Maryland Transportation Plan Technical Memorandum
Conditions, Trends, and Challenges

February 2018

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0 Purpose

The Maryland Transportation Plan (MTP) is developed to address federal and State requirements to create a framework for transportation priorities and investments. The plan is prepared with a twenty-year horizon and is updated every five years.

The Conditions, Trends, and Challenges Technical Memorandum is a background report that provides information that will guide and support the development of the MTP including its goals, objectives, and strategies. The document has five sections:

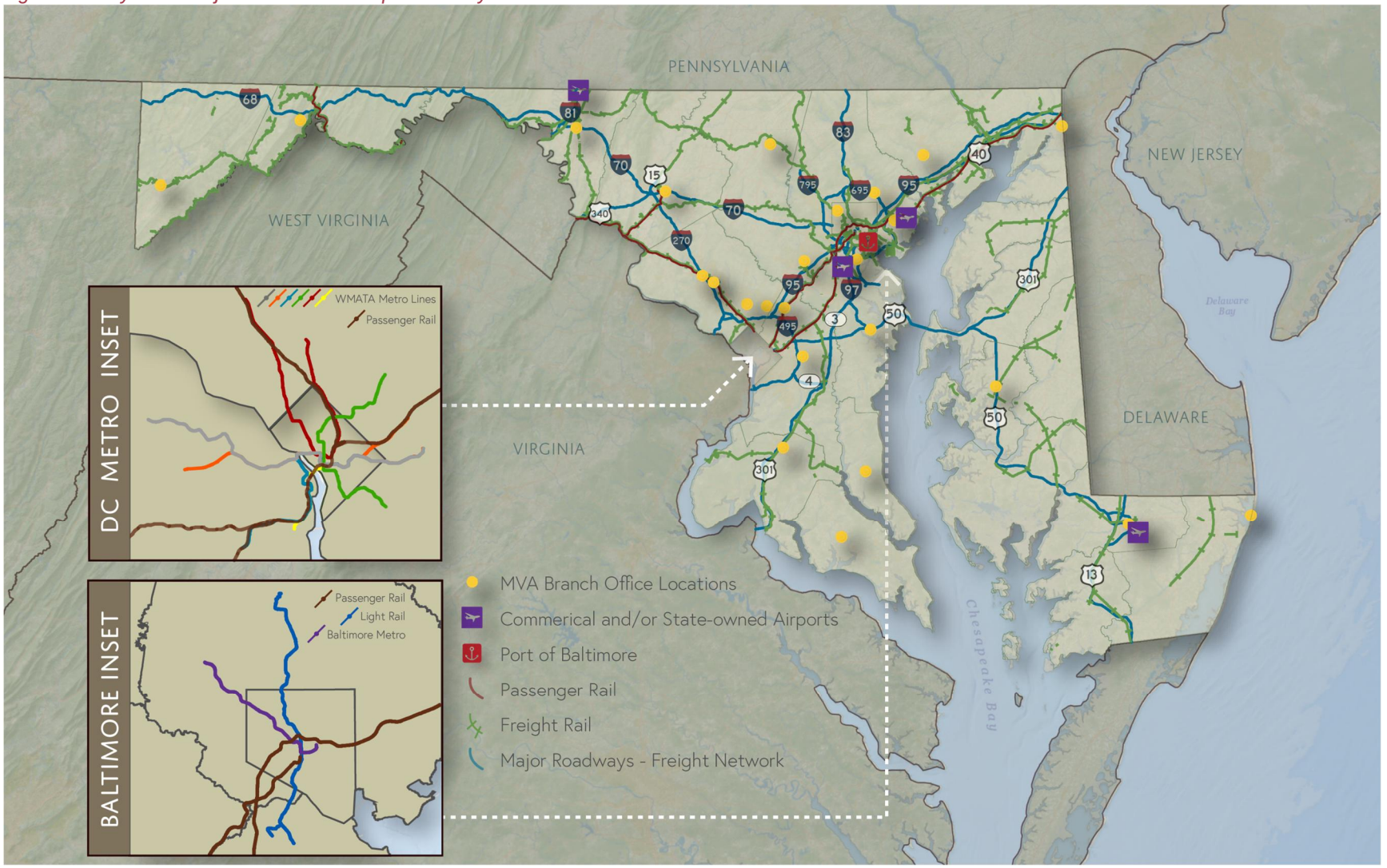
1) Transportation System Extent, which describes Maryland's transportation system;
2) Factors that Influence Transportation in Maryland, which discusses Maryland's geography, population, and economy;
3) Travel Characteristics, which describes Maryland's travel trends;
4) Environment, which outlines the steps the Maryland Department of Transportation (MDOT) is taking to minimize the impact of transportation on the environment; and
5) Maryland's Transportation Challenges and Opportunities, which outlines the issues that will need to be considered as part of the MTP development process.

1 Transportation System Extent

MDOT is a multimodal organization that includes five transportation business units and one Authority: including the State Highway Administration (MDOT SHA), the Maryland Transportation Authority (MDTA), the Maryland Port Administration (MDOT MPA), the Maryland Aviation Administration (MDOT MAA), the Maryland Transit Administration (MDOT MTA), the Motor Vehicle Administration (MDOT MVA), and The Secretary's Office (TSO). Because of its unique multimodal structure, MDOT has responsibility for the assets and coordination of multiple modes of transportation. Figure 1 shows a map of the network.

The following section provides an overview of the transportation system infrastructure inventory of MDOT.

Figure 1: Maryland's Major Statewide Transportation System



Source: Maryland Department of Transportation

1.1 State-owned Highways and Bridges

MDOT SHA owns, operates, and manages the State's highway system, while MDTA owns, operates, and maintains the State's nine tolled facilities. Together MDOT SHA and MDTA are responsible for approximately 21,411 lane miles of roadways, including interstates, national highway system (NHS) routes, and other non-NHS state routes. Table 1 below shows the lane miles of each of the systems for both MDOT SHA and MDTA facilities. Along these 21,411 lane miles of roadway, MDOT is responsible for maintaining 2,973 bridges. MDOT MTA and MDTA are also each responsible for maintaining two tunnels.

Table 1: MDOT SHA and MDTA Roadway Lane Miles

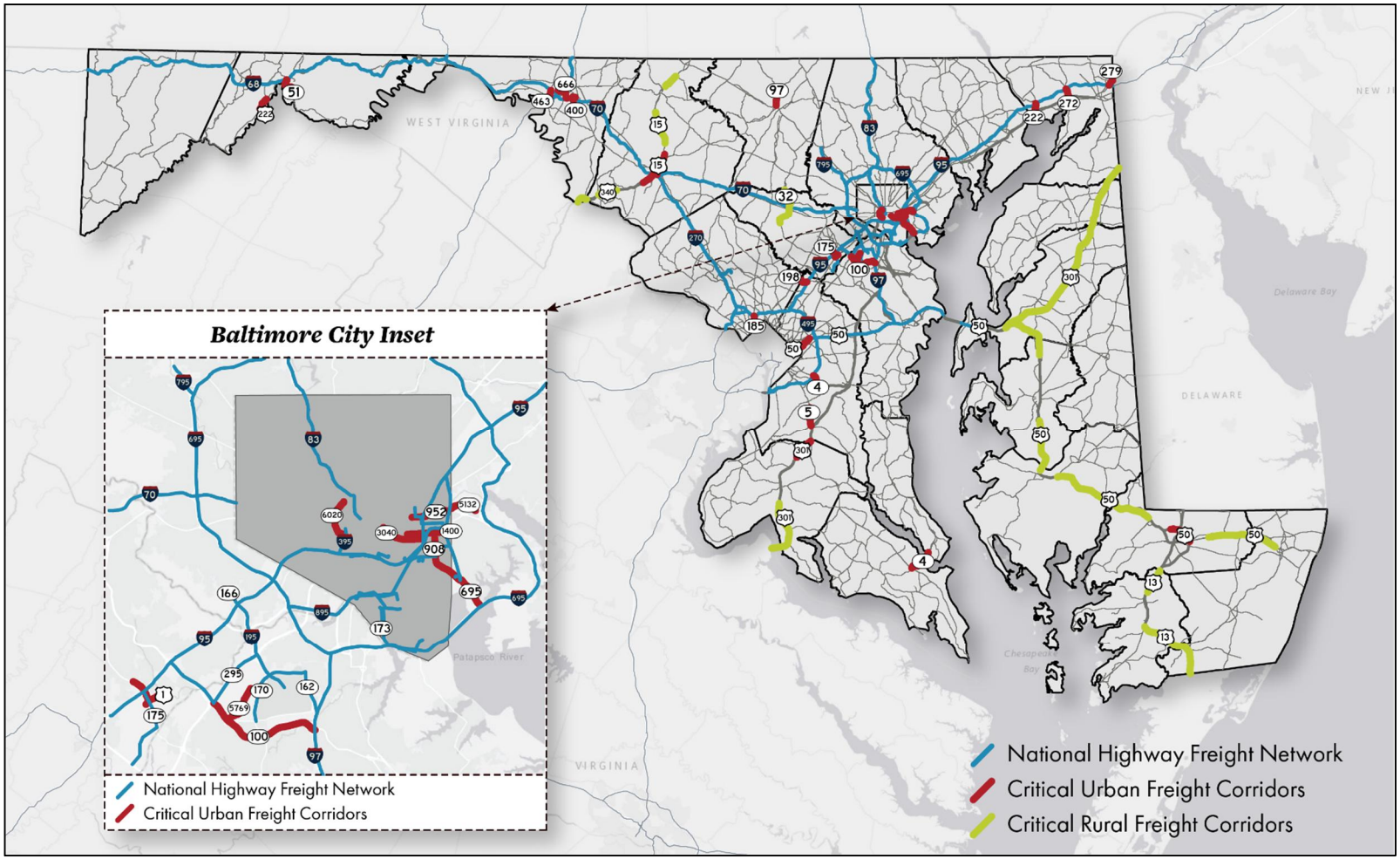
Roadway	Lane Miles
Total Interstate	3,451
Urban Interstate	2,720
Rural Interstate	731
Non-Interstate NHS	6,570
Non-NHS State roadways	7,939

The Maryland Truck Route System, which is part of the State's highway network, is approximately 900 miles long and includes all Interstate segments in Maryland, six segments of the US highway system, and eight segments of the state highway network. The FAST Act requires Federal Highway Administration (FHWA) to designate selected highways across the country as part of the National Highway Freight Network (NHFN). Maryland's 548 miles of NHFN include:

- 375 miles of federally designated Primary Highway Freight System (PHFS) routes and 29 miles of PHFS intermodal connectors that are considered most critical to freight transportation.
- 143 miles of non-PHFS Interstates.
- 150 miles of Critical Rural Freight Corridors (CRFCs) and 75 miles of Critical Urban Freight Corridors (CUFCs) that provide access to the PHFS.

The NHFN, CRFC, and CUFC routes are shown Figure 2.

Figure 2: National Highway Freight Network (NHFN), Critical Urban Freight Corridors (CUFCs), and Critical Rural Freight Corridors (CRFCs)



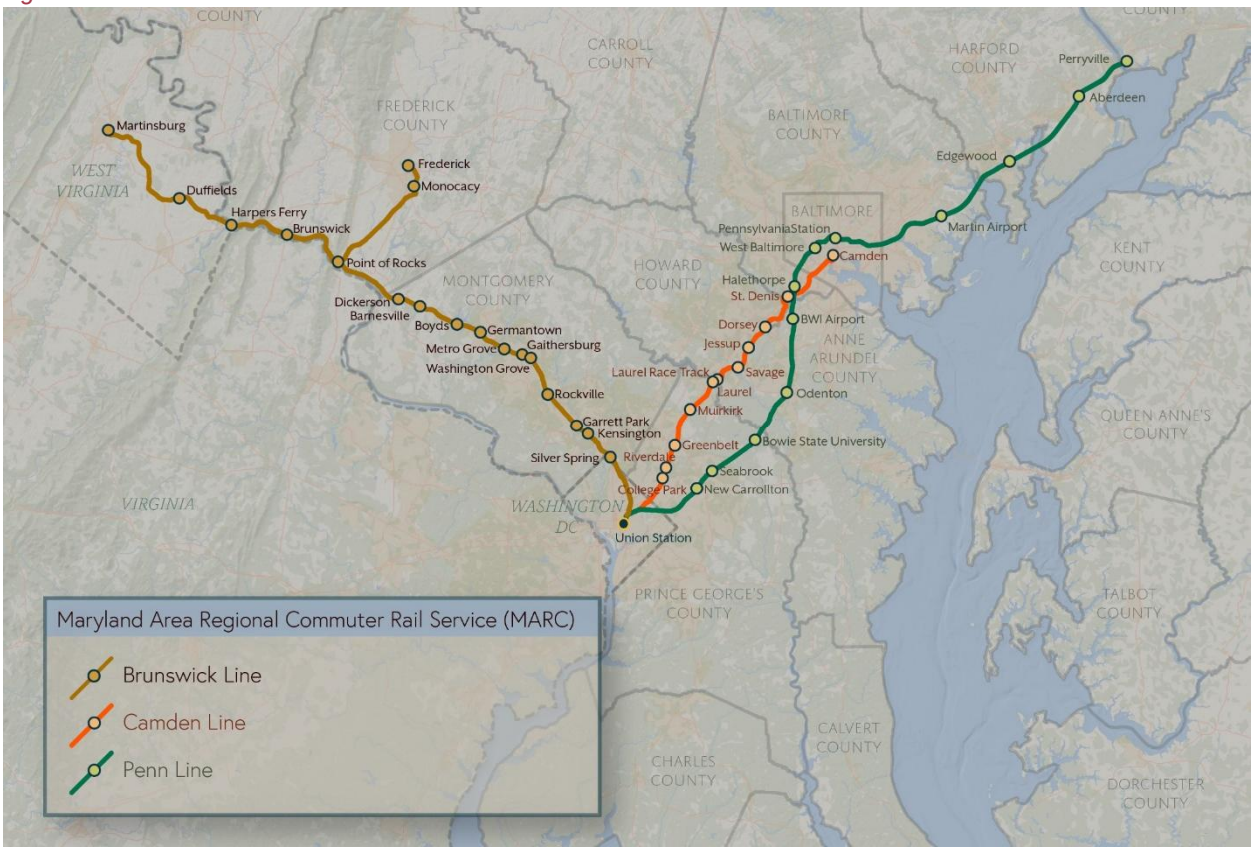
Source: Maryland Department of Transportation

1.2 Transit

MDOT MTA operates 66 local bus routes (CityLink, LocalLink, and Express BusLink) throughout the Baltimore area; 38 commuter bus routes; light rail (Light RailLink); Metro SubwayLink; and the Maryland Area Regional Commuter (MARC) train service. MARC service areas are shown in Figure 3 and include:

- Anne Arundel County
- Baltimore City
- Baltimore County
- Frederick County
- Harford County
- Howard County
- Montgomery County
- Prince George's County
- Washington County
- Washington, D.C.

Figure 3: MARC Service Area



Source: Maryland Department of Transportation

Light RailLink trains operate between Timonium and Linthicum, Hunt Valley and Timonium, Linthicum and Baltimore/Washington International Thurgood Marshal (BWI) Airport, and Linthicum and Cromwell Station/Glen Burnie. MDOT MTA also operates Maryland paratransit for citizens unable to use fixed route services (MobilityLink). MDOT MTA also directs funding and provides technical assistance for transit systems in each of Maryland's 23 counties.

MDOT MTA's revenue-producing vehicle fleet includes:

- 794 buses
- 477 vans
- 328 rail cars (100 Metro, 52 Light Rail, and 176 MARC)
- 53 locomotives (49 MARC and 4 freight)

The agency also maintains nearly 30 miles of light rail track, 15.5 miles of Metro subway, and 14 Metro SubwayLink stations.

MDOT is also a funding partner of the regional Washington Metropolitan Area Transit Authority (WMATA), and coordinates with WMATA and the Washington Suburban Transit Commission (Montgomery and Prince George's Counties) to provide planning and oversight of transit and paratransit service in the Washington Metro Region.

1.3 Intercity Bus

Intercity bus service provides vital connections between more rural areas and the urban economic centers in Maryland. MDOT MTA administers the MDOT MTA Intercity Bus (ICB) Program. MDOT MTA ICB Program sponsors intercity bus services in the following corridors:

- I-68 corridor connecting Grantsville, Frostburg, and Hancock to the Baltimore metro area (operating assistance)
- US-50 corridor connecting the eastern shore communities of Denton, Mardela Springs, and Vienna to the Baltimore metro area (operating assistance)
- US-40 corridor connecting Elkton, North East, Perryville, and other rural communities to the Baltimore metro area (capital assistance)

The connections to the Baltimore metro area made through intercity bus service allows passengers to access other modes of transportation available in Baltimore as well as access to jobs, educational institutions, and health care. In other areas of the state, local transit operations provide long distance transportation that connects with the larger/national intercity bus network.

1.4 Ports

The Port of Baltimore includes seven state-owned public cargo terminals and an international cruise terminal that are managed by the MDOT MPA. The Port also includes many privately-owned terminals. Maryland has the largest Roll-on/Roll-off (RoRo) port in the US. The Port of Baltimore is the fourth fastest growing port in North America. MDOT MPA is a landlord and its tenants handled 10.3 million tons of cargo in FY 2017 – the seventh consecutive fiscal year in which a record was set.

1.5 Airports

MDOT MAA operates two airports, BWI Thurgood Marshall International Airport and the Martin State Airport, a general aviation/reliever airport northeast of Baltimore. Maryland continues its distinction as the only state in the continental US that owns and operates their commercial airports. Commercial air growth continues in Maryland. BWI is the 22nd busiest airport in the nation with 25.7 million passengers at BWI in FY 2017, and 78 nonstop markets served directly from BWI. MDOT MAA also oversees federal grants for the 36 public-use airports in the State.

1.6 Passenger and Freight Rail

Maryland's rail network consists of approximately 1,152 miles of track and is comprised of two Class I freight railroads, four Class III short line freight carriers, one switching terminal/railroad, and one passenger railroad. Four of these railroads – CSX, Norfolk Southern (NS), Maryland and Delaware Railroad (MDDE), and Amtrak – own 76 percent of the entire network. The other 24 percent of the rail network consists of short lines, rail operating within ports, and track banked by MDOT for future use. Other freight and passenger rail carriers, such as MARC, operate via trackage rights and do not contribute to the track system mileage.

1.7 Non-motorized

More than 700 miles of sidewalks exist along Maryland state roads. MDOT SHA has created 68 miles of bicycle and shared-use lanes in Maryland. In addition to the on-system facilities, Maryland has 343 miles of rail trails. These important facilities provide connections to other modes, particularly transit. Half of Maryland's rail transit stations are within one-half mile of a trail, and 100 percent of MDOT MTA buses have bicycle racks.

2 Factors that Influence Transportation in Maryland

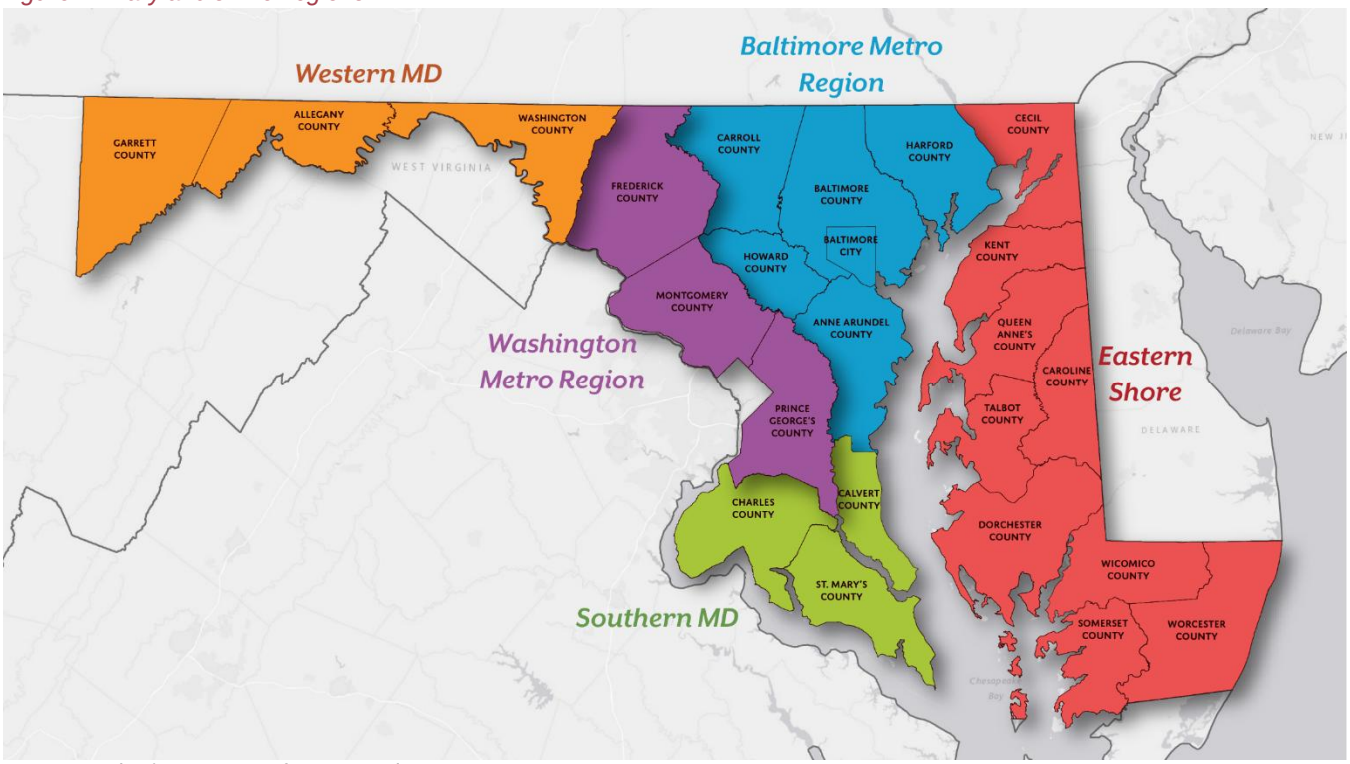
Maryland's geography, population, and economic characteristics influenced how Maryland's transportation network developed and shape how it is used today. As MDOT develops the MTP, it is important to understand these factors and the influences they can exert.

2.1 Maryland's Geography

Though Maryland is the ninth smallest state, it contains a remarkable degree of geographic diversity.[1] As shown in Figure 4, the State's defining geographic feature is the Chesapeake Bay, which nearly divides the State. The Bay's extensive shoreline (nearly 7,000 miles in length) affords numerous natural harbors for ships large and small; the most prominent is the Port of Baltimore, one of the nation's busiest ports.[2] Figure 4 also illustrates Maryland's five regions – the Eastern Shore, the Baltimore Metro Region, the Washington Metro Region, Southern Maryland, and Western Maryland. Each of the regions has its own distinct needs and associated transportation system.

