MDOT SHAs' Motor Carrier Division is the Virtual Weigh Station (VWS) program. This program uses technology to protect the reliability of the pavement and keep trucks moving smoothly. Maryland's VWS promotes 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 high speeds. The VWS can record the speed, height, and weight of a commercial vehicle without requiring the vehicle to stop, which reduces delay time 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. Currently, there are eleven active VWS sites across the state. Six more sites are anticipated to be constructed over the next year with three additional sites planned by 2020. 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.

MDOT SHA's Maryland One permit system program involves processing applications more efficiently for large size 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. In May 2016, the new automated Maryland One permit system became operational. More than 80% of permit applications submitted with this system are 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 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 hazard. The expansion of truck parking was 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 Welcome Center at South Mountain in Frederick County. Public truck parking locations and the location of VMS are shown in Figure II-2.

Nine new virtual weigh stations are anticipated to be constructed by 2020.

Figure II-2



Public Truck Parking and Virtual Weigh Station Locations
MARYLAND
WEST VIRGINIA
DELAWARE
VIRGINIA
N
INSET 1
INSET 2
Legend
Public Truck Parking
Existing Virtual Weigh Station Location
Proposed Virtual Weigh Station Location
INSET 2
I-95 SB
I-95 NB
Tydings Memorial Bridge
CECIL
US 40 WB
US 40 EB
HARFORD
Hatem Memorial Bridge
INSET 1
BALTIMORE CITY
BALTIMORE COUNTY
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
ANNE ARUNDEL
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MD 272 Irishtown Road to Church Road

4. **RAILROAD CROSSING PROJECTS**

Railroad at-grade crossings can present a safety issue for all users. Each year approximately 8 of the 633 public at-grade crossings and 22 separate pedestrian crossings are updated to eliminate hazards. These improvements can include a range of possible solutions such as new flashing light signals (with or without gates replacement), updating of components at existing active warning devices, and improved crossing surfaces on State/county and municipal roads. Locations that were modified in 2016 included MD 214, MD 978A, Hahn Road, Reidtown Road, Ashton Road, Trovinger Mill Road, Ironshire Station Road and Tindley Road.

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. In February 2016, MDOT announced $14 million in reimbursable grant funding for walking, biking and recreational trail projects. MDOT has allocated $100 million to upgrade these facilities since the start of the various programs.

Sections of sidewalk where gaps occur or sidewalks that are in poor shape are major candidates for sidewalk improvement projects. There were 9 miles of new sidewalk constructed in 2016 including:

- MD 267 - Market Street to MD 7C (Cecil County)
- MD 272 - Irishtown Road to Church Street (Cecil County)
- MD 765 - Calvert Beach Road to Woods Road (Charles County)

Bike projects could include on-street bike lanes or off street facilities to encourage safe bicycle use. MDOT SHA projects in 2016 incorporated upgrades of more than $2 million for bicycle retrofit programs. This included 88.3 miles of marked bike lanes and 5.6 miles of marked shared use lanes. Among the locations of new bicycle facilities were:

- MD 4 - MD 235 to Patuxent Boulevard (St. Mary's County)
- US 1 - US 1 Alt to Baltimore City Line (Baltimore County)
- MD 182 - Poplar Run Drive to MD 200 (Montgomery County)

6. PAST PROJECT BENEFITS

The completion of construction projects along Maryland's freeway/expressway system in the past five years continues to provide operational benefits to motorists using those facilities. Three 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)

Several other projects on the freeway/expressway system have been completed but some did not provide capacity improvement to the mainline (eg. I-695 at MD 144) or have on-going construction that is impacting operations in the area where the first project was completed (eg. I-695 at Milford Mill Rd construction is influencing the operations at the I-695/ MD 26 interchange).

A comparison was made between traffic operations before the projects were constructed and 2016 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 2016 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 2016 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	2016 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	1.03	+28
MD 295 PM NB I-695 to W. Nursery Rd	AA	0.5	1.86	1.02	+45
MD 295 PM NB @ W. Nursery Rd Interchange	AA	0.5	2.24	1.08	+52
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	1.01	+23

The MD 295 widening and the I-95 express toll lanes had a major impact on travel time throughout the corridor. Average travel times were reduced from 20% to over 50% on a segment.

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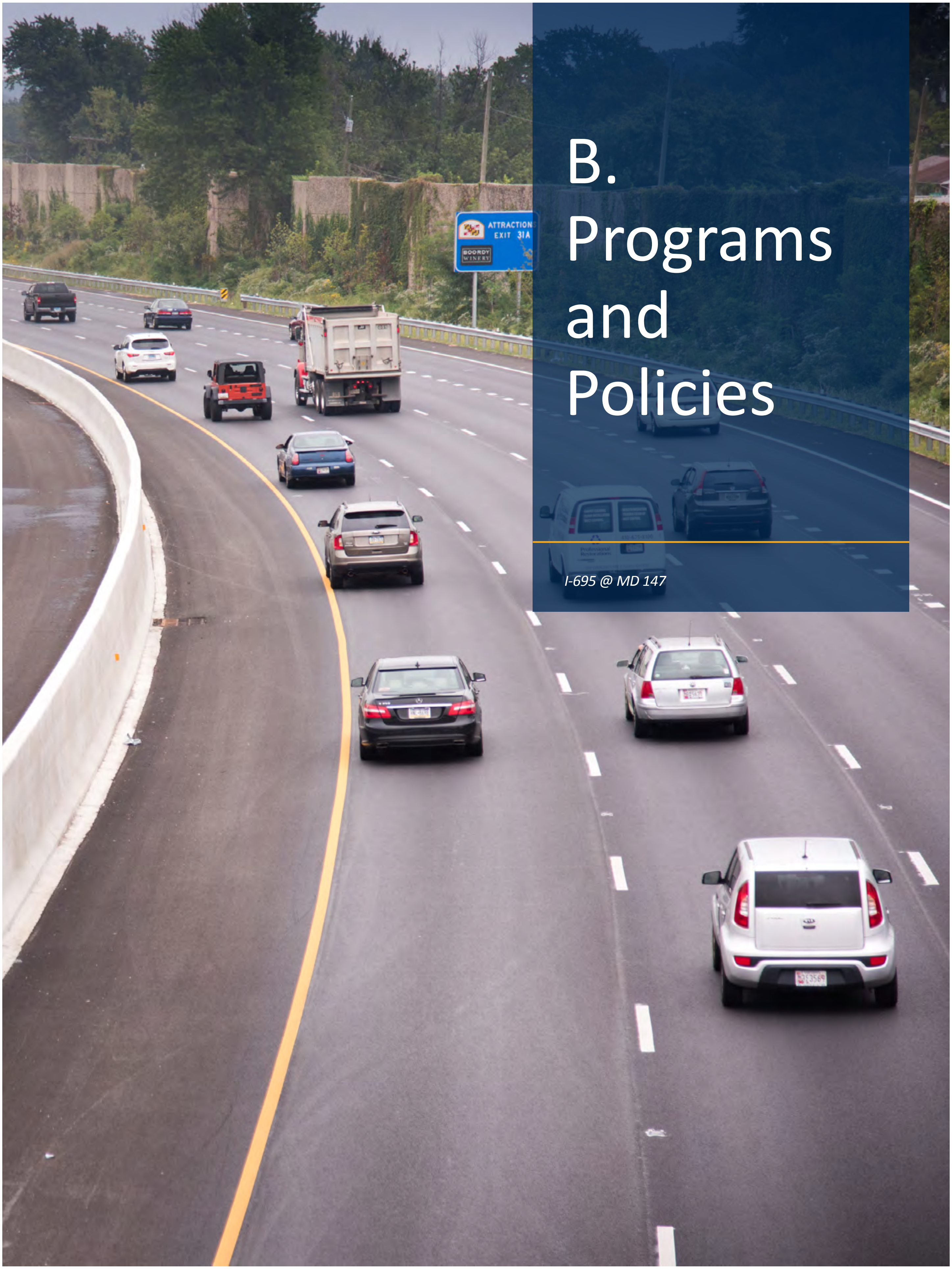
B. Programs and Policies



I-695 @ MD 147

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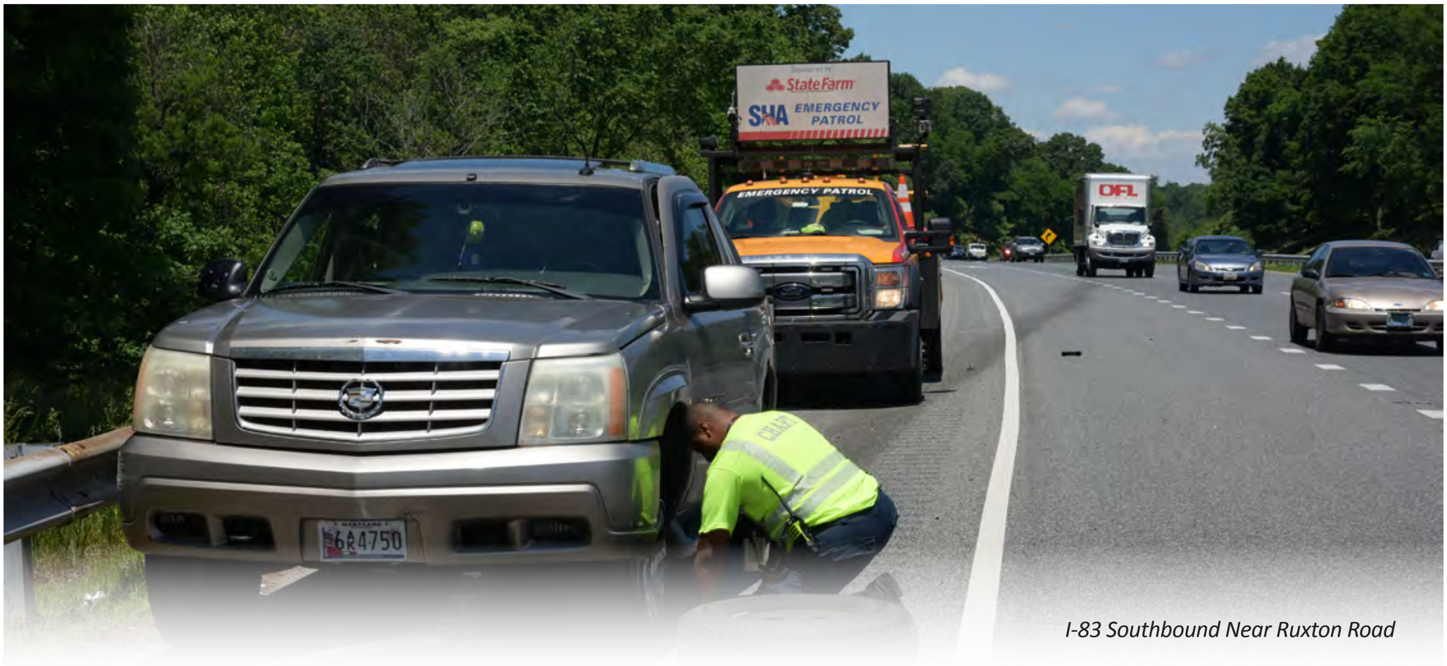

