Chesapeake
BAY CROSSING STUDY
TIER 2 NEPA

PURPOSE AND NEED REPORT

Maryland Transportation Authority

U S DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION

FEBRUARY 2025

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ABBREVIATIONS AND ACRONYMS

AET	All Electronic Tolling
ALCS	Automated Lane Closure System
B&A	Baltimore & Annapolis (Trail)
BTS	Bureau of Transportation Statistics
C&D	Chesapeake & Delaware (Canal)
CHART	Coordinated Highways Action Response Team
EIS	Environmental Impact Statement
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
LOS	Level of Service
MDOT	Maryland Department of Transportation
MDTA	Maryland Transportation Authority
MPA	Maryland Port Administration
MPH	Miles per hour
MTA	Maryland Transit Administration
MVM	Million Vehicle Miles
MWCOG	Metropolitan Washington Council of Governments
NEPA	National Environmental Policy Act
NOI	Notice of Intent
O-Ds	Origins-Destinations
PHFS	Primary Highway Freight System
PNCD	Preliminary Navigational Clearance Determination
PPX	Post Panamax
PTI	Planning Time Index
ROD	Record of Decision

RPCA	Recommended Preferred Corridor Alternative
SHA	State Highway Administration
TEU	Twenty-foot Equivalent Unit
VPHPL	Vehicles per hour per lane
U.S.	United States
USCG	United States Coast Guard
USDOT	United States Department of Transportation

1 INTRODUCTION

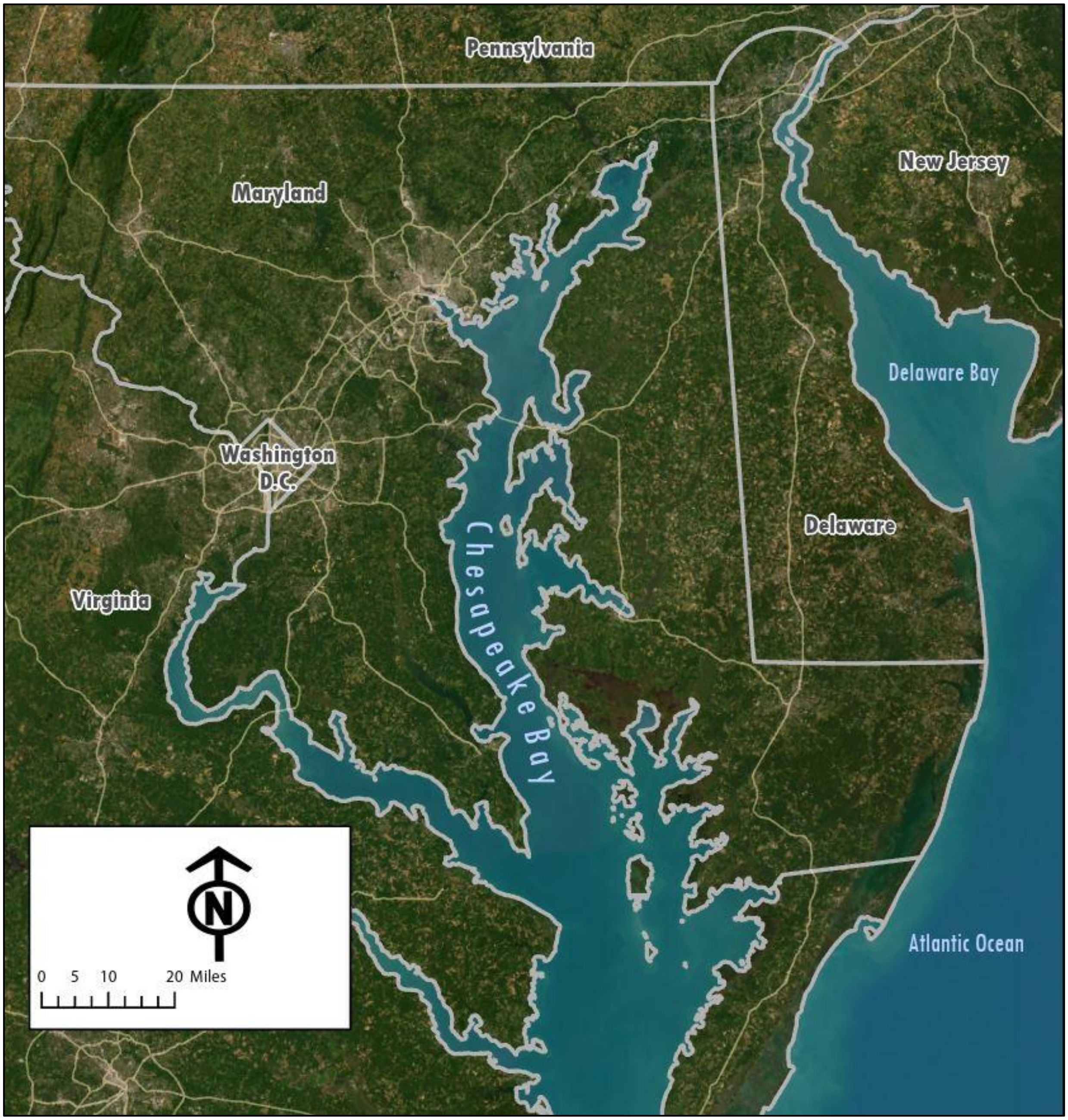
The Chesapeake Bay Crossing Study (Bay Crossing Study) is a two-tiered engineering and environmental study being advanced by the Maryland Transportation Authority (MDTA) in coordination with the Federal Highway Administration (FHWA) to address existing and future transportation issues at the William Preston Lane, Jr. Memorial Bridge (Bay Bridge) and its approaches along U.S. 50/301. Each tier of the Bay Crossing Study involves development of an Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA) to describe potential significant environmental effects and inform the evaluation of alternatives. Tier 1 of the Bay Crossing Study (Tier 1 Study) was completed in April 2022. At that time, the FHWA issued a Final Environmental Impact Statement/Record of Decision (FEIS/ROD) identifying Corridor 7, the corridor including the Bay Bridge and its approaches as the Selected Corridor Alternative for further evaluation.

Tier 2 of the Bay Crossing Study (Tier 2 Study) was launched in June 2022 to focus on project-level (site-specific) analysis within the Tier 1 Selected Corridor Alternative (Corridor 7). As part of the NEPA process, the Tier 2 Study includes an analysis of purpose and need, alternatives, and anticipated environmental impacts. This Purpose and Need Report for the Tier 2 Study provides the foundation for decision-making throughout the NEPA process. It guides development, analysis, and basis for evaluating alternatives by stating what the project or study is intended to do and outlining the issues it seeks to address. It also establishes the reasons for moving forward with the project or study. This report describes existing and anticipated future conditions of the Bay Bridge and its approaches, presents the purpose of the Tier 2 Study, and identifies the needs and additional objectives.

1.1 Background

The Chesapeake Bay, displayed in **Figure 1**, is one of Maryland's most important natural, economic, and cultural resources and the largest estuary in the United States. The 64,000-square-mile watershed that flows into the Bay spans six states and the District of Columbia and includes 150 major rivers and over 100,000 tributaries. The Bay has historically shaped the region's identity, culture, and traditions. Due to the ecological resources and geographical location, the Chesapeake Bay area has a rich archaeological history that spans thousands of years and has also played an important role in the founding and development of the United States of America. The Eastern Shore of Maryland is now best known for its farming and agricultural enterprises, seafood and waterfront industries, as well as tourism and recreational activities in coastal areas, influenced by the Bay.

Figure 1: Aerial of the Chesapeake Bay



The Western Shore is characterized by its major metropolitan employment centers and surrounding communities in the Baltimore-Washington region, complemented by agricultural, seafood, and waterfront industries.

The Bay Bridge is a two-span structure that crosses the Chesapeake Bay from Anne Arundel County on the Western Shore to Queen Anne's County on the Eastern Shore. The original span was built in 1952 to connect the communities on both sides of the Bay (**Figure 2**). Within ten years of opening, the traffic volumes on the original span had nearly doubled. Planning began for a new structure that would provide additional capacity and a parallel span directly north of the original Bay Bridge was opened in 1973. The Bay Bridge has become one of Maryland's most iconic and recognizable landmarks, used by millions of Marylanders and other travelers. As Maryland's only crossing of the Chesapeake Bay, the Bay Bridge plays a major role in the State's regional transportation system and is vital in facilitating transportation, commerce, and tourism in the region.

Figure 2: Construction of the Original Bay Bridge Span in 1952

In 1974, (the first full year that both the first and second span were open to traffic), 7.5 million vehicles crossed the bridge. By 2002, that number had more than tripled, to 25.0 million. Annual volumes have been above 25.0 million each year since, except for the COVID-19 pandemic year of 2020. Today, the Bay Bridge structures have inadequate capacity for current volumes, particularly during summer weekends. Queues longer than one mile routinely occur, and can persist for as long as eight hours. During those eight hours, queues have been observed to extend to nearly five miles. Based on regional and statewide estimates for population growth and travel demand patterns, it is projected that traffic volumes across the Bay Bridge will continue to increase over time (see **Section 3.1** for information related to future conditions). Increases in congestion reduce regional mobility and reliability, which is needed for accessing employment and recreation areas, moving commerce, and providing capacity for emergencies or evacuation events. Congestion also increases during instances of infrastructure maintenance and incident management, both of which can result in closed lanes and are expected to exacerbate conditions as the structures age and risk of congestion-related traffic incidents rises.

1.2 The Tiered NEPA Process

Through the years, the Bay Bridge and its approaches have been the subject of many studies and subsequent transportation improvements, some of which are described in **Section 1.3**. Despite these improvements, transportation issues at the Bay Bridge and its approaches have persisted. To study possible solutions that could address these continued issues, the MDTA and FHWA are conducting the Bay Crossing Study as a tiered NEPA Study. The tiered approach to NEPA allowed the MDTA and FHWA to focus on broader, planning-level decisions related to the preferred location of a potential new Bay crossing in the Tier 1 NEPA EIS, and then analyze more specific, project-level alternatives and potential impacts in the subsequent Tier 2 NEPA EIS. NEPA regulations issued by the FHWA, 23 CFR Part 771.111(g), recognize tiering as a reasonable approach for complying with NEPA.

The tiered approach has been implemented for the Bay Crossing Study due to the broad nature of needs being addressed, the large study area, the multiple crossing possibilities and potential alternatives over nearly 100 miles of the Chesapeake Bay, and the potential for large-scale environmental impacts. In the Tier 1 Study, the MDTA narrowed the area under consideration to an approximately two-mile-wide corridor located around the existing Bay Bridge and its approaches. This smaller geographic area for the Tier 2 Study allows for a more detailed evaluation and more efficient environmental review.

1.2.1 Tier 1

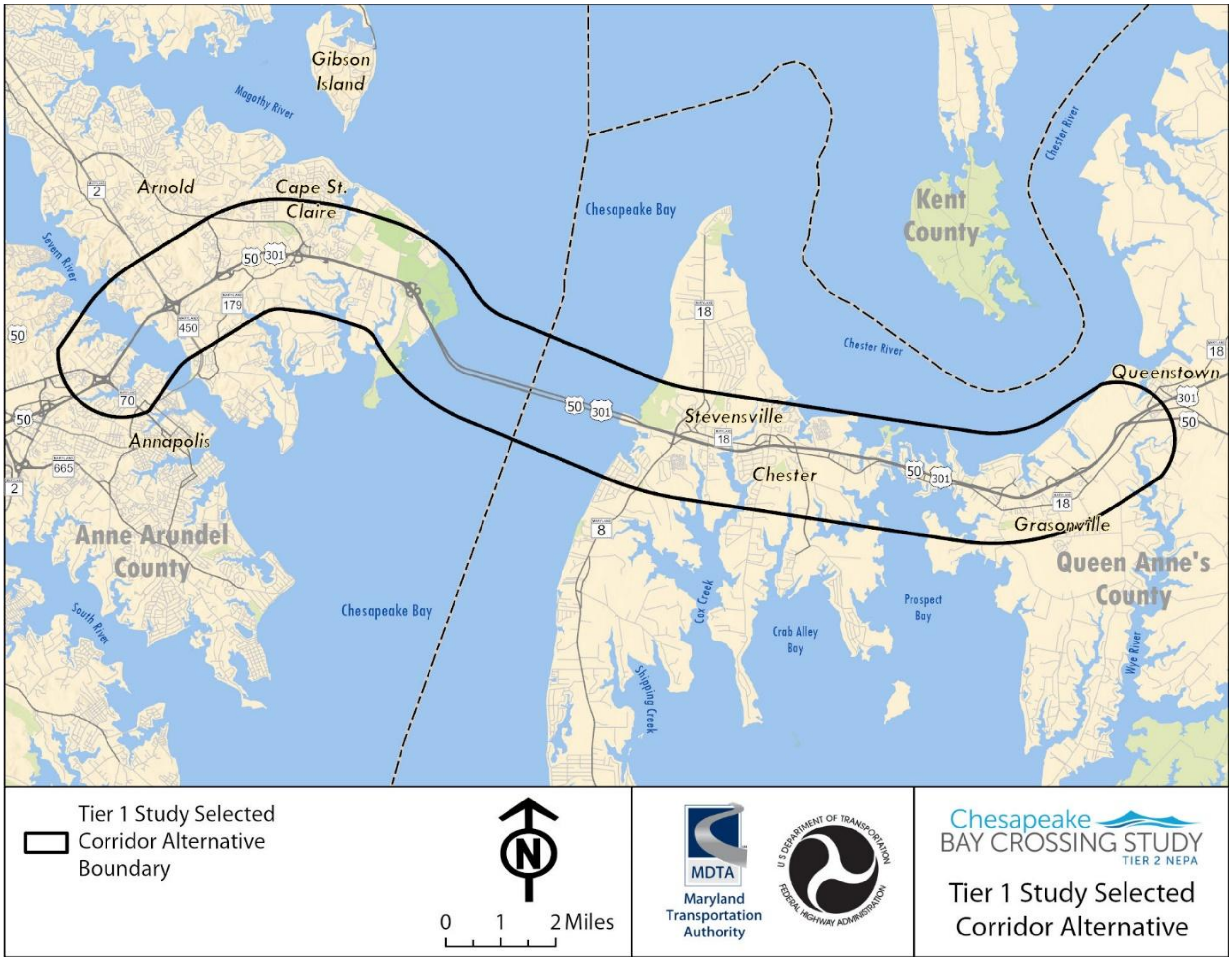
The MDTA and FHWA initiated the Tier 1 Study in 2016. The Tier 1 Study encompassed a broad geographic area that spanned nearly 100 miles of the Chesapeake Bay between Harford and Cecil counties to the north, and St. Mary's and Somerset counties to the south. The Tier 1 Study EIS defined existing and future transportation conditions and needs at the existing Bay Bridge, identified broad corridor alternatives (including a "No-Build" alternative), documented the corridor alternative screening process, and concluded with the identification of a Selected Corridor Alternative in the Tier 1 Study FEIS/ROD in April 2022.