[1] Source: Maryland Geological Survey, http://www.mgs.md.gov/esic/fs/fs2.html
[2] Ibid

Figure 4: Maryland's Five Regions

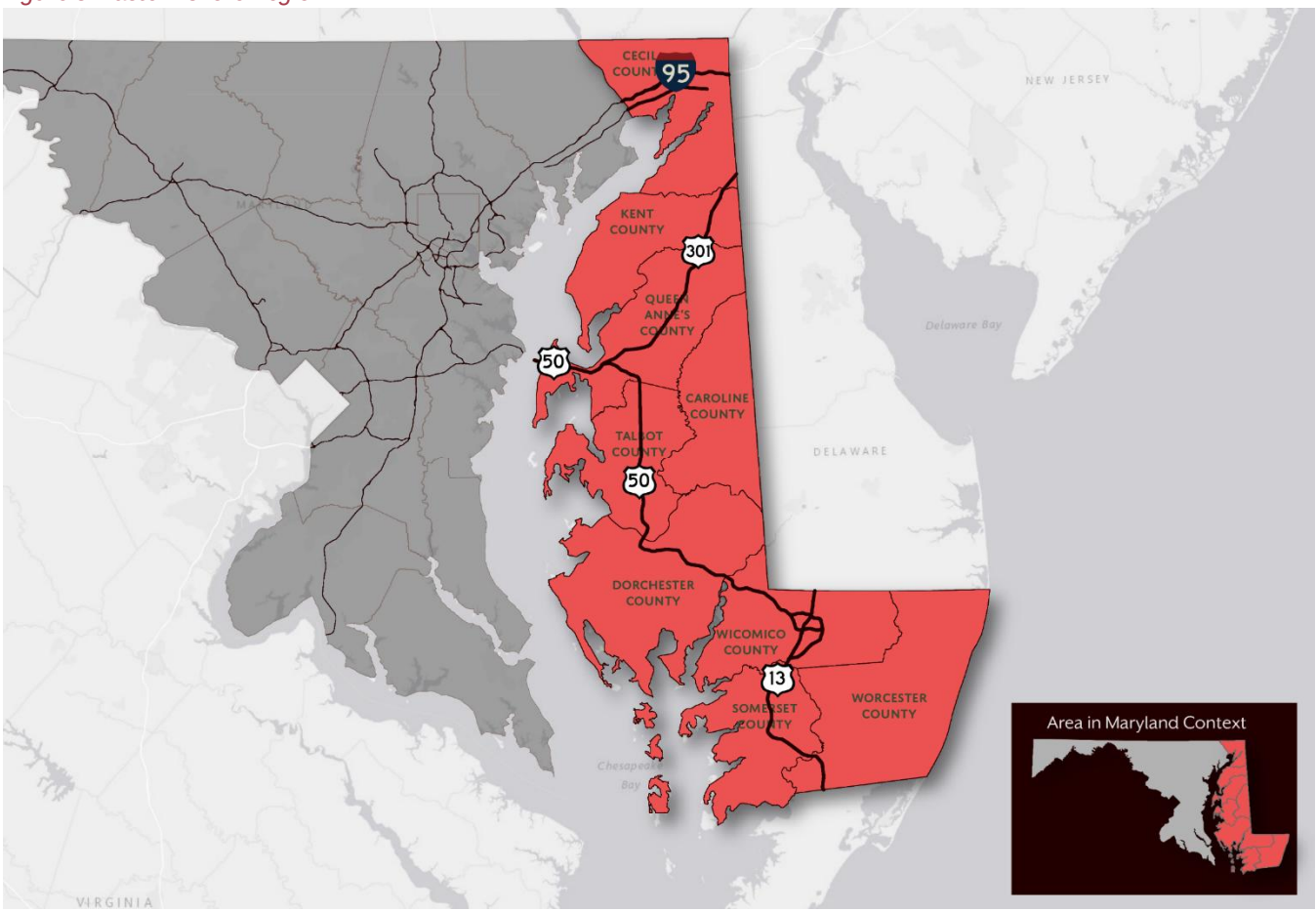


Source: Maryland Department of Transportation

2.1.1 Eastern Shore

The east side of the Chesapeake Bay on the Delmarva Peninsula is the Eastern Shore of Maryland. It is relatively flat and predominately rural with a thriving agriculture industry, including large poultry farms. The small city of Salisbury is a center of this industry, especially with respect to chicken processing. Tourism is also important on the Eastern Shore; especially for the ocean side beach town of Ocean City. The counties that make up the Eastern Shore north to south are Cecil, Kent, Queen Anne's, Caroline, Talbot, Dorchester, Wicomico, Worcester, and Somerset. (See Figure 5.)

Figure 5: Eastern Shore Region



Source: Maryland Department of Transportation

The Eastern Shore's transportation system is primarily highway-oriented. Key roadway routes include

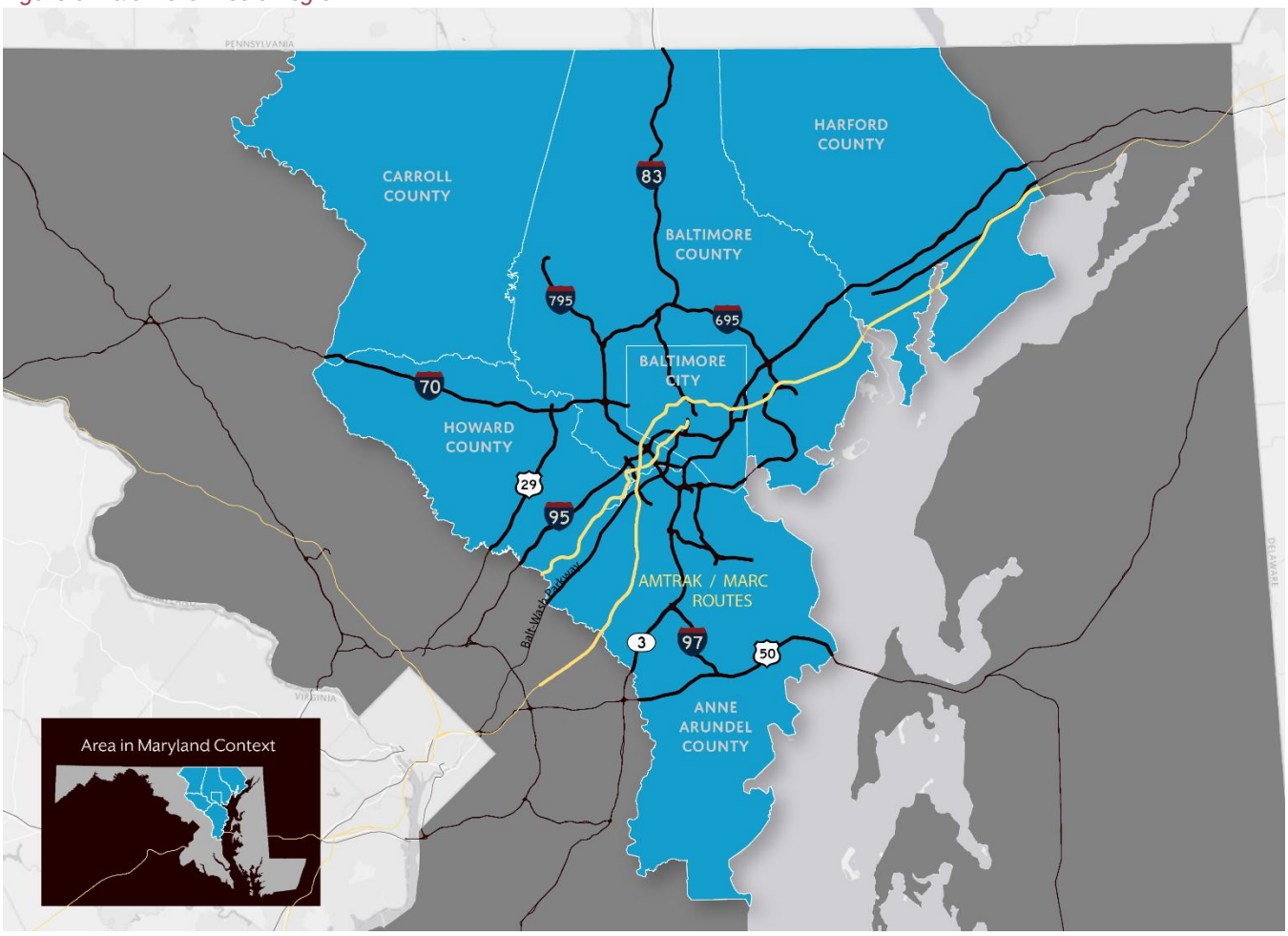
- Interstate 95, the main highway connecting major cities on the East Coast, which runs across Cecil County at the far northern end of the region
- US 50, which crosses the Chesapeake Bay Bridge and provides a link between the Eastern Shore and the rest of the State; it is also a key route for holiday traffic to Ocean City and to the Delaware Beaches
- US 301, which provides access to the northern portion of the eastern shore near Chestertown
- US 13, which traverses the length of the Eastern Shore and connects Wilmington, Delaware with Tidewater, Virginia

In addition to the roadway network, some communities, such as Salisbury and Ocean City, operate local fixed-route bus systems.

2.1.2 Baltimore Metro Region

The Baltimore Metro Region comprises Baltimore City and its surrounding counties – Carroll, Baltimore, Harford, Howard, and Anne Arundel. Included within the region is Annapolis, the State capital. (See Figure 6.)

Figure 6: Baltimore Metro Region



Source: Maryland Department of Transportation

Land use in the region is varied with dense historic urban cores in Baltimore and Annapolis transitioning into medium to low density suburban areas in southern Baltimore, northern Harford Counties, eastern Howard County, and northern Anne Arundel County. The landscape becomes progressively more rural as one moves towards the periphery of the region. Socio-economic shifts have included population loss in portions of Baltimore City and continued outward suburban expansion with low density housing developments consuming agricultural lands (particularly in Howard, Carroll, and Harford Counties). Baltimore County has continued to maintain a strong growth management policy, potentially resulting in growth across its northern boundary in Pennsylvania, increasing congestion on the I-83 corridor.

A wide variety of multimodal transportation options are available in this region. Key highways include:

- Interstate 95, which provides a vital connection along the nation's East Coast and links Baltimore with Washington, D.C.
- Interstate 70, which provides an important connection between Baltimore and Frederick (in the Washington Region) and points west
- Interstate 83, which provides access from Baltimore City to central Pennsylvania and points north
- Interstate 97, which links Baltimore and Annapolis
- US 50, which links Washington, D.C., Annapolis, and the Eastern Shore
- Baltimore-Washington Parkway, which provides an alternate route to Interstate 95 between Baltimore and Washington
- Interstate 695, the Baltimore Beltway, which is a circumferential highway around Baltimore City

Intercity train service along the US's East Coast is provided by Amtrak along the Northeast Corridor. Within the Baltimore Metro Region, trains stop at Aberdeen in Harford County, Pennsylvania Station in Baltimore City, and the BWI rail station in Anne Arundel County. Regional commuter rail service within the region is provided by the MDOT MTA's MARC service. The Baltimore Metro Region has two MARC commuter lines – the Camden Line and the Penn Line. The Camden Line travels between Baltimore City and Washington, D.C. The Penn Line travels between Washington, D.C., Baltimore City, and northeastward to Perryville. In addition to servicing the urban stations, MARC trains also stop at more suburban locations along the route.

MDOT MTA operates the Baltimore region's transit service. It includes core bus service in Baltimore City and Baltimore County; Metro subway between Owings Mills in northwest Baltimore and downtown Baltimore City; Light Rail between Hunt Valley in northern Baltimore County and Cromwell and BWI Airport in Anne Arundel County; and commuter buses between suburban locations and downtown Baltimore, Fort Meade, and from Howard and Anne Arundel Counties to downtown Washington. The counties also operate their own county-based bus systems.

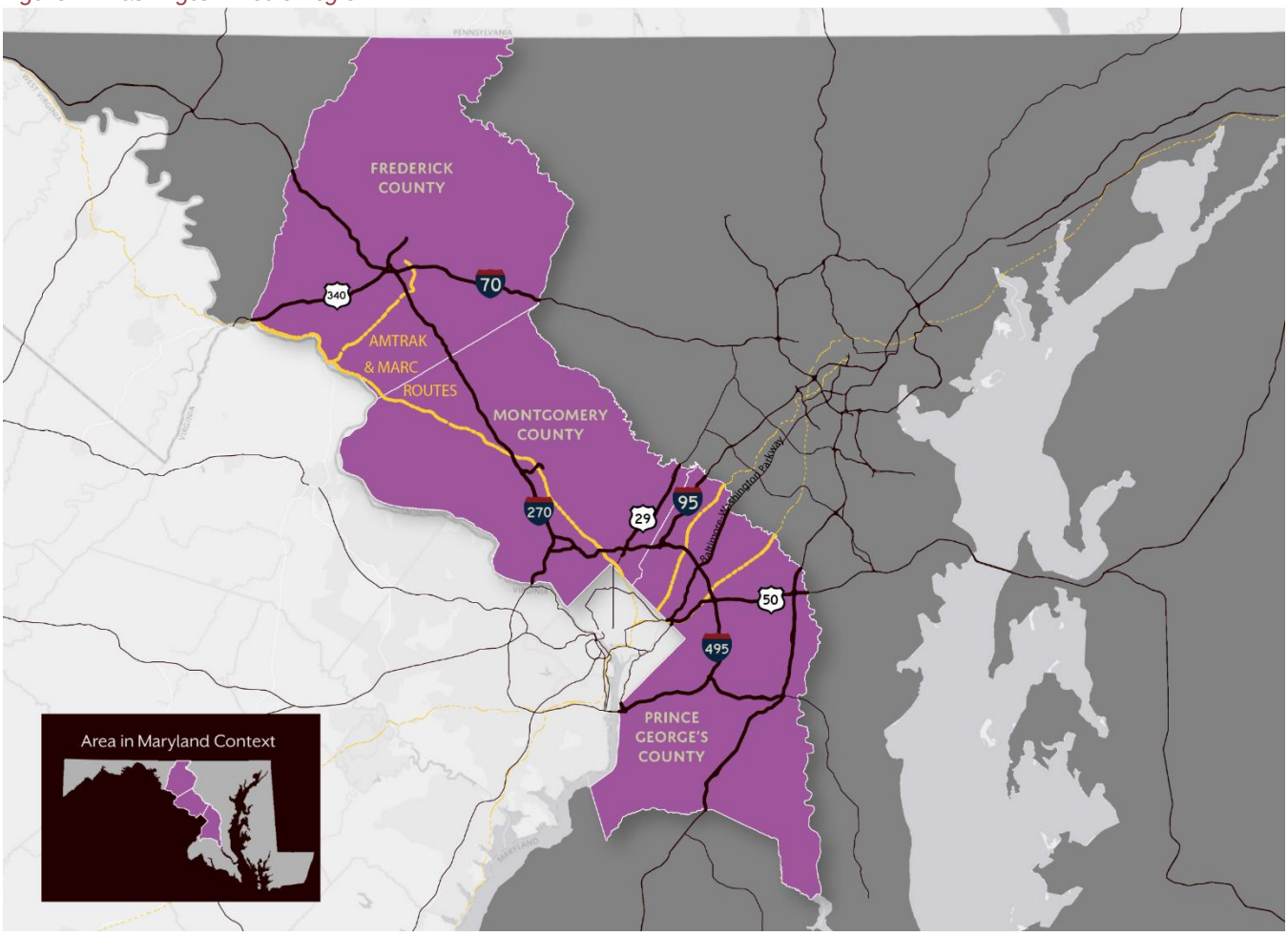
The Baltimore Metro Region is home to the Port of Baltimore, BWI Thurgood Marshall Airport, and Martin State Airport.

2.1.3 Washington Metro Region

The Washington Metro Region is made up of the suburban counties surrounding Washington, D.C. – Montgomery and Prince George's Counties – and Frederick County, which is just north of Montgomery County. (See Figure 7.)

Land use in the region is primarily suburban or rural with newer dense urban nodes. The City of Frederick has a moderately dense historic town center. A key land use trend in the region is rapid suburban growth along the I-270 corridor, especially in southern Frederick County. Some of this new suburban growth is fairly dense (that is, 3.5 to 8 dwelling units per acre), but there is also a large amount of low density housing being built on former farmlands in both Frederick and Prince George's Counties.

Figure 7: Washington Metro Region



Source: Maryland Department of Transportation

The highway system in the region is highly radial with the focal point being Interstate 495, the Capital Beltway.

- From the Beltway, Interstate 270 extends to the north and west linking Washington with suburban Montgomery County, Frederick, and points west
- Interstate 95 follows the east side of the Capital Beltway before heading northeast towards Baltimore, Philadelphia, and New York; the Baltimore-Washington Parkway and US 29 run parallel to this portion of I-95 providing important alternate routes and, in the case of the Parkway, a freeway connection to downtown Washington, D.C.
- US 50 heads east from the Washington, D.C. boundary line providing a direct highway connection to Annapolis and the Eastern Shore

An extensive and heavily-used transit network is a key transportation feature in this region. WMATA's Metro subway provides an efficient connection to downtown Washington from inner suburban Montgomery and Prince George's Counties. WMATA also operates an extensive core bus service throughout these counties. Each county in the region also has its own bus system to provide for local

travel and regional connections. Augmenting these transit services, MDOT MTA provides MARC service along three corridors - northwestward from Washington, D.C. through Montgomery County to Frederick and Brunswick (Brunswick Line), northward from Union Station paralleling I-95 to connect to downtown Baltimore at the Camden Station (Camden Line), and a more easterly route which connects along Union Station and Baltimore's Penn Station (Penn Line) on the same alignment traveled by Amtrak service. There are also several commuter bus options to downtown Washington, D.C. and Fort Meade.

The Purple Line is a 16-mile light rail line currently under construction that will extend from Bethesda in Montgomery County to New Carrollton in Prince George's County. It will provide a direct connection to the Metrorail Red, Green and Orange Lines at Bethesda, Silver Spring, College Park, and New Carrollton. The Purple Line will also connect to MARC, Amtrak, and local bus services.

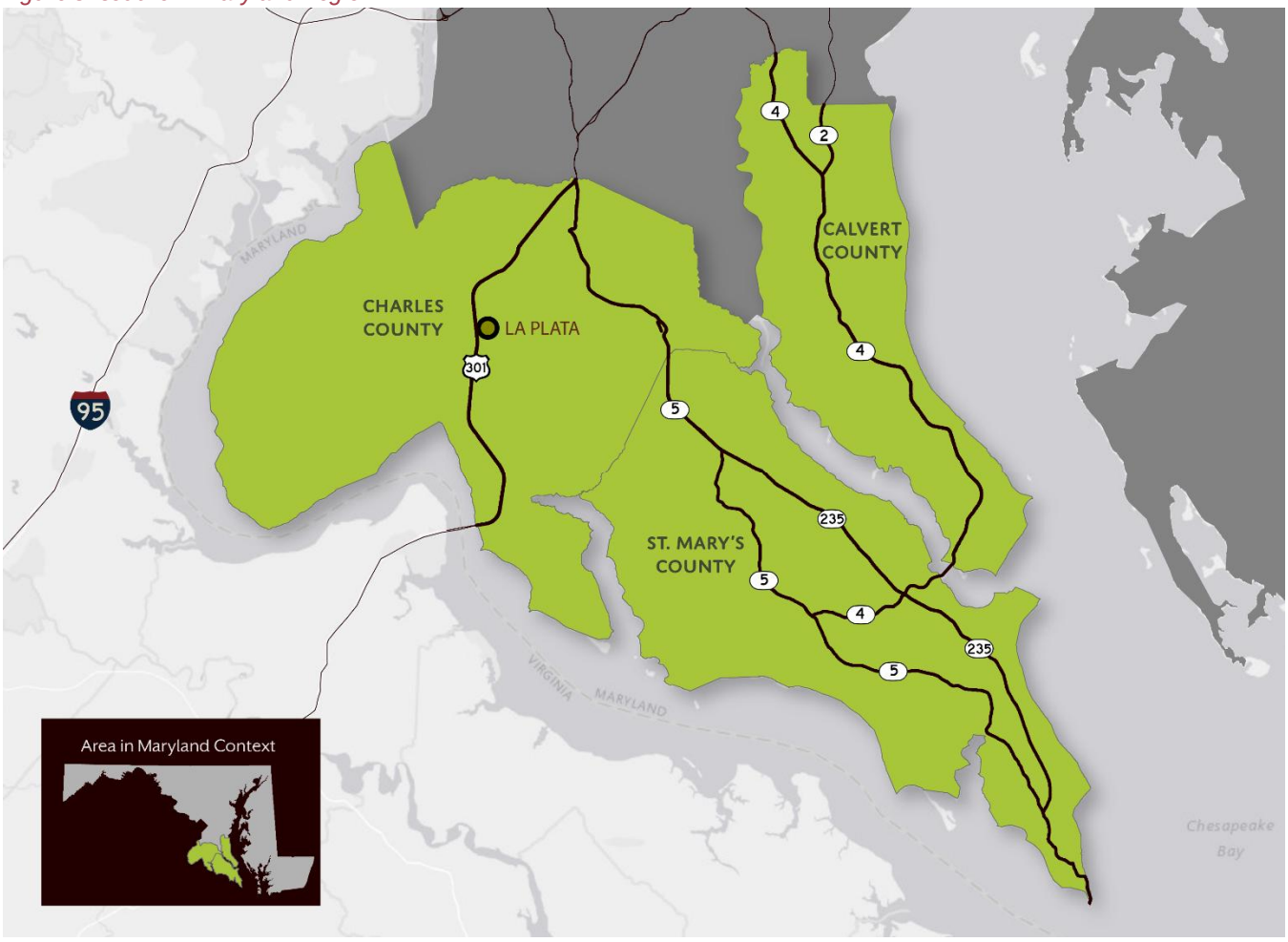
For longer distance trips, an Amtrak connection to its busy Northeast Corridor line is available in New Carrollton (Prince George's County). Another Amtrak station is in Rockville (Montgomery County) on the route linking Washington, D.C. to Pittsburgh and points west.

2.1.4 Southern Maryland

Southern Maryland comprises the counties to the south and east of Washington, D.C. on the western shore of the Chesapeake Bay. This region is, in percentage terms, projected to be the fastest growing in Maryland. Important transportation facilities include the Governor Harry W. Nice Memorial Bridge, which connects Charles County, MD with King George County, VA on US 301 and the Governor Thomas Johnson Memorial Bridge, which joins Calvert and St. Mary's Counties. (See Figure 8.)

Rapid, low-density suburbanization is a key land use feature of this portion of the State. The growth is attributable to expansion of employment opportunities within the region (most notably by employment growth associated with Patuxent Naval Air Station) and an influx of people who work in the Washington, D.C. region.

Figure 8: Southern Maryland Region



Source: Maryland Department of Transportation

The transportation network in the Southern Maryland Region is heavily automobile-oriented. However, there are few limited access expressways in the region. Key four-lane arterials include:

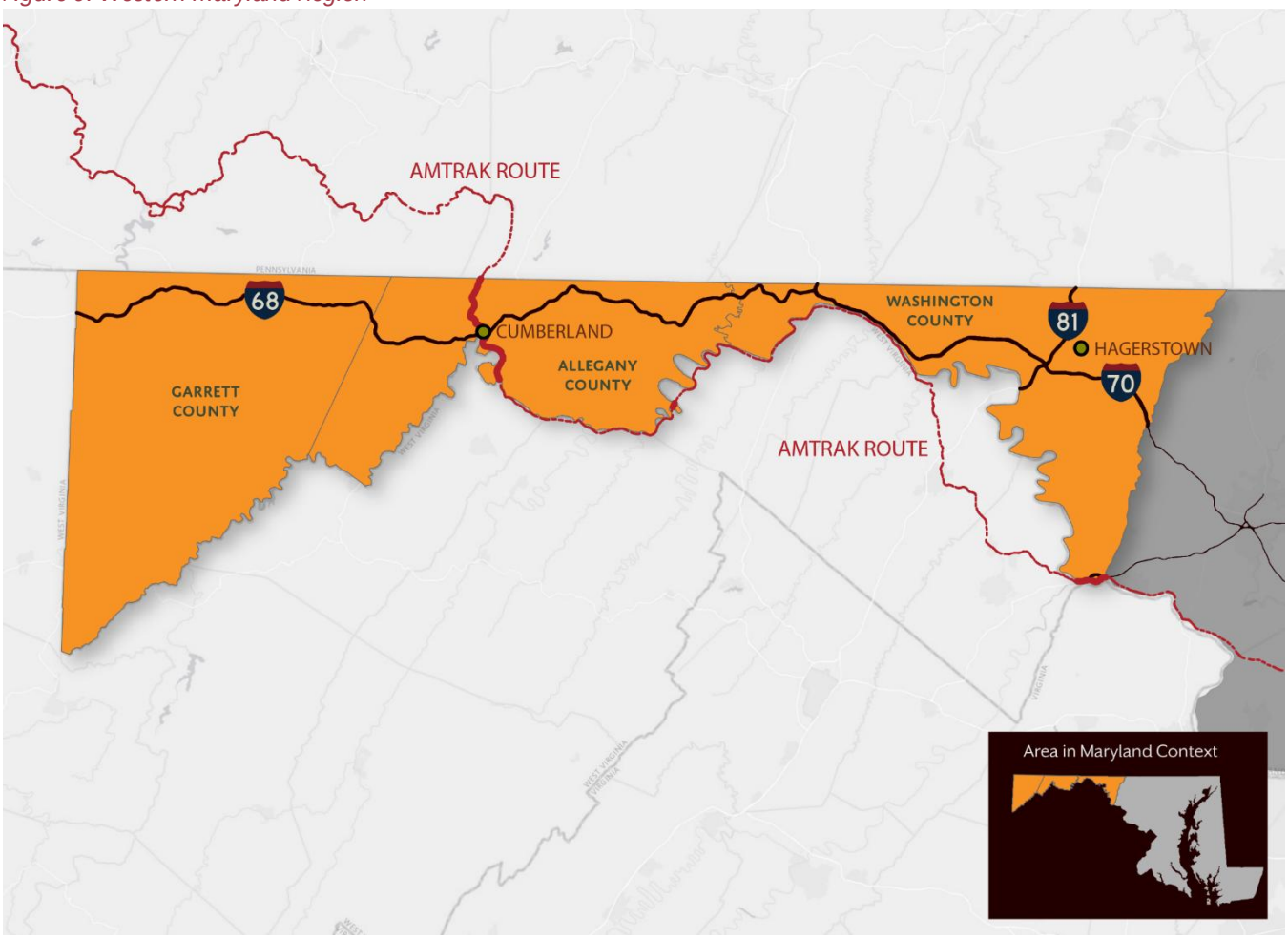
- MD 4, which connects Calvert County to the Washington Metro Region
- MD 5, which connects St. Mary's County to Charles County and Prince George's County
- MD 235, which provides access along the length of St. Mary's County
- US 301, which traverses Charles County north to south and is the only route in the region that crosses the Potomac River into Virginia. It can be used as an alternative to I-95 to avoid congestion on the Washington Beltway and in northern Virginia

MDOT MTA operates several commuter bus routes from points within the region's counties to downtown Washington, D.C. In addition, each county operates its own county-based fixed-route bus systems.