I-83 Southbound Near Ruxton Road

1. CHART TRANSPORTATION SYSTEM MANAGEMENT AND OPERATIONS (TSM&O)

Transportation System Management and Operations (TSM&O) is a program to optimize the performance of the existing transportation system through real-time management. 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, supported by three other regional centers, is the main coordination hub. The SOC and the strategically located Traffic Operations Centers (TOCs) use the previously mentioned 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 Florida to Maine that are part of the I-95 Corridor Coalition working cooperatively to improve inter-regional travel in the northeast 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** - Emergency Traffic Patrols, CHART Operations Centers, and Emergency Response Units.
- **Traffic Management** - Special Event and Work Zone Management.
- **Traffic and Roadway Monitoring** - Cell phone #77.
- **CCTV, and Public/Private Partnerships.**
- **Traveler Information** - Maryland 511 Traveler Information System - High-quality, Timely, and Comprehensive Travel Information to Motorists, CCTV Camera Video Sharing with First Responders, and Internet (www.traffic.maryland.gov).

US 40/Rossville Boulevard

In 2016, the CHART program responded to and cleared more than 30,000 incidents and assisted over 42,000 stranded motorists.

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, and clear collisions or other traffic impacting incidents so traffic operations can be restored as quickly and safely as possible. Emergency traffic patrols (ETPs) monitor major roadways to assist drivers when their vehicles become disabled or when involved in a crash. These ETP's 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 at 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 in Figure 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 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 in delay savings, wasted fuel, and emissions.

The number of CHART service patrol responses has greatly increased in the past three years due to increase in full-time ETPs. Between 2013 and 2016, the number of responses has grown by more than 50%.

The total number of CHART responses on a yearly basis is illustrated in the Figure II-4.

Figure II-3

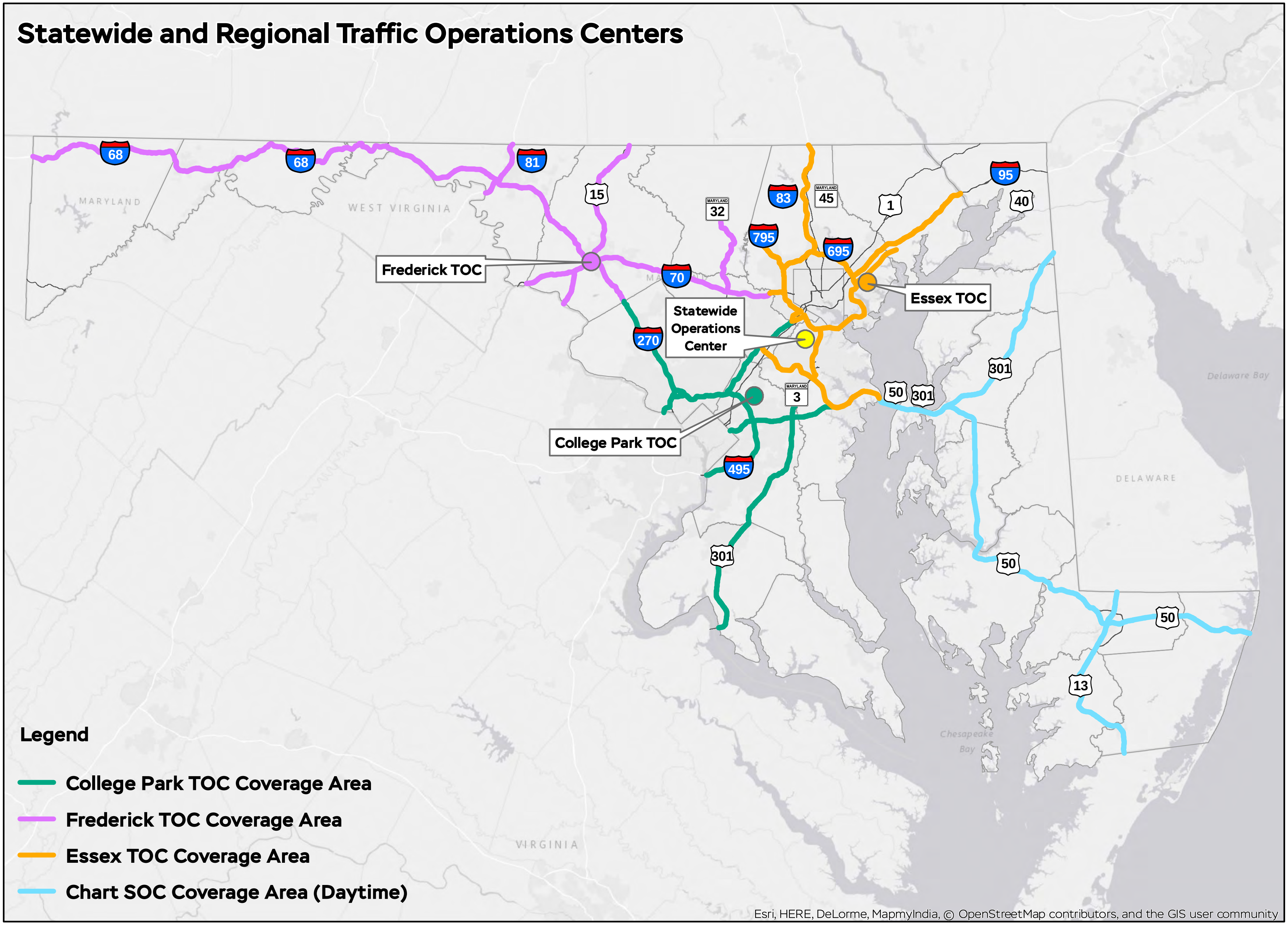
Statewide and Regional Traffic Operations Centers
Frederick TOC
Statewide Operations Center
Essex TOC
College Park TOC
68
68
81
15
70
270
32
795
83
45
695
1
95
40
301
50
301
3
495
301
50
50
13
MARYLAND
WEST VIRGINIA
VIRGINIA
DELAWARE
Delaware Bay
Chesapeake Bay
Legend
College Park TOC Coverage Area
Frederick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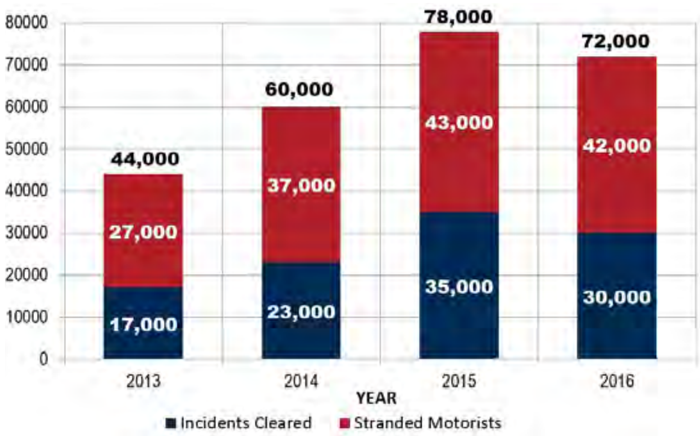
Figure II-4

CHART SERVICE PATROL RESPONSES



The type of incident and its time of occurrence can have a wide range on its impact to the travelling public. A broken-down vehicle on the shoulder late at night may not impact traffic operations while a dual-lane closure due to a crash in 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 (ETP's), which are used to provide emergency motorist assistance and to clear disabled vehicles from the travel lanes.
- Emergency Response Units (ERU's), 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.
- A "Clear the Road" policy, which 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 which are blocking travel lanes.
- 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 average response time to an incident in 2016 was 11.8 minutes and the average incident took 24.1 minutes to clear.

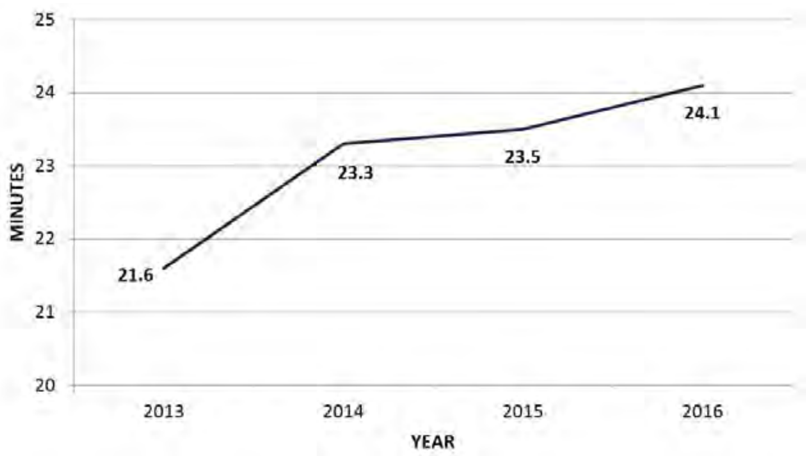
Various factors are evaluated in reviewing the performance of CHART over the past year. This includes the amount of time it takes to respond to an incident, the length to clear that incident, the reduction in delay, and ultimately the annual user cost savings provided by CHART. Figure II-5 depicts the trends of average incident duration and reduction in delay over the last four years.

Especially in the Baltimore-Washington region with already heavy congested conditions, the longer an incident takes to clear the greater the cost associated with the delay experienced by motorists. Every minute in time savings translates into savings in annual user costs. In 2016, the annual user cost savings amounted to $1.5 billion which is 10% greater than 2015 levels as shown in Figure II-5. Annual user cost includes reduction in delay, savings in fuel, and emissions.