The purpose stated in the Tier 1 Study was to consider corridors for providing additional capacity and access across the Chesapeake Bay in order to improve mobility, travel reliability, and safety at the existing Bay Bridge. The evaluation of potential corridors included assessments of existing and potentially expanded transportation infrastructure needed to support additional capacity, improve travel times, and accommodate maintenance activities, while considering financial viability and environmental responsibility. Three primary needs were identified in the Tier 1 Study and were the basis for evaluating corridor alternatives: adequate capacity; dependable and reliable travel times; and flexibility to support maintenance and incident management in a safe manner.

The Tier 1 Study evaluated 14 possible corridor alternative locations in total. Corridor 7 was identified as the MDTA-Recommended Preferred Corridor Alternative (MDTA-RPCA). After close coordination with regulatory and resource agencies, the public and other stakeholders to identify critical resources and determine potential impacts, the Tier 1 FEIS/ROD was approved by the FHWA on April 14, 2022.

The Tier 1 Study Selected Corridor Alternative (Corridor 7), depicted in **Figure 3**, is a two-mile-wide and 22-mile-long corridor that follows existing U.S. 50/301 and includes the location of the existing Bay Bridge. On the Western Shore, the western limit of the corridor is west of the Severn River near the MD 70 (Rowe Boulevard) interchange, north of Downtown Annapolis. On the Eastern Shore, the eastern limit of the corridor is the U.S. 50/301 split near Queenstown.

Figure 3: Tier 1 Study Selected Corridor Alternative



The Selected Corridor Alternative was chosen because it would provide the greatest congestion relief at the existing bridge crossing, particularly at peak hours, thus having the greatest ability to meet the purpose and need identified in the Tier 1 Study. Corridor 7 was also the least costly corridor due to the ability to utilize existing infrastructure, particularly the U.S. 50/301 roadway and associated right-of-way. Additionally, this location is the shortest distance across the Chesapeake Bay between the Western and Eastern Shores. The Tier 1 Study also concluded that Corridor 7 would likely have the least adverse impacts to sensitive natural areas and less indirect effects than the other corridors. A full summary of the Tier 1 Selected Corridor Alternative analysis is included in Chapter 6 of the Tier 1 FEIS/ROD.

1.2.2 Tier 2

The Tier 2 Study was launched in June 2022 to focus on project-level (site-specific) analysis within the Tier 1 Selected Corridor Alternative (Corridor 7). It includes detailed engineering of alternatives and the assessment of potential environmental impacts associated with alternatives within Corridor 7 such as alignments, structure types, and modal and operational alternatives.

In this Purpose and Need Report for the Tier 2 Study, the transportation issues identified during the Tier 1 Study have been further developed and refined to better describe the specific needs associated with Corridor 7. Tier 2 Study alternatives within the Selected Corridor Alternative will be evaluated based on this refined purpose and need in the Tier 2 Study EIS. The Tier 2 Study EIS will also include a "No-Build" alternative, which consists of no significant proposed action and would provide a baseline for which the impacts of other alternatives can be compared. Consistent with NEPA requirements, agency and public involvement is an essential part of the Tier 2 NEPA process. Engineering and environmental impact analyses will be conducted with robust public and agency involvement.

1.2.3 Tier 2 Study Limits

To determine the appropriate study limits for the Tier 2 Study, the MDTA analyzed the traffic volumes along Corridor 7 and its interchanges. As with the Tier 1 Study, the traffic analysis included the collection of traffic volume data on both non-summer weekdays and summer weekends. Traffic counts were collected beyond the limits of Corridor 7, which were used to ensure identification of appropriate endpoints. The MDTA obtained traffic volume data for the Bay Bridge and the U.S. 50/301 corridor covering the period from April 1, 2022, through December 31, 2022.

On the Western Shore, the analysis showed that 42 to 65 percent of the traffic crossing the Severn River traveling westbound enters U.S. 50/301 from the Broadneck Peninsula and approximately 55 to 71 percent of the traffic crossing the Severn River traveling eastbound exits U.S. 50/301 to the Broadneck Peninsula. Eastbound traffic across the Severn River Bridge is higher than across the Bay Bridge by approximately 39 percent on a non-summer weekday and 23 percent on a summer Friday. Approximately 1/3 of the traffic crossing the Bay Bridge traveling westbound exits from U.S. 50/301 to the Broadneck Peninsula. Traffic volumes across the Bay Bridge are lower than volumes across the Severn River Bridge on both non-summer weekdays and summer weekends. The analysis of the traffic volumes demonstrates that the Severn River Bridge and the Chesapeake Bay Bridge have independent traffic volumes. Thus, there is a clear distinction between traffic volumes associated with the Bay Bridge and traffic volumes on U.S. 50/301 west of the MD 2/MD 450 interchange at the Severn River Bridge. a western study limit beyond the eastern end of the Severn River Bridge would therefore go beyond the scope of addressing issues related to crossing the Chesapeake Bay.

On the Eastern Shore, the traffic analysis shows that the westbound traffic across the Kent Narrows Bridge is approximately the same as across the Bay Bridge, and westbound traffic just west of the U.S. 50/301 split is also similar to westbound traffic across the Kent Narrows Bridge. Eastbound, traffic across the Kent Narrows Bridge is similar to traffic crossing the Bay Bridge and also similar to traffic just west of the U.S. 50/301 split. The U.S. 50/301 split is a major highway decision point for traffic heading north or south on the Eastern Shore with nearly 60 percent of the traffic using U.S. 50 and approximately 40 percent of the traffic using U.S. 301 on non-summer weekdays. On summer weekends, the traffic split is approximately 70 percent using U.S. 50 and approximately

30 percent using U.S. 301. Traffic volume graphics with additional supporting information are available in the **Notice of Intent Additional Project Information Document**.

As a result of the analysis described above, the Tier 2 western study limit has been identified as the MD 2/MD 450 interchange, and the Tier 2 eastern study limit has been identified as the U.S. 50/301 split, as both interchanges provide logical termini given the possible extent of transportation improvements and are rational end points for a comprehensive review of environmental impacts that could result from additional transportation capacity across the Chesapeake Bay.

1.3 Other Related Actions and Studies

The MDTA has adopted transportation management operation practices to improve traffic flow at the Bay Bridge and manage the growing travel demand. However, congestion has persisted despite these practices. Major efforts have included:

- Allowing for two-way traffic during peak periods: With completion of the second span in 1973, the MDTA was able to implement a reversible traffic lane that could be changed to accommodate heavier traffic in either direction.

- Elimination of the westbound toll plaza: Due to increases in traffic volumes, the MDTA eliminated the westbound toll plaza and increased the prices at the eastbound plaza in 1989. This was completed to encourage the free flow of westbound traffic without reducing revenue from toll collection at the Bridge.

- Implementation of all-electronic (cashless) toll collection and removal of the eastbound toll plaza: All-electronic tolling was completely implemented in May 2020. Travelers without an electronic tolling device are tolled through video tolling, "Pay-by-Plate" or third-party tolling apps.

- Implementation of an Automated Lane Closure System (ALCS) Project: This project allows two-way operations on either span to be initiated or discontinued remotely. The ALCS began full operation in March 2023 with the goal of improving safety for motorists and MDTA employees.

- Extensive promotional and education efforts: The MDTA encourages travelers to take trips during off-peak periods through a variety of methods which include website updates, news releases, social media updates, and traffic advisories. The MDTA also provides live traffic cameras that show current traffic conditions.

Since 2004, the MDTA has completed a number of studies that are related to the Bay Crossing Study, as described below. Information and findings from these previous MDTA studies will be considered during the Tier 2 NEPA evaluation where applicable.

- 2004 Transportation Needs Report: The MDTA initiated a study of transportation and safety needs associated with the existing Bay Bridge in 2001, which resulted in the 2004 Transportation Needs Report. The study found that the lack of roadside shoulders impacts the vehicular capacity of the bridge during incident management activities. The study also determined that the bridge carried approximately 53 percent more traffic on an average summer weekend day than on an average weekday.

- 2006 Task Force Report: In 2005, the MDTA formed a Task Force to examine a range of issues to help educate stakeholders about the need for additional capacity across the Bay. As a result of the Task Force's recommendation for more detail study, subsequent studies were conducted to evaluate the potential for transit or ferry service across the Bay to provide capacity and alleviate congestion on the Bay Bridge, including the September 2007 Analysis of Transit Only Concepts to Address Traffic Capacity Across the Chesapeake Bay.

Figure 4: Existing Bay Bridge spans, looking east

- 2007 Transit Study: The MDTA conducted a study in response to input received from the Task Force to assess the role of transit in addressing the capacity needs at the Bay Bridge without additional highway capacity. It concluded that at the time of the study, transit as a standalone alternative would not provide significant relief to summer weekend or peak period weekday traffic. While transit service would reduce some vehicle travel on the Bay Bridge, the reduction would be very small relative to the overall volume of traffic that used the bridge.

- 2015 Life Cycle Cost Analysis: The 2015 Life Cycle Cost Analysis was conducted to evaluate the travel operations and structural condition of the Bay Bridge, understand the costs and time frame associated with implementing future Bay Bridge improvements, and evaluate complementary improvements that would be needed if/when (a) new structure(s) were built including mainline U.S. 50/301 improvements. Build recommendations were not given in the analysis but a NEPA study was recommended for reviewing any proposed improvements.

- 2020 Public Operated Ferry Service for the Chesapeake Bay Crossings: The MDTA conducted a study examining the feasibility of electric ferry service as an alternative to additional roadway capacity across the Chesapeake Bay, at the request of the Maryland

General Assembly. The study found that an electric ferry service would not be a feasible standalone option to alleviate congestion at the Bay Bridge.

2 PURPOSE

In the NEPA environmental review process, the "purpose" is the specific intent of the agency's activity.

The purpose of the Chesapeake Bay Crossing Study: Tier 2 NEPA is to address existing and future transportation capacity needs and access across the Chesapeake Bay and at the Chesapeake Bay Bridge approaches along the U.S. 50/301 corridor. The Tier 2 Study is evaluating measures to reduce congestion; improve travel times and reliability, mobility, and roadway deficiencies; and accommodate maintenance activities and navigation, while minimizing impacts to local communities and the environment.

3 NEEDS

The "needs" presented in a NEPA environmental review process are the elements and supporting data substantiating that a problem exists or is likely to occur. The MDTA has identified five needs for the Tier 2 Study, which have been updated since the Tier 1 FEIS/ROD was issued by the FHWA. These updates are based on the most recent available information and reflect the project-level (site-specific) focus of the Tier 2 Study.

The needs of the Tier 2 Study are:

- Adequate capacity and reliable travel times,
- Mobility,
- Roadway Deficiencies,
- Existing and future maintenance needs, and
- Navigation.

In addition to identifying needs, the MDTA has also identified two objectives for consideration:

- Environmental Responsibility
- Cost and Financial Responsibility.

These supporting objectives will be considered during alternatives development and screening. Both environmental and cost and financial responsibility, are fundamental to the planning process and an integral part of evaluating alternatives. However, including them as objectives in this Tier 2 Study will lead to heightened scrutiny and greater attention to these issues and will allow for greater efficiency in the early stages of alternatives development. Ultimately, this will allow for earlier and clearer communication with stakeholders and the public about high-quality, reasonable, and feasible alternatives and the decision-making process. The integration of these objectives also recognizes the importance of these issues given the sensitivity of the Chesapeake Bay and likely substantial cost of a proposed action. More information on the objectives is available in **Section 4** of this report.

The MDTA intends to develop alternatives that have the potential to meet the study needs and will evaluate the reasonableness of alternatives based on their overall ability to meet the needs and objectives. An alternative may be deemed reasonable even if it does not address every need completely. Therefore, it is possible that the alternative selected from the NEPA environmental review process may not eliminate all future congestion.

While much of this information, such as traffic and crash data, was identified during the Tier 1 Study, it has been updated to reflect more recent travel conditions and refined for the Tier 2 Study to focus on the more specific needs of the corridor and the project-level NEPA review process.