2.1.5 Western Maryland

Western Maryland is in Maryland's panhandle and, west to east, comprises Garrett, Allegany, and Washington Counties. (See Figure 9.) The region is mostly rural and characterized by forested mountain ridges, some agriculture, small towns, and the cities of Hagerstown in Washington County and Cumberland in Allegany County. Western Maryland is the State's least populous region.

Figure 9: Western Maryland Region



Source: Maryland Department of Transportation

As on the Eastern Shore, the transportation system in this region is primarily automobile-oriented. Key roadways include

- Interstates 70 and 68, which traverse the Appalachian Mountains and connect Maryland with the Midwest
- Interstate 81, which traverses a short distance through Maryland, is another critical roadway, especially for freight; it links the Northeast with destinations to the South and Southwest
- US 219 bisects Garrett County and provides connections between Oakland and West Virginia and Pennsylvania

- US 220 is the primary north-south route in central Allegany County and connects Cumberland to West Virginia and Pennsylvania

Locally operated fixed-route bus services are provided in Cumberland and Hagerstown. Amtrak also makes a station stop in Cumberland on its route between Washington, D.C. and Chicago.

The eastern portion of Western Maryland faces development pressures radiating from Frederick, Washington, D.C., and Baltimore as residents search for newer development at lower cost. The western portion of the region is dominated primarily by highway travel, linking lower density development with various commercial developments and towns including Cumberland and Frostburg (both in Allegany County).

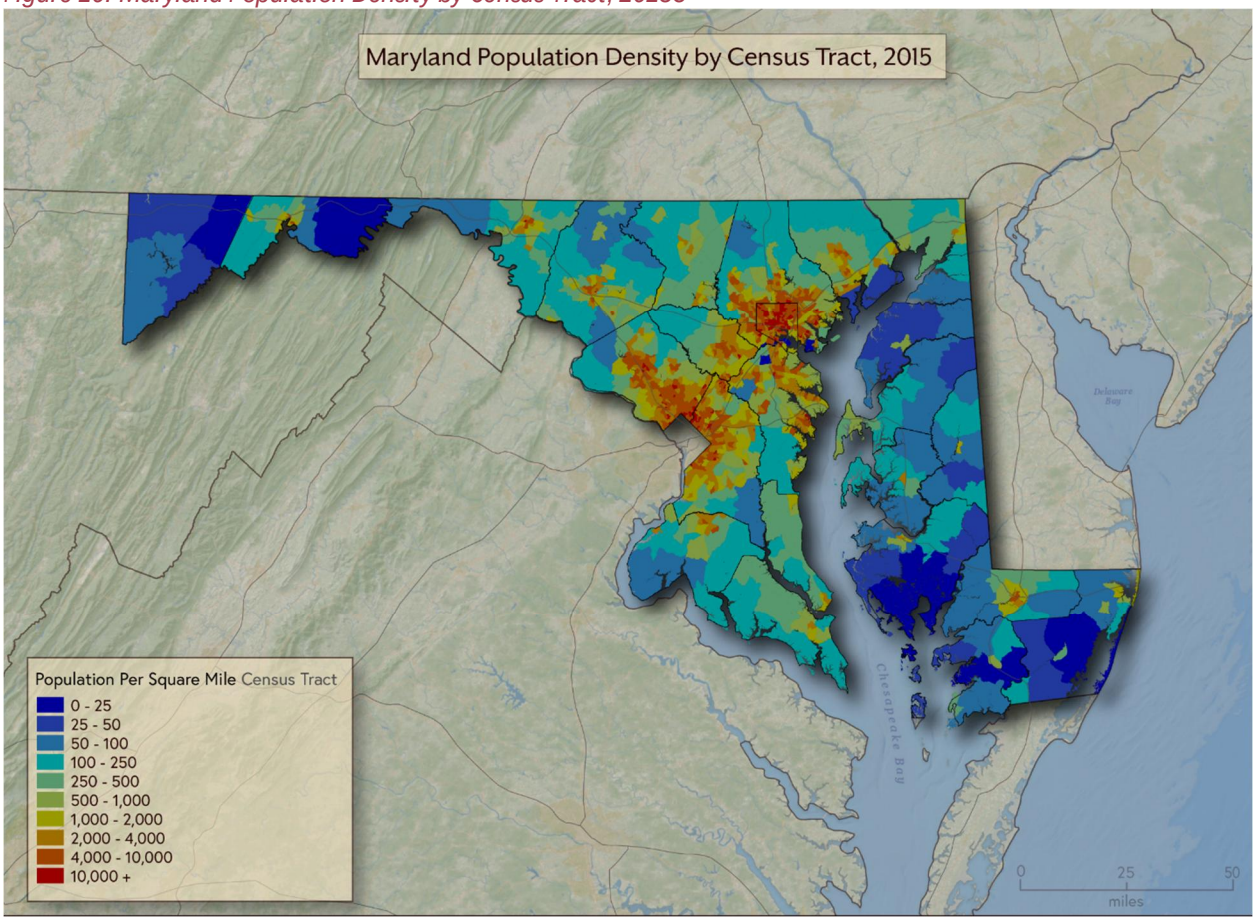
2.2 Maryland's Population

Demand for travel in Maryland is directly tied to population growth, density, and demographics. Population growth adds daily trips that the transportation system needs to accommodate. In areas of the state with high population density, residents tend to rely more on mass transit and non-motorized transportation modes, while less populated areas remain reliant on motor vehicles. Shifts in the composition of the population can impact relative demand for different modes of travel. For example, aging residents often require alternative modes of transportation to accommodate their needs.

2.2.1 Population Growth and Distribution

As of 2016, Maryland's population is estimated at 6.0 million, placing it 19th among states in terms of total population. However, the state ranks 42nd in land area, making it the fifth most-densely populated state. As shown in Figure 10, *population and population density are primarily concentrated in central Maryland along the I-95 corridor between Washington, D.C. and Baltimore, and also along radial lines extending out from Washington, D.C.* As of 2016, the combined Baltimore and Washington region, which includes only nine of the State's 24 counties or county equivalent, contains over 82 percent of the state's population. Baltimore, Silver Spring, Bethesda, and Towson are key high-density population and employment nodes within this broader area. Outside of these areas, land uses become more suburban in character before transitioning into land uses more rural in character.

Figure 10: Maryland Population Density by Census Tract, 20153



Source: 2015 5-year ACS Data (Census Tract Geographies – 2010 US Census)

Maryland's overall population is growing. Between 2000 and 2010, the State's population grew 9.0 percent, just below the national average of 9.7 percent. Growth has continued at a steady rate since then, with the state adding an additional 250,000 residents between 2010 and 2016. As Table 2 shows, population has grown most rapidly in the Washington Metro and Southern Maryland regions during this time, with the regions seeing over a 6 percent increase in population, compared to only 4.2 percent statewide. The Eastern Shore region, on the other hand, saw growth of only 1.0 percent during this period, and Western Maryland experienced a population decline.

Table 2: Population Trends by Region

	2010	2016	Percent Growth	Share of State Population (2016)
Baltimore Metro Region	2,662,691	2,749,957	3.3%	45.7%
Washington Metro Region	2,068,582	2,199,503	6.3%	36.6%
Southern Maryland Region	340,439	361,153	6.1%	6.0%
Western Maryland Region	252,614	251,847	-0.3%	4.2%

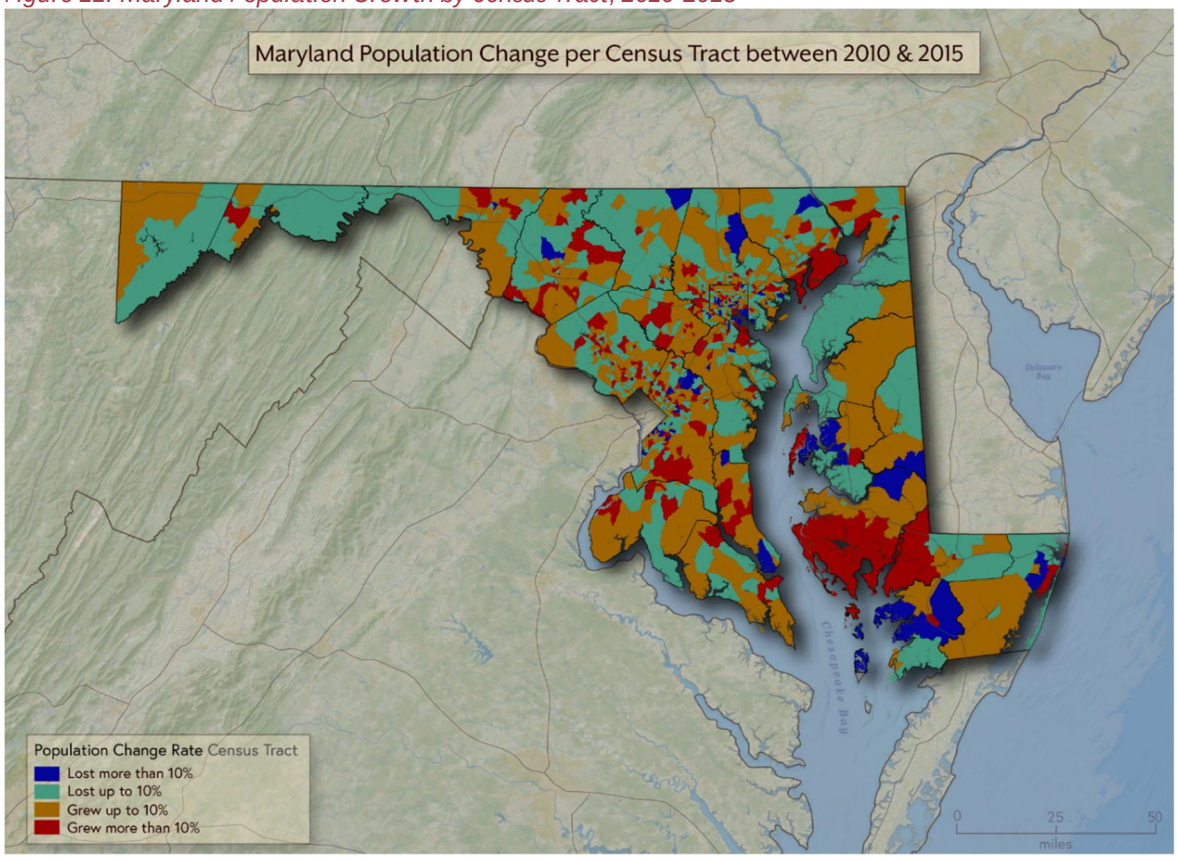
[3] Source: U.S. Census Bureau

	2010	2016	Percent Growth	Share of State Population (2016)
Eastern Shore Region	449,226	453,597	1.0%	7.5%
Maryland	5,773,552	6,016,447	4.2%	100.0%

Source: Population Division, U.S. Census Bureau, Prepared by the Maryland Department of Planning, March 2017

Figure 11 below shows geographic variation in population growth at a more granular level – by Census tract. *While most tracts across the State experienced population growth between 2010 and 2015, a concentration of tracts in western Maryland, Baltimore City, and the Upper Eastern Shore saw population declines*. Population growth between 2010 and 2015 was highest around the suburbs of Washington, D.C. and Baltimore, as well as in the Southern Maryland region. The counties that experienced the most growth during this period, in order, were Howard, Charles, Montgomery, St. Mary's, Frederick, Anne Arundel, and Prince George's Counties – each of which experienced growth over 5 percent. The arc of suburban growth occurring around Washington, D.C. is putting great pressure on the transportation system in central Maryland. (The high percentage of growth shown on the western side of the lower Eastern Shore is based on having a small population, which amplifies the effect of even a small increase in population.)

Figure 11: Maryland Population Growth by Census Tract, 2010-2015



Source: 2010 US Census Data, 2015 5-year ACS

Future population growth is expected in Maryland. (See Table 3.) By 2040, the State is projected to add 800,000 new residents, representing an increase of 13.6 percent. Population in Southern Maryland is expected to grow over 30 percent, the fastest among the five regions. This will put further strain on the existing transportation system.

Table 3: Population Forecasts by Region

	2016	2040	% Growth
Baltimore Metro Region	2,749,957	2,989,250	8.7%
Washington Metro Region	2,199,503	2,511,700	14.2%
Southern Maryland Region	361,153	474,350	31.3%
Western Maryland Region	251,847	297,450	18.1%
Eastern Shore Region	453,597	561,750	23.8%
Maryland	6,016,447	6,834,500	13.6%

Source: Population Division, U.S. Census Bureau, Prepared by the Maryland Department of Planning, March 2017

Maryland has also seen an increasingly aging population in line with national trends. As seen in Table 4, the 65-and-older cohort grew 23.8 percent between 2010 and 2016; this rate is almost six times that of the state's overall population. In 2016, the population age 65 and over equaled 14.56 percent of the total population, compared to just 12.22 percent in 2010. This growth is expected to continue as the Baby Boomer generation ages, presenting new transportation challenges for the state of Maryland. These challenges are not unique to Maryland as the percentage of older residents in Maryland corresponds to national averages of 12.4 percent in 2010 and 15.2 percent in 2016.

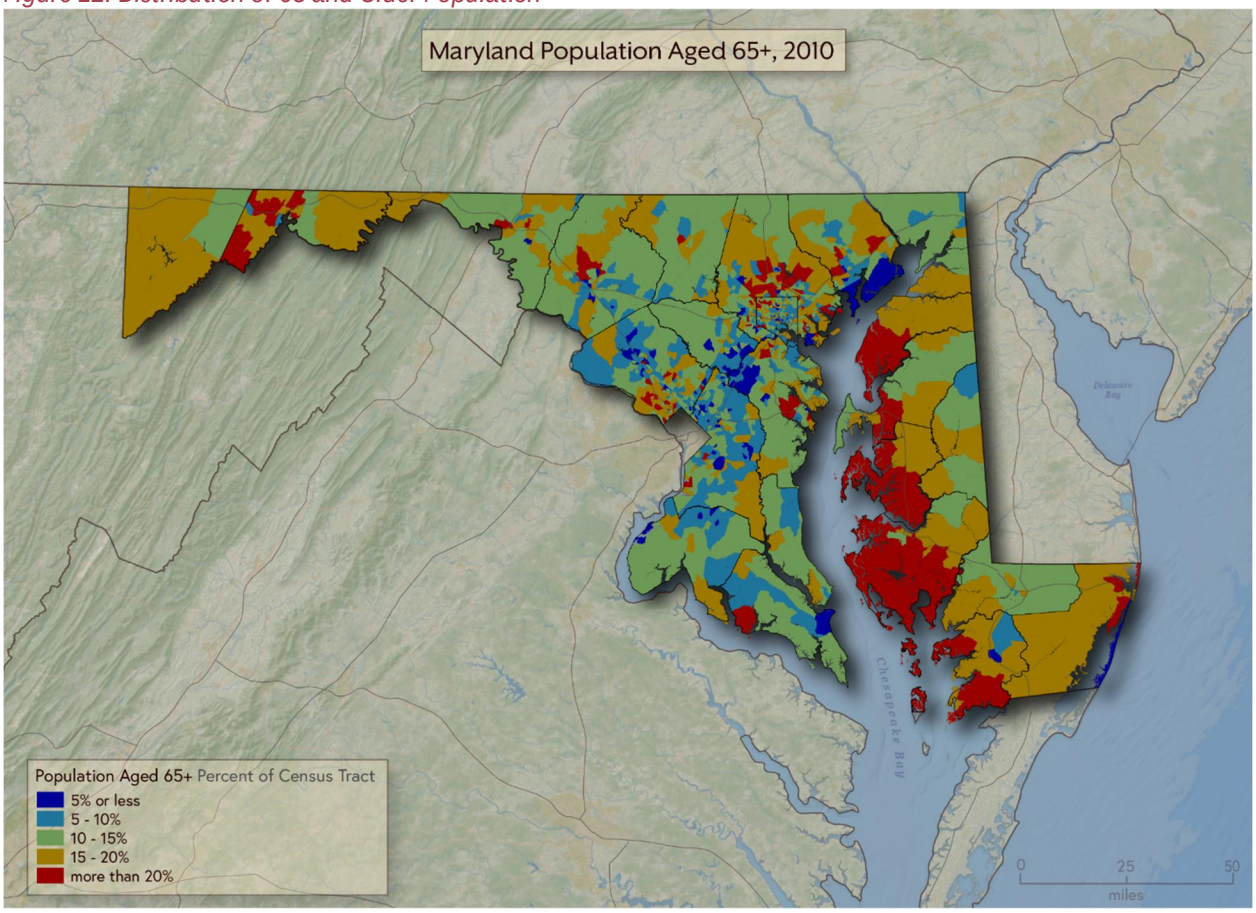
Aging residents often require alternative modes of transportation to help meet their needs. Improved pedestrian infrastructure and transit service are two ways the State can address this challenge. Figure 12 shows where *there are concentrations of older populations, much of which is in more rural areas with more dispersed populations*. The geographic locations of seniors could present additional challenges to ensuring that they have access to transportation choices. It should be noted, however, that this map is highlighting *concentrations* of elderly residents as the absolute number of aging residents can still be higher in areas of more dense overall populations.

Table 4: Population Age Distribution

	2010	2016	% Growth
0-19	1,516,626	1,503,031	-0.9%
20-39	1,533,149	1,618,872	5.6%
40-64	2,016,135	2,018,334	0.1%
65+	707,642	876,210	23.8%
Total	5,773,552	6,016,447	4.2%

Source: Population Division, U.S. Census Bureau, Prepared by the Maryland Department of Planning, March 2017

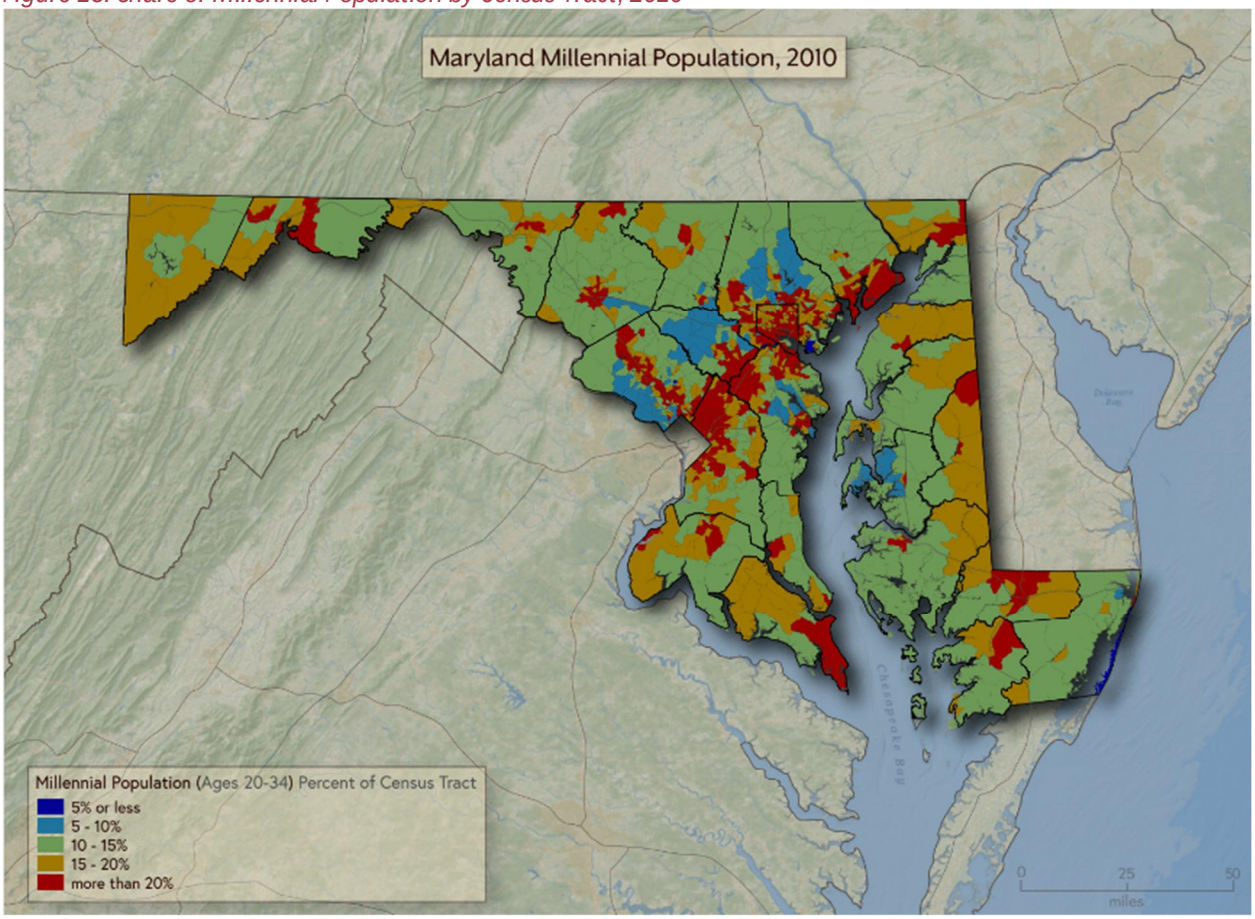
Figure 12: Distribution of 65 and Older Population



Source: US Census Data 2010

After the 65-and-older cohort, the 20-to-39 age cohort was the one with the next highest rate of population growth, as seen in Table 4. This category largely overlaps with that of the "Millennial Generation," a demographic cohort that is usually defined to consist of those born between the mid-1980s and late 1990s. Figure 13, which shows *the concentration of Maryland's Millennials (ages 20-34) by census tract, reveals that they are most clustered in the Baltimore-Washington corridor – a dense, highly developed part of the state well-served by public transit*. Millennials tend to prefer living in such environments, which may provide additional challenges for transportation planners, particularly as this generation continues to enter the workforce.