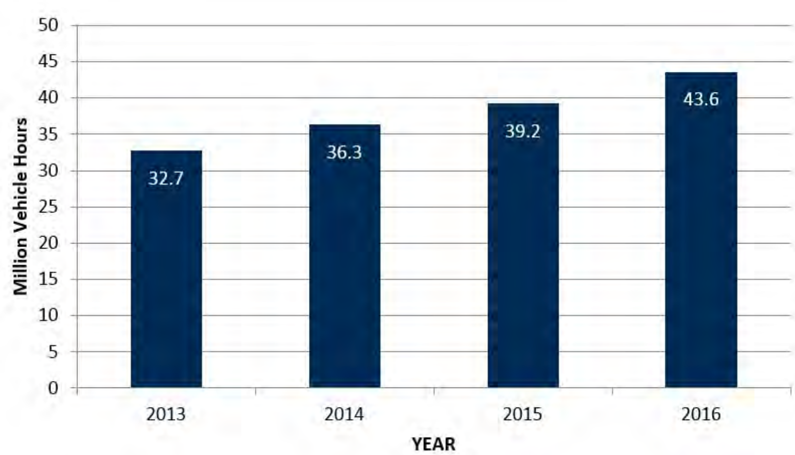
CHART achieved a $1.5 Billion savings to motorists and reduced delay by approximately 43.6 million vehicle hours.

Figure II-5

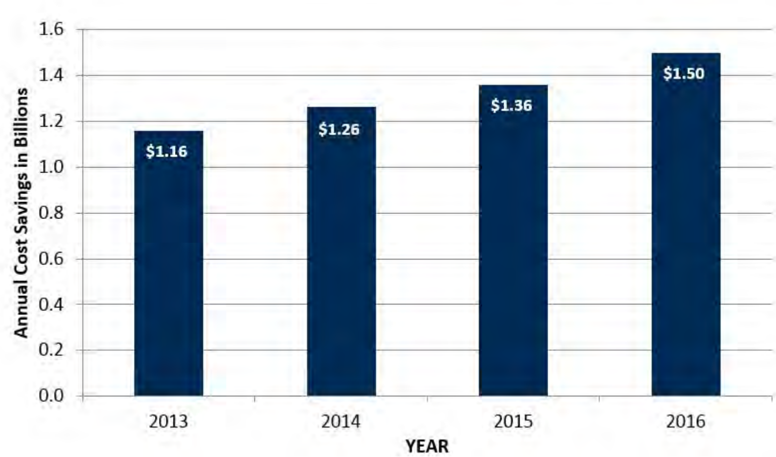
AVERAGE INCIDENT DURATION



REDUCTION IN DELAY



ANNUAL USER COST SAVINGS



Average incident duration in 2016 remained at similar levels as 2015, but the CHART program yielded a 14% reduction in overall delay (compared to 2015). This resulted in more than a 10% annual user savings compared to 2015 levels.

I-95 Cecil County

b. ITS/511

CHART and MDTA collect data from a wide variety of ITS devices that are strategically located throughout the State. This data is disseminated to motorists to allow them to make better decisions, there by reducing congestion and increase mobility. Travel time information is made available based on the analysis of INRIX probe speed data and displayed on more than 200 Dynamic Message Signs (DMS). The Maryland 511 Travel Information System continues to provide useful, high-quality, timely, and comprehensive 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

MD 97

MDOT SHA maintains 1,561 traffic signals in 257 signal systems in Maryland's 23 Counties.

2. SIGNAL OPERATIONS

Traffic signals provide control for conflicting movements at intersections along many arterial, collector and local roadways. 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. These projects provide improved safety and increased person throughput on corridors, by retiming of signals to be more responsive to traffic flows, thereby reducing delay to motorists and decreasing automobile emissions. Another benefit of signal retiming is that a more walkable environment can be established. The benefit cost ratio of improving signal timings ranges up to 40:1 on a nationwide basis as a result improving travel time, reducing the number of vehicles stopped, and fuel consumed.

In 2016, MDOT SHA's Signal Retiming Program reduced delay by 875,000 hours and saved 231,000 gallons of fuel. This resulted in $28.7 annual user savings.

MD 7 North of I-695

Various counties and municipalities operate traffic signals, but the majority are 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. A total of 306 signals were reviewed and 202 signals were proposed to be retimed. New timings were installed on 16 systems involving 71 signals in calendar year 2016 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 number of vehicle hours of delay are as follows:

- MD 193 - Metzrott Rd. to 15th Ave.
- MD 4 - Ward Rd. to Town Center Blvd.
- MD 139 - I-695 Ramps to Kenilworth Dr.
- MD 210 - Old Fort Rd. South to Wilson Bridge Rd.
- MD 198 - Russett Green East to MD 197
- MD 450 - MD 202 to MD 564

These six (6) systems provide a reduction of more than 55,000 vehicle hours of delay annually. In addition, the following systems provided more than a 20% reduction in delay:

- Konterra Dr. at Muirkirk Rd.
- MD 4 - Ward Rd. to Town Center Blvd.
- MD 139 - I-695 Ramps to Kenilworth Dr.
- MD 108 - Centennial Ln. to Ten Mills Rd.

Overall, signal retiming and optimization modifications provided an estimated reduction of 875,000 hours of delay (8%) for motorists and saved nearly 231,000 gallons of gasoline.

Retimed signals in 2016 reduced delay by 8% compared to 2015 levels.

Figure II-6

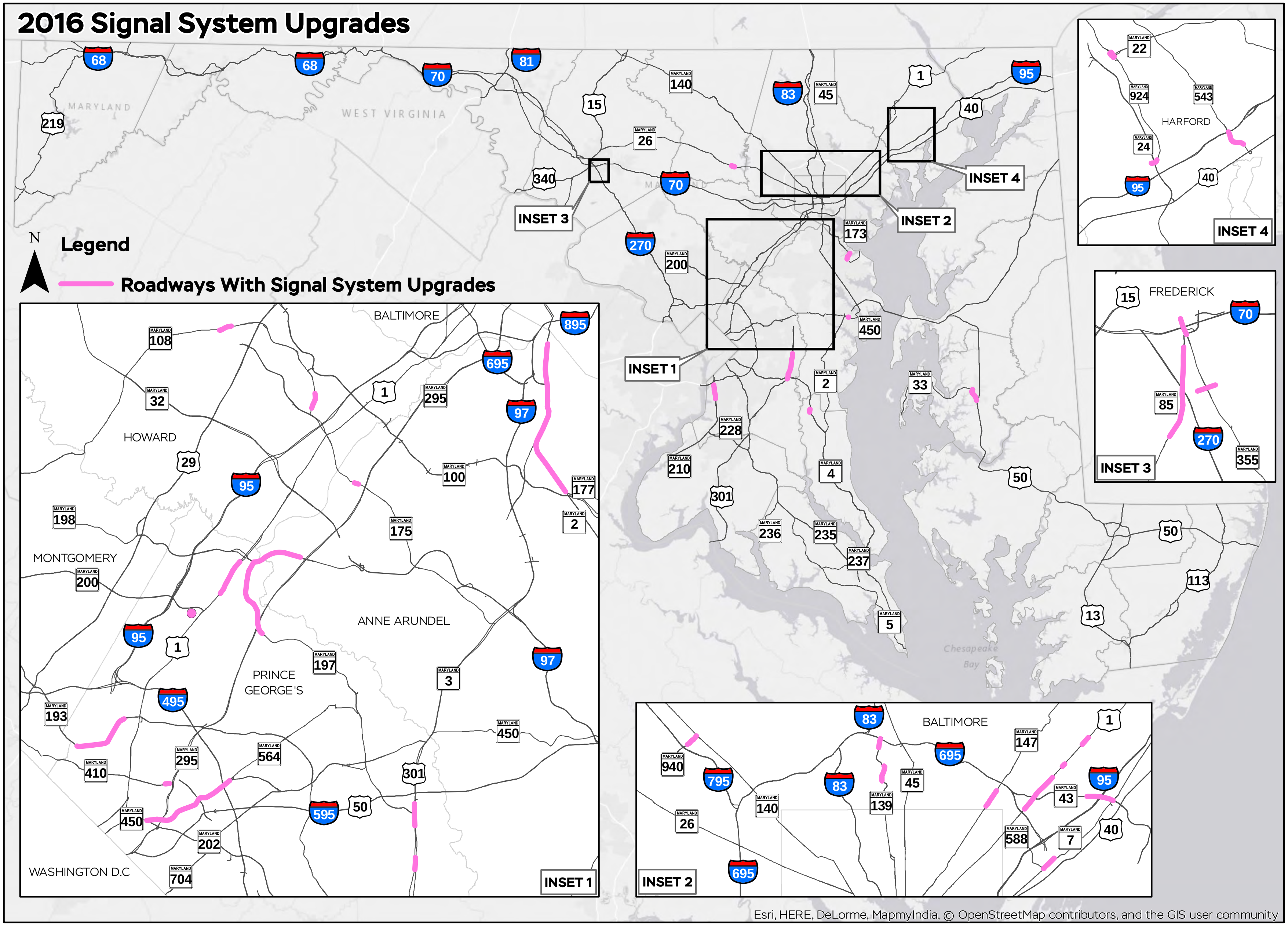

2016 Signal System Upgrades
Legend
Roadways With Signal System Upgrades
N
MARYLAND
WEST VIRGINIA
INSET 1
INSET 2
INSET 3
INSET 4
BALTIMORE
HOWARD
MONTGOMERY
ANNE ARUNDEL
PRINCE GEORGE'S
WASHINGTON D.C
HARFORD
FREDERICK
Chesapeake Bay
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Table II-3