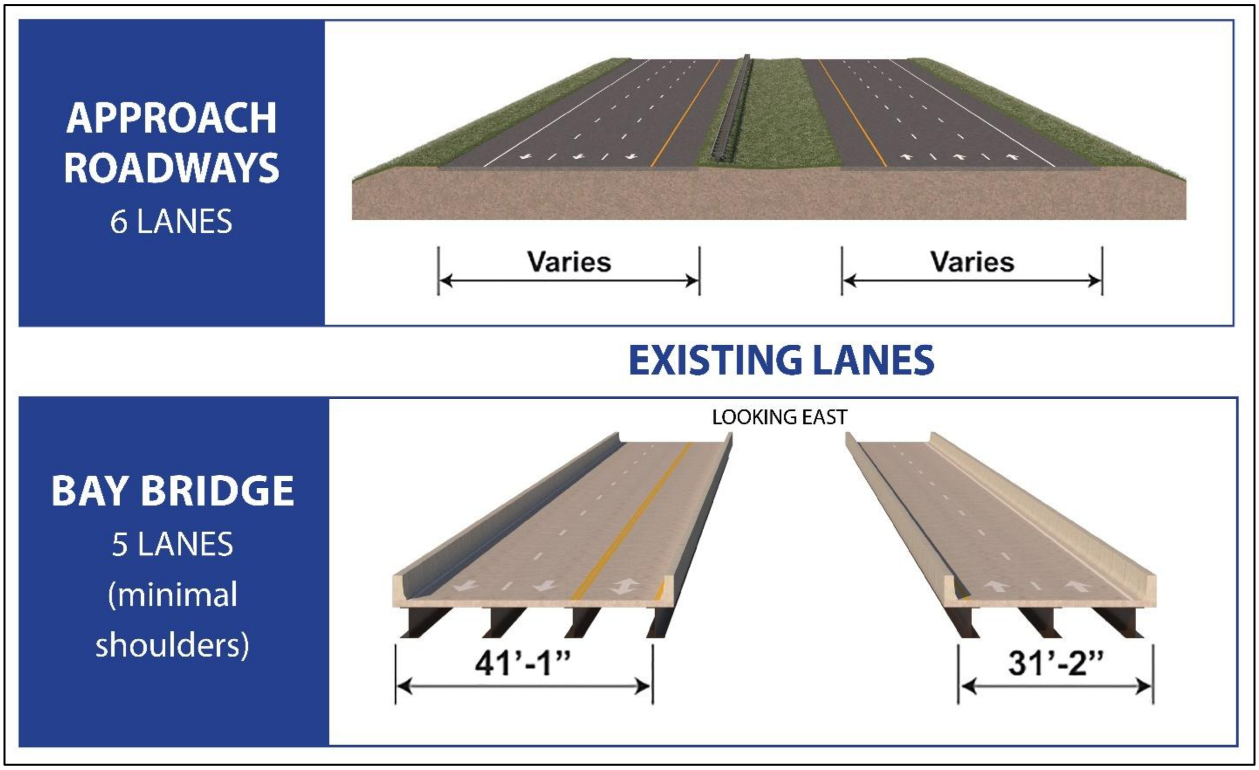
3.1 Adequate Capacity and Reliable Travel Times

The MDTA obtained traffic data for the Bay Bridge and the U.S. 50/301 corridor covering the period from April 1, 2022, through December 31, 2022. Traffic counts were collected during this period for the purposes of having post-pandemic data that would most accurately represent the existing conditions. This period also includes the summer months, which typically experience the highest overall traffic volumes, in order to provide a comparison between summer weekend and non-summer weekday conditions. Additional traffic data was also collected at a small number of locations in 2023 and 2024. Based on the data and analysis presented in this section, the capacity of the Bay Bridge and its approaches on U.S. 50/301 are not sufficient to accommodate existing and anticipated travel demand, resulting in traffic congestion on the Bay Bridge and adjacent roadway network.

3.1.1 Capacity

While the approaches on the Eastern and Western shores have six lanes with three lanes of traffic in each direction, the Bay Bridge has five lanes of traffic total. The southern span has two lanes that typically carry eastbound traffic and the northern span has three lanes that typically carry westbound traffic. During periods of heavy travel, construction, emergencies, or other incidents that require lane closures, traffic on either span can be reversed. For example, one lane on the northern span is often reversed during periods of high eastbound congestion to provide a third eastbound lane. This reverse travel flow condition is called “contra-flow” or “two-way” operation. Although two-way traffic can be implemented on either span, the northern span is referred to as the “westbound span” and the southern span is referred to as the “eastbound span,” both colloquially and throughout this report. **Figure 5** depicts a cross section of the number of lanes on the Bay Bridge and its approaches.

Figure 5: Roadway Cross Section of Bay Bridge and Approaches



On the Eastern Shore, at the U.S. 50/301 split near Queenstown, the number of lanes reduces to two lanes in each direction along both U.S. 50 and U.S. 301. On the Western Shore, the number of lanes on U.S. 50/301 to the west of the MD 2/MD 450 interchange is variable, with as many as five lanes in one direction being provided in some sections between interchanges.

The existing approach roadways are classified as freeways with posted speed limits of 55 miles per hour (mph) on the Eastern and Western Shores. Between the Oceanic Drive interchange on the Western Shore and the toll gantry on the Eastern Shore, the speed limit for all eastbound traffic is reduced to 40 mph then increases to 50 mph mid-way across the eastbound span and the speed limit for all westbound traffic is reduced to 50 mph. On the Bay Bridge, the individual lane widths range from approximately 11 feet to 12 feet, but each lane is a consistent width across the length of the bridge. The maximum shoulder width on the Bay Bridge is approximately two feet.

The existing Bay Bridge carries large volumes of travelers and frequently approaches or exceeds its capacity for long durations. These travel volumes have increased over time and are expected to continue increasing in the future. They contain a high percentage of trucks during weekdays. The increasing volumes correlate with increases in regional population and employment, and result in greater congestion. Queues begin to develop when traffic volumes approach capacity. While the observed capacity of the Bay Bridge in either direction is approximately 1,500 vehicles per hour per lane (vphpl), queues from traffic congestion have been observed to begin forming at demand levels at or less than 1,150 vphpl.

Due to the reduction in the total number of lanes on the Bay Bridge compared to its approaches, the capacity of the bridge is lower than the other segments of U.S. 50/301. Furthermore, the reduced lane and shoulder widths encourage slower driving speeds and further constrict the free flow of traffic. This leads to a condition where traffic levels that are free flowing on the approaches can result in slow-moving and congested traffic levels on the bridge. As discussed in **Section 3.3**, bridge heights and substandard lane and shoulder widths along the Bay Bridge can also cause anxiety among users and slower driving speeds. Therefore, the bridge itself is the constraining factor to travel flow.

3.1.1.1 Historic and Existing Volumes

Figure 6 displays the annual number of vehicle trips across the Bay Bridge and illustrates the historical increase of travel volumes. Before the second span opened in 1973, annual crossings rose gradually to approximately 6 million crossings per year. In the following decades, the number of crossings grew to over 10 million in 1979, over 20 million in 1995, and peaked in 2019 with 27.6 million crossings. Despite the reduction in crossings during the COVID-19 pandemic, travel patterns have since adjusted and the number of crossings exceeded 26 million in 2021 and 2022.

In 2022, average daily eastbound traffic volumes on the Bay Bridge were 34,857 vehicles per day during a non-summer weekday and 52,751 vehicles per day on summer Fridays. The average daily westbound traffic volume in 2022 was 34,731 vehicles per day for non-summer weekdays and 51,533 vehicles per day for summer Sundays.

The increase in crossings has accompanied a steady increase in the population of the state of Maryland, Anne Arundel and Queen Anne's counties, the other Eastern Shore counties south of Cecil County, and the southern Delaware counties of Kent and Sussex. Population data by decade starting from when the Bay Bridge opened is located in **Table 1.**

Figure 6: Annual Crossings of the Bay Bridge

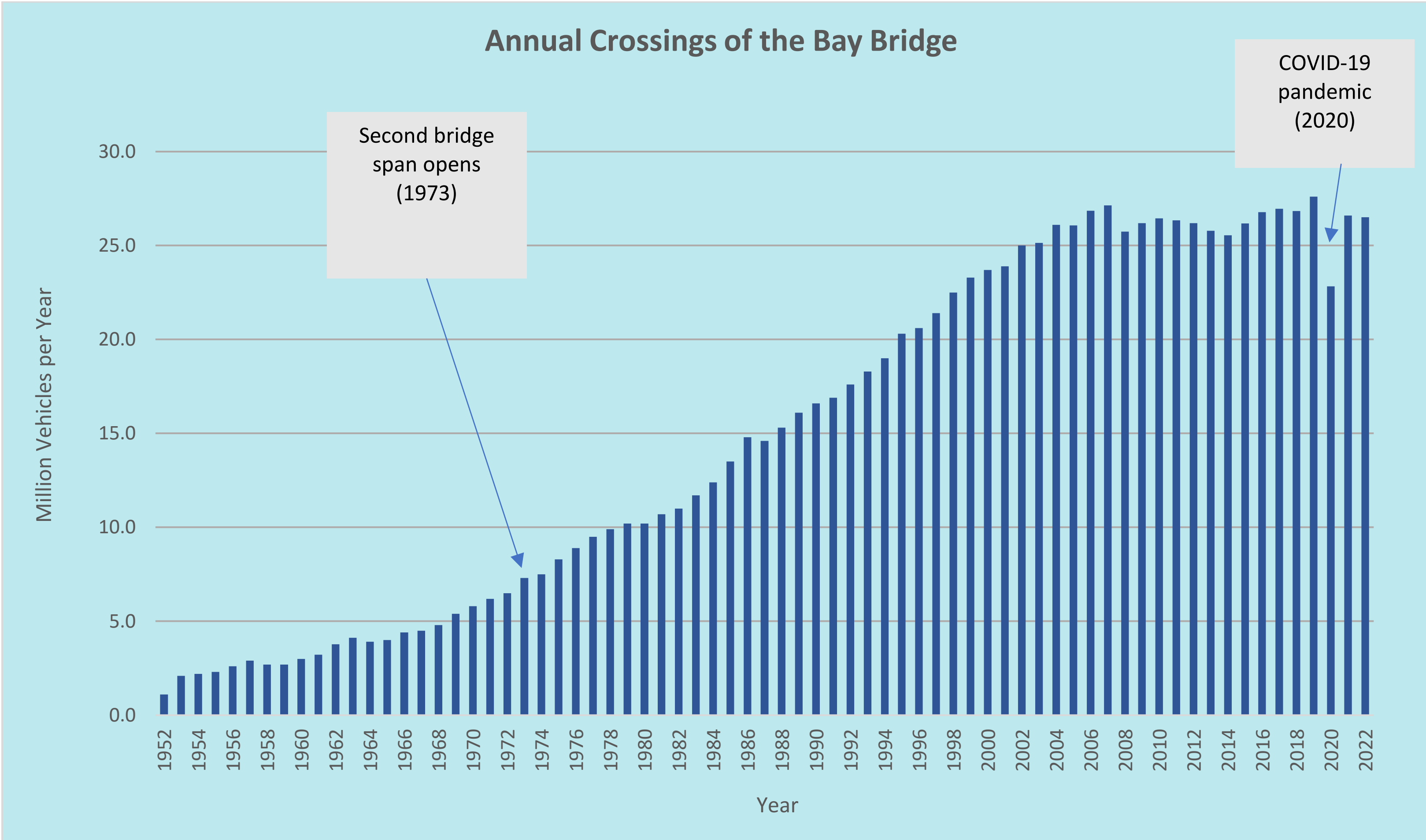


Table 1: Regional Population Growth

Year	Population				
	Maryland (in millions)	Anne Arundel County, MD	Queen Anne's County, MD	Other MD Eastern Shore Counties*	Southern Delaware Counties**
1952 (original span of Bay Bridge opens)***	2.5	117,392	14,579	162,688	99,206
1973 (second span of Bay Bridge opens)***	4.1	297,539	18,422	186,616	162,248
1980	4.2	370,775	25,508	210,682	196,223
1990	4.8	427,239	33,953	238,469	224,222
2000	5.3	489,656	40,563	269,389	283,335
2010	5.8	537,656	47,798	300,320	359,455
2022	6.1	593,286	51,711	306,487	442,902

*"Other MD Eastern Shore Counties" consists of Kent, Caroline, Talbot, Dorchester, Wicomico, Worcester, and Somerset Counties

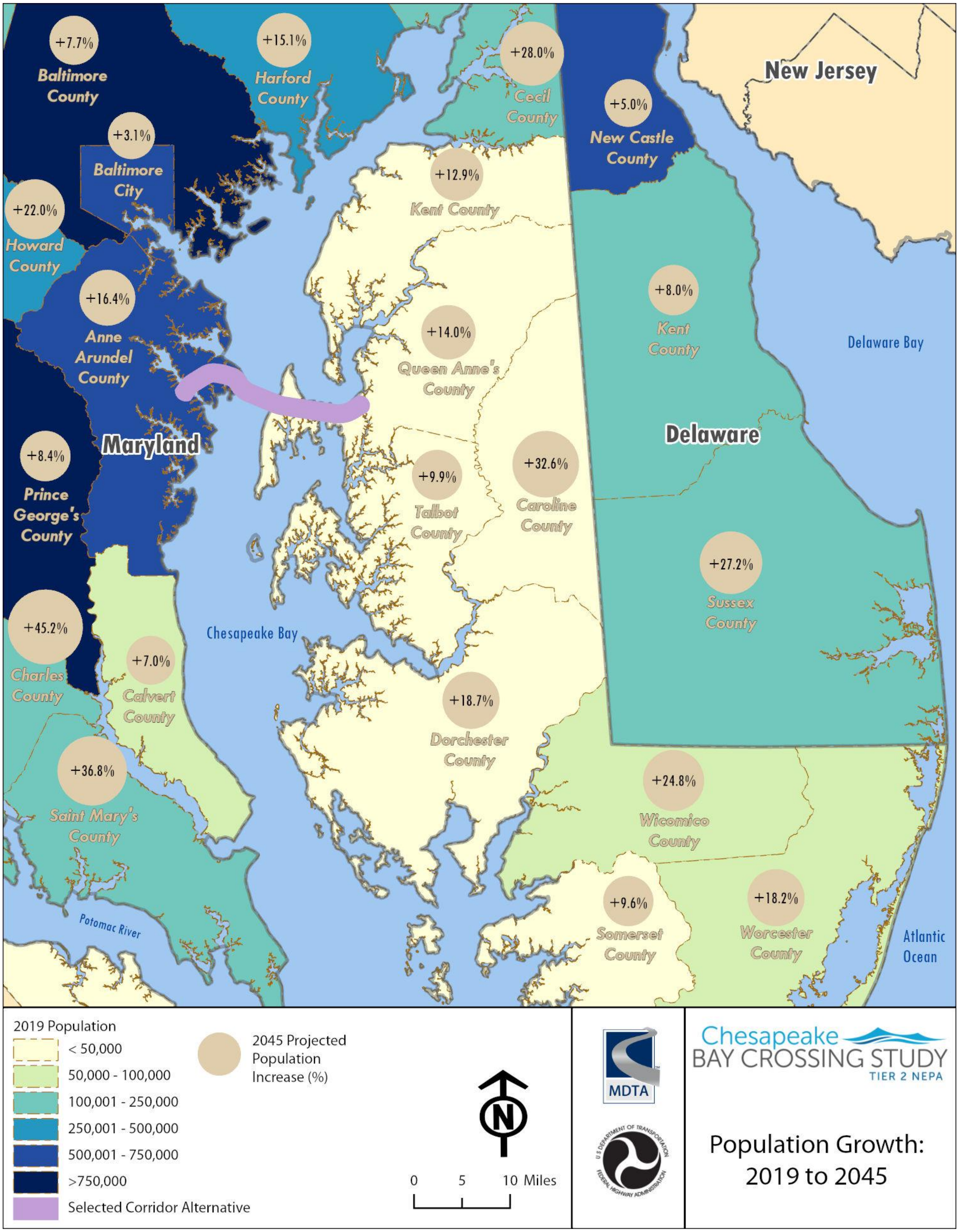
**"Southern Delaware Counties" consists of Kent and Sussex Counties

***County population data from the counties was taken from nearest U.S. Decennial Census (1950 and 1970)

3.1.1.2 Projected Population Growth

Through 2045, population in the state of Maryland is expected to increase by 892,384 people, which represents an approximate 15 percent increase in population compared to 2019 levels. This data is based on the Round 9A Baltimore Regional Transportation Board-endorsed cooperative forecast and Metropolitan Washington Council of Governments land use model Round 9.0. Telework has been accounted for in projections based on the data that was collected in 2019. This projected growth is depicted in **Figure 7**.