Figure 13: Share of Millennial Population by Census Tract, 2010

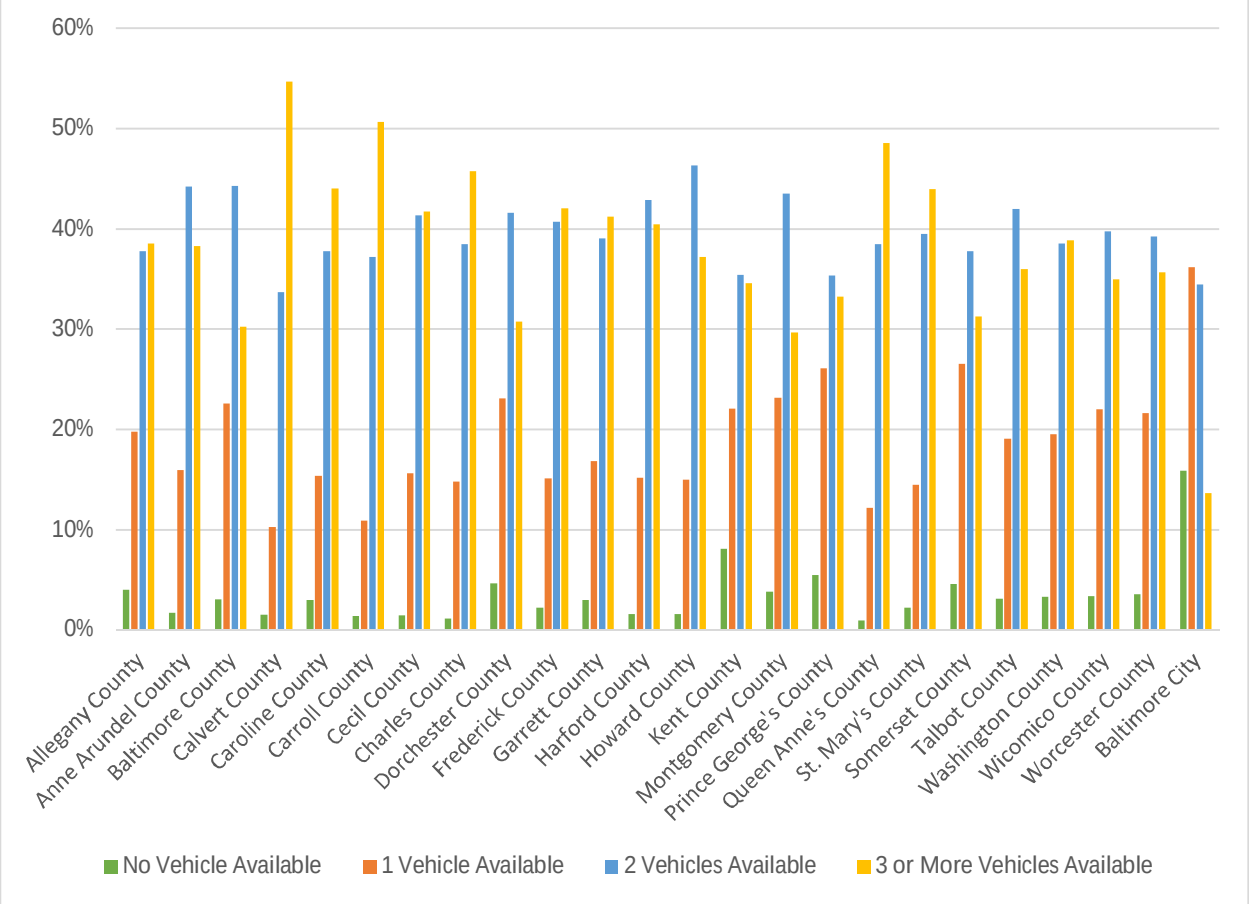


Source: US Census Data 2010

2.2.2 Vehicle Availability

Of the nearly 2.2 million households in Maryland, 9.1 percent (or 200,000) do not have a car. This could be by choice or because of an inability to afford a vehicle. Figure 14 shows the number of vehicles per house varies greatly by county.

Figure 14: Household Vehicle Availability by County

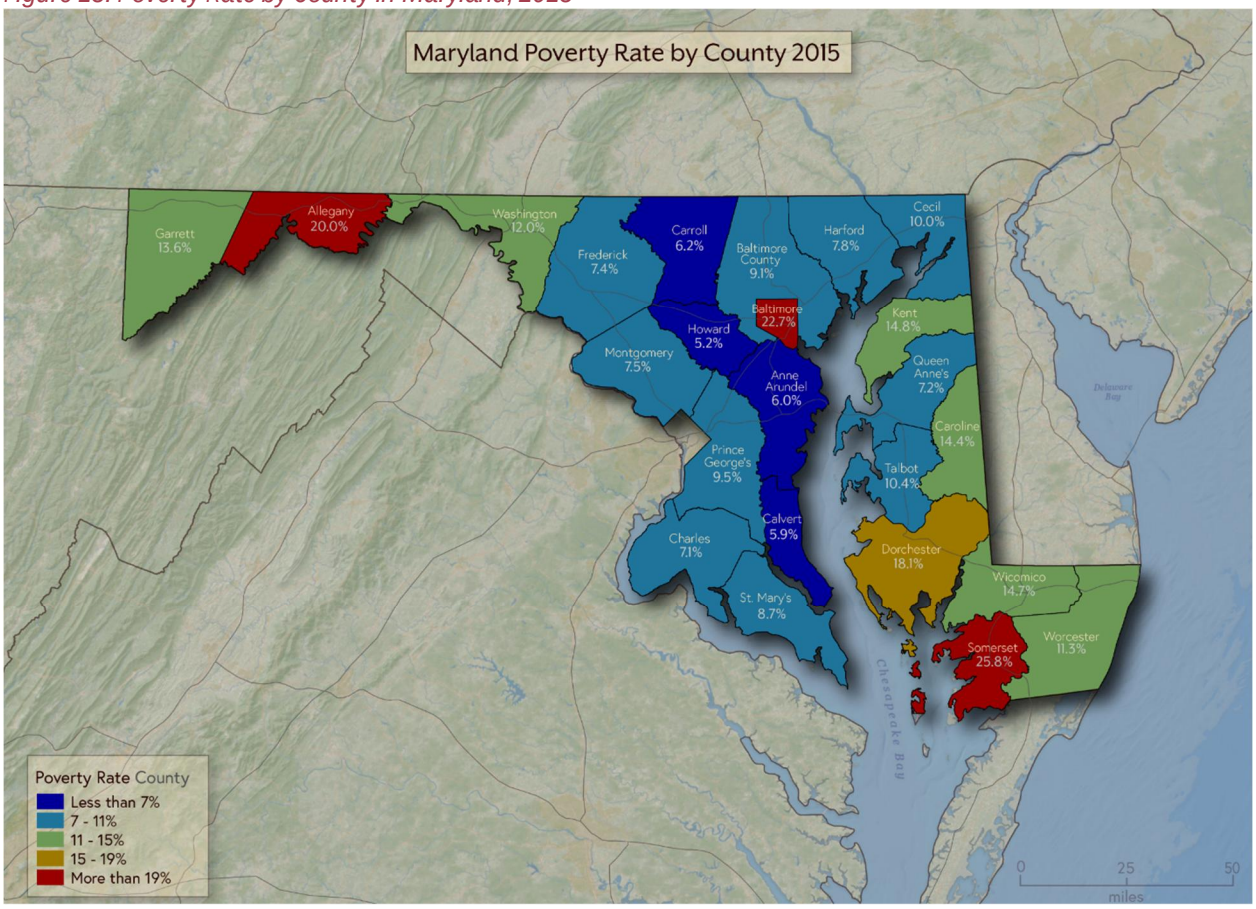


Source: U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates

2.2.3 Poverty

Baltimore City faces a poverty rate (22.7 percent) more than double the statewide average of 9.9 percent. *Outside of Baltimore City, poverty in Maryland tends to be concentrated in Western Maryland and the Eastern Shore*. Eleven of the twelve counties in these regions has a poverty rate higher than the state average. Figure 15 displays poverty rates by county in Maryland.

Figure 15: Poverty Rate by County in Maryland, 2015



Source: U.S. Census Bureau, Small Area Income and Poverty Estimates data from 2015.

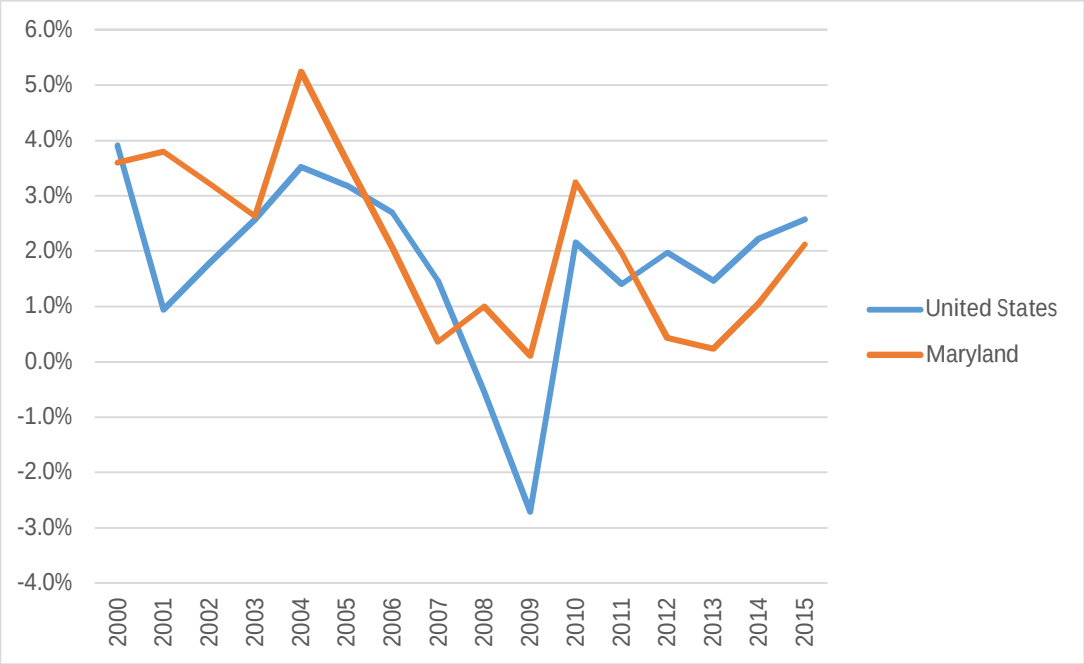
2.3 Maryland's Economy

A well-functioning transportation system is critical to Maryland's economic competitiveness and opportunities. Maryland residents rely on the transportation system every day to commute to work, to attend business meetings, to visit stores, and to reach key destinations and attractions, including key tourist attractions throughout the State. Businesses rely on the transportation system to receive raw materials for manufacturing and to ship finished products. Transportation – including the highway and rail systems, air freight, and the Port of Baltimore – links Maryland's businesses to regional, national, and international markets, allowing them to grow and prosper. Businesses seeking to relocate or open new facilities will often consider transportation opportunities as well as congestion hindrances as factors in order to ensure goods can be shipped on time and that employees can enjoy a high quality of life. A well-functioning transportation system will allow Maryland residents and businesses to complete activities in a timely and efficient manner and will make the state attractive to new businesses, boosting economic growth.

To adequately provide for the needs of residents and businesses, Maryland's transportation system improvements should be informed by trends and conditions in the State economy. This section discusses trends in economic output, employment, industry composition, and freight movement in Maryland.

Maryland's Gross State Product (GSP), a measure of overall economic activity in the state, increased from $242.3 billion in 2000 (2009$) to $329.1 billion in 2015 (2009$). That growth represents an increase of 35.8 percent, compared to 27.6 percent nationally. While Maryland has seen slower economic growth than the US since 2011, its economy never contracted. That is, Maryland did not experience zero or negative growth during the Great Recession, while the national economy faced nearly a 3 percent dip in 2009. This is largely due to the outsized presence of the government sector in Maryland, which was not as deeply affected by the economic downturn. Figure 16 displays year-over-year real GSP growth for Maryland and the United States.

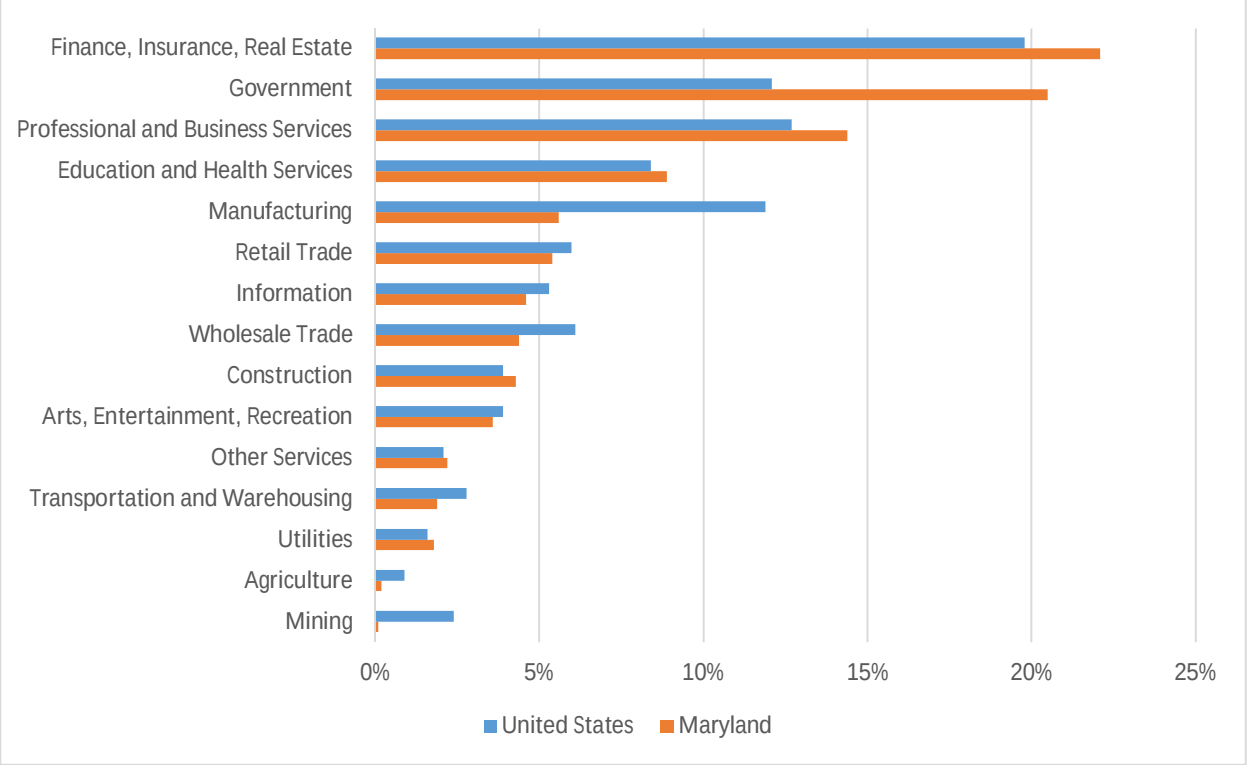
Figure 16: Maryland vs. United States: Year-over-Year Real GSP Growth, 2000-2015



Source: U.S. Bureau of Economic Analysis, Real GDP by State (Chained 2009$)

Maryland's largest supersector by share of GSP is finance, insurance, and real estate, which contributes to 22.1 percent of GSP, compared to 19.8 percent nationally (see Figure 17). Certain industries have a substantially stronger presence in Maryland relative to the United States. The government sector is overrepresented by almost 70 percent in Maryland, contributing to 20.5 percent of Maryland's GSP, compared to only 12.1 percent nationally. This is due to the concentration of federal government offices and support services located in the state. Conversely, manufacturing is underrepresented in the Maryland economy, contributing to only 5.6 percent of GSP, compared to 11.9 percent nationally. In general, compared to the country has a whole, Maryland's economy is more heavily reliant on the service sector (94.2 percent vs. 87.2 percent) and less reliant on the manufacturing (5.6 percent vs. 11.9 percent) and agriculture (0.2 percent vs. 0.9 percent) sectors.

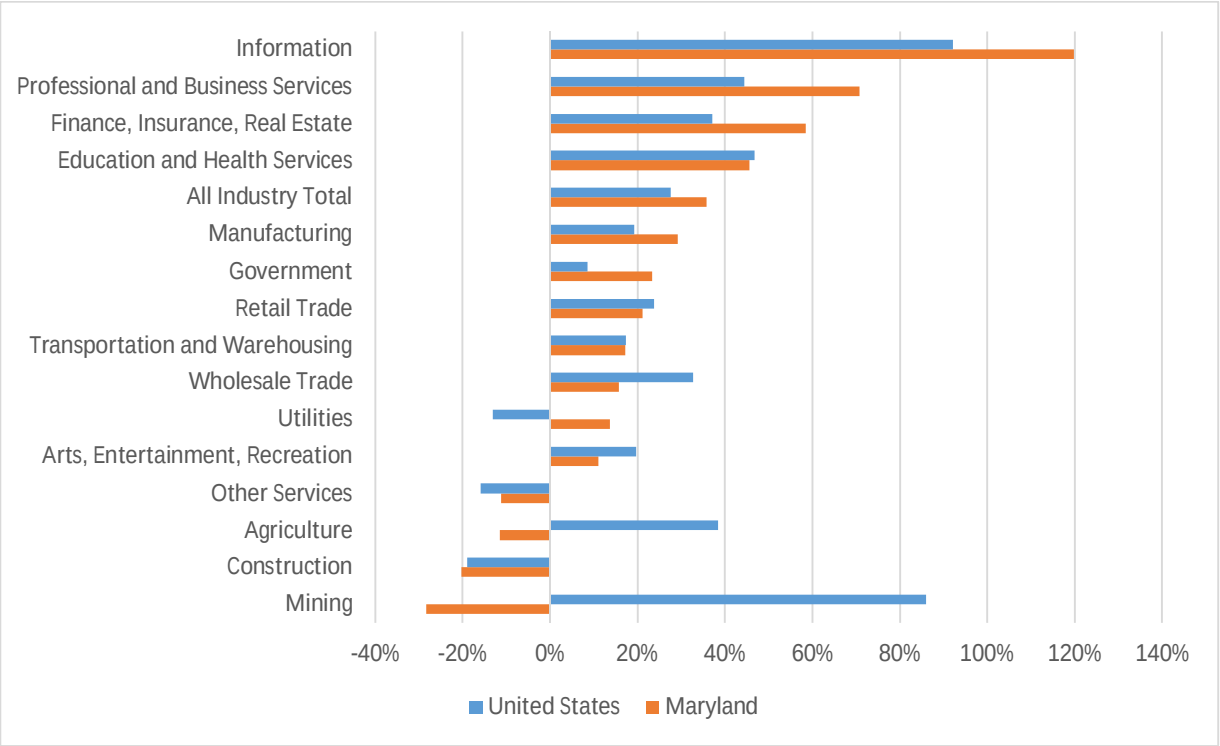
Figure 17: Maryland vs. United States: Supersectors by Share of Real GSP (2015)



Source: U.S. Bureau of Economic Analysis, Real GDP by State

The dominance of the service sector in Maryland is expected to become even more pronounced in the future. Between 2000 and 2015, Maryland's fastest growing industries by GSP were all high-value-add services. The three fastest growing sectors were information; professional and business services; and finance, insurance, real estate each outpacing their national counterparts (see Figure 18). While still expanding, the manufacturing and government sectors lagged behind overall GSP growth in Maryland. Meanwhile, the agriculture, construction, and mining sectors contracted during this period. If current trends continue, each of these five sectors can be expected to comprise a declining share of statewide economic output in the future.

Figure 18: Maryland vs. United States: Real GSP Growth by Supersector (2000-2015)

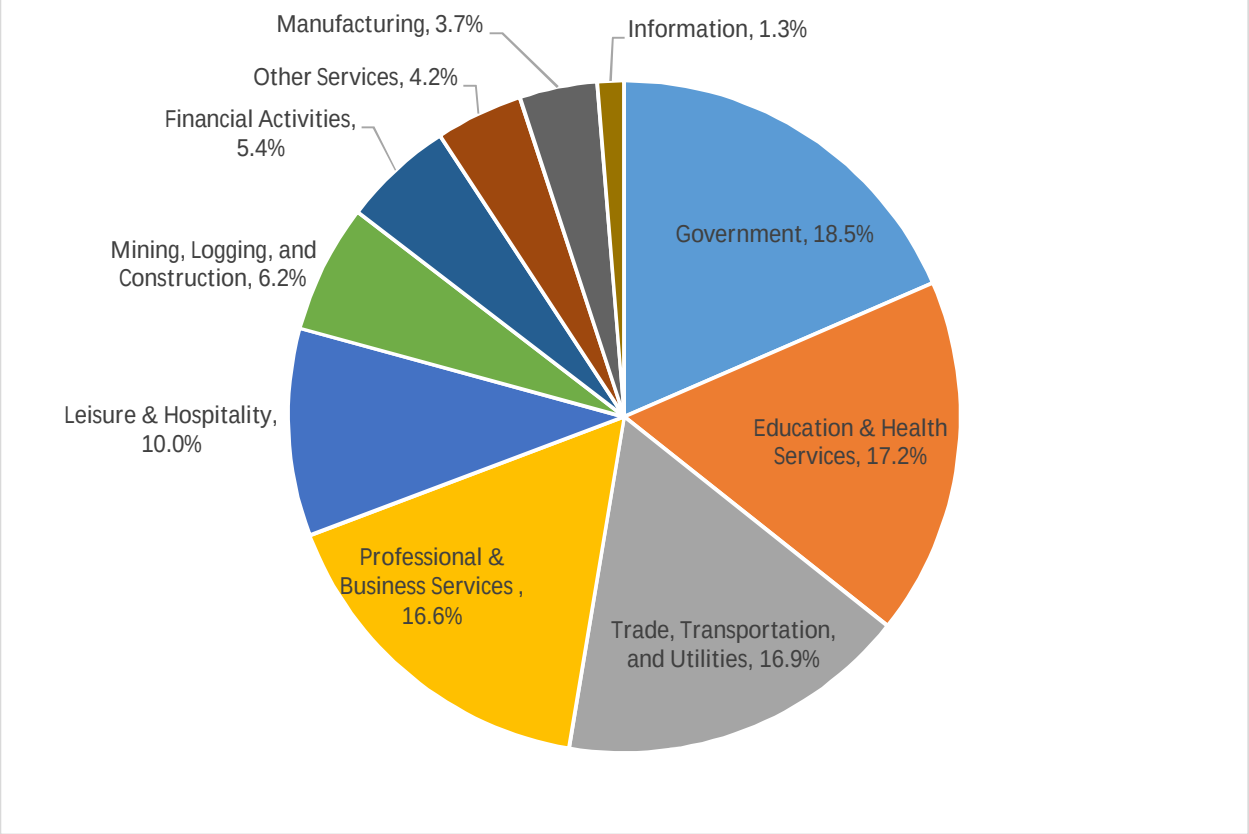


Source: U.S. Bureau of Economic Analysis, Real GDP by State

As with GSP, employment in Maryland is led by the service sector. Government; education and health services; trade, transportation, and utilities; and professional and business services (Maryland's largest supersectors by employment) comprise about 70 percent of jobs in Maryland (Figure 19). While overall employment has trended consistently upward in Maryland following the Great Recession, the manufacturing and information sectors have seen declines in employment. However, the largest sectors – particularly educational and health services, and professional and business services – have seen strong employment growth in recent years. Continued employment growth in service sectors may have implications for commuting patterns in terms of both employment locations and work hours. Maryland's transportation system must address these challenges to continue to attract the employers that will drive economic growth.

Maryland's labor force participation rate has hovered between 65 and 70 percent since 2007. It currently stands at 68.4 percent as of September 2017. The national labor participation rate for the same period is 63.0 percent.