2016 NETWORK DELAY SAVINGS FOR SIGNAL SYSTEM UPGRADES		
LOCATION	NO. OF SIGNALS	DELAY SAVINGS (VEH-HRS)
MD 193 - Metzerott Rd. to 15th Ave.	8	120,000
MD 4 - Ward Rd to Town Center Blvd.	2	101,000
MD 139 - I-695 Ramps to Kenilworth Dr.	3	96,000
MD 210 - Old Fort Rd. South to Wilson Bridge Dr.	7	76,000
MD 198 - Russett Green East to MD 197	8	68,000
MD 450 - MD 202 to MD 564	20	56,000
Konterra Dr. at Muirkirk Rd.	1	52,000
US 1 - Contee Rd. to Montrose Ave.	7	43,000
MD 43 at I-95 between NB and SB on and off ramps	3	38,000
MD 197 - S. Laurel Dr. to MD 198	14	30,000
MD 108 - Centennial Ln. to Ten Mills Rd.	2	22,000
US 301 - Excalibur Rd. to Governor Bridge Rd.	4	21,000
MD 85 - Guilford Dr. to Westview Dr.	10	18,000
MD 322 - MD 33 to Washington St.	6	17,000
MD 26 - Hemlock Dr. to Monroe Ave.	3	15,000
MD 7 - MD 588 to Rossville Blvd.	5	14,000
MD 175 - National Business Pkwy to Shannons Glen Dr.	2	12,000
MD 147 - Putty Hill Rd. to Taylor Ave.	4	12,000
MD 450 - Admiral Dr. to Chinqupin Round Rd.	2	10,000
US 301 - Trade Zone Ave. to Marlboro Square SC	7	9,000
MD 173 - Bar Harbor Rd. to Edwin Raynor Blvd.	5	8,000
US 1 - Fitch Ave. to Silver Spring Rd.	10	7,000
MD 410 - 62nd Ave. to 67th Ave.	6	6,000
US 1 BUS/MD 22/MD 924 - Pennsylvania Ave. to Fulford Ave.	10	6,000
MD 2 - 8th Ave. to MD 177	14	6,000
MD 543 - I-95 Ramps to Brass Mill Rd.	5	5,000
MD 924 - Constant Friendship Blvd. to Woodsdale Rd.	4	4,000
MD 108 - Lark Brown Rd. to Mayfield Blvd.	4	3,000
MD 139 - GBMC to Chestnut Rd.	3	N/A
MD 355 - Holiday Dr./Genstar Dr.	3	N/A
MD 355 - MD 85 to Walser Dr.	6	N/A
MD 940 - Dolfield Rd. to MD 140 Connector	2	N/A
US 1 - Chapel Rd. to Forge Rd.	3	N/A
US 1 - Joppa Rd./India Ave. to Ebenezer Rd.	3	N/A
US 301 - Mitchellville Rd. to Pointer Ridge Dr.	2	N/A
Total	198	875,000

MD 24

A major part of the optimization effort relates to the implementation of Centracs for adaptive signal system operations. The adaptive system allows for timings to be adjusted based on conditions such as allowing more green time for the major road when necessary. The second adaptive signal system was implemented on MD 24 in the Bel Air area at 13 intersections. An 8.1% delay reduction has occurred for corridors with an adaptive signal system.

Transit signal priority (TSP) is another initiative to improve person throughput. This 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. A joint state/county policy and criteria for location identification has been developed, and corridors have been screened to determine the most beneficial locations for potential implementation. The first project is located on MD 355 in Montgomery County. Initial deployment with funding is anticipated in 2017/2018 and will be for Ride On additional express bus service between Lakeforest Mall and the Medical Center Metro Station. TSP is being installed at 30 intersections along the route to allow Ride On Extra buses to take advantage of the technology. Transit service is scheduled to begin in the Fall of 2017.

Owings Mills Metro Center

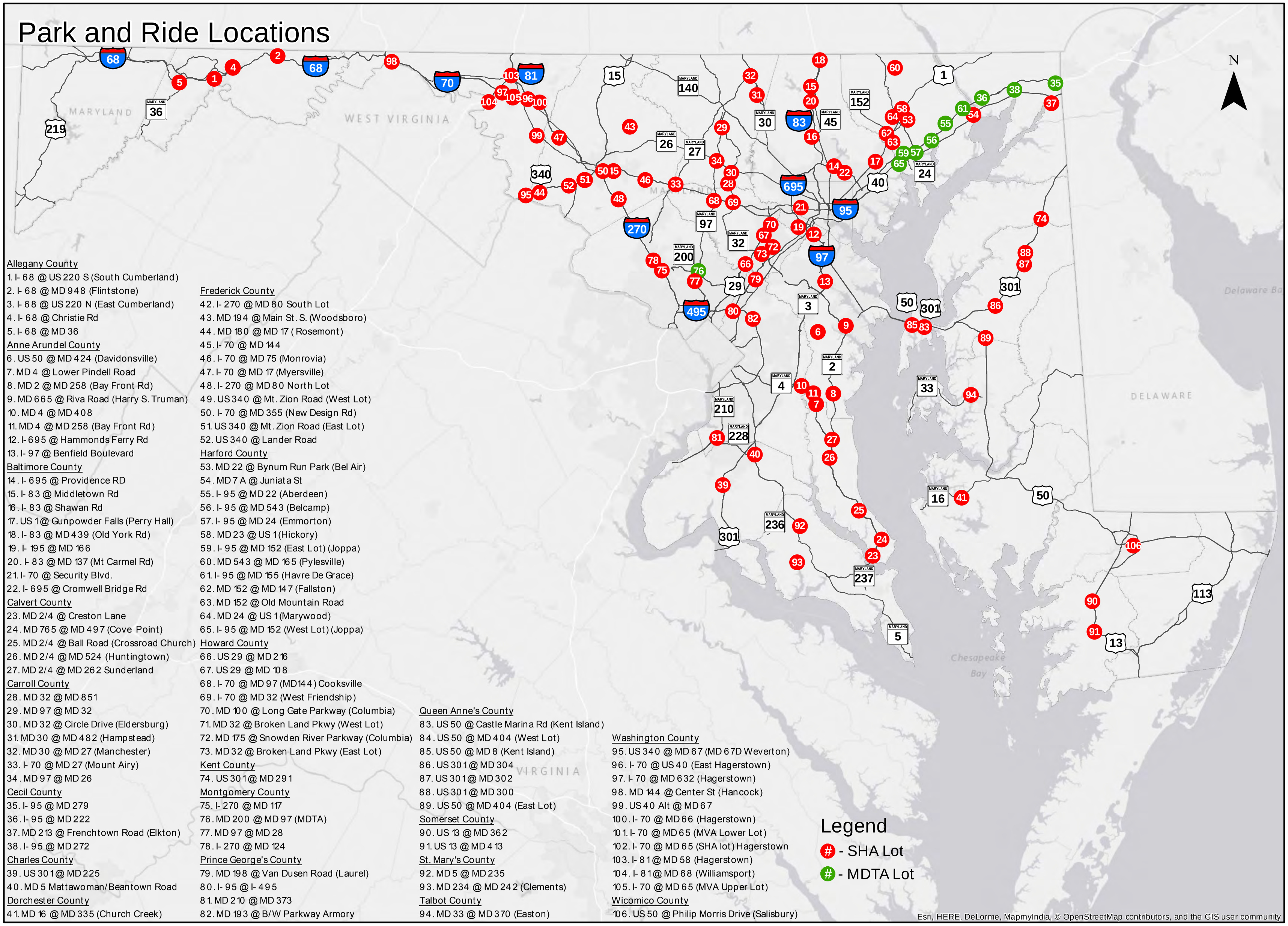
3. MULTI-MODAL

a. Park and Ride

One method to connect motorists to multi-modal transit connections is through a network of park and ride lots. MDOT has established and maintains 106 locations in 20 counties providing over 13,300 spaces. Motorists that park at these lots reduce single occupant vehicles and encourage transit use and ride-sharing. MDOT SHA partners with the Maryland Transit Administration and local transit agencies to encourage transit connections to the lots. The mutually beneficial relationship increases 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. Various minor adjustments have occurred to the number of spaces at various lots statewide due to remarking or other modifications.

Figure II-7 shows the location of all the Park and Ride lots operated by SHA and 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 7 A @ 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 (MD 144) 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)
Legend
- SHA Lot
- MDTA Lot
MARYLAND
WEST VIRGINIA
VIRGINIA
DELAWARE
Chesapeake Bay
Delaware Bay
N
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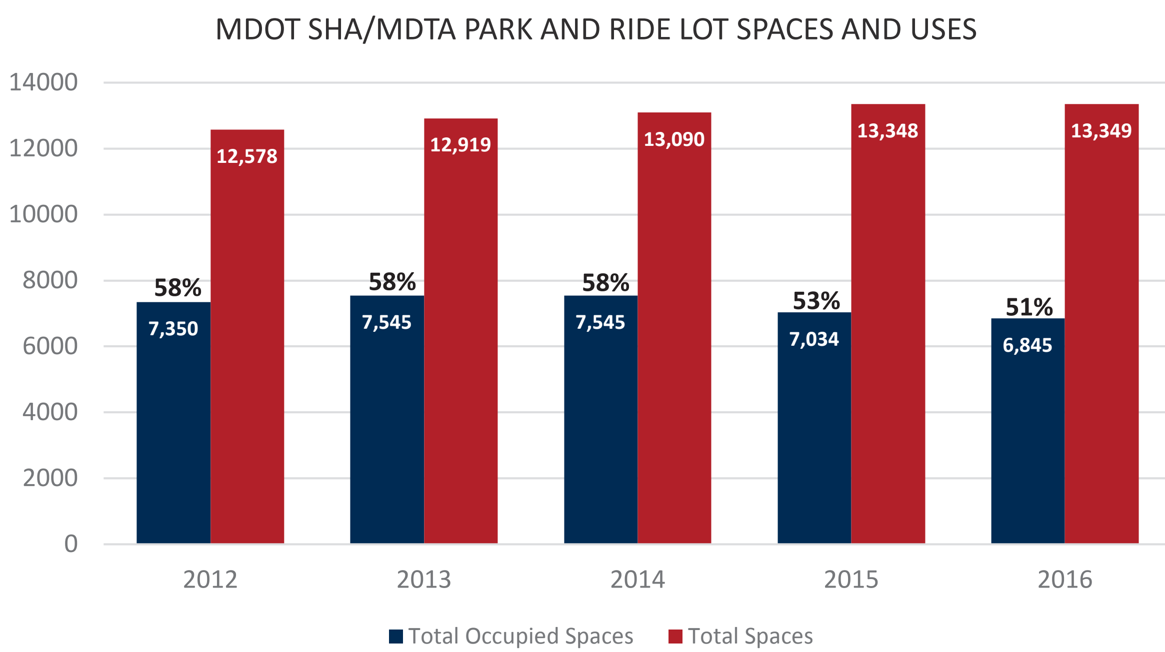
I-95 @ MD 152

An occupancy survey is performed 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. The reduction in the price of fuel may have contributed to a reduction in the utilization of the lots as shown in Figure II-8.

FIGURE II-8

MDOT SHA/MDTA PARK AND RIDE LOT SPACES AND USERS



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

- I-270 at MD 117
- US 50 at MD 424

Five park and ride lots had over 20 additional motorists parking at these locations.