Figure 7: 2019 Population and Projected Growth to 2045 by County



By 2045, Anne Arundel County is expected to grow by approximately 16 percent with 94,650 new residents and the population of Queen Anne's County is expected to increase by approximately 14 percent, with 6,900 new residents. Other areas in the vicinity of the State of Maryland are expected to see similar population increases during that period. The population of the State of Delaware is expected to grow by approximately 11 percent with 106,150 new residents by 2045. The District of Columbia is also expected to see an approximate 39 percent increase in population with 262,056 new residents.

Since projected population growth remains one of the industry standards for projecting future trip and travel demand, this anticipated growth is expected to increase demand for trips across the Bay during the average weekday, as well as weekends during summer months. Despite fluctuations in annual vehicle crossings in recent years, under "No-Build" conditions, traffic volumes at the Bay Bridge are expected to grow by 31 percent on non-summer weekdays and by approximately 25 percent on summer weekend days, as shown in **Table 2**.

Table 2: Daily Trips Across the Bay Bridge (vehicles per day)

Day Type	2022	2045 No-Build	Percent Change (%)
Typical Non-Summer Weekday	69,588	91,150	31
Typical Summer Weekend Day	104,284	130,500	25

3.1.2 Levels of Service

Quantifying congestion is an important analytical step when evaluating potential alternatives and comparing their ability to accommodate traffic. In a study like the Tier 2 Study, this quantification is typically established by using the Highway Capacity Manual (3) (HCM) to evaluate traffic operations in terms of level of service (LOS). LOS, as defined by the HCM, "is a quantitative stratification of a performance measure or measures that represents quality of service, measured on an A through F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worst."

At LOS D, flow is still stable, and travel times are relatively predictable. At LOS E, flow is volatile, and travel times can vary widely. Capacity is the breakpoint between LOS E and LOS F. Accepted transportation planning and traffic engineering expertise and practice suggest that achieving at least a LOS D is preferred, but LOS E or even LOS F may be all that is possible for some facilities. At the Bay Bridge, field observations conducted during 2022 revealed that queues begin to form on the Bridge, and thus on its approach roadways, at a volume of approximately 1,150 vehicles per lane per hour. This volume corresponds to an LOS in the lower half of the D range on the bridge, and to an LOS in the lower half of the C range on the approach roadways.

A summary of the 2022 directional hourly LOS for both average typical non-summer weekday and summer weekend conditions across the Bay Bridge is presented in **Table 3**. Under "With Two-way" traffic conditions, a lane is reversed on the westbound span to temporarily increase the capacity for eastbound travel.

As depicted in **Table 3**, "With Two-way" values for a non-summer weekday indicate the best-case LOS in the eastbound direction at any given hour during which eastbound congestion would otherwise occur, even while reducing capacity for westbound travel. Values in the "With Two-Way" column provide LOS for a summer weekend that assume three lanes eastbound throughout Friday and three lanes westbound throughout Sunday. With two-way operations, traffic does not typically exceed LOS D during average weekdays. However, during summer weekends, traffic approached bridge capacity for five hours in the eastbound direction and three hours in the westbound direction. Thus, while implementing two-way operations is helpful in allowing the MDTA the ability to manage and alleviate congested conditions, volumes regularly approach the available capacity on the bridge, resulting in periods of congestion. The MDTA continually strives to optimize the level of service on the Bay Bridge, modifying the implementation of two-way operations in response to changing travel conditions. However, the five lanes available on the Bay Bridge simply do not provide sufficient capacity to avoid congestion in one or both directions at all times.

Under 2045 no-build conditions, hourly travel demand is predicted to approach or even exceed the capacity of the Bay Bridge in at least one direction for nine hours on an average non-summer weekday and 11 hours on a summer weekend day with two-way operations. Further information is displayed in **Table 4**.

Table 3: 2022 Hourly Levels of Service across the Bay Bridge

Time of Day	With Two-way				Without Two-way			
	Non-Summer Weekday		Summer Weekend		Non-Summer Weekday		Summer Weekend	
	EB	WB	EB	WB	EB	WB	EB	WB
12-1AM	A	A	A	A	A	A	A	A
1-2AM	A	A	A	A	A	A	A	A
2-3AM	A	A	A	A	A	A	A	A
3-4AM	A	A	A	A	A	A	A	A
4-5AM	A	A	A	A	A	A	A	A
5-6AM	A	B	A	A	A	B	A	A
6-7AM	B	C	C	A	B	C	C	A
7-8AM	C	D	D	A	C	D	D	A
8-9AM	C	C	C	B	C	C	D	B
9-10AM	C	C	C	C	C	C	E	C
10-11AM	C	C	D	D	C	C	F	D
11AM-12PM	D	B	E	D	D	B	F	D
12-1PM	D	B	E	E	D	B	F	E
1-2PM	D	C	E	E	D	C	F	E
2-3PM	C	D	D	E	E	C	F	E
3-4PM	D	D	D	D	F	C	F	D
4-5PM	D	D	E	D	F	C	F	D
5-6PM	D	D	E	D	F	B	F	D
6-7PM	C	C	D	D	D	B	F	D
7-8PM	B	B	D	D	D	A	E	D
8-9PM	B	A	D	D	D	A	D	D
9-10PM	B	A	B	D	B	A	D	D
10-11PM	A	A	B	B	A	A	D	B
11PM-12AM	A	A	A	A	A	A	D	A

Note: Levels of service were computed using hourly volumes, which were developed by using MDTA toll system volumes for eastbound traffic and using MDTA permanent count station volumes for westbound traffic. The period April 1, 2022 – December 31, 2022, was used. For the purposes of analysis, summer conditions were defined as beginning on Thursday May 26 (the start of Memorial Day Weekend) and ending on Monday September 5 (the end of Labor Day weekend). The remainder of the data collection period comprised non-summer conditions. Non-summer weekday volumes were an average of Tuesday and Wednesday volumes during the non-summer period, with outlier days (such as the Tuesday and Wednesday of Thanksgiving week) removed. Summer weekend volumes in the eastbound direction were from Fridays; summer weekend volumes in the westbound direction were from Sundays, with outlier days (such as the Sunday of Labor Day weekend) removed. Summer weekends are measured by summer Friday conditions for eastbound traffic and summer Sunday conditions for westbound traffic.

Table 4: 2045 No-Build Hourly Levels of Service across the Bay Bridge

Time of Day	With Two-way				Without Two-way			
	Non-Summer Weekday		Summer Weekend		Non-Summer Weekday		Summer Weekend	
	EB	WB	EB	WB	EB	WB	EB	WB
12-1AM	A	A	A	A	A	A	A	A
1-2AM	A	A	A	A	A	A	A	A
2-3AM	A	A	A	A	A	A	A	A
3-4AM	A	A	A	A	A	A	A	A
4-5AM	A	B	A	A	A	B	A	A
5-6AM	A	C	B	A	A	C	B	A
6-7AM	C	D	C	A	C	D	C	A
7-8AM	D	E	C	B	D	E	E	B
8-9AM	D	D	D	C	D	D	E	C
9-10AM	D	D	D	D	D	D	F	D
10-11AM	C	E	E	E	D	C	F	E
11AM-12PM	C	E	F	E	E	C	F	E
12-1PM	C	E	F	F	E	C	F	F
1-2PM	D	E	F	F	E	C	F	F
2-3PM	D	E	F	F	F	C	F	F
3-4PM	E	E	F	F	F	C	F	F
4-5PM	E	E	F	E	F	C	F	E
5-6PM	E	E	F	F	F	C	F	F
6-7PM	D	D	E	E	E	B	F	E
7-8PM	D	D	D	E	D	B	F	E
8-9PM	C	A	D	E	D	A	E	E
9-10PM	B	A	D	D	D	A	D	D
10-11PM	B	A	D	D	D	A	C	D
11PM-12AM	A	A	D	D	D	A	B	D

Source: Calculations based on 2022 counts and Maryland Statewide Travel Model.
Note: Summer weekends are measured by summer Friday conditions for eastbound traffic and summer Sunday conditions for westbound traffic.

3.1.3 Queue Lengths

Figure 8: Eastbound queue forming near Oceanic Drive

Increasing travel demand at the Bay Bridge has resulted in growing congestion and vehicle queues. Despite implementation of two-way traffic on the eastbound span, queue lengths of up to four miles eastbound and two and a half miles westbound during summer weekends have been continually observed since the beginning of the Tier 1 Study (**Figure 8**). In 2022, these queues regularly reached up to nearly five miles eastbound and three and half miles westbound. Queues longer than one mile can last for up to eight hours during a summer weekend afternoon and evening.

Due to projected increases in travel demand volumes at the Bay Bridge, the current summer weekend vehicle queues are projected to increase to over ten miles in both the eastbound and westbound direction by 2045. During average weekdays, current evening eastbound queues are expected to increase to over four miles long by 2045, while westbound morning queues up to five miles in length are expected to form by 2045. **Table 5** shows the existing 2022 and anticipated 2045 maximum length and duration of queue lengths at least one mile while utilizing two-way operation.

Table 5: 2022 and Anticipated 2045 Max. Queue Lengths and Durations with Two-Way Operations

Year	Conditions	Eastbound		Westbound	
		Max. Queue (miles)	Duration of Queue >1.0 Mile (Hours)	Max. Queue (miles)	Duration of Queue >1.0 Mile (Hours)
2022	Non-summer weekday	0	0	0	0
	Summer weekend	4.8	8	3.5	8
2045 No-Build	Non-summer weekday	4.1	4	4.9	11
	Summer weekend	>10.0	14	>10.0	14

Furthermore, as noted in **Table 5**, even with contra-flow operations intended to minimize queuing in the eastbound direction, queues in excess of one mile in length are expected for up to four hours eastbound and eleven hours westbound on a non-summer weekday, and for fourteen hours in each direction on summer weekend days in 2045. This increase in queue length and duration will further decrease the LOS and travel reliability of the roadway.

3.1.4 Crash Rates

Rear-end, sideswipe and opposite direction type crashes occurred in this corridor at a rate significantly higher than the Maryland Statewide Average rate for urban freeways/expressways. Rear-end type crashes, which occurred at the highest rate along this segment of U.S. 50/301, and sideswipe crashes are typically experienced during congested conditions because of the fluctuating vehicle speeds and the desire to change lanes to advance more quickly. Additionally, most of these incidents occurred during the summer months, the part of the year where traffic volumes across the bridge increase and congested conditions are most severe. In 2019, for example, over 55 percent of all crashes occurred within the four-month period from May to August.

In March of 2020, the COVID-19 pandemic led to sudden and dramatic changes in both traffic volumes and numbers of crashes. While traffic volumes at the Bay Bridge have generally recovered since that time and now closely resemble pre-pandemic conditions, crash rates are continuing to evolve. Additionally, the conversion to cashless tolling on the eastbound span in March 2020 and the subsequent removal of the toll plaza in 2021 have changed traffic operations approaching the Bay Bridge. These improvements have also likely had an impact on crash rates.

To account for these changes, six years of crash data were obtained and reviewed, as shown in **Table 6**. This data was obtained for the segment of U.S. 50/301 between Oceanic Drive and Maryland Route 8 and includes the entire Bay Bridge.

Table 6: Number of Crashes and Crash Rates at the Bay Bridge (2017-2022)

Year	2017	2018	2019	2020	2021	2022
Number of Crashes	52	81	111	101	92	82
Million Vehicle Miles (MVM) of Travel	140.13	143.65	147.94	122.21	142.58	142.04
Crash Rate (Crashes per 100 MVM)	37.1	56.4	75	82.6	64.5	57.7

Crash rates for the Bay Bridge were higher than statewide freeway crash rates for four of the six reported years. Per data from SHA, the crash rates on the Bay Bridge exceeded statewide freeway crash rates in 2018, 2019, 2020, and 2021. The total number of crashes at the Bay Bridge peaked in 2019. However, the crash rate was at its highest in 2020, due to a sharp decrease in the number of vehicles crossing the Bay Bridge compared to a proportionally small decrease in the number of crashes. In 2021 and 2022, both the number of crashes and the crash rate decreased. **Figure 9** shows the types of crashes most frequently reported for this segment of U.S. 50/301.