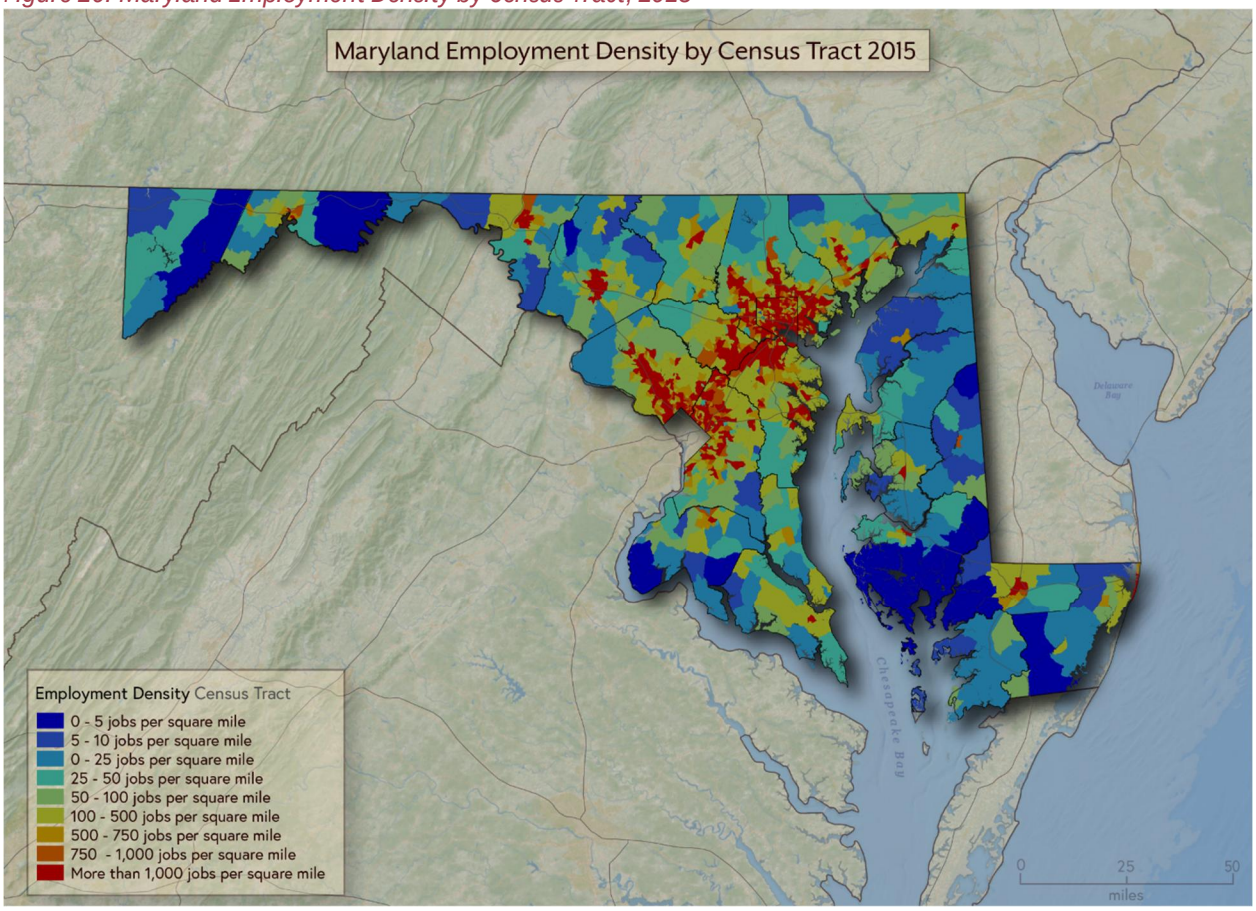
Figure 19: Employment by Sector in Maryland



Source: Bureau of Labor Statistics, "Maryland Economy at a Glance" [Oct. 2017 data]

Geographically, employment tends to concentrate in a limited number of key locations near major cities and transportation arteries. As Figure 20 shows, *employment density is highest in the urban and suburban spine of central Maryland* from Bethesda and Silver Spring northeastward to Baltimore and Towson.

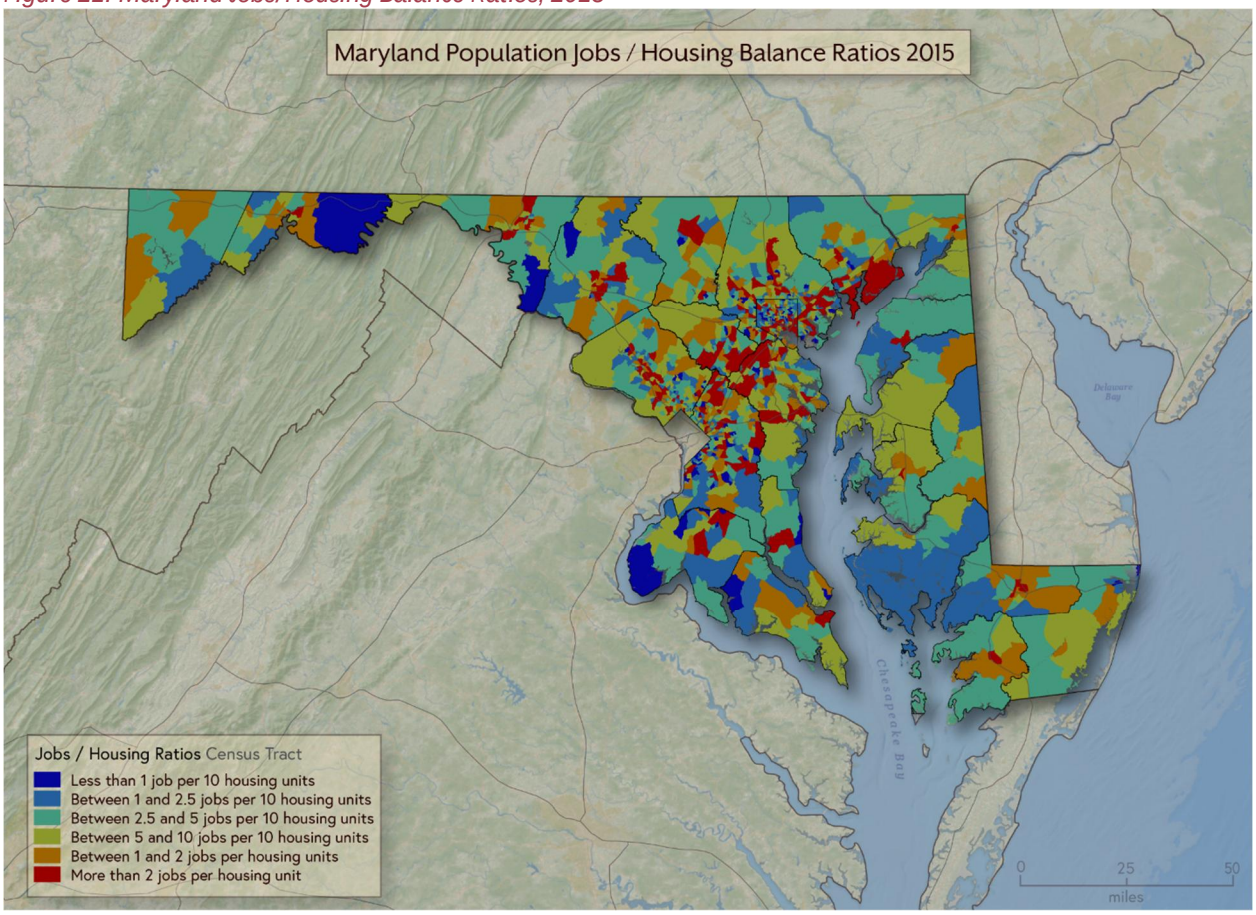
Figure 20: Maryland Employment Density by Census Tract, 2015



Source: Longitudinal Employer Household Dynamics Data 2015, (Census Tract Geographies – 2010 US Census)

Although jobs are clustered, housing for those who work in these employment-dense locations is more dispersed. Ideally, the number of jobs and households in each community would be fairly equal, allowing workers to live near their work and have shorter commutes, reducing demand on the transportation system. However, as Figure 21 illustrates, *there are relative imbalances between jobs and housing throughout the state*. The map shows a concentration of jobs relative to housing units in central Maryland with outlying areas acting as "bedroom communities" where there are more households than jobs. This imbalance, combined with the auto-oriented design of many of the employment centers, encourages long-distance commuting by car. This results in widespread congestion along corridors providing access to these job centers at peak times. People living near the major employment centers tend to drive less overall because of their proximity to work and shopping destinations and because of the availability of other modes of travel (e.g., transit, walking, bicycling), which is supported by employment density. As the state of Maryland continues to grow, it will be important to coordinate transportation improvements to ensure that they are implemented in a way that improves travel efficiency.

Figure 21: Maryland Jobs/Housing Balance Ratios, 2015



Source: Longitudinal Employer Household Dynamics Data 2015 | 2011-2015 5-year ACS

Maryland's transportation infrastructure also helps facilitate freight movement, essential to the State economy. According to the state's "Strategic Goods Movement Plan," released in 2015, Maryland's goods movement transportation network moved nearly 631 million tons of freight worth $835 billion in 2012. While freight is shipped using a variety of domestic modes, truck transportation is the dominant one. In 2015, 95 percent of freight by tonnage and by value was moved using Maryland's roads and highways.

A particularly important geography for understanding freight flows is the "megaregion," a closely integrated network of metropolitan areas that is, in part, defined by an interconnected freight transportation system. Maryland lies within the Washington, D.C.-Virginia Megaregion, which covers most of Maryland; all of Delaware and Washington, D.C.; and much of northern and eastern Virginia. The I-95 corridor in Maryland – stretching from Wilmington, Delaware to Washington, D.C. – plays a key part in facilitating regional freight flows. Other high value flows can be found on the Eastern Shore from Wilmington to Salisbury and from Washington, D.C. to the Eastern Shore and western Maryland.

3 Travel Characteristics

Maryland's transportation system is interconnected, complex, and critical to the State's success. Residents and employers have made decisions about where to live and locate their businesses based on their transportation needs and how well the system meets them. Future decisions made by residents, businesses, and policy makers will influence the system's effectiveness moving forward. The charts that follow show Marylanders' travel characteristics and how they have changed over time.

3.1 Commute Time

Based on U.S. Census data, Maryland has some of the longest commute time in the nation. Table 5 shows the top ten states in terms of commute time, and Maryland and New York are tied for number one. Table 6 lists the top ten Maryland counties with the longest commute times. Figure 22 shows that there is a *pattern of long commutes running down the center of the state* with Carroll, Frederick, Montgomery, Prince George's, Charles, and Calvert Counties having average commute times greater than the State average. These long commutes result from congestion and from residents commuting from their home counties to destinations in the Baltimore and Washington areas. It also shows that many of the counties in Western Maryland and on the Eastern Shore have lower than average commute times, possibly due to lower levels of congestion and residents being able to live closer to their jobs.

Table 5: Top 10 States with the Longest Commute Times

Rank	State	Average Commute Time (Minutes)
1	Maryland	32.3
1	New York	32.3
3	New Jersey	31
4	D.C.	29.7
5	Massachusetts	28.7
6	Illinois	28.4
7	California	28
8	Virginia	27.9
9	Georgia	27.4
10	New Hampshire	26.9

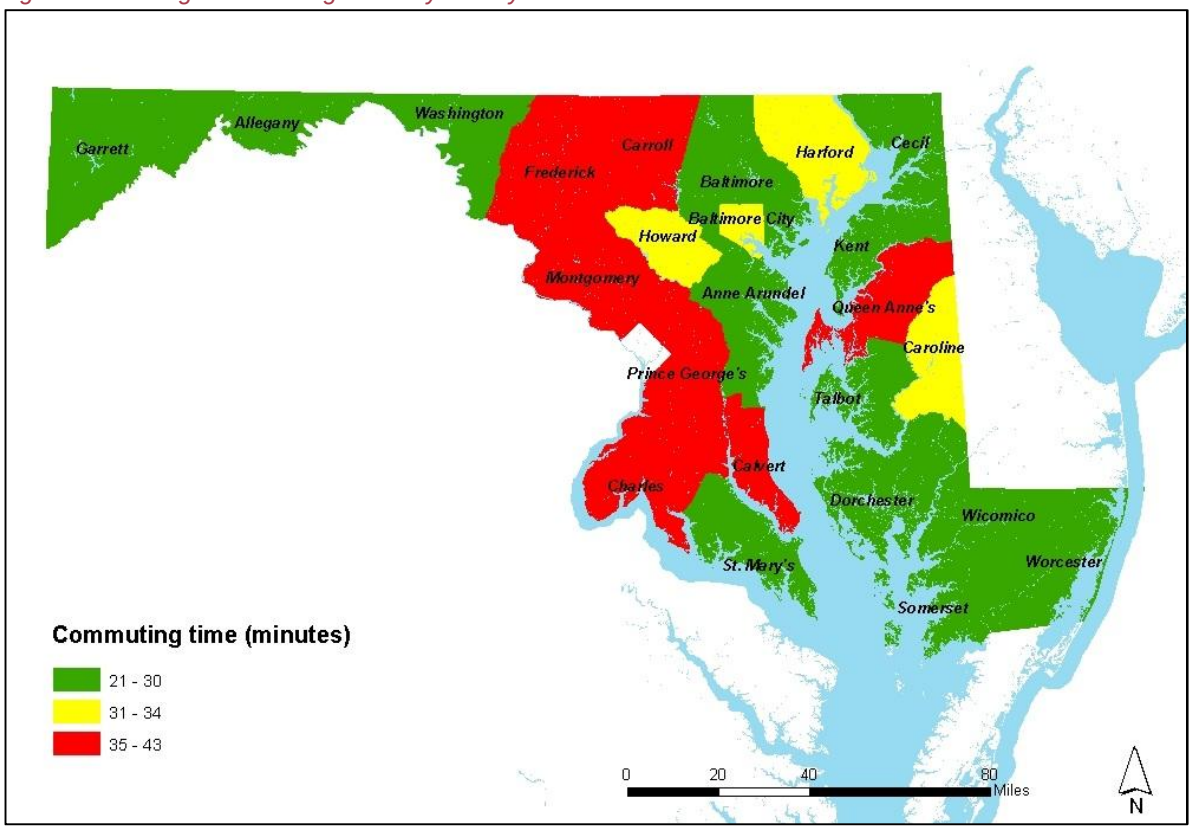
Source: U.S. Census American Community Survey (2011-2015)

Table 6: Top 10 Maryland Counties with the Longest Commute Time

Rank	County	Average Commute Time (Minutes)
1	Charles County	42.8
1	Calvert County	40.1
3	Prince George's County	36.5
4	Carroll County	35.2
5	Frederick County	34.9
6	Queen Anne's County	34.7
7	Montgomery County	34.5
8	Caroline County	32.9
9	Harford County	31.7
10	Howard County	30.5

Source: U.S. Census American Community Survey (2011-2015)

Figure 22: Average Commuting Times by County

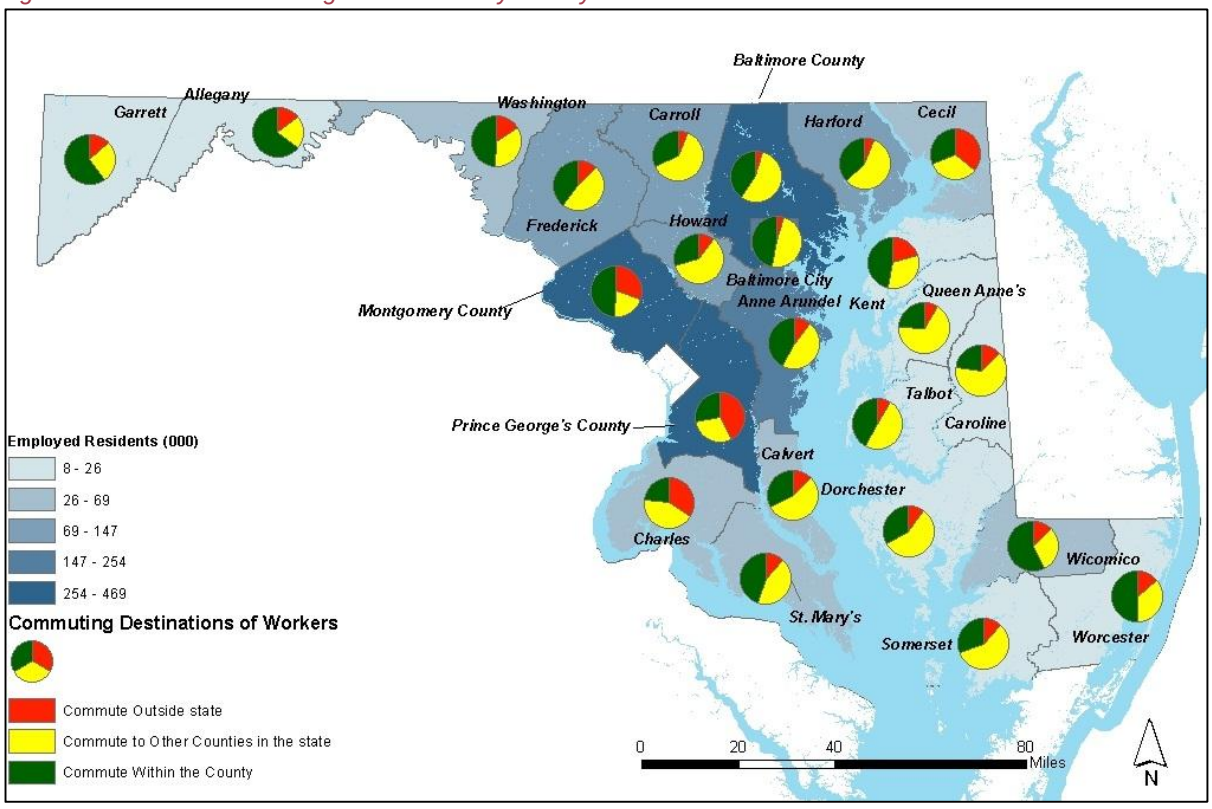


Source: U.S. Census American Community Survey (2011-2015)

3.2 Commute Destinations

Figure 23 shows that for most Maryland counties, commuters tend to have work destinations within the state and many are even within the county. Cecil County is an exception, with commuters headed to Wilmington, Delaware or Southeastern Pennsylvania. Other exceptions are Montgomery, Prince George's, and Charles Counties, where commuters have destinations in Washington D.C. or Northern Virginia.

Figure 23: Share of Commuting Destinations by County

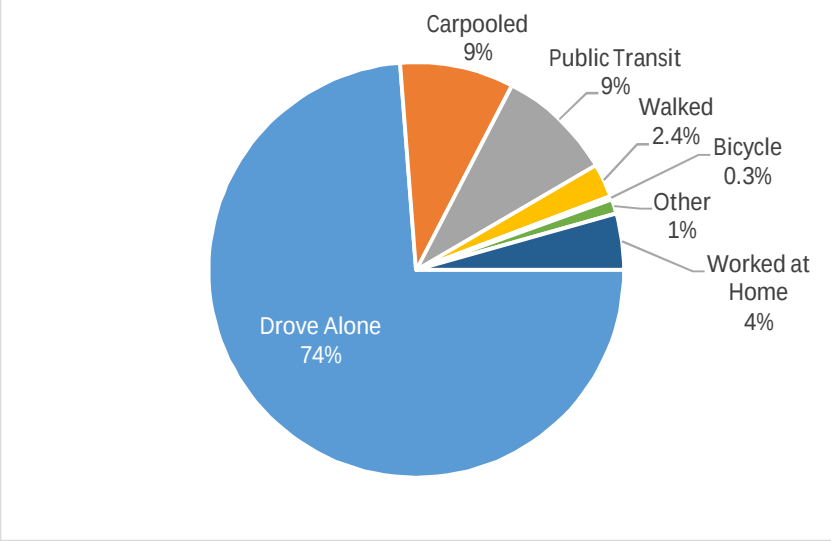


Source: *U.S. Census Longitudinal Employment and Household Dynamics (LEHD) 2014*

3.3 Commute Mode Split

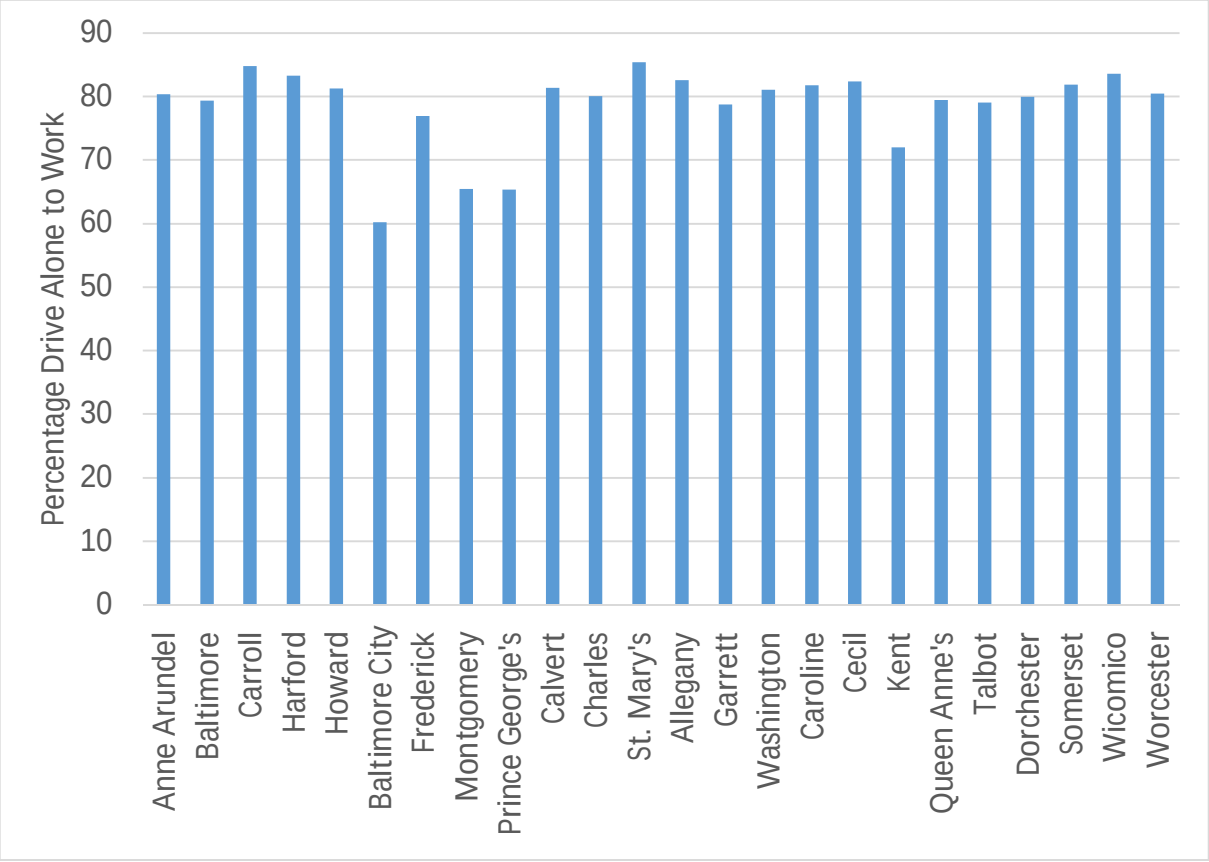
As Figure 24 shows, most Marylanders use a private car to travel to work. Figure 25 shows the percentage of workers driving alone for each county. Not surprisingly, the counties that have below-average drive-alone commute rates have more significant transit resources, as is the case in Baltimore City with its MDOT MTA service and Montgomery and Prince George's Counties that are served by WMATA and locally-operated fixed route services. (It is worth noting that even though these counties have below-average drive-alone commute rates, driving alone is still the dominant mode choice for all regions.) Kent County, on Maryland's Eastern Shore, also has a below average percentage of people driving alone. This appears to be accounted for by a very high percentage of people walking to work; seven percent of Kent County residents walk to work as opposed to 2.4 percent statewide.

Figure 24: Maryland Commute Mode Split



Source: US Census, American Community Survey, 2015 1-Year Estimate

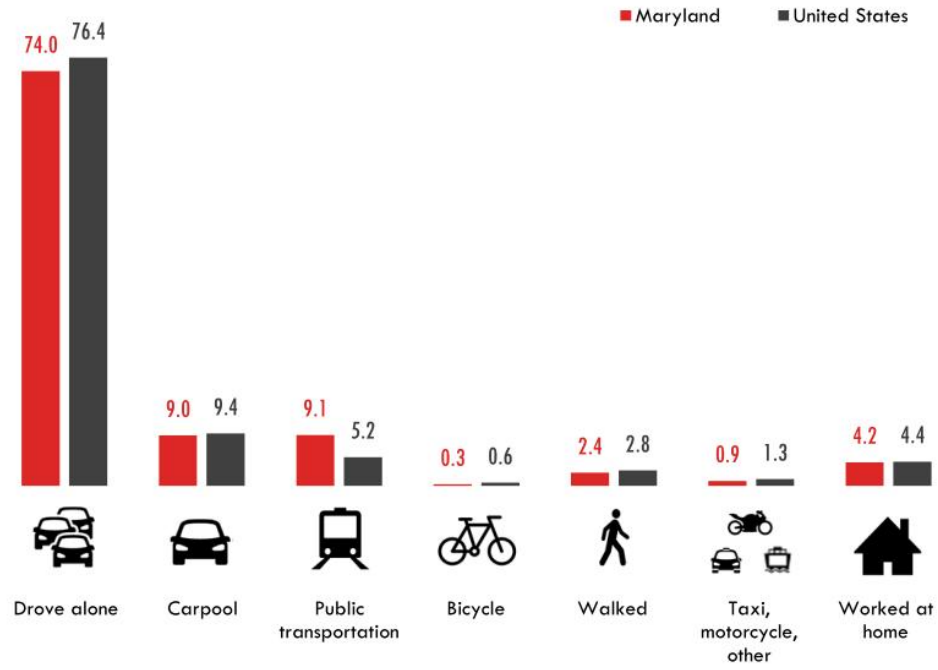
Figure 25: Percentage Drive Alone by County



Source: US Census, American Community Survey, 5-year Estimates, 2011-2015

Figure 26 shows that Maryland has fewer people driving alone and more people taking transit compared to the entire country. However, Maryland has fewer commuters using non-motorized transportation compared to the nation. Continued investment in bicycle and pedestrian infrastructure remains a priority.