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:

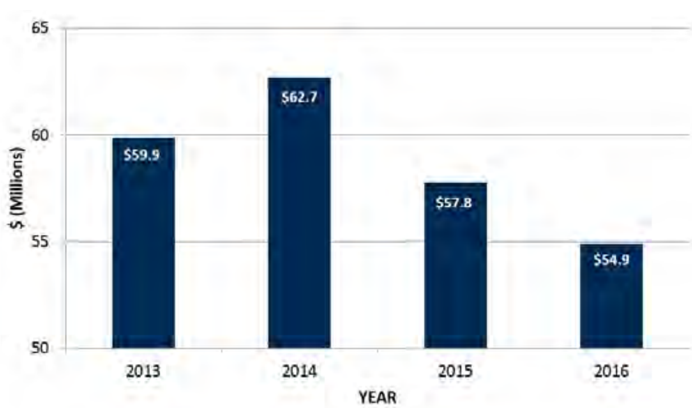
- I-68 @ US 220 N (Allegany County)
- MD 2/4 @ Ball Road (Calvert County)
- MD 32 @ Springfield Ave (Carroll County)
- US 340 @ Mt Zion Road (East and West Lot) (Frederick County)

The estimated annual user savings over the past four years is shown in Figure II-9.

In 2016, MDOT SHA/MDTA Park and Ride Program reduced VMT by 101.7 million miles. This resulted in $54.9 million annual user savings.

In addition to MDOT SHA and MDOT MDTA, other agenices provide park and ride lots. 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)



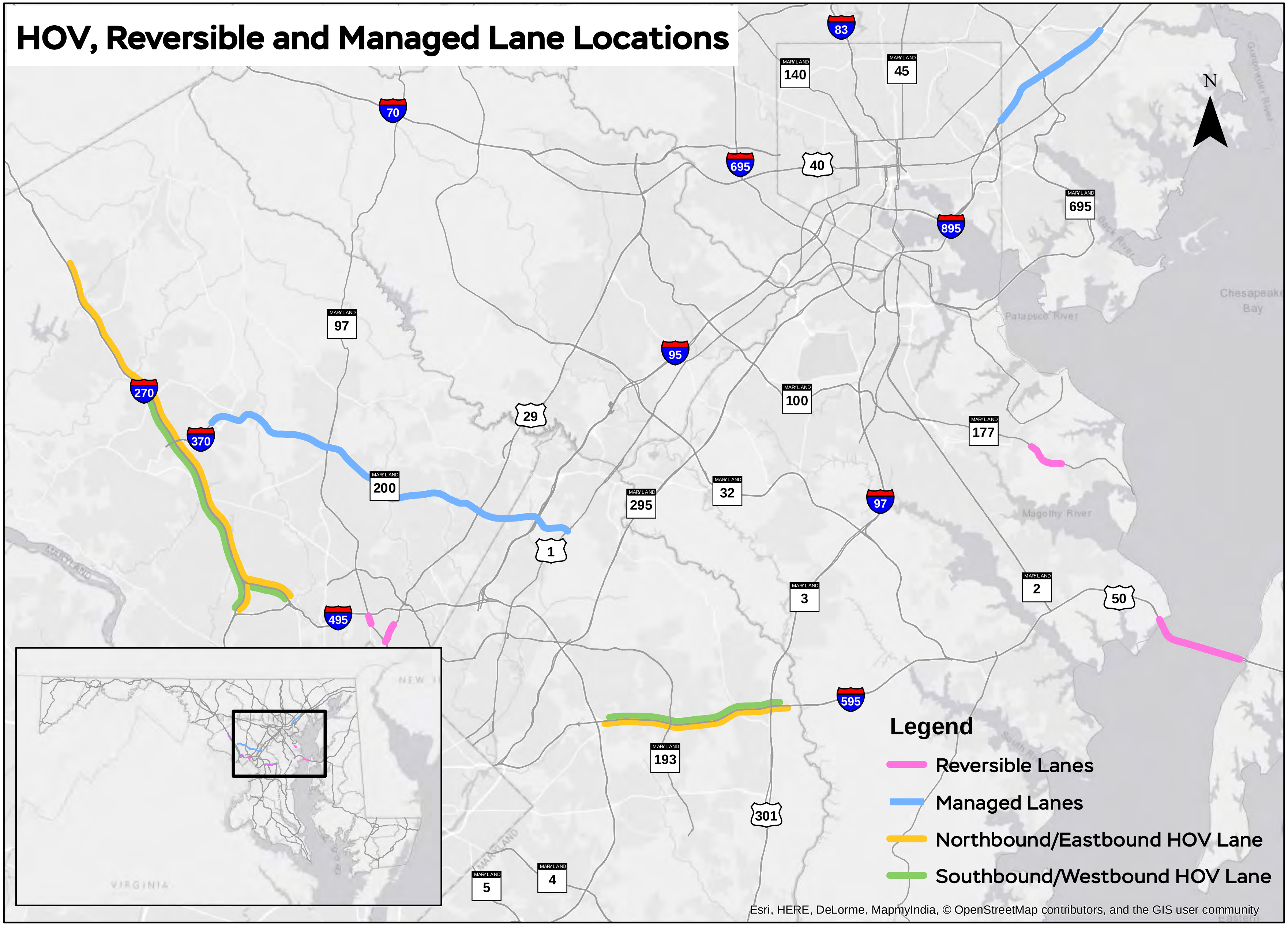
b. HOV Lane Operation (HOV)

High occupancy vehicle (HOV) lanes are utilized to encourage carpooling and reduce the number of single occupant vehicles. These lanes offer a travel time savings 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 transportation mode for commuters in Maryland. This provides an effective Active Travel Demand Management (ATDM) strategy. 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.

A study was conducted to analyze the performance of the HOV lanes relative to the general purpose lanes. This was accomplished by the Metropolitan Washington Council of Government (MWCOG) using travel time data from GPS data loggers and analyzing person throughput, and determining travel time savings. 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 200 to 500 additional people compared to an average general purpose lane.

Figure II-10

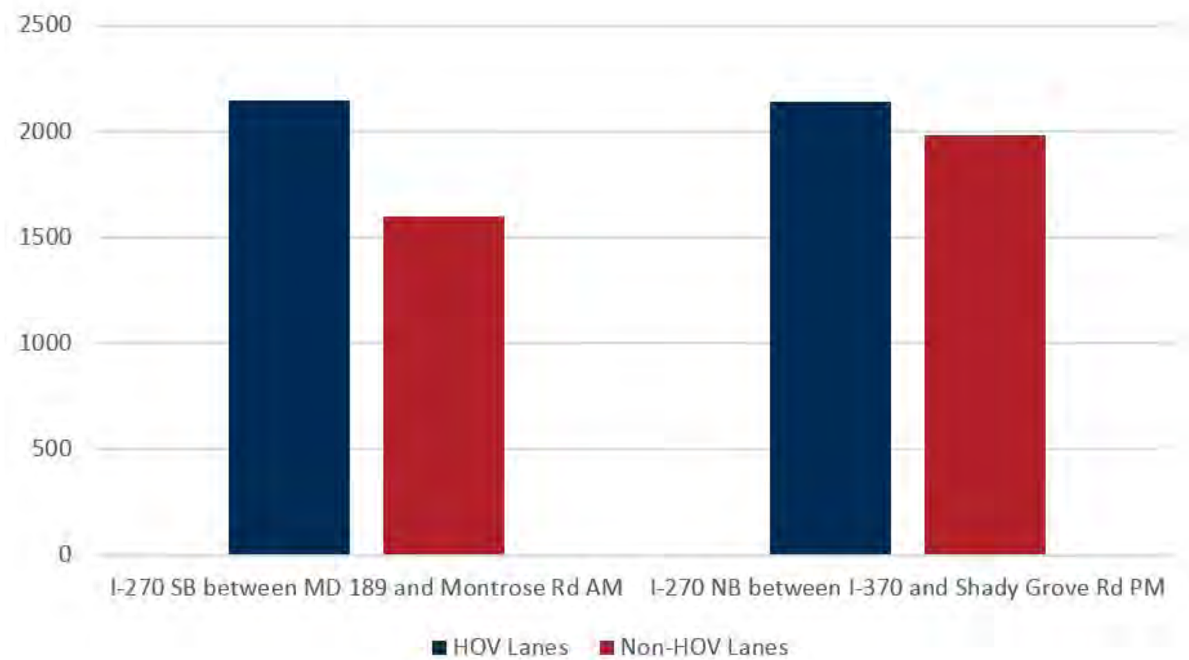

HOV, Reversible and Managed Lane Locations
Legend
Reversible Lanes
Managed Lanes
Northbound/Eastbound HOV Lane
Southbound/Westbound HOV Lane
N
83
140
45
70
695
40
895
695
97
95
270
370
29
100
177
200
295
32
97
1
2
50
3
495
595
193
301
5
4
Chesapeake Bay
Patapsco River
Magothy River
VIRGINIA
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

I-270 HOV

The HOV lane carries as many as 2,200 persons per lane per hour as shown in Figure II-11:

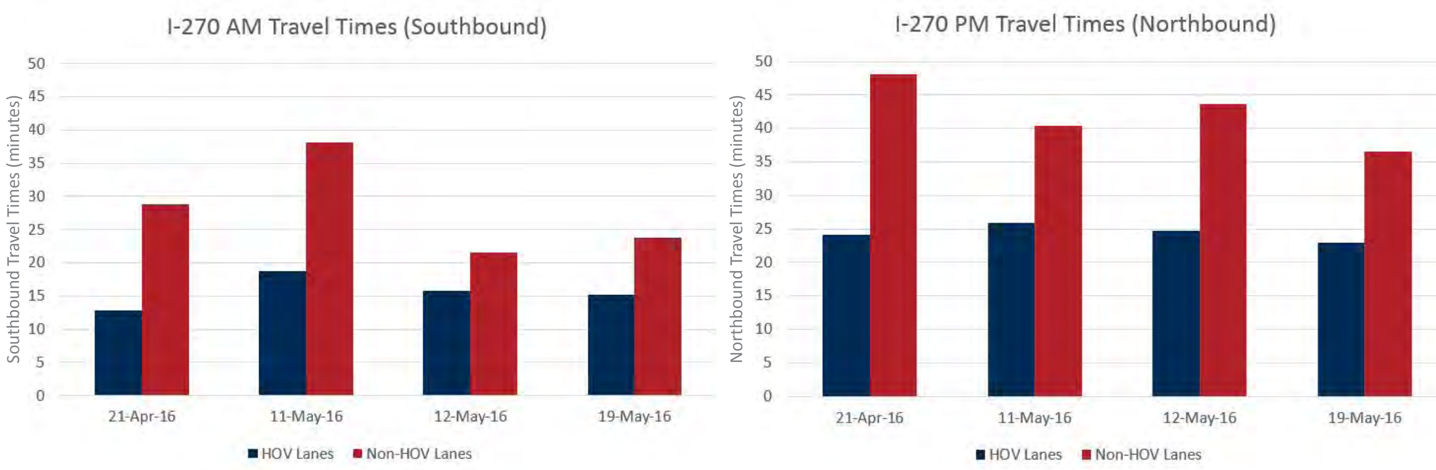
FIGURE II-11

I-270 PERSON THROUGHPUT PER LANE PER HOUR



Multi-occupant vehicles using the HOV lanes have a major advantage in travel time savings. Along I-270 in the morning peak period, the travel time savings was as much as 20 minutes with an average of 12 minutes. The afternoon peak period provided even greater travel time savings with a maximum of almost 25 minutes and an average of approximately 18 minutes. A minimal average time savings of two (2) minutes occurs on US 50 for the HOV users versus those motorists using the non-HOV lanes for the AM peak period eastbound. A four 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