Figure 9: Percentages of Crashes by Reported Type at the Bay Bridge (2017-2021)

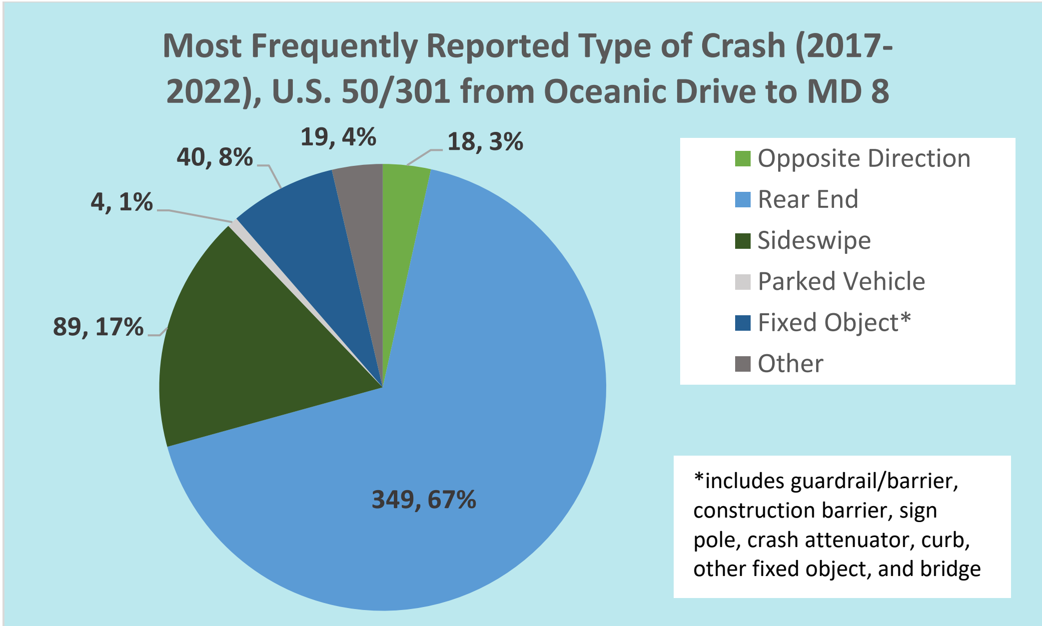


Table 7 shows the relative frequency with which eastbound and westbound vehicles were involved in crashes.

Table 7: Percentages of Crashes Involving Eastbound and Westbound Vehicles (2017-2022)

Direction of Vehicles	Number of Crashes	Percentage of Crashes
EB Vehicles Only	367	70.7%
WB Vehicles Only	131	25.2%
EB and WB Vehicles	21	4.0%

According to **Table 7**, crashes involving only eastbound vehicles occurred at a higher rate than crashes where westbound vehicles were involved. Specifically, crashes involving only eastbound vehicles accounted for over 70 percent of all crashes at the Bay Bridge. Incidents involving both eastbound and westbound vehicles represented less than five percent of the total percentage of crashes at the Bay Bridge. While incidents involving vehicles heading in opposite directions during two-way operations have not yielded any fatalities from 2017 to 2022, these collisions could be fatal and could cause serious injury and property damage. Bay Bridge traffic congestion also affects traffic on the adjacent U.S. 50/301 corridor. As congestion increases on the bridge, traffic backs up along the adjacent corridor and the likelihood of incidents on the approaches increases.

3.1.5 Travel Reliability

Beyond congestion due to high travel demand, events along a transportation facility such as vehicle breakdowns, crashes, weather events, and maintenance activities reduce usable capacity and affect the reliability of the facility. These nonrecurring events add to the variability of trip times provided by the transportation system, making trip planning difficult.

The annual State Highway Mobility Report, published by the Maryland State Highway Administration (SHA), accounts for non-recurring events in trip reliability using the measurement of the Planning Time Index (PTI). The PTI represents the 95th percentile travel time for a section of the freeway/expressway system and is considered the total time travelers should allow for trips on these corridors to assure on-time arrival at destinations. If free-flow conditions allow a five-minute trip, a traveler should allow 15 minutes when the PTI is 3.0. If free-flow conditions allow a five-minute trip, a traveler should allow five minutes when the PTI is 1.0. Thus, the higher the number, the more unreliable the corridor is during that hour for users and the greater likelihood that a typical trip may take longer than normally anticipated. The lower the PTI, the more reliable the trip planning time. Statewide PTI are categorized as follows:

PTI less than 1.5 – Reliable
PTI between 1.5 and 2.5 – Moderately Unreliable
PTI above 2.5 – Highly to Extremely Unreliable

The PTI for a trip along U.S. 50/301 between the MD 2/MD 450 interchange in Anne Arundel County and the U.S. 50/301 split in Queen Anne's County for each travel direction was calculated for 2022 during average weekdays and Fridays and Sundays during the summer. **Table 8** presents the PTI findings. Times with PTI above 2.5 are shaded.

The highest PTI for an eastbound trip in 2022 occurs on a summer Sunday between 2 PM and 3 PM with a measurement of 3.52. On average, there are four hours during weekdays, 14 hours on summer Fridays, and 12 hours on summer Sundays that have PTIs at or greater than 1.5. For westbound traffic, the highest PTI for a 2022 westbound trip occurs on a summer Friday between 7 PM and 8 PM with a measurement of 4.83. On average, there are six hours during weekdays, 12 hours on summer Fridays, and nine hours on summer Sundays that have PTIs at or greater than 1.5.

Table 8: Planning Time Index for Eastbound Trips on U.S. 50/301 in Study Area

Time of Day	2022 Average Weekday		2022 Summer Friday		2022 Summer Sunday	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
12-1AM	1.17	1.50	1.80	1.72	1.67	1.49
1-2AM	1.26	1.50	1.33	1.60	1.55	1.30
2-3AM	1.32	1.54	1.26	1.61	1.89	1.23
3-4AM	1.29	1.49	1.31	1.62	1.79	1.30
4-5AM	1.26	1.15	1.06	1.26	1.30	1.29
5-6AM	1.03	0.96	1.01	1.00	1.13	1.17
6-7AM	1.03	0.99	1.00	1.00	1.05	1.06
7-8AM	1.03	1.09	1.02	1.00	0.97	0.98
8-9AM	1.02	1.35	2.12	1.01	1.00	0.98
9-10AM	1.12	1.20	1.93	1.04	1.47	0.99
10-11AM	1.18	1.05	1.71	1.19	1.81	1.03
11AM-12PM	1.28	1.09	1.94	1.31	2.78	1.40
12-1PM	1.27	1.34	1.85	1.57	3.08	2.07
1-2PM	1.29	1.49	2.10	2.13	3.33	2.74
2-3PM	1.34	1.14	2.79	2.54	3.52	4.13
3-4PM	1.63	1.08	3.21	3.83	2.91	4.60
4-5PM	1.98	1.18	3.03	2.53	2.67	4.60
5-6PM	1.80	1.29	2.73	2.08	2.17	4.05
6-7PM	1.37	1.27	1.51	3.05	1.46	3.59
7-8PM	1.06	1.08	1.89	4.83	1.15	2.81
8-9PM	1.46	1.25	1.70	1.16	1.02	1.88
9-10PM	1.52	1.57	1.06	1.19	1.04	1.28
10-11PM	1.22	1.53	1.00	1.45	1.04	1.06
11PM-12AM	1.26	1.57	1.01	1.10	1.06	1.05

The poor reliability of trip travel times across the Chesapeake Bay supports the need for additional capacity. With expected growth in vehicle queue length, duration, and a predicted increase in the number of hours of unsatisfactory LOS, trip reliability is expected to decrease.

Planning Time Index is retroactively developed and cannot be reliably forecasted into the future, given the numerous variables that could alter potential travel times. As a result, PTI can only be provided based on existing data.

3.1.6 Truck Traffic

The current rates of truck traffic traveling across the Bay Bridge affect capacity on the bridge. Trucks occupy a larger amount of space and do not accelerate as quickly as smaller vehicles, particularly when climbing grades such as those on the existing Bay Bridge. On the eastbound span, the Bay Bridge rises for approximately 1.5 miles to the high point of the bridge; the steepest grade in that section is 3.5 percent. On the westbound span, the westbound uphill grade is less steep, but longer; in the approximately two-mile ascent, the steepest grade is 1.9 percent.

The average daily truck percentage obtained from the data collection period ranged from a low of approximately three percent to a high of approximately ten percent. During the hour of peak flow on the bridge, the truck percentage was approximately four percent. On an average non-summer weekday, truck traffic on the Bay Bridge exceeds the Maryland Statewide average of five percent for urban freeway/expressways. The number of trucks traveling across the Bay Bridge is expected to rise in the future, as shown in **Table 9**.

Table 9: Existing and Forecasted Truck Volumes and Percentages across the Bay Bridge

Conditions	Existing (2022) Conditions			2045 No-Build Conditions		
	Total Traffic (vehicles per day)	Truck Percentage	Daily Truck Volumes	Total Traffic (vehicles per day)	Truck Percentage	Daily Truck Volumes
Non-Summer Weekday	69,588	5.4	3,758	91,150	5.7	5,200
Summer Weekend Day	104,284	3.9	4,067	130,500	4.0	5,200

3.1.7 Recent and Planned Improvements

Since the original Bay Bridge was constructed, the MDTA has introduced several projects to improve traffic flow and prevent traffic delays at the bridge as described in **Section 1.3**. These projects include contra-flow, implementation of electronic toll collection at the toll plaza, removal of the toll booths at the toll plaza and conversion to high-speed tolling, implementation of an ALCS, and extensive promotional and education efforts.

In 2013, safety improvements such as a buffer zone between the westbound left lane and center lane with additional signage, modified pavement markings, and rumble strips were implemented. These improvements allow for more effective two-way management to relieve eastbound traffic congestion during peak times and provide overall flexibility for varying capacities of traffic throughout the day. However, during peak times, the Bay Bridge and its approaches still experience severe traffic back-ups and congestion.

In May 2020, the MDTA began permanently utilizing highway-speed all electronic (cashless) tolling (AET) at the Bay Bridge, which allows all users to cross without stopping at a toll facility. The gantry, installed on the Eastern Shore between the Bay Bridge and MD 8, uses video tolling, "Pay-by-Plate" or third-party tolling apps for users who do not have an *E–ZPass®*. Despite the benefit of uninterrupted traffic flow afforded by AET, congestion remains during peak periods and during periods of incident management or maintenance along the Bay Bridge, due to the reduced capacity of the Bay Bridge itself. The MDTA also recently implemented the ALCS project. This project allows two-way operations to be initiated or discontinued remotely, reducing the on-site operations required by maintenance crews. Work to install ALCS included reconfiguring the former toll plaza area and installing overhead lane-use signals, dynamic message signs, horizontal swing gates, and illuminated pavement markers. The MDTA began the transitional period of phasing in the implementation to familiarize drivers in Fall 2022. Though the project enhances two-way operations, it does not impact current traffic volumes and has had little effect on congestion.

Despite the many projects the MDTA has implemented to improve traffic flow and alleviate congestion since the construction of the original Bay Bridge, the bridge remains a bottleneck with limited capacity. Traffic volumes continue to increase and cause congestion during peak periods, which limits mobility and increases travel time.

3.2 Mobility

There is a lack of mobility for all modes of travel, including vehicles, trucks, and transit services, caused by existing and anticipated future conditions at the Bay Bridge. Congestion at the Bay Bridge and its approaches and subsequent spillover effects on local roadways limit the movement of people, goods, and services across the Chesapeake Bay and in adjacent communities.

3.2.1 Regional Mobility

The connection provided by the existing Bay Bridge is critical to the overall mobility, accessibility, and economic prosperity of the region. Regionally, many communities throughout Maryland and neighboring states, particularly communities on the Delaware-Maryland-Virginia (Delmarva) peninsula, rely on the Bay Bridge for travel across the Chesapeake Bay.

U.S. 50/301 is also a part of the Primary Highway Freight System (PHFS), a network of highways managed by the FHWA Office of Freight Management and Operations that has been designated as the most critical highway portions of the United States freight transportation system. However, the corridor was also identified as one of the top truck bottlenecks in the State, according to the 2021 Mobility Report.[1] Additionally, according to the Maryland State Freight Plan, the eastbound route approaching the Bay Bridge was ranked the least reliable corridor for truck travel in the State of Maryland; westbound was ranked the second most unreliable. This has particularly hindered agricultural transport from local areas.

While the bottleneck at the Bay Bridge impacts commerce going to and from Queen Anne's County, Anne Arundel County, and other neighboring counties and jurisdictions, it also contributes to larger freight mobility and supply chain issues that affect the entire Mid-Atlantic region. In 2022, the state of Delaware had the second highest delay per mile for corridors included in the PHFS with 6,198 truck hours, while the state of Maryland had the third highest delay per mile at 6,109 truck hours; Washington, DC ranked fifth at 5,809 truck hours. Since U.S. 50/301 is

[1] *Maryland State Highway Mobility Report*, Tenth Edition (2021), p. 54.

an important freight route for cargo moved via trucks, current and forecasted increases in traffic volume will increase travel times and decrease travel reliability, decreasing the efficient movement of goods and impeding commerce to and from communities around the Chesapeake Bay.