Figure 26: Comparison of Mode Split Between Maryland and United States



Source: Maryland Department of Transportation State Highway Administration

3.4 Licensed Drivers

As Table 7 shows, the number of licensed drivers has increased slightly over time. However, Maryland's population has grown at a greater rate, meaning the share of licensed Marylanders has decreased slightly between 2010 and 2014.

Table 7: Number and Percentage of Maryland Drivers Licenses

	2010	2011	2012	2013	2014
Maryland Total Population	5,788,409	5,844,171	5,890,740	5,936,040	5,975,346
Number of Driver's Licenses	4,082,412	4,083,411	4,102,154	4,140,103	4,142,997
Percentage of Maryland Population with a Maryland Driver's License	71%	70%	70%	70%	69%

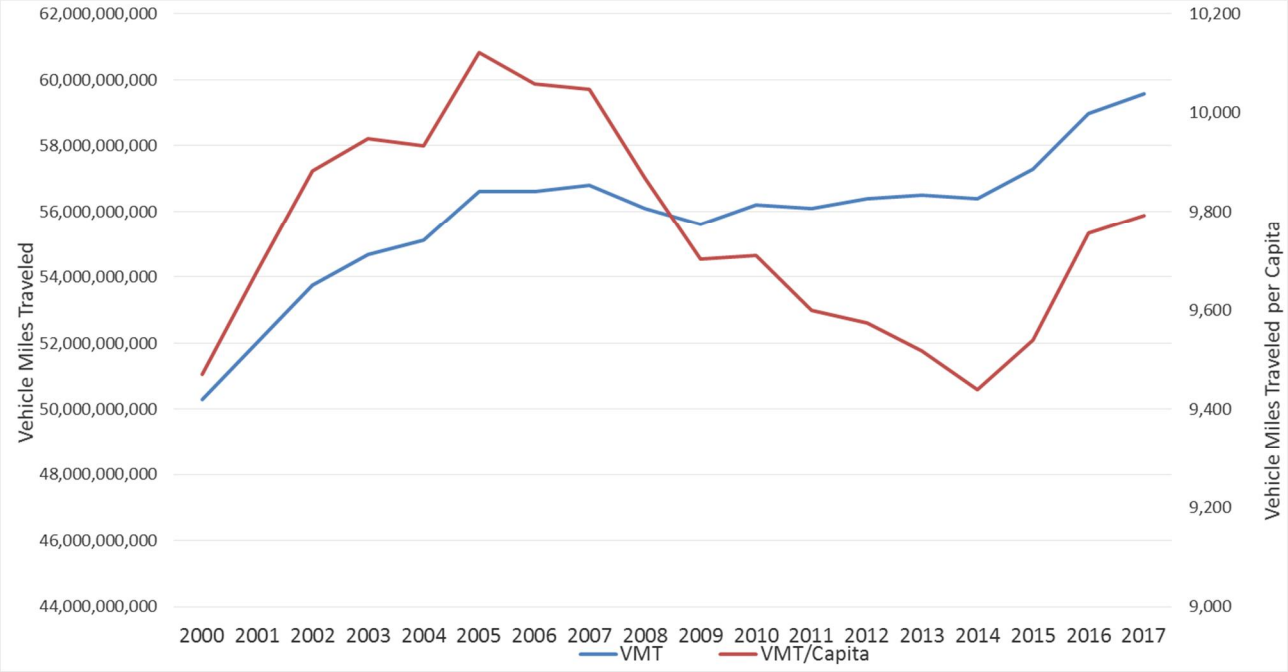
Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System Performance

3.5 Vehicle Miles Traveled

The number of vehicles miles (VMT) traveled and the VMT per capita is increasing. Growth in VMT and per capita VMT slowed during the 2008 economic slowdown. As the economy rebounded in 2014, the amount of VMT has increased as Figure 27 shows, and travel demand forecasting performed by MDOT

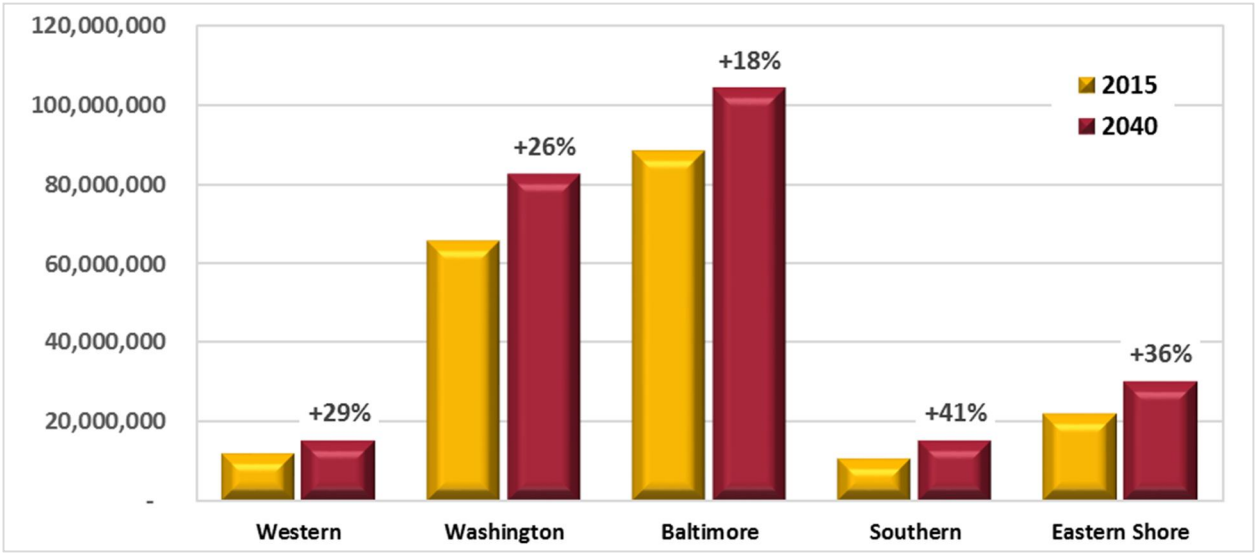
SHA indicates that VMT will continue to grow in the future. (See Figure 28.) This is different from the national VMT, which has declined every year since 2006.

Figure 27: Vehicle Miles Traveled and Vehicle Miles Traveled per Capita, Maryland



Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System Performance

Figure 28: Change in Vehicle Miles of Travel by Region, 2015 and 2040



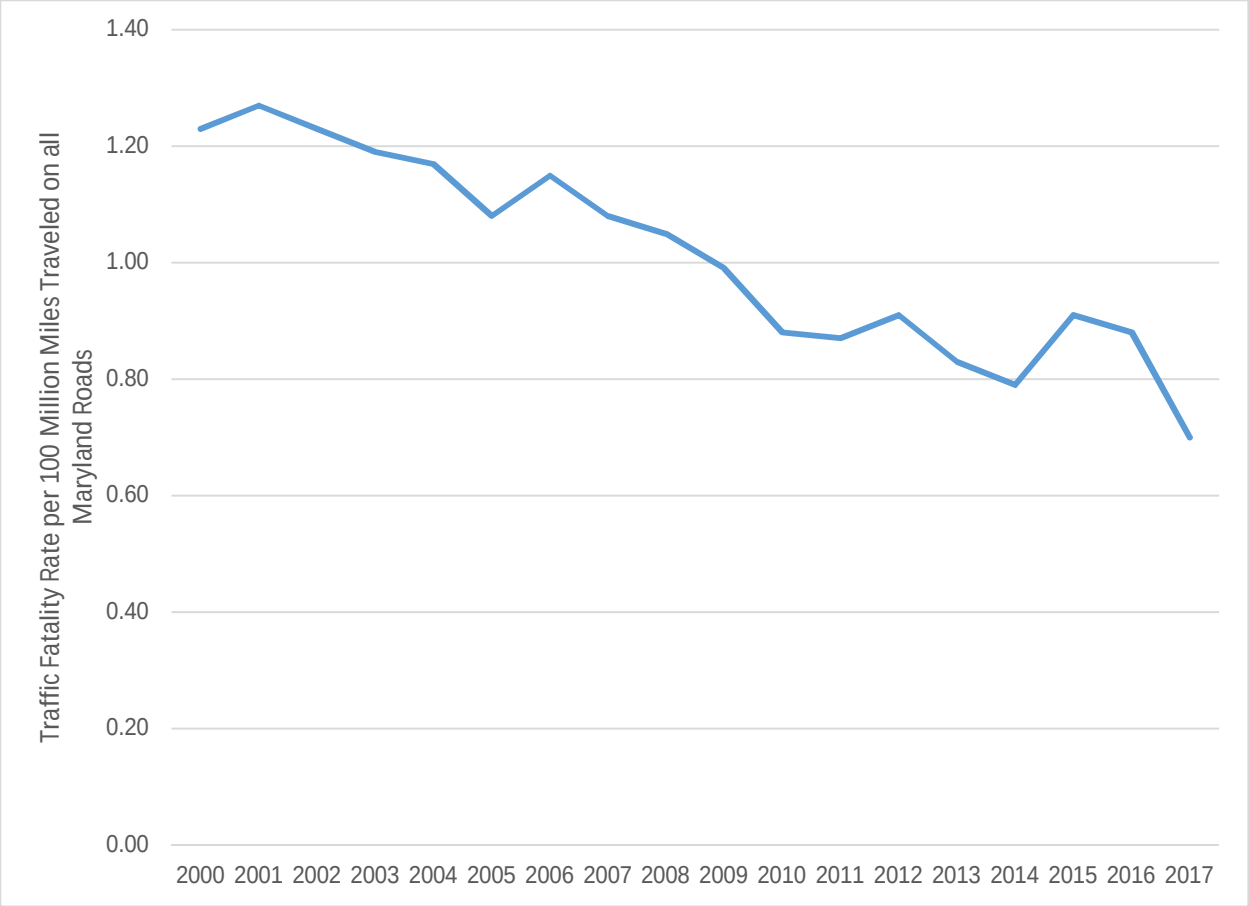
Source: Maryland Department of Transportation State Highway Administration, MSTM V1.1

3.6 Safety

Maryland's roads have become safer. Despite the increase in VMT, the traffic fatality rate per 100 million vehicle miles traveled on all Maryland roads has decreased. Figure 29 shows how the fatality rate

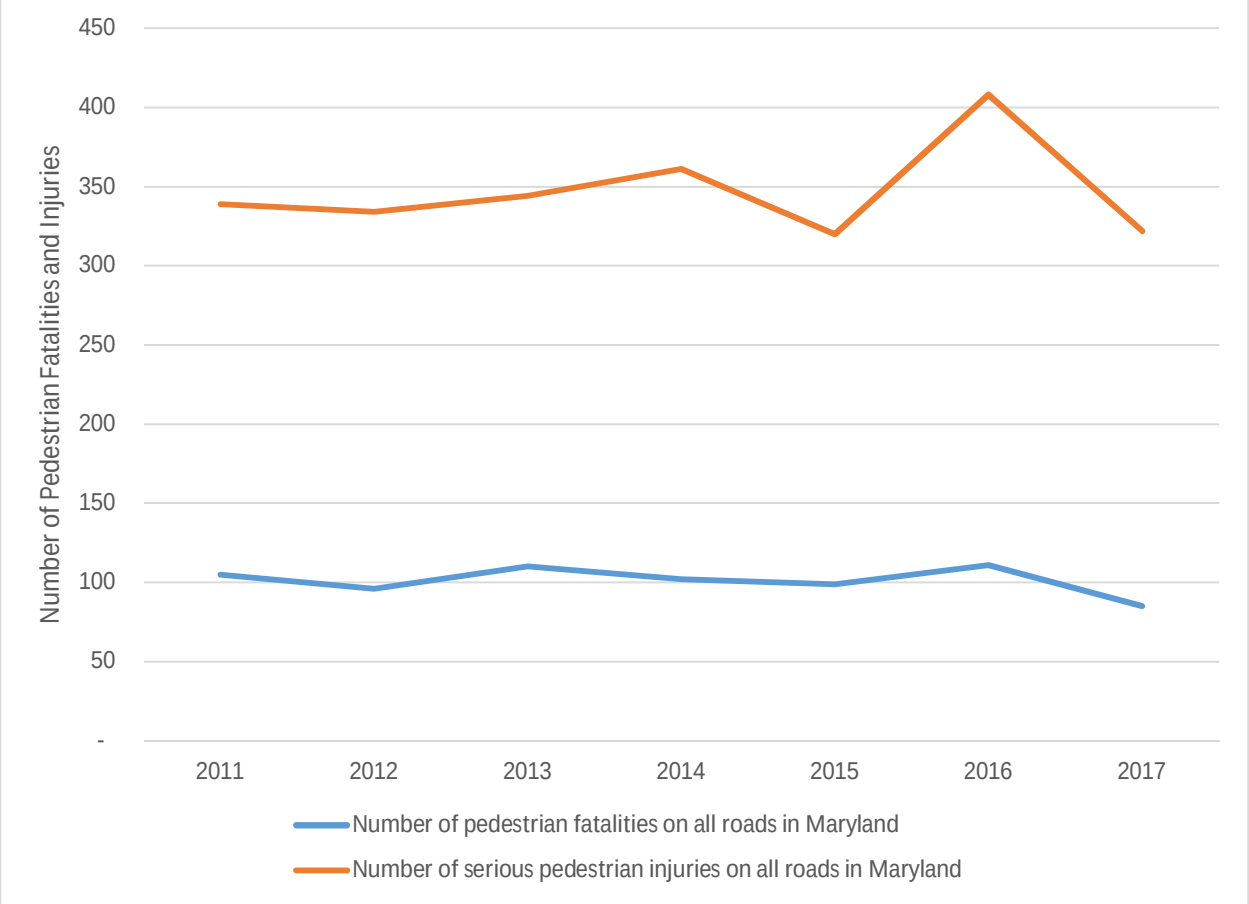
has decreased over time. Figure 30 shows that the number of pedestrians killed or injured on Maryland roads has remained fairly constant despite a spike in 2016.

Figure 29: Traffic Fatality Rate



Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System Performance

Figure 30: Pedestrian Fatalities and Injuries

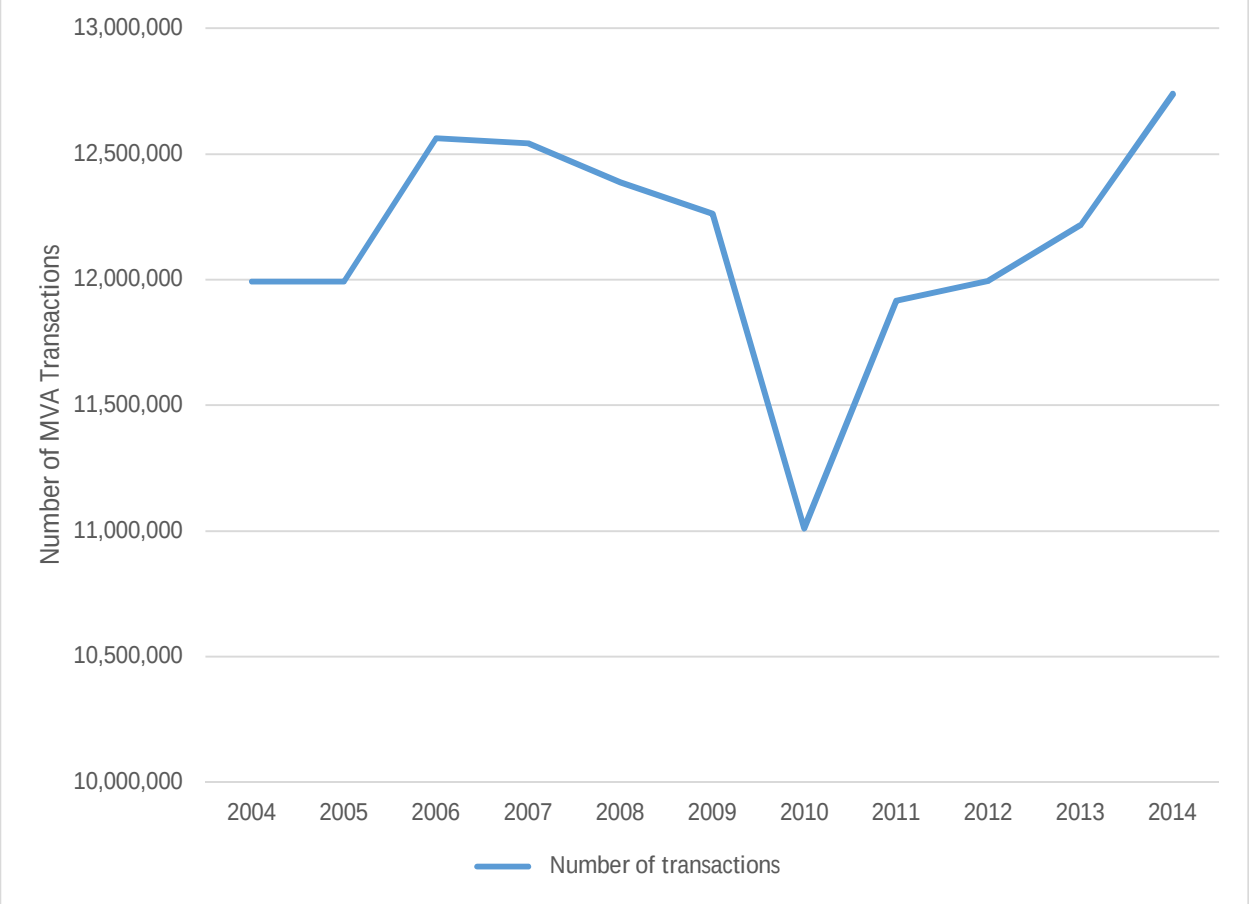


Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System Performance

3.7 MDOT MVA Transactions

Figure 31 shows the number of annual MDOT MVA transactions. Transactions started declining in 2006 and had a steep drop in 2010, which was because of a one-time decrease of Vehicle Emissions Inspection Program (VEIP) branch transactions. The number of registered vehicles, driver's licenses issued, motorcycle licenses issued, and commercial driver's licenses issued has been relatively consistent. Since 2010, transactions have increased each year and are now higher than they were at their previous peak in 2006.

Figure 31: Number of Annual MDOT MVA Transactions

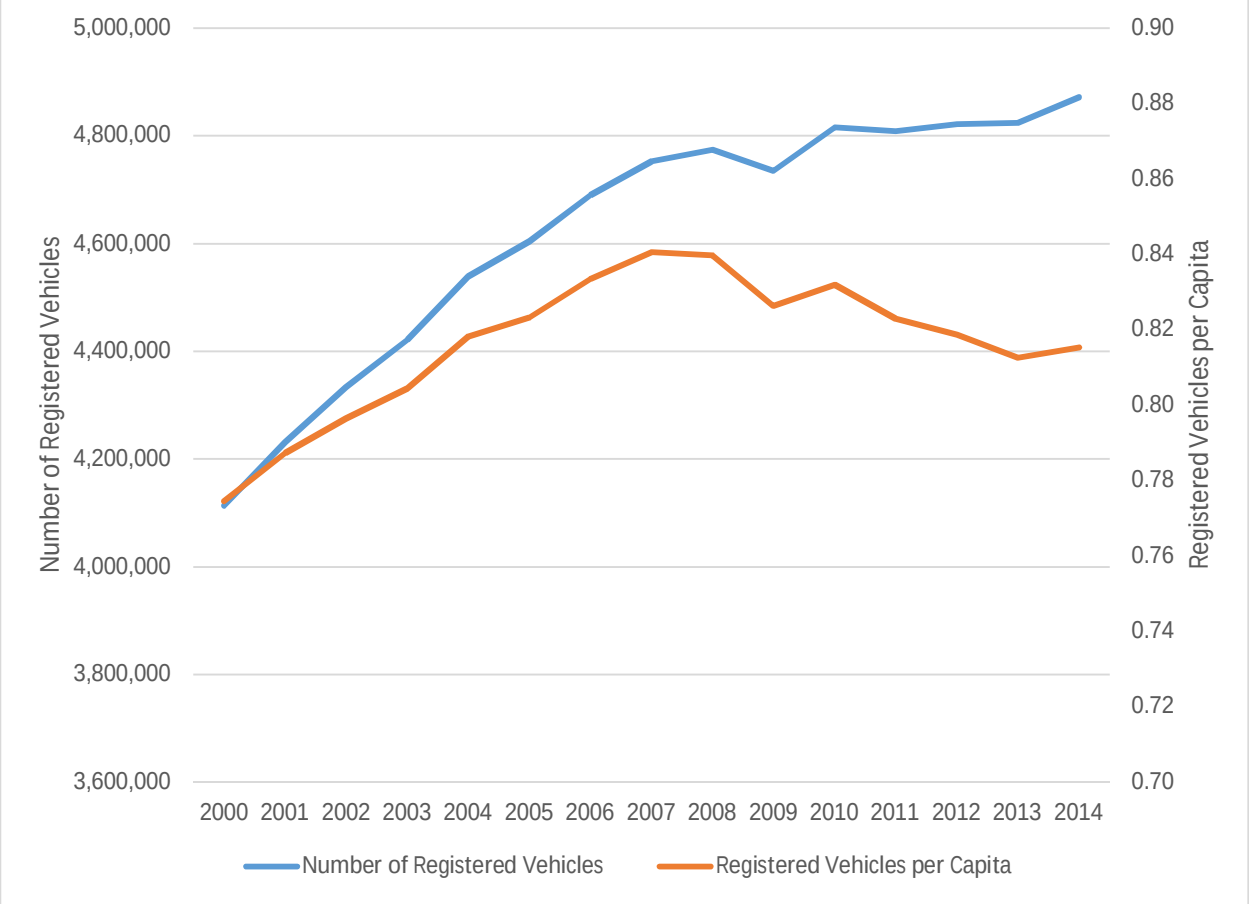


Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System

3.8 Registered Vehicles

The number of vehicles registered in Maryland has been increasing, however, since 2008 the rate of growth has slowed. Some of this growth can be attributed to a growing population, however, the number of registered vehicles per capita has been decreasing. Figure 32 shows the change in vehicle registrations. While the numbers of registered vehicles per capita has declined since a high in 2007, the change isn't great: 0.84 vehicles per person in 2007 to 0.81 vehicles per person in 2013.

Figure 32: Registered Vehicles and Registered Vehicles per Capita

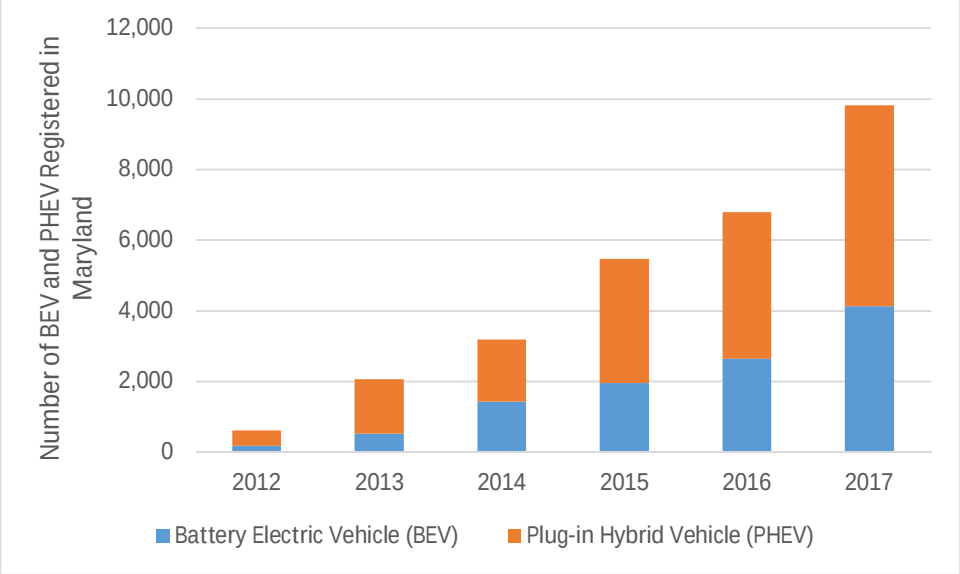


Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System Performance

3.9 Registered Electric Vehicles

Over the past five years, there has been exponential growth in the number of registered electric vehicles in Maryland, as Figure 33 shows. There is now approximately one registered electric vehicle for every 629 people in Maryland. While growth is occurring in both Battery Electric Vehicles (BEV) and Plug-In Hybrid Electric Vehicles (PHEV), there are more PHEVs. PHEVs have an electric motor and internal combustion engine and can substitute electricity for gasoline. BEVs run exclusively on electricity and are charged by plugging the vehicle into an outlet or charging station.