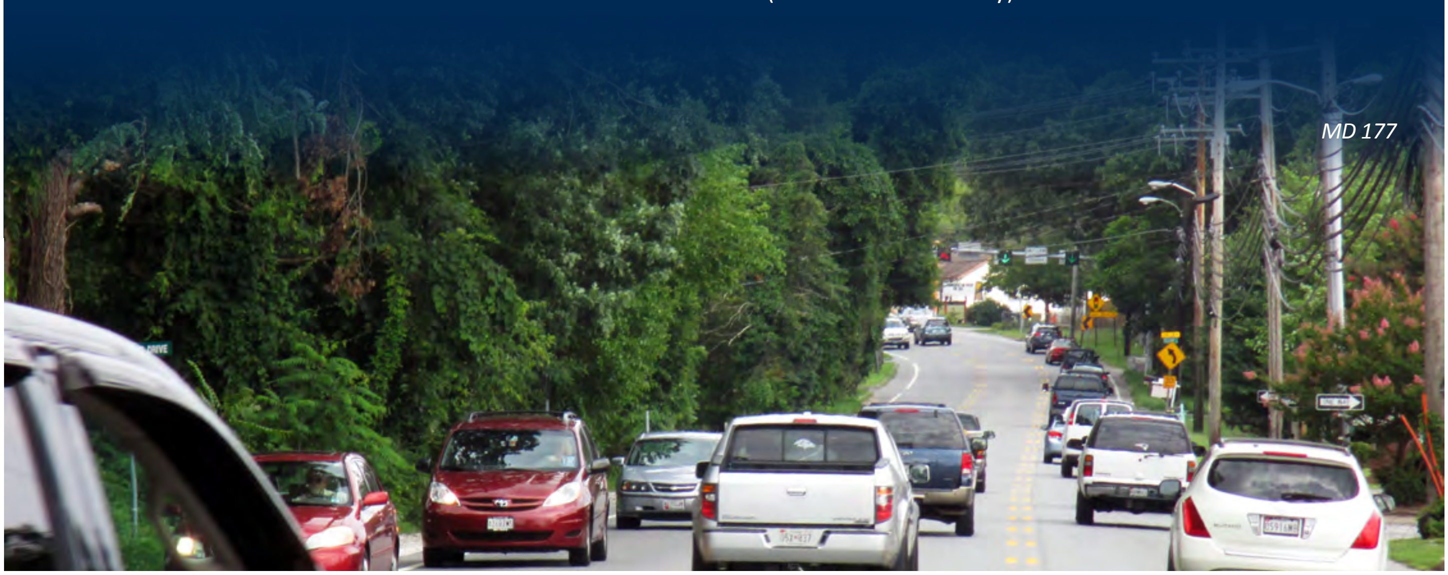


c. Reversible Lane Operation

The use of reversible lanes is another method to improve mobility. Reversible lanes increase person throughput, and reduce congestion while minimizing investment. Reversible lanes have been implemented on selected corridors with high directional traffic volumes in the peak periods. This reduces the impact to surrounding residents, businesses and environmental resources. 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 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



MD 177

MD 97

The five lane Chesapeake Bay Bridge (US 50/US 301) is the most recognizable reversible lane location to most Marylanders. Families and commuters traveling to/from the Eastern Shore and locations such as Ocean City utilize the normal two eastbound lanes and three westbound lanes across the Bridge. In peak travel periods such as Saturday mornings, Friday evenings and the PM peak period through the use of overhead lane signing, the lane designations are changed to allow for three eastbound lanes and two westbound lanes. Two of the other reversible lane locations occur inside the Washington DC Beltway (I-495). These are along US 29 and MD 97 which provide access to the downtown Silver Spring employment center and to the WMATA Metro Red Line. The lanes operate southbound in the AM peak period and northbound in the PM peak period. The fourth location is along MD 177 (Mountain Rd.). This 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 number of motorists utilizing the reversible lanes varies per facility. The highest volumes occur on the Chesapeake Bay Bridge and US 29 with over 1,000 motorists in the peak direction as shown in Table II-4.

TABLE II-4

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	1,500 (1,100)	1,100 (1,200)
US 50/301	N/A (3,000)	N/A (1,600)
MD 97	2,550 (2,600)	610 (825)
MD 177	1,100 (1,250)	340 (350)

In addition to MDOT several other agencies provide for reversible lane facilities. This includes 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

Two innovative projects opened in Maryland over the last five years. These involved the use of managed lanes. Managed lanes can involve numerous different types of strategies to handle the flow of traffic. These two projects involved utilizing tolls to insure traffic in the managed lanes operate at acceptable travel speeds and do not experience delays. The first project was the InterCounty Connector (ICC) which was an 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 the ICC are more than 50,000 vehicles per day on sections west of US 29. These volumes have grown 100% in those five years. The growth in traffic volumes is illustrated in Figure II-13.

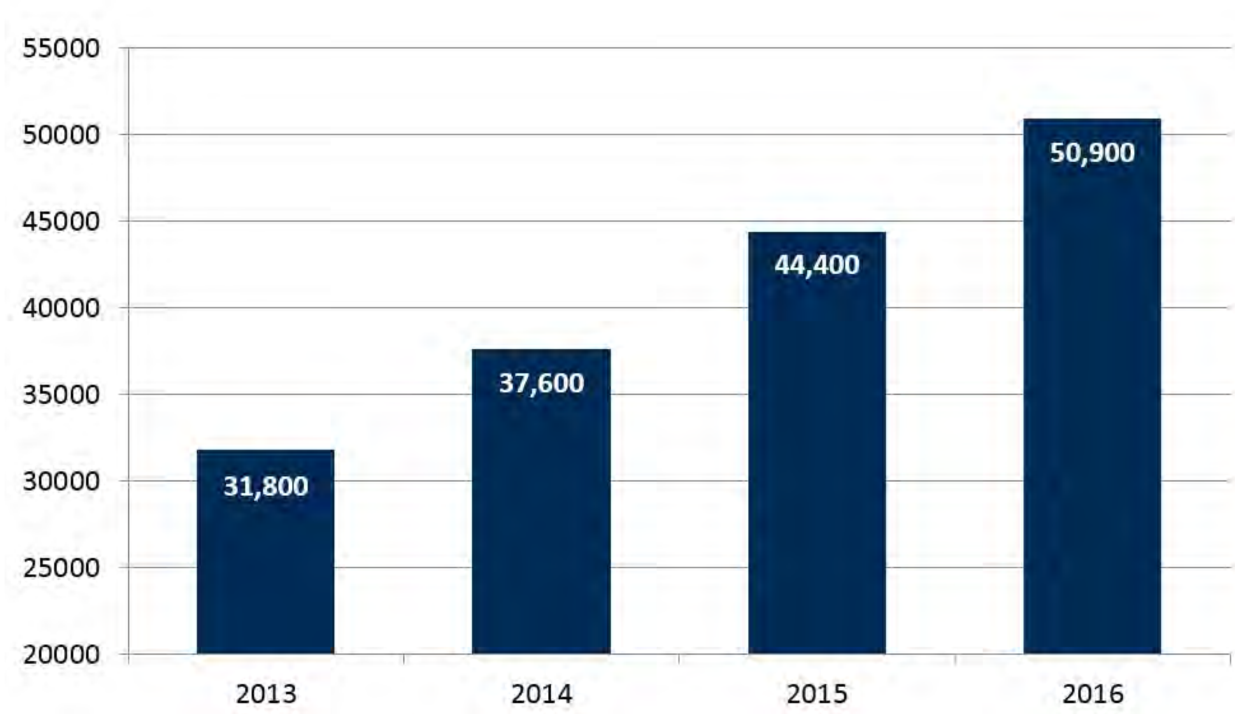
The second project is the implementation of express toll lanes on I-95 from I-895 to north of MD 43. Motorists have the option of utilizing the four free general purpose lanes or paying a toll using E-Z Pass to travel in the free flow express toll lanes. Transit vehicles are allowed to use the lanes for free improving their reliability. There are over 23,000 motorists per day using the express toll lanes. PM peak hour volumes on the express toll lanes in the northbound direction have exceeded 2,000 vehicles per hour on a Friday in the summer. The general purpose lanes carry over 6,000 vehicles in the PM peak hour. This project has substantially reduced congestion in the highest volume section of I-95 north of the Baltimore City Line.

Over 23,000 persons per day use the I-95 managed lanes.

I-95 Managed Lanes

FIGURE II-13

ICC AVERAGE DAILY TRAFFIC VOLUMES BETWEEN I-370 AND I-95 FOR FIVE SEGMENTS



e. Bicycles and Pedestrians

A multi-modal approach to a transportation network must include a robust bicycle and pedestrian program. MDOT SHA does this through a series of strategic investments to improve accessibility, safety, and convenience. In addition, bicycle and pedestrian facilities are incorporated into MDOT SHA roadway projects to provide better multi-modal connections. These facilities provide numerous benefits including reducing auto emissions, improving public health, and enhancing community vitality to encourage more sustainable and livable places. The Bicycle and Pedestrian Master Plan provides for a 20-year vision to support biking and walking. Many resources have been developed to support this such as the Cycle Maryland Interactive Bicycle Map.

One method that MDOT SHA incorporate pedestrian and bicycle users on projects is by a Complete Streets policy. 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.

There are several MDOT SHA programs to implement the planning, design, and construction of bicycle and pedestrian facilities throughout the State. These programs are:

MD 33 East of St. Michaels

- **Bicycle Retrofit** - Bicycle improvements including signing and marking upgrades, modifying typical sections and creating off road trails to facilitate bicycle mobility. (MD 170)
- **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. (Rockville Town Center)
- **Maryland Bikeways Program** - Funding for improvements ranging from low cost bicycle treatments to shared/use paths, cycle tracks and trails. (Anacostia Riverwalk Trail)
- **New Sidewalk Construction for Pedestrian Access** - Sidewalk program to fill in gaps or construct key pieces of the pedestrian network.
- **Recreational Trails Program** - Construction of new trails or maintenance/rehabilitation of existing trails.
- **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. (Rock Creek Hiker Biker Trail)
- **Urban Reconstruction Program** - Projects to promote safety and economic developments such as including sidewalks in priority funding areas.