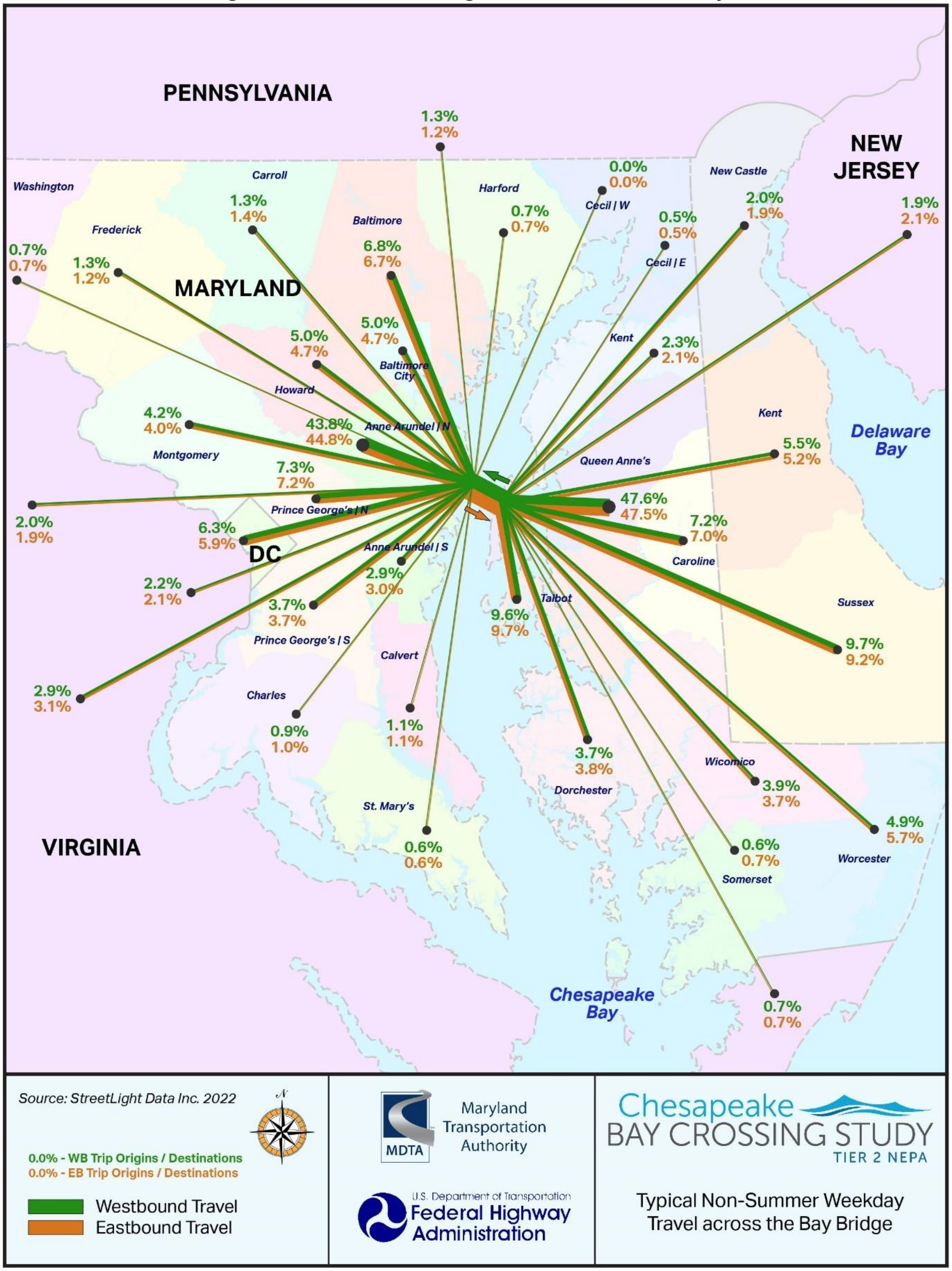
As an evacuation route, the Bay Bridge is a critical connection during emergencies. Most of the counties on the Eastern Shore have communities that lie within a storm evacuation zone, including Queen Anne's, Dorchester, Wicomico, Kent, Somerset, Talbot, and Worcester counties, as well as other communities throughout Southern Delaware. For residents within these communities, the Bay Bridge provides a crucial connection to the Western Shore during evacuations due to storms. Certain weather conditions can also affect the operation of the Bay Bridge. For example, truck traffic is prohibited during wind warnings and restrictions and complete closures may occur in the event of extreme weather conditions. Thus, the ability of the current span to efficiently move high volumes of traffic can vary, particularly during weather events when many travelers may specifically depend on the bridge.

The current Bay Bridge provides the only roadway connection across the Chesapeake Bay over a distance of nearly 200 miles; Elkton, Maryland to the north is over 50 miles away from the current Bay Bridge and the Chesapeake Bay Bridge Tunnel, which provides an additional connection across the Chesapeake Bay, is over 130 miles to the south in Virginia. Without the connection provided by the Bay Bridge, travelers would need to take these alternate routes and trips to and from destinations on the opposite side of the Chesapeake Bay could take two or three times as long in duration. However, increased congestion has constrained the mobility of this important connection and could also lead to congestion at the alternative routes throughout the region.

3.2.2 Origins and Destinations

The Bay Bridge supports local trips (e.g., work related and discretionary trips) with origins and destinations (O-Ds) relatively close to the shores of the Chesapeake Bay, and regional trips (e.g., commerce, recreation, regional travel) with O-Ds throughout and beyond Maryland. **Figure 10** shows the O-Ds for average non-summer weekdays.

Figure 10: O-Ds for Average Non-Summer Weekdays



During typical non-summer weekdays, approximately 48 percent of trips crossing the Bay Bridge begin or end in Queen Anne's County while approximately 48 and 47 percent of trips crossing the Bay Bridge respectively begin or end in Anne Arundel County. These are typical origins and destinations for local or commuter trips. More information on non-summer weekday trip origins and destinations is shown in **Table 10** and **Table 11**, using vehicular volumes in lieu of percentages. In the last two columns of both tables, green cells are above zero and result from higher summer weekend volumes compared to non-summer weekdays; red cells are below zero and result from lower summer weekend volumes compared to non-summer weekdays.

Table 10: Daily Vehicular Trips across the Bay Bridge to and from Locations on the Eastern Shore

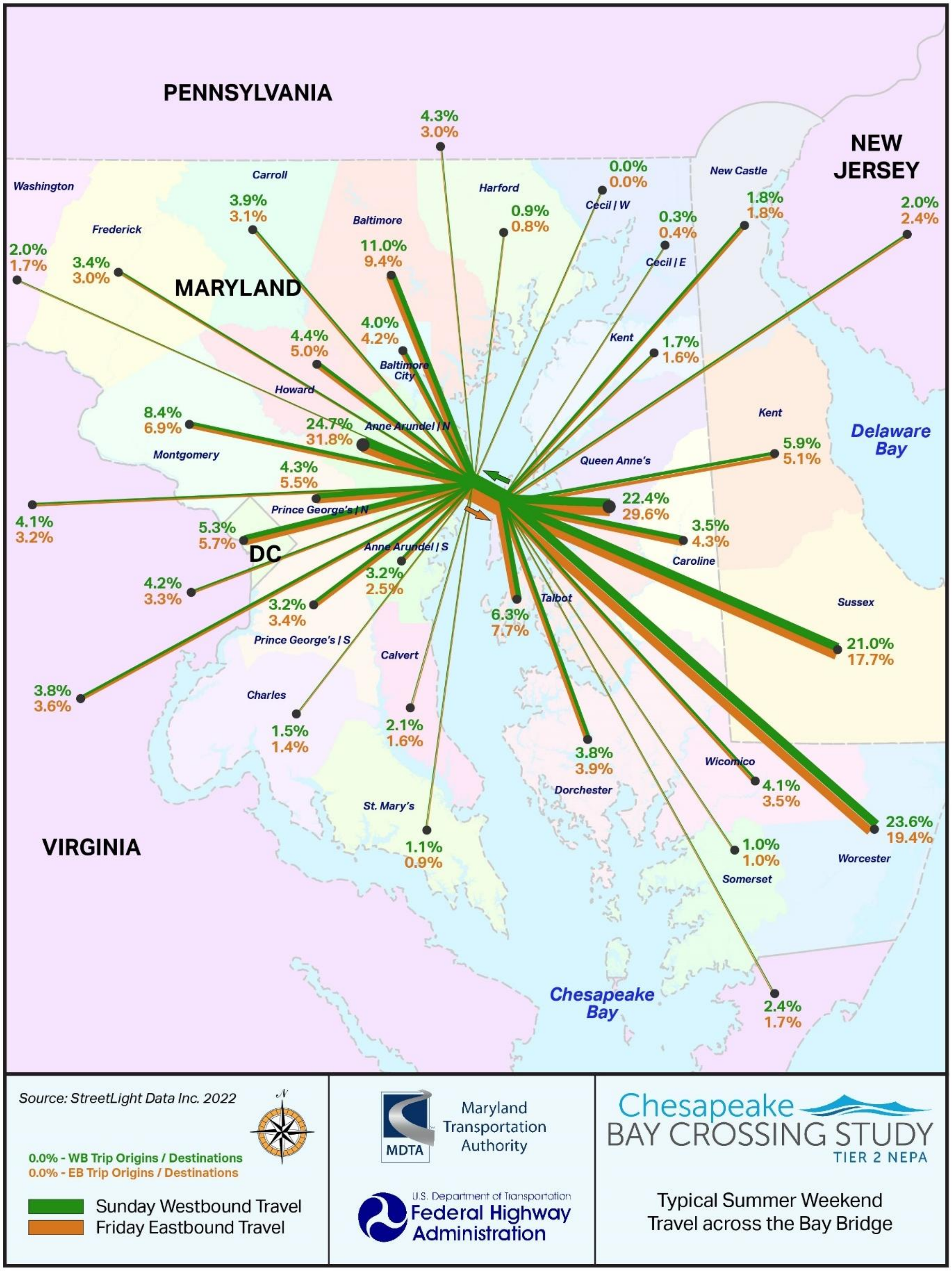
Location	Non-Summer Weekday		Summer Weekend		Summer Weekend - Non-Summer Weekday	
	Eastbound Trips	Westbound Trips	Eastbound Trips (Fri)	Westbound Trips (Sun)	Eastbound Trips (Fri)	Westbound Trips (Sun)
Caroline County, MD	2,440	2,501	2,268	1,804	-172	-697
Cecil County, MD | E	174	174	211	155	37	-19
Dorchester County, MD	1,325	1,285	2,057	1,958	733	673
Eastern PA, NJ and Beyond	732	660	1,266	1,031	534	371
Kent County, DE	1,813	1,910	2,690	3,040	878	1,130
Kent County, MD	732	799	844	876	112	77
New Castle County, DE	662	695	950	928	287	233
Queen Anne's County, MD	16,557	16,532	15,614	11,543	-943	-4,989
Somerset County, MD	244	208	528	515	284	307
Southeast VA and Beyond	244	243	897	1,237	653	994
Sussex County, DE	3,207	3,369	9,337	10,822	6,130	7,453
Talbot County, MD	3,381	3,334	4,062	3,247	681	-88
Wicomico County, MD	1,290	1,355	1,846	2,113	557	758
Worcester County, MD	1,987	1,702	10,234	12,162	8,247	10,460
Totals	**34,857**	**34,731**	**52,751**	**51,533**	**17,894**	**16,801**

During summer weekends, there is a higher percentage of trip destinations beyond the western and eastern ends of the bridge, as compared to weekday trips. By comparison, approximately 34 and 28 percent of trips respectively begin or end in Anne Arundel County and approximately 22 and 30 percent of trips respectively begin or end in Queen Anne's County. Percentages of origins and destinations for trips crossing the bridge during the summer weekends are shown in **Figure 11**. More information on summer weekend origins and destinations is also shown in **Table 8** and **Table 9**.

Table 11: Daily Vehicular Trips across the Bay Bridge to and from Locations on the Western Shore

Location	Non-Summer Weekday		Summer Weekend		Summer Weekend - Non-Summer Weekday	
	Eastbound Trips	Westbound Trips	Eastbound Trips (Fri)	Westbound Trips (Sun)	Eastbound Trips	Westbound Trips
Anne Arundel County, MD | N	15,616	15,212	16,775	12,729	1,159	-2,484
Anne Arundel County, MD | S	1,046	1,007	1,319	1,649	273	642
Baltimore City, MD	1,638	1,737	2,216	2,061	577	325
Baltimore County, MD	2,335	2,362	4,959	5,669	2,623	3,307
Calvert County, MD	383	382	844	1,082	461	700
Carroll County, MD	488	452	1,635	2,010	1,147	1,558
Cecil County, MD | W	0	0	0	0	0	0
Central PA and Beyond	418	452	1,583	2,216	1,164	1,764
Charles County, MD	349	313	739	773	390	460
Fairfax County, VA	732	764	1,741	2,164	1,009	1,400
Frederick County, MD	418	452	1,583	1,752	1,164	1,301
Harford County, MD	244	243	422	464	178	221
Howard County, MD	1,638	1,737	2,638	2,267	999	531
Montgomery County, MD	1,394	1,459	3,640	4,329	2,246	2,870
Prince George's County, MD | N	2,510	2,535	2,901	2,216	392	-319
Prince George's County, MD | S	1,290	1,285	1,794	1,649	504	364
Southern VA and Beyond	1,081	1,007	1,899	1,958	818	951
St. Mary's County, MD	209	208	475	567	266	358
Washington, DC, Arlington, VA and Alexandria, VA	2,057	2,188	3,007	2,731	950	543
Western MD and Beyond	244	243	897	1,031	653	788
Western VA and Beyond	662	695	1,688	2,113	1,026	1,418
Totals	**34,856**	**34,729**	**52,747**	**51,533**	**17,891**	**16,803**

Figure 11: O-Ds for Summer Weekend Days



Percentages for other counties that are located further from the Bay Bridge also increase on the summer weekends, indicating that increases in volumes on summer weekends are likely due to non-local travel. For example, on non-summer weekdays, approximately five and six percent of trips respectively start or end in Worcester County, which is located on the Atlantic Ocean and is home to Ocean City. On summer weekends, the percentages increase to approximately 19 percent of trips crossing the Bay Bridge on summer Fridays with Worcester County as a destination, and approximately 24 percent of trips crossing the Bay Bridge on Summer Sundays with Worcester County as an origin. As the region's population and employment levels grow, the demand for all trip types will increase, requiring more travel capacity across the Chesapeake Bay.