Figure 33: Number of BEV and PHEV Registered in Maryland

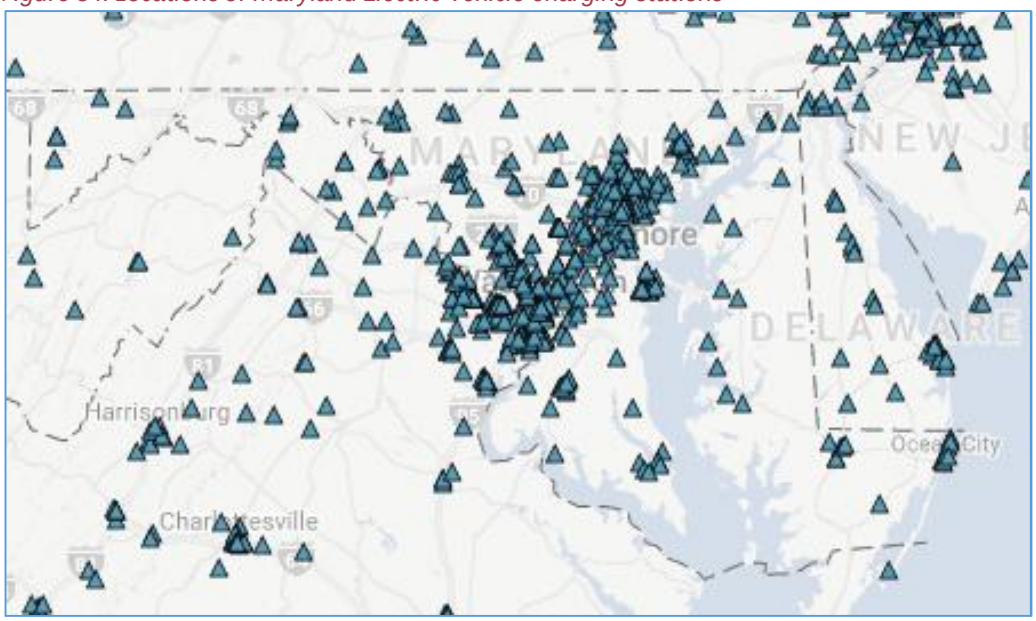


Source: 2016 Maryland Electric Vehicle Council (EVIC) Annual Report and MDOT MVA

3.9.1 Number of Electric Vehicle Charging Stations

As the number of electric vehicles increase, there is more need for charging stations. Within Maryland there are 468 electric stations and 1,196 public charging outlets. As Figure 34 shows, each of Maryland's regions has at least one charging station. However, most of the stations are concentrated in the Baltimore/Washington corridor.

Figure 34: Locations of Maryland Electric Vehicle Charging Stations



Source: https://www.afdc.energy.gov, accessed 12/19/2017

3.10 Total Freight Volume

Maryland's goods movement transportation network comprises 32,143 public road lane miles (21,411 State-owned lane miles), 758 rail miles, 530 inland waterway miles, and over 50,000 feet of air cargo runways. Together, these modes moved nearly 631 million tons of freight, worth $835 billion, in 2012, the most recent year for which data was available. Table 8 shows the percent of shipments – by weight and by value – made via each domestic mode. By 2040, more than 1 billion tons of freight, worth close to $1.6 trillion, is expected to move within and through Maryland.

Table 8: Percent of Shipments by Domestic Mode, 2015

Mode	Total	Within Maryland	From Maryland	To Maryland	Through Maryland*
Truck Tonnage	95.5%	98.8%	88.6%	88.4%	88.4%
Truck Value	*94.5%*	*98.2%*	*91.5%*	*90.3%*	*97.2%*
Rail Tonnage	3.5%	1.1%	8.6%	11.3%	10.6%
Rail Value	*2.1%*	*1.3%*	*2.7%*	*5.1%*	*2.8%*
Domestic Water Tonnage**	0.9%	<0.5%	2.7%	<0.5%	0%
*Domestic Water Value**	*0.9%*	*<0.5%*	*1.2%*	*1.4%*	*0%*
Domestic Air Tonnage***	<0.5%	<0.5%	<0.5%	<0.5%	0%
*Domestic Air Value****	*0.9%*	*<0.5%*	*4.6%*	*3.2%*	*0.0%*

*Through Maryland includes freight movement between NE (CT, DE, ME, MA, NH, NJ, NY, RI, VT) and SE (VA, FL, GA, NC, SC) states. Modes not shown in the table are pipeline and multimodal.

**Domestic water Includes shallow draft, deep draft, Great Lakes, and intra-port shipments, but does not include international waterborne trade through the Port of Baltimore. The domestic (landside) moves of Port of Baltimore trade are accounted for in other modes.

***Domestic air includes air cargo between U.S. and domestic origin-destination pairs. The domestic portions of international air cargo movements are accounted for in the appropriate domestic modes.

Source: Maryland Department of Transportation State Highway Administration, FAF 4.4 data

Goods movement is essential to the economy. The health of an economy is directly connected to the performance of its transportation system and ability to transport goods. The need for the supply chain to have the capacity to provide reliable and cost-effective transportation is an integral component of this relationship. Simply put, the freight transportation network keeps commerce flowing.

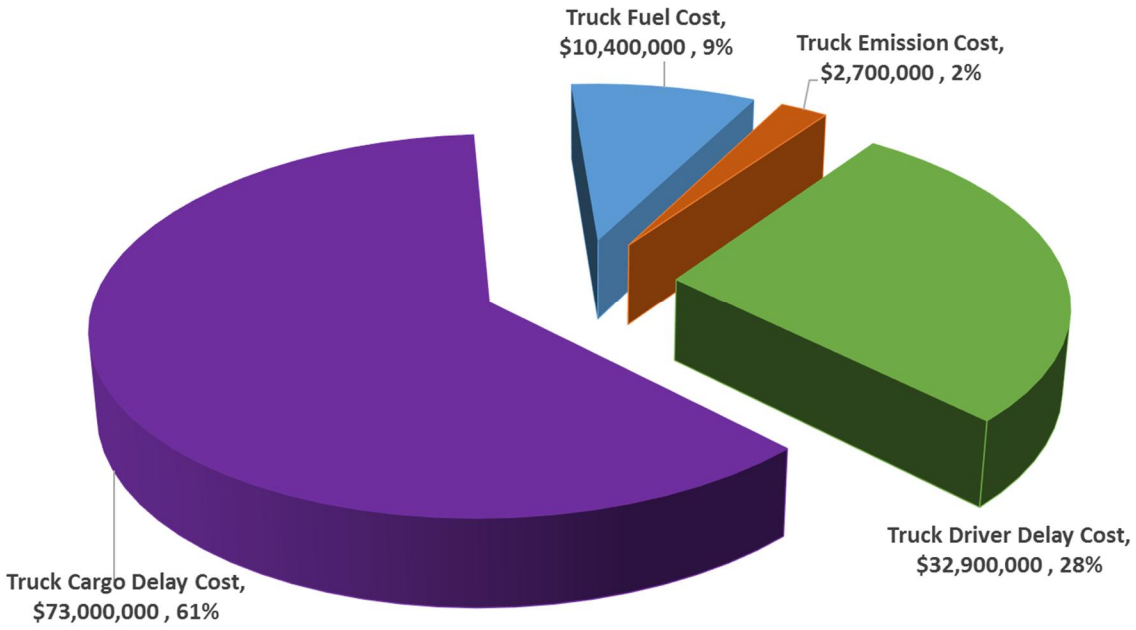
Figure 35 shows the economic impact of freight dependent industries in Maryland.

Figure 35: Role of Freight Transportation and Warehousing and Freight-Dependent Industries on Maryland's Economy, 2012

Source: IMPLAN; US Census, Bureau of Labor Statistics, analyzed by Maryland Department of Business and Economic Development and Cambridge Systematics, Inc

Figure 36 shows the costs of congestion on the freeway/expressway system experienced by truckers. These include driver delay costs, cargo delay costs, diesel costs, and increased emissions, amounting to an estimated $119 million in 2015.

Figure 36: Freight Congestion Cost on Maryland's Freeways and Expressways, 2015

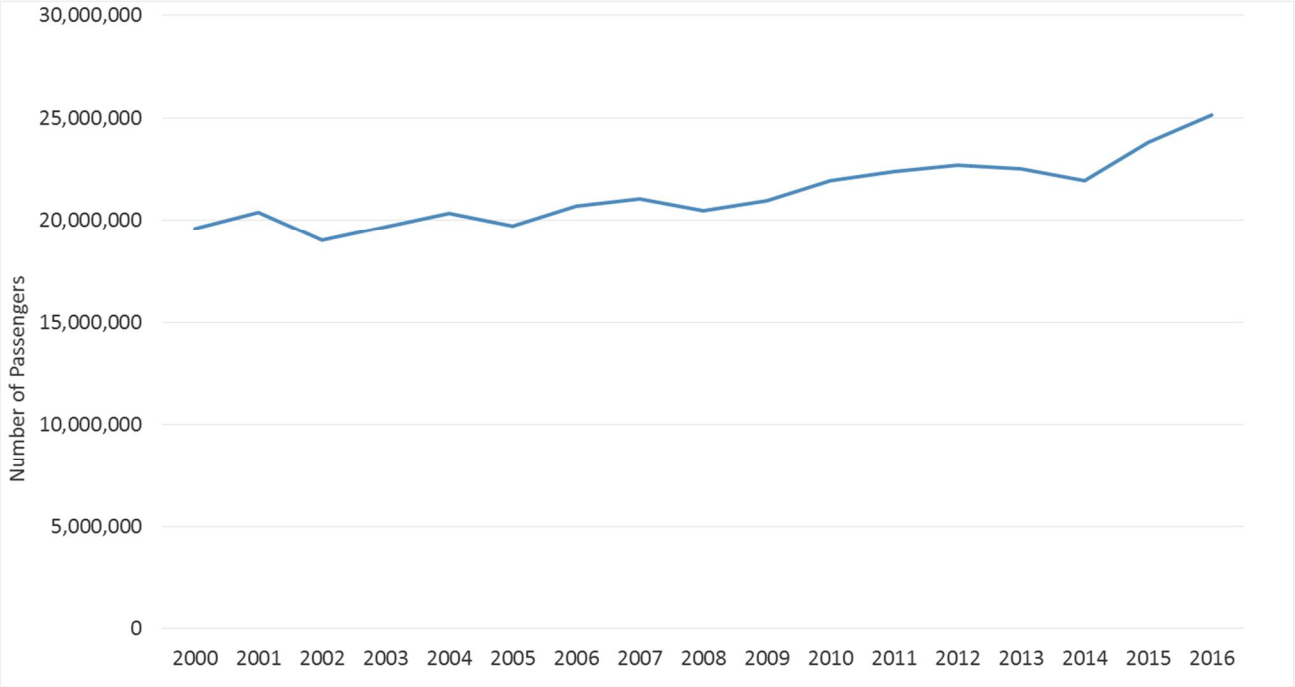


Source: 2016 Maryland State Highway Annual Mobility Report

3.11 Passengers Traveling Through BWI

Figure 37 shows that while passenger numbers at BWI Marshall Airport have risen and fallen year over year, passenger numbers have been increasing over the long term. The decline shown in 2013 and 2014 was a result of the 2013 sequestration, which reduced travel demand, and the FY 2014 federal government shutdown, which halted the government and contractor flights and reduced personal air travel in the region.

Figure 37: BWI Thurgood Marshall Passenger Numbers

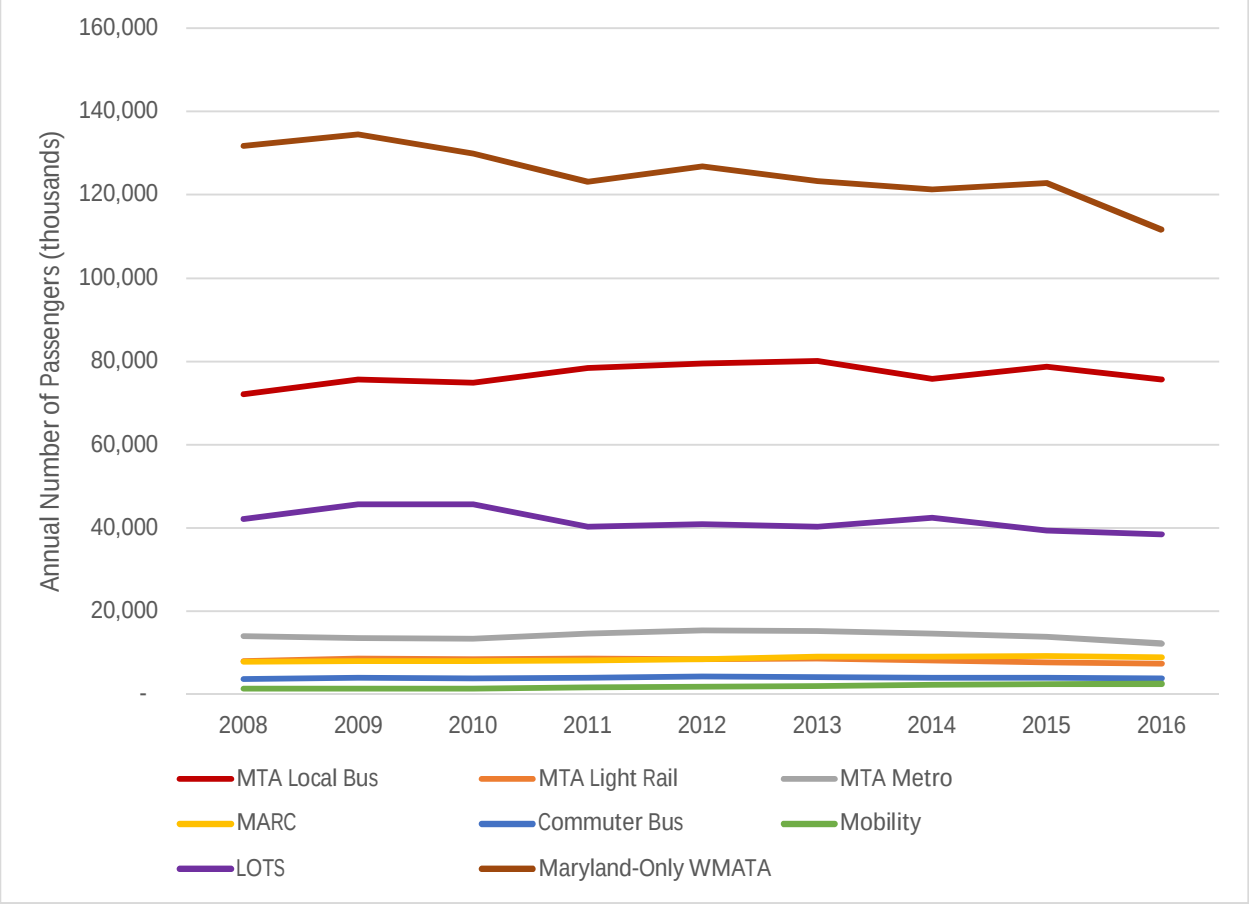


Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System Performance

3.12 Transit Ridership

Marylanders have a variety of transit services available to them. In the Baltimore Metro Region, there is core bus service that serves Baltimore City and Baltimore County, Metro subway between Owings Mills in northwest Baltimore and downtown Baltimore City, and Light Rail between Hunt Valley in northern Baltimore County and Cromwell and BWI Airport in Anne Arundel County. In the Washington Metro Region, WMATA operates Metro subway and buses in Montgomery and Prince George's Counties. Commuter buses operate between suburban areas and downtown Baltimore and Washington, D.C. and MARC train service provides commuter rail access to Baltimore and Washington, D.C. from Aberdeen and Frederick. For residents who are functionally unable to get to a bus stop, wait unassisted at a stop or station, or board or ride a bus or train by themselves, the MDOT MTA offers a shared-ride service called Mobility. Finally, the counties all operate their own county-based bus systems. These are called LOTS (locally-operated transit systems). As Figure 38 shows, transit ridership is slightly down.

Figure 38: Maryland Transit Service Ridership



Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System Performance

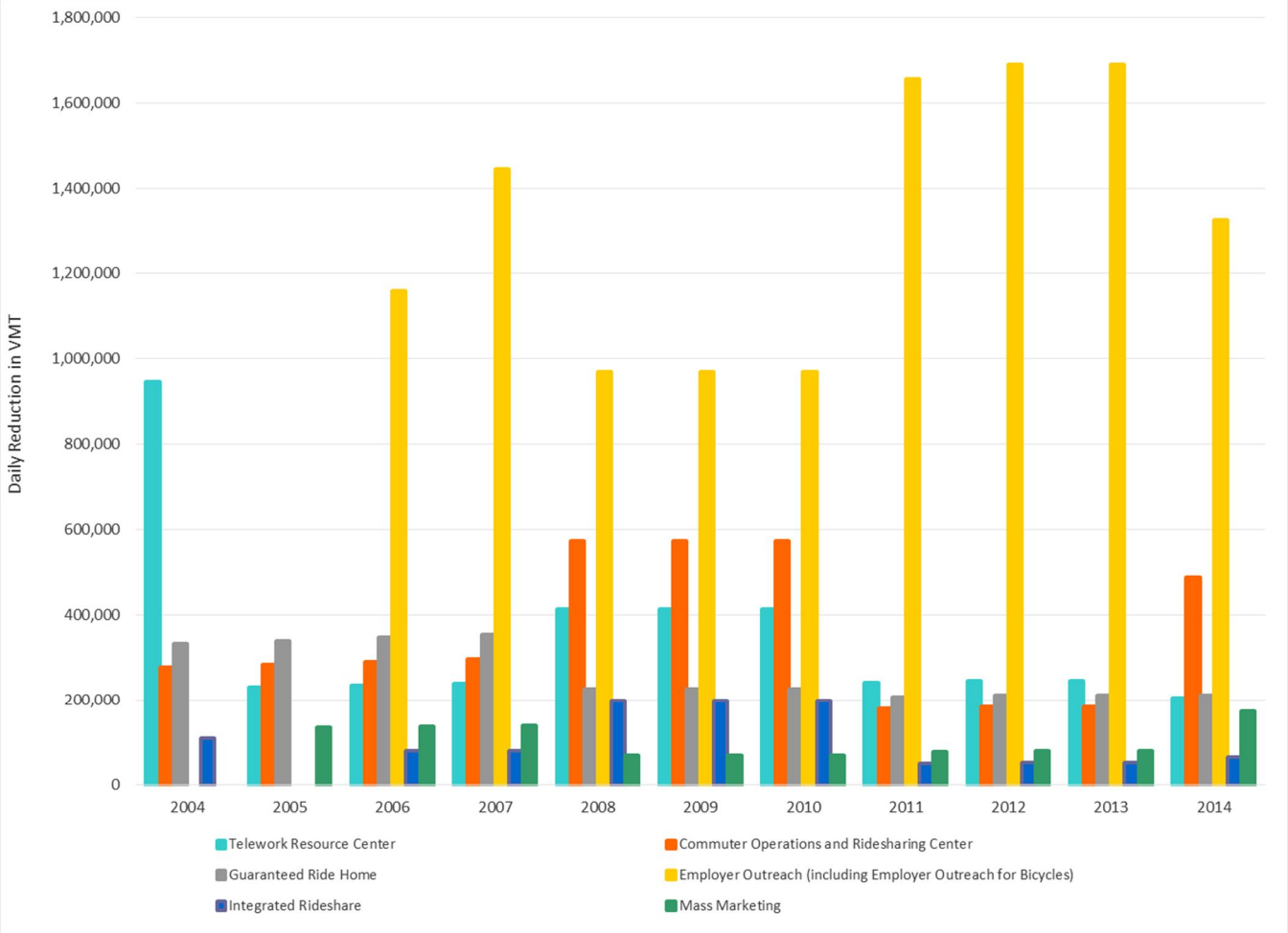
4 Environment

The transportation network impacts the environment in many ways. Transportation emissions contribute to air quality, and runoff from roadways and other transportation facilities contribute to the health of the Chesapeake Bay and other waterways. MDOT is working with Maryland Department of the Environment and other state and federal agencies to reduce emissions and decrease runoff.

4.1 Transportation Demand Management

Transportation Demand Management (TDM) is a set of strategies designed to maximize traveler choice, facilitate economic opportunity, and conserve energy, which in turn helps protect the environment. TDM is a key component of MDOT's transportation portfolio and emphasizes multimodalism, ridesharing, and alternative work schedules. Figure 39 shows the reduction in daily VMT generated by various TDM strategies. Employer outreach has been the most successful strategy, by far.

Figure 39: Daily Reduction in VMT of Different TDM Strategies



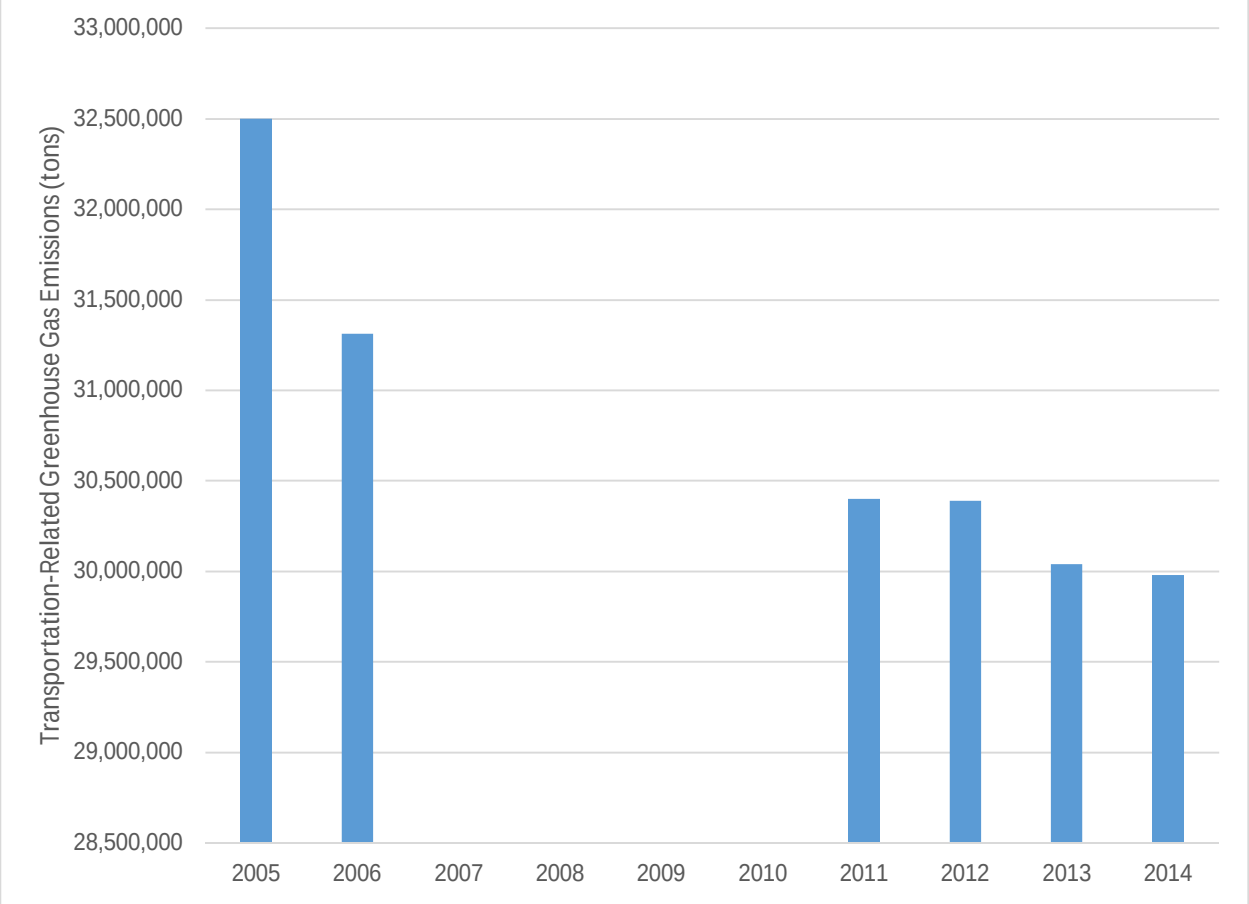
Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System Performance

4.2 Greenhouse Gas Emissions

As Figure 40 shows, Maryland has been steadily reducing its transportation-related greenhouse gases (GHG). In 2009, the Maryland's General Assembly passed the Greenhouse Gas Reduction Act (GGRA), which requires the state to achieve a 25% reduction in GHG from 2006 levels by 2020. In 2016, the law was reauthorized. The bill not only maintained the 2009 bill's goal of reducing GHG by 25 percent by 2020, but it further extended the goal to a 40 percent reduction by 2030. MDOT has played a role in the reduction in several ways including supporting and expanding TDM programs; increasing the efficiencies of the MDOT SHA, MDTA, and MDOT MTA fleets; installing electric vehicle charging stations; and developing policies and securing funding to promote integration and expansion of electric vehicles.