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 Office of Tourism.

Owings Mills Metro Center

f. Transit Oriented Development

Maryland defines a Transit Oriented Development (TOD) as “a dense, mixed-use deliberately-planned development within a half-mile of transit stations that is designed to increase transit ridership”. Although, this is the main focus, there are many other 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, offer attractive public spaces, enhance public transportation ridership, and encourage 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 allows 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-14.

The development of TODs includes partnerships between MDOT and the Washington Metropolitan Area Transit Authority (WMATA). The two agencies are working together at locations such as New Carrollton, Twinbrook, White Flint, and Branch Avenue Metro stations to develop joint projects.

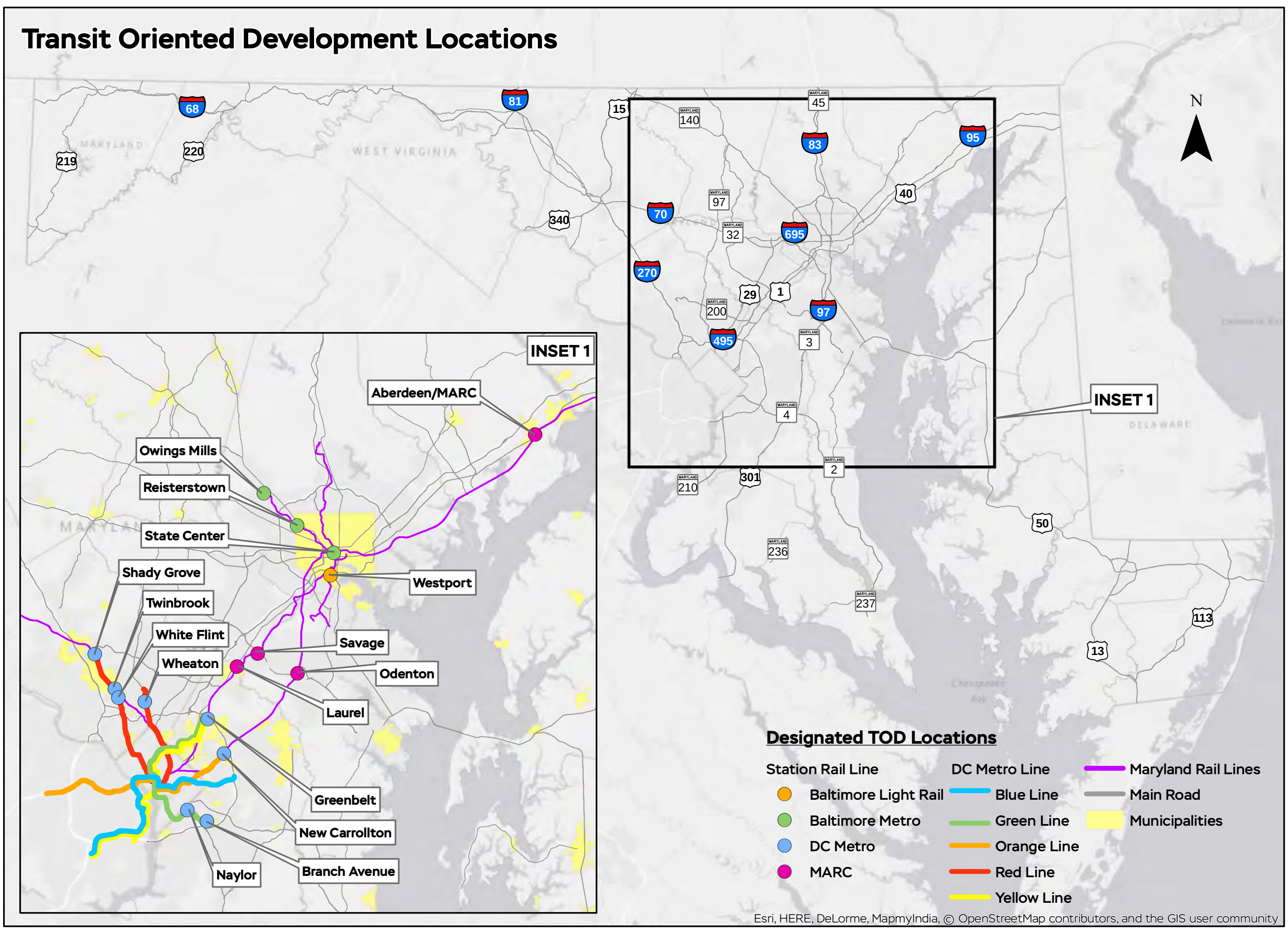
The amount of development at the 16 sites varies throughout the State. Certain locations are much more active with construction on-going while other locations are waiting for the right opportunities. Table II-5 shows the most active TOD sites.

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

TABLE II-5

ACTIVE DEVELOPMENT AT TODs		
TOD Location	**MULTI-MODAL CONNECTION**	**ON-GOING DEVELOPMENT**
Owings Mills	MTA-METRO	200,000 sf office
Annapolis Junction/Savage	MARC	100,000 SF office 14,000 SF retail 416 residential units
New Carrollton	WMATA-METRO	1,370 apartments 1.1 million SF office 150,000 sf retail 150,000 sf hotel
White Flint	WMATA-METRO	340,000 sf retail 463 apartments 104 condos

FIGURE II-14



I-95/I-495

4. FREIGHT

Truck traffic is vital to the economy but is often perceived negatively by people living near or using the routes these vehicles are travelling on. In order to balance these interests, the Maryland Truck Route System was established and has been utilized since the 1980's. In 2016, the National Highway Freight Network was designated as 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. Each state is required to establish and designate critical urban and rural freight corridors. The National Highway Freight Network includes all interstate routes (481 miles) plus MD 695 and portions of US 50/301. As required by the FAST Act, Maryland must also establish the Maryland Multi-Modal Freight Network, 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, improve freight mobility and connections and identify other freight routes experiencing a high-severity index related to truck crashes. The three freight networks are shown in Figure II-15.

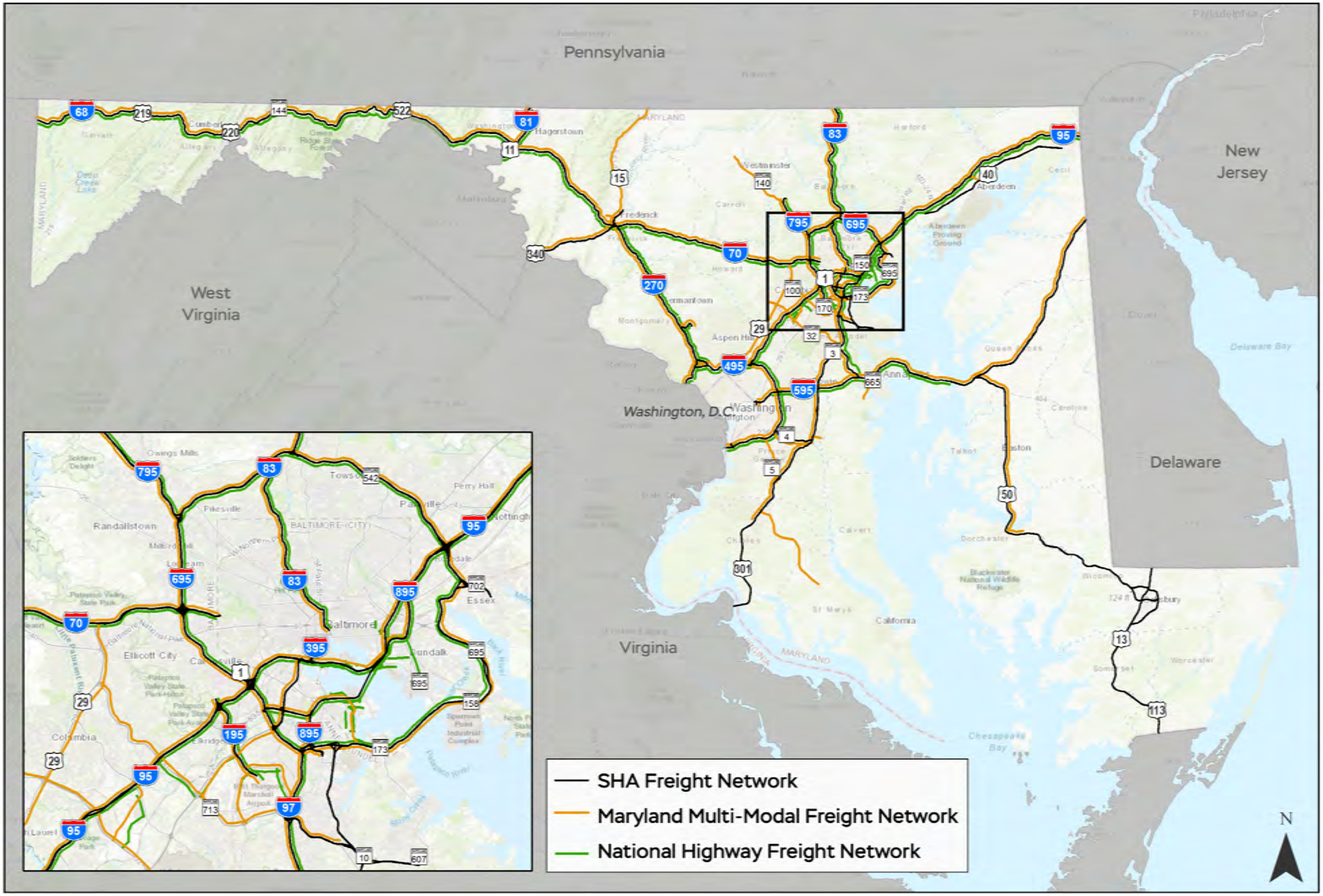
Several programs and policies have been developed to improve freight safety and mobility. These include upgrades to at-grade railroad crossings through the Highway-Rail Crossing Program, programs to construct virtual weigh stations, Commercial Vehicle Information Systems, and Networks (CVISN) facilities to the implementation of the Maryland One Hauling Permit System, and the continual monitoring of truck parking as part of 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.

MDOT SHA has several on-going initiatives related to Jason's Law. This includes beginning the design of up to ten additional spaces at the Westbound Welcome Center at South Mountain. In addition, the existing I-95/I-495 site is being evaluated for expansion. 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.
- Researching 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.