3.2.3 Local Mobility

Higher levels of congestion can produce spillover traffic onto the local roadway network. The Kent Narrows Community Plan, the Queen Anne's County Comprehensive Plan, and the Anne Arundel County Comprehensive Plan, Plan2040, have cited several priority issues within the roadway network surrounding the Bay Bridge due to pass-through traffic, local roadway congestion, and lack of connectivity. Congestion can limit mobility and connectivity within local communities and can inhibit access to employment, healthcare, and other important resources, whether nearby or across the Chesapeake Bay. Not only can heavy traffic cause delays in response times for emergency service providers managing incidents on U.S. 50/301, but it also prohibits residents within the adjacent local communities from accessing necessary emergency services when needed. Communities like Broadneck, Arnold, and Cape St. Claire on the Western Shore and Stevensville, Chester, Kent Narrows, and Grasonville on the Eastern Shore often experience the worst side effects of the congestion on U.S. 50/301.

During peak periods of congestion, traffic from U.S. 50/301 has frequently resulted in spillover traffic onto local roadways of adjacent communities in the Study Area. Many motorists will divert away from U.S. 50/301 to avoid congestion, inadvertently causing other traffic backups. Mobile apps and other technology programmed to help users avoid congested roadways can also contribute to this issue. This diversion of traffic impacts the reliability and level of service of the local roadway network and the motorists who utilize them.

Additionally, congested conditions also make merging onto the roadway difficult, causing traffic congestion at local roadways with connections to on-ramps. Impacted roadways on the Western Shore include:

- Oceanic Drive,
- College Parkway,
- Whitehall Road, and
- St. Margarets Road (MD 179).

In recent years, Queen Anne's County has led efforts to reduce diversions onto local roadways. However, congestion on the Eastern Shore resulting from traffic on the Bay Bridge, especially on Kent Island, remains an ongoing issue and has been identified by Queen Anne's County as a priority concern. On the Eastern Shore, impacted roadways include:

- Main Street (MD 18),
- Romancoke Road (MD 8),
- Kent Narrows Road,
- Cox Neck Road, and
- Dominion Road.

Local roadways typically experience spillover traffic most frequently during periods of high queuing on U.S. 50/301, meaning it is most severe during rush-hour traffic in late afternoons and particularly during summer weekends. Since queues are anticipated to increase in length and duration, local diversions are also anticipated to increase and worsen in the future.

3.2.4 Transit Services

Four public agencies operate transit service across and adjacent to the Bay Bridge, including:

- The Maryland Transit Administration (MTA), which provides Commuter Bus Service and includes three routes depicted in **Figure 12**, with limited stop service from various Park and Ride lots on Kent Island to points west of the Bay Bridge in Annapolis, south to Davidsonville and Washington, DC, and to the north to Baltimore;

- Annapolis Transit, which operates eight fixed routes within the City of Annapolis and paratransit service for people with disabilities who are not able to ride the fixed-route public transportation;

- Anne Arundel County Transit, which operates 12 fixed routes throughout the County depicted in **Figure 13**, and two on-demand or Call N' Ride zones: one in north county and one in south county; and

- Queen Anne's County Ride, which operates four deviated fixed routes, which provide paratransit trips that deviate up to three quarters of a mile from fixed routes, and county-wide demand response service.

Figure 12: MTA Commuter Bus Existing Transit Service

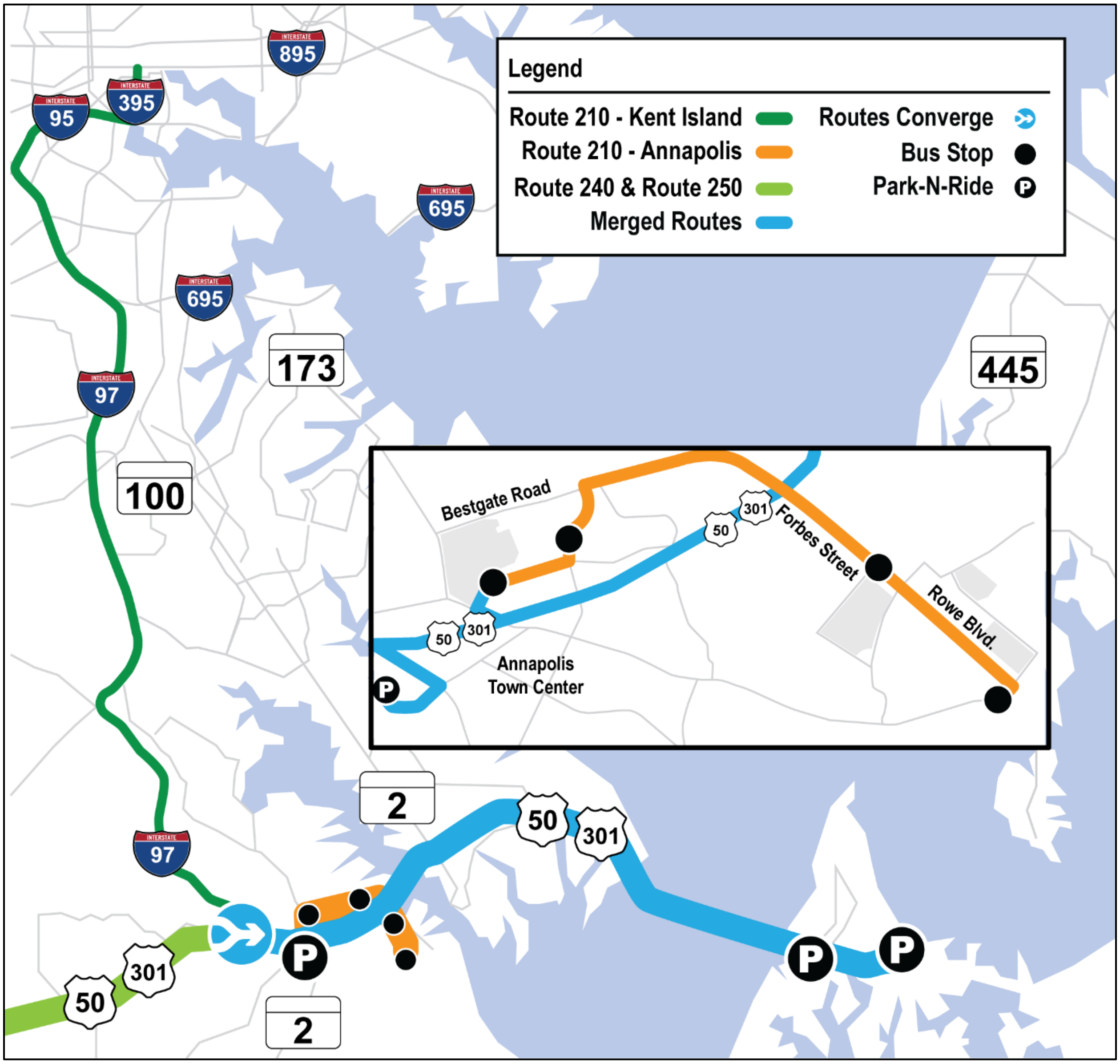
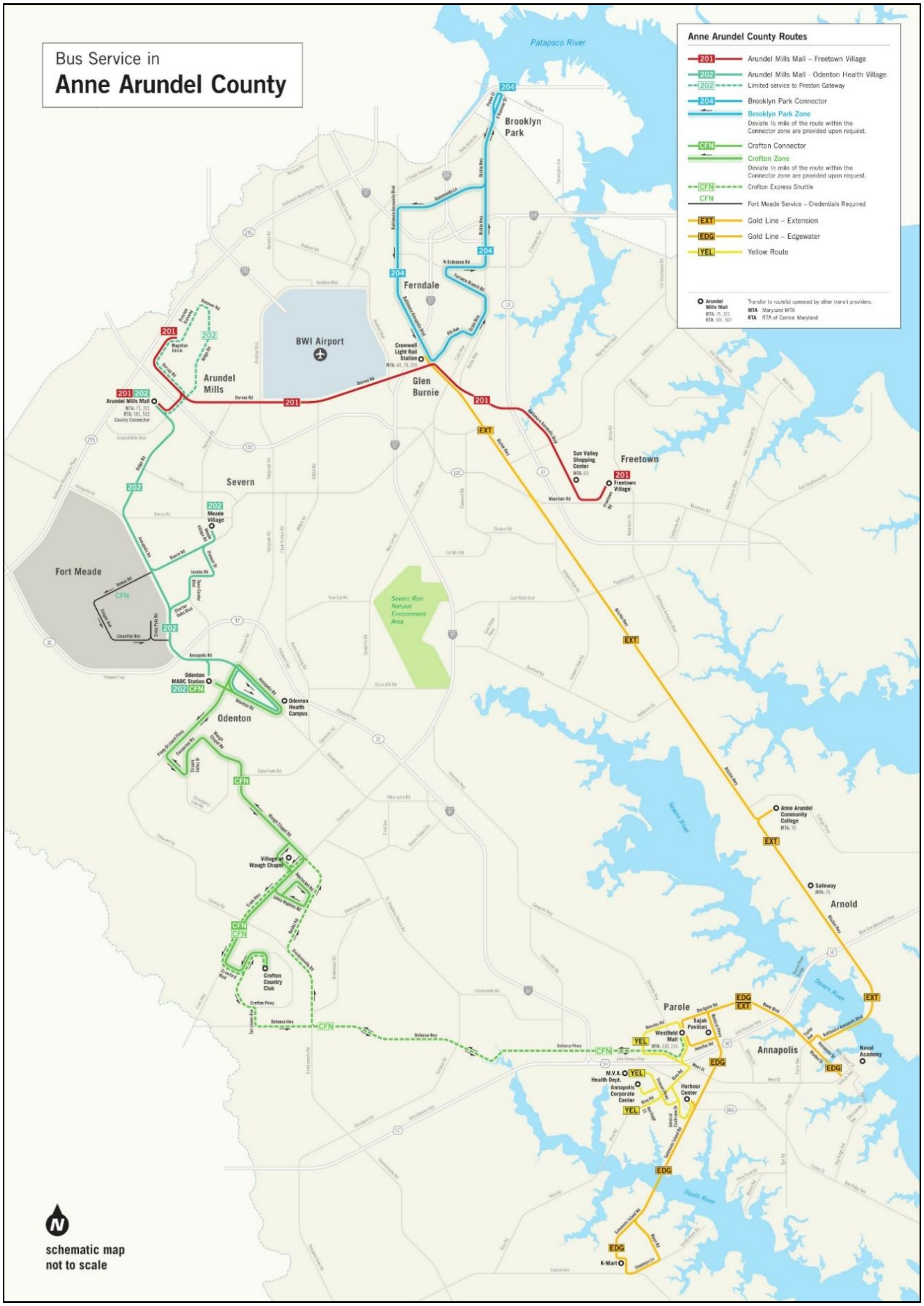


Figure 13: Anne Arundel County Transit Existing Bus Service



The only transit services that cross the bridge are the MTA Commuter Bus Service and the Queen Anne's County Ride Annapolis Route, which has service every two hours starting around 6 AM and ending around 5 PM.

There are two Park and Ride locations within the Study Area for drivers who utilize local bus networks. The Stevensville Park and Ride is located on the southeastern side of the U.S. 50/301 and MD 8 (Romancoke Road) interchange. The Kent Narrows Park and Ride is located beneath U.S. 50/301 at Kent Narrows, between Piney Narrows Road and Main Street.

Ridership on Anne Arundel County Transit and Queen Anne's County Ride went down significantly during the COVID-19 pandemic in 2020 and 2021. After fare decreases and enhancements, Anne Arundel County Transit has reported ridership of approximately 20,000 or more per month, slightly higher than pre-pandemic levels. Queen Anne's County Ride has also decreased fares and the post-pandemic ridership is about 65 to 70 riders per month, a slight decrease from pre-pandemic levels which were between 80 to 100 riders per month.

All transit agencies report congestion is a major issue in keeping transit schedules, specifically on Thursday and Friday afternoons. In addition to transit agencies, local organizations and private operators provide bus service for medical trips as well as senior and disabled individual transport. There are no existing ferries or passenger rail routes across the Chesapeake Bay.

3.2.5 Pedestrian and Bicycle Connectivity

The Chesapeake Bay is a major natural barrier to pedestrian and bicycle travel between the Eastern and Western Shores. The existing Bay Bridge does not include any facilities dedicated for pedestrian or bicycle use. Additionally, due to the type of roadway, limited shoulder widths, and speed limits, safe on-road bicycle use is not possible across the Bay Bridge. U.S. 50/301 also lacks direct connectivity to other pedestrian and bicycle facilities on either side of the Chesapeake Bay.

Although there are no pedestrian and bicycle facilities that cross the Chesapeake Bay, pedestrian and bicycle recreation are popular activities within the Chesapeake Bay region and within the immediate vicinity of the Study Area. On the west side of the Bay, there are bicycle lanes on St. Margaret's Road, Whitehall Road, and Skidmore Drive. The Baltimore and Annapolis (B&A) Trail connects to bicycle lanes on Boulters Way and Ritchie Highway near the Severn River. The Annapolis Connector of the B&A Trail at Boulters Way, near the Severn River, currently provides the only connection between the north and south side of U.S. 50/301. The Broadneck Trail, which is complete between Bay Dale Drive and East College Parkway, is under construction to extend to Sandy Point State Park. Future extension to the west will connect the Broadneck Trail with the B&A Trail near Arnold, MD. While pedestrians and bicyclists still use Oceanic Drive, MD 179, and Bay Dale Drive to travel through the corridor, these roadways do not have dedicated bicycle lanes. Worsening congestion on local roadways caused by spillover traffic creates barriers and safety hazards for pedestrians and bicycle users in the surrounding communities on both sides of the Chesapeake Bay.