Due to changing methodology and reporting requirements as the Greenhouse Gas Reduction Act (GGRA) planning process expanded and matured, MDOT did not develop emissions data for 2009 and 2010. At one time, it did show 2007 and 2008 data, but moved away from that in 2011.

Figure 40: Transportation-Related Greenhouse Gas Emissions



Source: Maryland Department of Transportation, 2017 Annual Attainment Report on Transportation System Performance

4.3 Stormwater

To monitor its impacts on stormwater, MDOT SHA tracks how well it employs resource protection and conservation practices in project development, construction, operations, and maintenance of transportation assets. It measures this by determining the percentage of compliance on erosion and sediment control ratings. MDOT SHA has consistently been at 99 percent compliance.

4.4 Wetlands

As transportation projects are constructed, wetlands that are impacted by the construction must be mitigated elsewhere. As part of that restoration, additional wetlands beyond what is required can be created. Since 2000, MDOT SHA has restored 200 acres beyond what has been required. MDOT MPA has created, restored, or improved 1,829 acres of wetlands since 2000.

5 Maryland's Transportation Challenges and Opportunities

Maryland's extensive, multimodal transportation network faces a number of challenges. Some are inherent to the network itself – continuing to ensure the safe and efficient movement of people and goods, while others are related to changing transportation needs associated with technological, societal, demographic, land use, climate, and other environmental changes. MDOT and the MTP will need to

balance demand and available resources so that it can accommodate current needs as well as begin to create the transportation network needed in the future.

5.1 Safety

Ensuring the safe use and operation of Maryland's transportation system is paramount. Although fatalities and injuries of motorists on Maryland roads have been declining, there is still room for improvement. In addition, reductions in bicycle and pedestrian fatalities and injuries are not occurring as quickly as those of motorists. Creating a resilient transportation network and preparing for changing conditions, whether environmental or man-made threats is another important safety challenge. Finally, a new safety challenge facing Maryland's TBU's is protection of customer data. This includes data provided by the customer (such as credit card information for online payments) and customer data collected by the transportation system through cameras, fare boxes, and toll facilities.

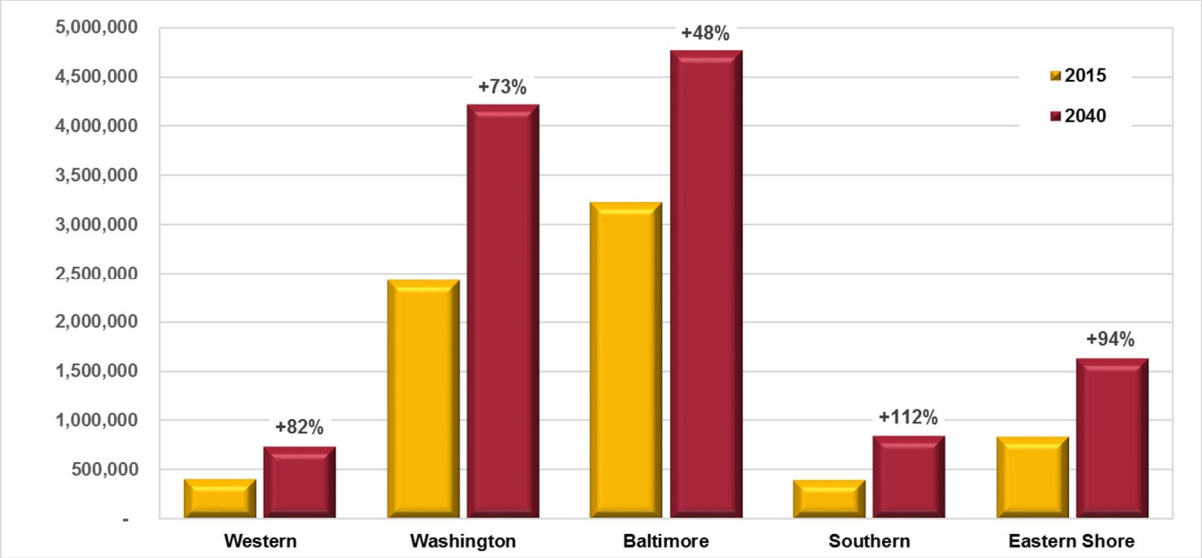
5.2 Aging Infrastructure

Maintaining, and modernizing as appropriate, the existing transportation network and infrastructure is a continuous challenge that requires significant investment. System preservation forms the foundation of MDOT's transportation investments. MDOT MTA, WMATA, and LOTS have maintained their transit fleets and infrastructure. MDOT MPA has kept shipping channels open by providing dredged material placement facilities. MDTA and MDOT SHA have maintained roadways and kept the number of structurally-deficient bridges low. As Maryland faces pressure to expand the transportation network, it is important for MDOT to continue its "fix it first" approach to ensure that its older and existing infrastructure continues to be kept in a state of good repair. This is not a challenge only facing Maryland, many highways and bridges on major routes, especially along the East Coast are nearing the end of their useful lives and will require maintenance, repair, and perhaps even replacement. Asset management programs are critical to ensuring public investment is optimized and needs are prioritized.

5.3 Congestion

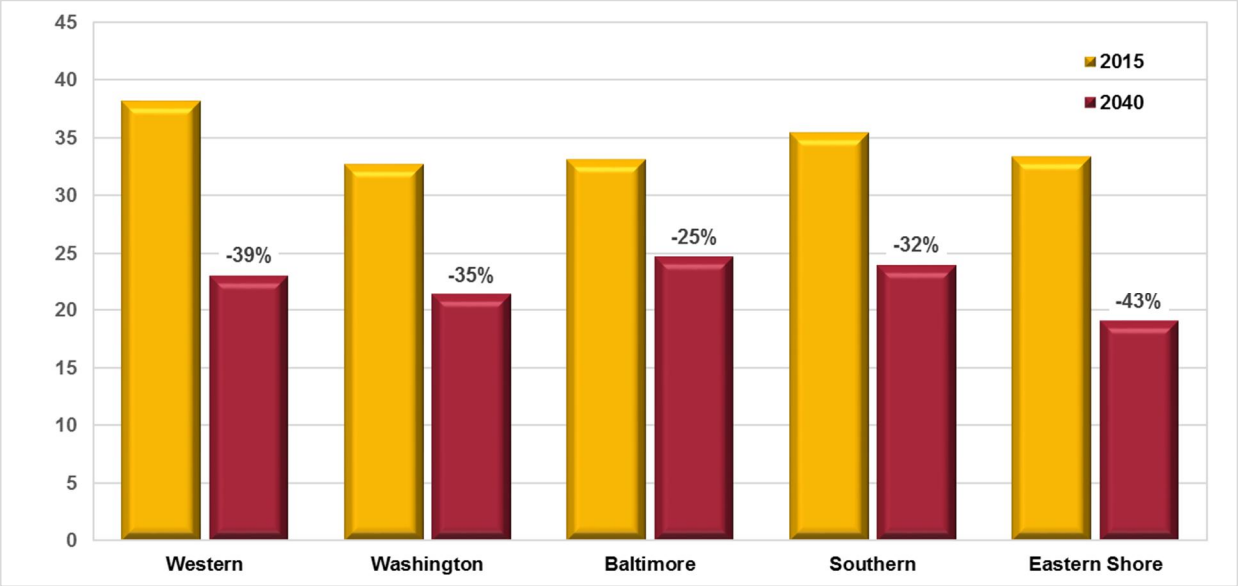
As Maryland's population and employment increases between now and 2040, congestion is forecast to increase. For many years, Maryland's urban areas have operated at saturated congestion levels, and national studies consistently cite the Baltimore-Washington region as one of the most congested transportation systems in the country. Many of the State's major facilities operate at capacity for multiple hours of the day. The result of adding approximately 25 percent more travel demand on top of existing conditions (with the majority of the travel occurring in peak periods) will be the network operating in over-saturated conditions for multiple hours of the day. This would result in system breakdowns and lower system efficiency, all of which would contribute to very high levels of congestion and exponential growth in travel times. Figure 41 and Figure 42 show the change in vehicle hours of travel (VHT) and change in average congested speeds.

Figure 41: Change in Vehicle Hours of Travel (VHT)



Source: Maryland Department of Transportation State Highway Administration, MSTM V1.1

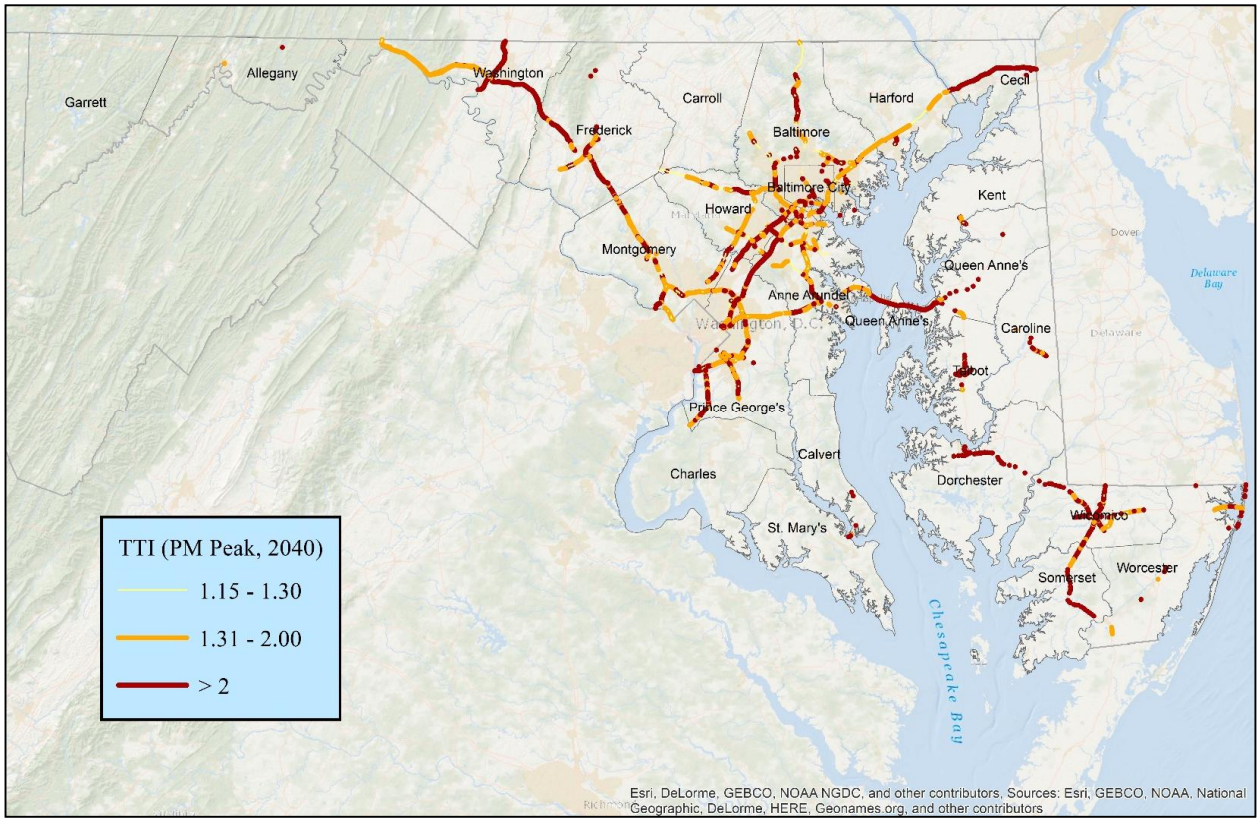
Figure 42: Change in Average Congested Speeds



Source: Maryland Department of Transportation State Highway Administration, MSTM V1.1

TTI (Travel Time Index) measures the congestion conditions on individual roadway links. The TTI compares free flow time, the travel time when there is no congestion, to congested travel time. A TTI of 2.0 or above indicates that a trip which takes ten minutes in light traffic would take 20 minutes in heavy traffic.[4] Figure 43 shows the travel time index for projected 2040 conditions in Maryland. It shows that by 2040 there will be a large amount of congestion within the state, particularly in the area bounded by Frederick County, Cecil Count, Montgomery County and Anne Arundel County. Figure 44 shows the roadway segments that are forecast to experience a TTI increase of 50 percent or more.

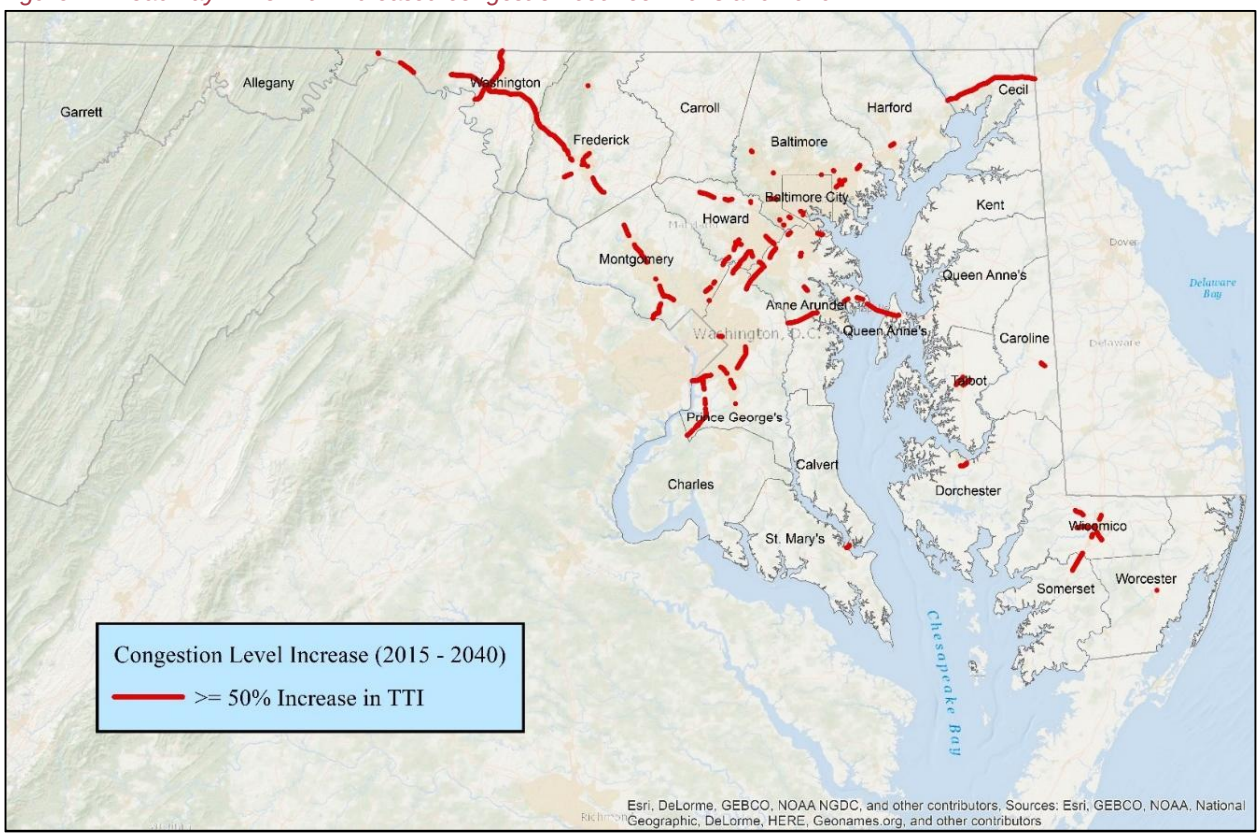
Figure 43: Congested Highway, Freeway, and Expressway Links (2040)



Source: Maryland Statewide Transportation Model 2015

[4] https://ops.fhwa.dot.gov/congestion_report_04/appendix_C.htm

Figure 44: Roadway Links with Increased Congestion between 2015 and 2040



Source: Maryland Statewide Transportation Model 2015

5.4 Shared Economy

Ridesharing services such as Uber and Lyft substitute for traditional taxi services, providing a cheaper and more immediate alternative. To date, ridesharing has been effective in large, dense urban areas with a significant demand and significant number of drivers. While demand for ride sharing is growing, it is unlikely the services will be able to extend far beyond urban areas. It is uncertain how ridesharing will impact the number of vehicle registrations, licensed drivers, or transit riders. In addition, these services may be augmented or, conversely, reduced with the increase in automobile automation.

5.5 Online Retail

Retailing in the United States is in the midst of a major shift and consolidation. The shift toward online shopping has reduced the number of individual shopping trips and increased the number of delivery trucks, leading to an overall reduction in vehicles on the road. Additionally, due to the overbuilding of shopping centers between 1960 and 1990, many centers are now closing. As a result, shopping trips will tend to become more concentrated at the remaining centers.

An additional challenge for Maryland associated with online shopping is the tremendous growth in the development of very large warehouse and distribution centers. These facilities provide jobs, but because of their locations with easy highway access, they can be difficult to access by transit. In addition, the presence of delivery vehicles coming into and out of the facilities impacts the surrounding roadways.

5.6 Electric Vehicles

Electric vehicles, which are beginning to enter the vehicle fleet, have significant advantages over vehicles with gasoline and diesel engines. They are cheaper to operate and generate zero emissions. They also face major disadvantages with recharging times greater than refueling times and a limited number of recharging stations in the state. Advances in battery technology and the installation of additional recharging stations will help promote the growth of electric vehicle use in the future. Two uncertainties related to electric vehicles remain. First, does the nation's power grid have sufficient capacity to support a large number of electric vehicles? Second, since the US Department of Transportation and most state Departments of Transportation rely on fuel taxes for a significant portion of their expenditures, how will the funding shortfall resulting from decreased fuel demand be resolved?

5.7 Autonomous Vehicles

Automated vehicles have the potential to change the length and destination of trips and represent a great challenge to the transportation system. In the immediate future, automated vehicles will allow drivers to perform other tasks, such as reading or using the internet, potentially making travel time less onerous and promoting longer trips. In addition, fully-autonomous vehicles could provide users who currently cannot travel in a single-occupancy vehicle opportunities to own and operate a vehicle, thus increasing the number of vehicles using the network. Looking further ahead, autonomous vehicles, due to embedded communication technologies, can operate closer together, thereby increasing highway capacity and speed. These vehicles will likely have two opposite impacts. They will facilitate denser development in urban areas by allowing a vehicle to be parked remotely, then summoned when needed. This would allow redevelopment to occur on areas once devoted to parking and allow future development to occur more densely as dedicated parking is reduced. At the same time, autonomous vehicles may promote greater residential dispersion through faster auto travel and greater willingness of drivers to make longer trips.

5.8 Climate Change

The potential impacts of climate change on transportation infrastructure and operations are a growing concern, and Maryland's transportation infrastructure will be impacted by changes to the climate. It is important to understand the location and extent of potentially-impacted infrastructure and for decision makers to consider investments that improve resiliency on key facilities.

The Port is a water-dependent function and since many of its facilities are within the flood plain, the MDOT MPA has conducted a vulnerability assessment and implemented policies to increase resiliency. To assess the vulnerability of the Maryland roadway network, MDOT modelled the impact to coastal area roads in the event of a 25-year flood[5] in 2015 vs. 2050, with the 2050 analysis using sea level rise projections of approximately two feet above current mean sea level. As shown in Error! Reference source not found. flood impacts on the highway network in 2050 would be considerably worse than the impacts of a storm today.

There are several types of impacts that need to be considered when building new infrastructure and rehabilitating existing infrastructure. They include rising seas, increased flooding, changes in precipitation levels, and increased temperatures. The future environmental conditions will stress

[5] A "25-year flood' means there is a 1 in 25 or 4 percent chance that a storm of this intensity will occur in any given year.

infrastructure in different ways than the stressors currently stressing today's infrastructure. Because those future factors are not typically considered in the current design specifications, infrastructure could meet today's standards, but fail in the future. This could mean storm drains not being sized large enough to remove higher volumes of water or pavement buckling in the summer.

The State has initiated action through the 2008 release of the Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change, Phase I: Sea-level rise and coastal storms; 2011 release of the Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change, Phase II: building societal, economic, and ecological resilience; and December 2012 Climate Change and CoastSmart Construction Order, which requires all new and reconstructed state structures and other infrastructure improvements to be planned and constructed to avoid or minimize future flood damage.

5.9 Changing Development Patterns

As growth continues to spread further from a centralized core (or cores), it becomes harder to provide transportation options in an efficient manner. Not only is it difficult to provide transit service to an area with a dispersed population, but it is also very expensive to build and maintain roads that do not serve a large portion of the population. In addition, as jobs and housing locate further from each other, demands on the transportation network increase, which can lead to increased congestion. Land use is a local decision; however, provision of transportation access has State implications. Therefore, a balance between competing needs and interests must be struck.

5.10 Millennial Generation

As the Millennial generation begin to enter the workforce, Maryland's transportation system will face challenges associated with that generation's preferences. Millennials tend to spend more on experiences (e.g., entertainment, restaurants, travel) than on things, which is changing the time of day and destination of trips. Whether collectively this will increase or decrease congestion remains to be seen.

Millennials also tend to prefer living in denser environments served by public transit. This may counteract the trend described in the "Changing Development Patterns" section above. It is possible that as Millennials choose to move into urban environments, it will become more cost-efficient and feasible to invest in transit options. This may serve to reduce congestion as well.

5.11 Aging Population

Maryland's population is getting older, and the implications of this population shift are uncertain. An increase in older drivers could change travel patterns and travel times. Unfortunately, with the exception of teen drivers, seniors have the highest crash death rate per mile driven, even though they drive fewer miles than younger people.[6] Many seniors exhibit safe driving habits such as wearing seatbelts, observing speed limits, and not drinking and driving and most avoid more challenging roadway conditions such as driving after dark, in rush hour, and in bad weather. However, seniors have age-related vulnerabilities such as arthritis, weaker muscles, reduced flexibility, and limited range of motion all of which can reduce one's ability to grip and turn a steering wheel or press the accelerator or brake. However, as seniors live longer coupled with increased awareness of one's driving ability there

[6] http://seniordriving.aaa.com/resources-family-friends/conversations-about-driving/facts-research/ (accessed 1/8/1018)

could be a reduction in licensed drivers and a decrease in the number of registered vehicles. Providing transportation for older Marylanders who no longer drive could also impact public transportation agencies, non-profit transportation providers, and/or private providers.

5.12 Support for Distressed Economic Regions

Transportation plays a critical role in the State's economy. It supports the ability for workers to get to jobs and for freight shipments to be completed in a timely and efficient manner. Maryland's largest employment centers are in the Baltimore and Washington regions. However, there are jobs and workers in other parts of the state, which also require transportation investments to ensure the continued growth of their economies. Striking a balance between the State's various transportation needs – in congested and growing areas and in slower growth areas in need of investment – is an important policy challenge facing the State.

6 Next Steps

The information contained in this document will help guide the development of the MTP. The transportation extent, socioeconomic and travel trends, and anticipated challenges will inform upcoming discussions on transportation system needs, statewide goals and objectives, representative projects, and performance measures that gauge progress. All of these elements will come together in an MTP that sets Maryland's transportation priorities and outlines actions about where and how to invest transportation resources.