Among efforts from a planning standpoint are developing an updated Strategic Goals Movement Plan (Maryland's State Freight Plan) including performance metrics for Truck Travel Time Reliability (TTTR), designated Critical Urban, and Rural Freight Corridors and a freight Financial Plan to identify where freight investments will be allocated statewide. This effort coincides with the development of a Maryland Freight Story Map to compliment and provide a visual overview of the updated Strategic Goods Movement Plan. The Maryland Freight Story Map will be an interactive geospatial dashboard which will include areas such as infrastructure access, mobility, and asset management. The updated 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 into the highway project planning process.

Figure II-15


Pennsylvania
West Virginia
Virginia
Washington, D.C.
New Jersey
Delaware
SHA Freight Network
Maryland Multi-Modal Freight Network
National Highway Freight Network
N

5. MARYLAND TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSM&O) PLAN IMPLEMENTATION

The need to maximize the performance of the existing highway system has led Maryland to become one of the first states to formally develop a Transportation Systems Management and Operations (TSM&O) Strategic Implementation Plan. The plan included four key goals, associated objectives, performance metrics, and strategies.

This TSM&O Plan is a strategic effort to maximize mobility and reliable travel by incorporating performance measures into a formal process. The objectives of the program include:

- Incorporate TSM&O oriented practices in planning and programming business processes.
- Promote culture supporting TSM&O both inside and outside of MDOT SHA and raise overall awareness.
- Develop freeway and arterial master plans (statewide monitoring, measurement, communication, infrastructure/detection technology and evaluation strategies).
- Develop Integrated Corridor Management plans to coordinate the assets of multiple transportation disciplines to provide reliable movement of goods and services.
- Implement a comprehensive system level performance measurement program and monitor progress toward mobility and reliability targets.
- Develop TSM&O Performance Monitoring System.
- Coordinate and ensure TSM&O is considered in SHA’s Asset Management Program.
- Include reliability in existing traffic analysis and travel forecasting modeling tools.
- Achieve a user cost savings of $1 billion annually by effective congestion management and TSM&O.

Various tasks are on-going to meet the goals and objectives of the plan. Among the areas that have been addressed include:

- Development of plans for implementing TSM&O strategies.
- Identification of priority corridors.
- Development of performance measures for freeway hot spots.
- Assessment of existing travel time reliability model.
- Created website, YouTube videos, and Twitter account focuses on operations strategies.

TSM&O
Maryland Transportation Systems Management & Operations

Goal 1.
Develop and implement a sustainable TSM&O Program at SHA.

Goal 2.
Improve travel time reliability for both people and freight on both freeways and arterial highways by enabling customers with information and choices.

Goal 3.
Develop data and performance driven approaches to support TSM&O planning, programming, implementation and evaluation decisions.

Goal 4.
Improve the travelling public’s experience on Maryland highways by enabling customers with information and choices.

CAV Activities

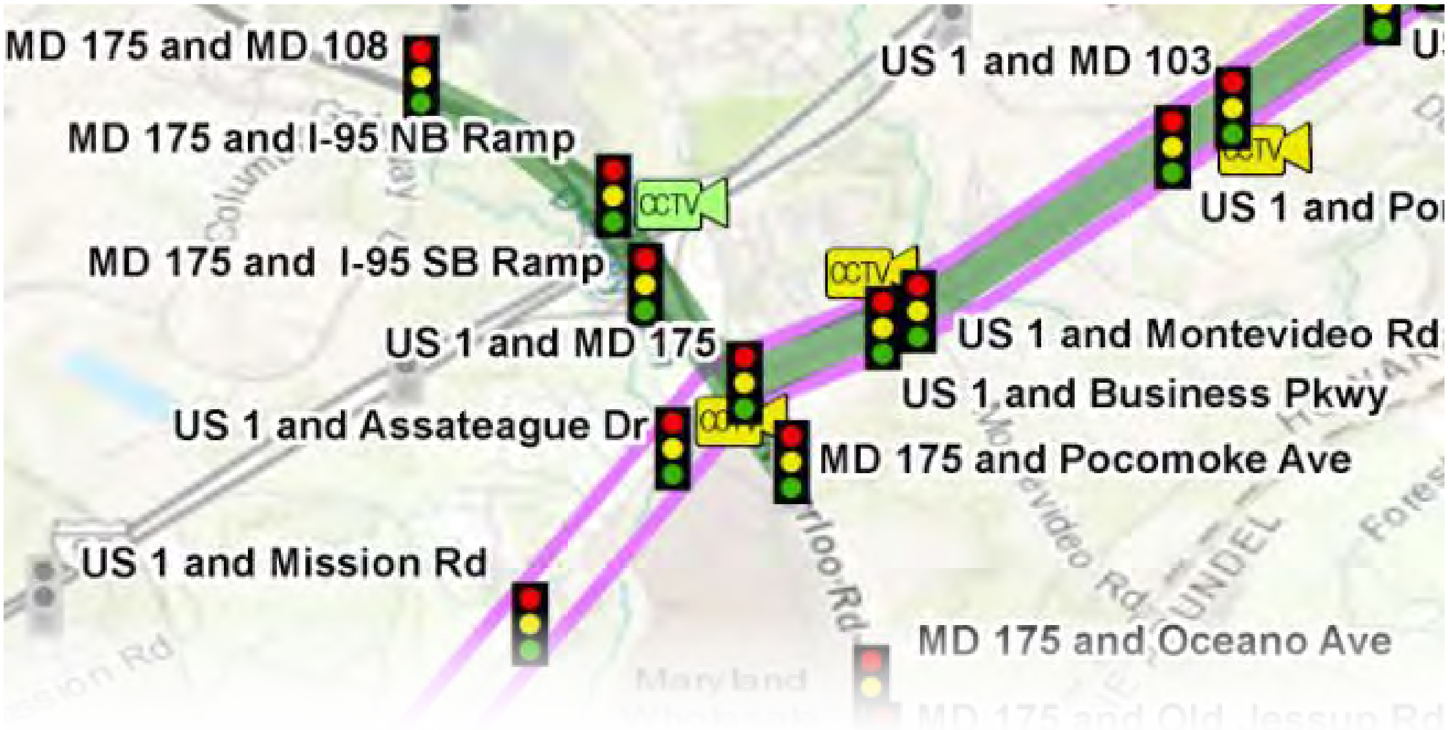
- **The Aberdeen Test Center has been recognized as a federally designated AV proving ground.**
- **MDOT is part of an FHWA program to support the development of Connected Vehicle Application study.**
- **US 1 in Central Maryland has been chosen as the pilot for an Innovative Technology Deployment Corridor.**
- **MDOT SHA is working with ATC in a community of interest for DSRC to develop standards and lessons learned.**
- **Participation in a FHWA pool funded study which includes development of a mult-modal intelligent traffic signal system.**
- **MDOT SHA continues to look for opportunities to partner with the University of Maryland, Johns Hopkins University Applied Physics Lab, and the National Transportation Center at Morgan State University for research into CAV.**

6. CONNECTED VEHICLES/AUTOMATED VEHICLES

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. The technology for connected vehicles is based on wireless communication between two or more vehicles or between a vehicle and the structural infrastructure surrounding it. Communication is split into two different forms; Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I). Both forms of communication will rely greatly on wireless technology - especially cellular networks, and Dedicated Short Range Communications (DSRC). Automated vehicles (AV) are vehicles that can perform at least one aspect of a safety-critical control function without direct driver input.

In 2015, Maryland Transportation Secretary Pete Rahn established the Autonomous and Connected Vehicle Working Group as the central point of coordination for the development and deployment of emerging automated and connected vehicle technologies in Maryland. The Working Group handles strategic planning for MDOT concerning automated and connected vehicles, and includes two subcommittees - the Policy Subcommittee responsible for legislative and policy issues and testing permits, and the Technical Subcommittee led by MDOT SHA, which is responsible for technical and operational issues, and test oversight.

In 2016, Maryland submitted and supported two USDOT applications for test sites to be part of a “federally designated AV proving ground” network - the I-95 Automated Vehicle Research and Production Corridor and the US Army Aberdeen Test Center (ATC) at Aberdeen Proving Ground. The ATC was selected as a designated site on January 19, 2017 and MDOT is currently engaged with ATC and exploring ways to collaborate on this exciting opportunity for Maryland. While the I-95 Corridor was not officially selected as an AV proving ground, MDOT is continuing to move forward with many of the resources, partnerships, and initiatives proposed in the application. In addition, all MDOT Transportation Business Units have been tasked with developing Strategic Plans in preparation for Connected and Automated Vehicles (CAV) in Maryland.



MDOT SHA's CAV vision is to "embrace technology and next generation mobility trends to provide safe and reliable travel for people and goods within Maryland". To support this vision, MDOT SHA is developing its CAV Strategic Plan which will address the following goals:

- 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

The following CAV initiatives are either funded or in progress in 2017:

- Automated Vehicle Testing Activities are being developed.
- MDOT is coordinating the possible use of several different transportation facilities for testing highly automated and connected vehicles, providing for a variety of different scenarios and conditions. MDOT MVA has established an online permitting system to accept and review expressions of interest and applications, and issue permits for testing.
- US 1 Innovative Technology Deployment was selected as a Corridor Pilot.

The goal of the US 1 Corridor Pilot is to develop a plan on US 1 between MD 32 and MD 100 that would integrate freeway and arterial traffic management. The pilot is expected to demonstrate CAV readiness to the private industry and be used to gain experience in multidisciplinary projects. Key elements include:

- Arterial CCTV to support incident and traffic management.
- Additional detection to support arterial travel times.
- Upgraded signal controllers to support future CAV applications.
- DSRC deployment at intersections in support of national Signal Phase and Timing (SMaT) Challenge.
- Fiber Optic communication connectivity (with redundancy) to support this and future needs.
- Other communication to support field equipment (e.g., point/multi-point or cellular).
- Additional exploration (arterial DMS, localized Road Weather Information System deployment, mid-block detection).

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MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

LARRY HOGAN
Governor

BOYD K. RUTHERFORD
Lt. Governor

PETE K. RAHN
MDOT Secretary

GREGORY I. SLATER
MDOT SHA Administrator

FOR FURTHER INFORMATION, PLEASE CONTACT:

SUBRAT MAHAPATRA

CHIEF

INNOVATIVE PERFORMANCE PLANNING DIVISION

MDOT SHA - Office of Planning and Preliminary Engineering

smahapatra@sha.state.md.us

MARYLAND STATE HIGHWAY ADMINISTRATION

707 North Calvert Street

Baltimore, MD 21202

800-323-MSHA

TTY 800-735-2258

roads.maryland.gov

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