On the Eastern Shore, the Cross Island Trail runs for approximately 6.5 miles from Terrapin Nature Park to the Cross County Connector Trail in Grasonville, with portions located adjacent to U.S. 50/301. The Cross Island Trail crosses under U.S. 50/301 at two points: Piney Narrows Road and Kent Narrows Road. The Cross Island Trail also provides a connection to the Chesapeake Heritage and Visitor Center at Kent Narrows. The South Island Trail runs parallel to MD 8, beginning at Matapeake State Park and ending at the Romancoke Fishing Pier. The Kent Island Bike Trail connects with the Cross Island Trail at Terrapin Nature Park and heads south to connect with the South Island Trail at Matapeake Park. East of the Kent Island Bike Trail is the Quiet Kent Bike Route, which is 23 miles long and follows state and county roadways south of Chester. East of Kent Narrows is the 25-mile Grasonville Flatlands Bike Route along rural roadways south of Grasonville. A full map of the existing trails and proposed bike routes under construction on both sides of the Chesapeake Bay near the Bay Bridge is shown in **Figure 14**.

3.3 Roadway Deficiencies

While the MDTA provides safe conditions at the existing Bay Bridge, the bridge does not "adhere to design criteria and/or standards" because of the existing narrow lane widths, lack of shoulders, and other factors. Since existing conditions do not meet current design standards, they do not provide nominal safety, as defined by FHWA and NCHRP Report 480.[2]

3.3.1 Current Cross Section Conditions

Several elements of the existing Bay Bridge cross section are geometrically deficient, including current lane and shoulder widths. Both eastbound and westbound on the Bay Bridge, the lane widths range from approximately 11 feet to 12 feet, but each lane is a consistent width across the bridge. In each direction, there is a maximum two-foot offset on the outside of the travel lanes to the outside barrier. According to the MDOT Policy for Bridge Width and the American Association of State Highway and Transportation Officials A Policy on Geometric Design of Highways and Streets 7th Edition published in 2018, travel lanes should be a minimum of 12 feet wide, and lane and shoulder widths on bridges should match the approach roadway. For bridges longer than 200 feet, shoulder widths can be narrowed but a minimum width of four feet is still recommended. Thus, the Bay Bridge does not meet current design criteria and standards for lane and shoulder width. Additionally, according to SHA Structural Design Guidance, the minimum cross section for a bridge structure should be 32 feet; at 31 feet and two inches, the eastbound bridge does not meet this current standard. These existing dimensions of the lane and shoulder widths create less-than ideal conditions by providing less space for vehicles within the lane; not providing a location for disabled vehicles to pull over; and allowing for drivers to more easily see, feel, and be affected by the height and curvature of the bridge.

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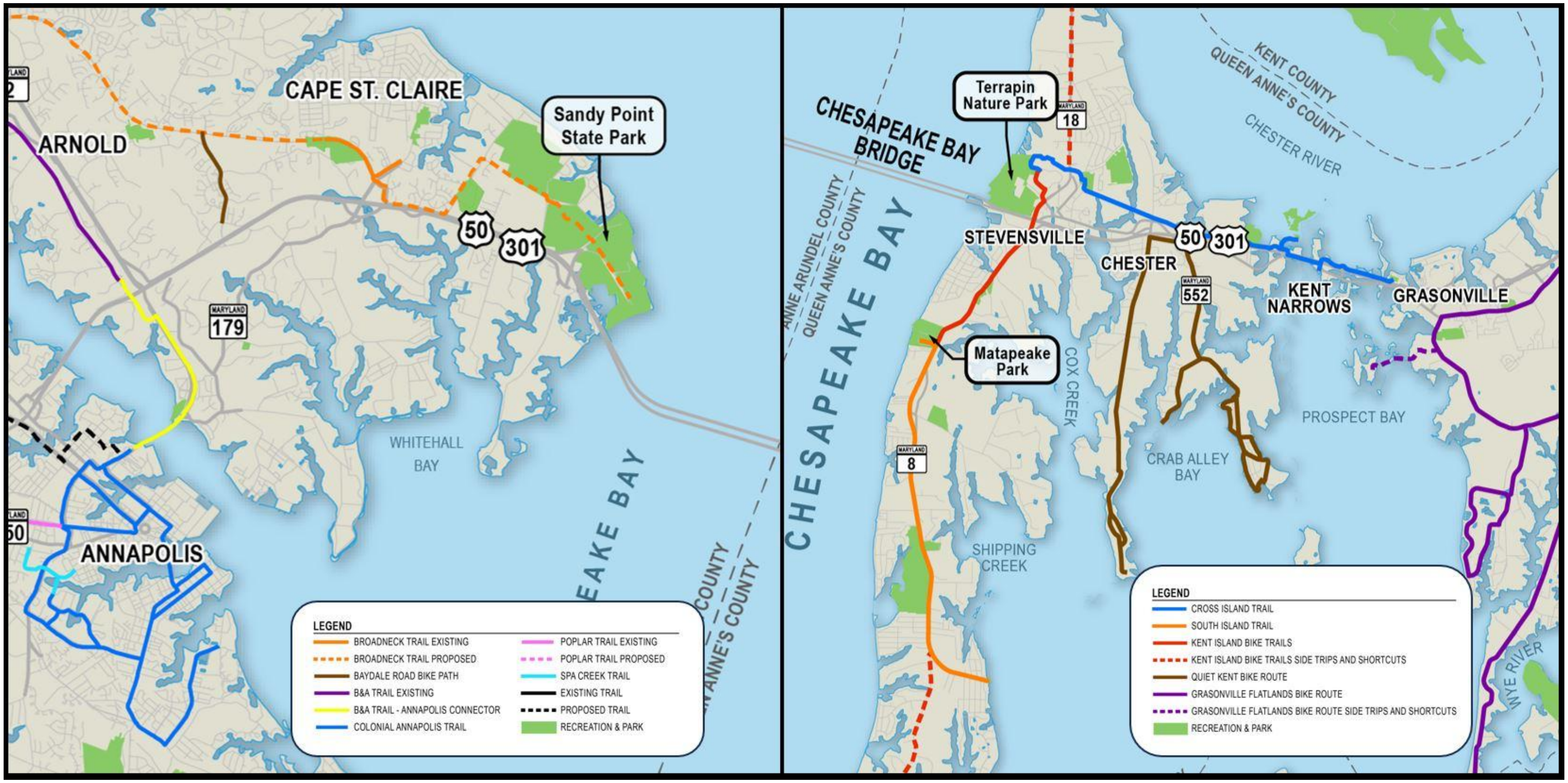
[2] NCHRP Report 480 A Guide to Best Practices for Achieving Context Sensitive Solutions, Transportation Research Board, Washington, D.C., 2002, Page 52.
https://highways.dot.gov/safety/zero-deaths/integrating-road-safety-nepa-analysis-primer-safety-and-environmental-4. U.S. Department of Transportation, Federal Highway Administration,

Figure 14: Existing and Proposed Bicycle Routes Near the Bay Bridge



Due to the height of the bridge, a fall from the Bay Bridge into the Chesapeake Bay could be fatal. While the Bay Bridge has concrete barriers and steel guardrails to guide motorists across the bridge, the current structures do not prevent incidents involving accidental falls or deter individuals from climbing over the outside of the barriers. There are no physical suicide deterrent systems (like tall barriers or netting) on the Chesapeake Bay Bridge. Suicides and suicide attempts occur on the Bay Bridge every year. Suicide deterrent systems on the bridge are limited to non-physical interventions and include cameras to help identify people in crisis, emergency call boxes, signs with suicide prevention information, and a team of eight MDTA patrol officers that specialize in crisis negotiations.

3.3.2 Incident Management and Maintenance

The MDTA follows specific policies for its bridges as a means of maintaining the safest roadway conditions possible for motorists and minimizing the risk of incidents. During an incident, the MDTA uses state-of-the-art management techniques to detect, verify, respond to, and clear the incident. The primary goal is to save lives and address any injuries, while protecting the public and MDTA employees from any further injury. Once those issues have been addressed, clearing the incident to restore full capacity of the crossing becomes priority.

The MDTA and the MDTA Police are active members of the Coordinated Highways Action Response Teams (CHART) program, which also includes the SHA and the Maryland State Police. This program provides advanced notification to travelers of an incident and the related progress made in clearing the incident. The CHART Program also coordinates evacuations with Maryland local government agencies and agencies in other states during major weather events. Both traffic-related incidents and weather events have the potential to cause lane closures and affect lane direction.

During incidents, the limited shoulder space and narrow lanes make it difficult for emergency responders to reach incidents, conduct incident management procedures, and close lanes if needed, causing delays in response times. Delay in response is exacerbated during periods of high traffic volumes. Additionally, the narrow widths often impede bridge maintenance activities. Current small shoulder widths provide insufficient room for roadway workers who need to conduct maintenance activities. Frequently, the lack of space requires lane closures, which further constrains traffic flow.

3.4 Existing and Future Maintenance Needs

Due to the age and design life of the existing Bay Bridge, substantial maintenance of the facility is needed now and in the future. These maintenance needs lead to lane closures that make incident management more difficult and cause increased traffic congestion and delays.

3.4.1 Cost and Maintenance of Existing Structures

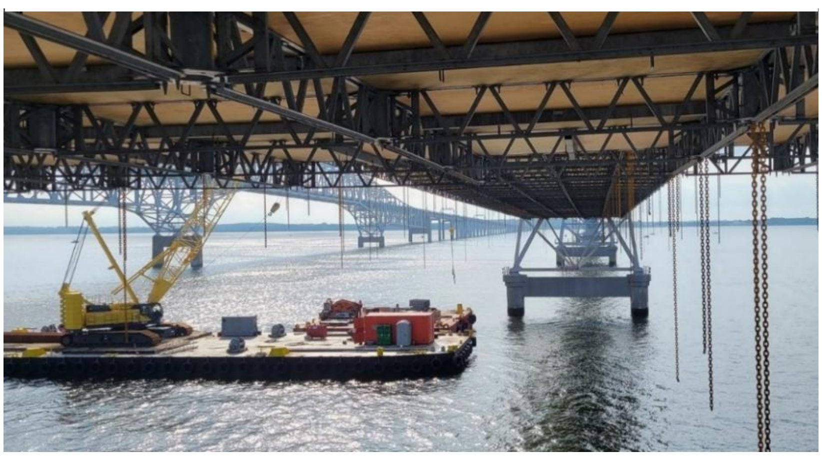
The existing Bay Bridge structures are currently in satisfactory condition and can remain functional for the next several decades until around 2065 with scheduled rehabilitation and maintenance (i.e., painting, deck replacement, suspension cable rehabilitation, and electrical repairs).[3] However, maintenance and rehabilitation activities, as well as incident management (i.e., crash response, debris removal) on the Bay Bridge often require lane closures. These restrictions reduce capacity on the Bay Bridge and increase congestion on the bridge and at its approaches.

The number of maintenance and rehabilitation activities needed will increase as the Bay Bridge ages. Beyond 2023, major superstructure and substructure rehabilitation/replacement work involving short- and long-term lane closures would be required to maintain fair condition of the bridges. The reduced capacity and the projected increase in traffic in the future would create more congestion and even less reliable travel operations across the Chesapeake Bay than exists today.

Since 2015, the MDTA has completed several major maintenance projects. These include the rewrapping and dehumidification of the main cables which was completed in 2016 for $41 million and the installation of supplemental cables and rehabilitation of the superstructure completed in 2020 for $29 million. More recently, the MDTA implemented AET at the Bay Bridge in 2020, the Westbound Lane 1 Overlay and Gantry Replacement in 2022, and the ALCS in 2023 to support tolling at highway and enhance safety during two-way operations.

Moving forward, the MDTA Board approved Phase 1 of the Eastbound Bay Bridge Deck Replacement Project on October 27, 2022, at a cost of $140 million. **Figure 15** depicts Phase 1 work on the eastbound span. The project will include the replacement of the deck floor system, structural rehabilitation of the steel superstructure, barrier upgrades, replacement of lane use signal gantries, relocation of utilities, and off-site stormwater management. Construction for the project began in fall 2023 and is expected to be completed in spring 2025.

Figure 15: Eastbound Bay Bridge Deck Replacement Project



The Eastbound Bay Bridge Deck Replacement project is designed to mitigate impacts to traffic, particularly during peak times. Still, the MDTA expects regular congestion during project construction and will actively monitor and make decisions on travel operations when feasible.

Other sections of the bridge will need similar upgrades in subsequent years through additional

[3] See MDTA. 2015. U.S. 50/301 William Preston Lane Jr. Memorial (Bay) Bridge: Life Cycle Cost Analysis. https://mdta.maryland.gov/sites/default/files/Files/Bay_Bridge_LCCA_Report_12-2015.pdf

phases. However, the timing and phasing of the sections will be determined based on funding availability and bridge conditions. Long term, the MDTA anticipates the full eastbound deck replacement and full repainting to be completed between 2030 and 2035, as well as other cable and superstructure work to be completed around 2045. Between 2030 and 2050, the MDTA anticipates the westbound bridge will also need a deck replacement, cable replacement, full repainting, and other various maintenance activities. By 2060, the MDTA estimates future repainting projects and deck replacements will be needed for both spans of the Bay Bridge. All projects would require a lane closure which would worsen congestion over time and compound existing traffic congestion, mobility, and safety issues. While every effort is made for lane closures to occur at night and during off peak hours, the length of closures will extend into peak travel periods. Certain required major rehabilitation, such as beam replacements, will require full-time (24/7) lane closures, which historically have had severe impacts even in winter months. The MDTA anticipates the cost of all future maintenance projects from 2023 through 2065 to be approximately \$3.8 billion. The cumulative past costs and projected future costs over time are depicted in **Figure 16**.

3.4.2 Short Term Maintenance Operations

Current capacity across the Chesapeake Bay is inadequate to maintain options for traffic movement during maintenance and for management of incidents on the Bay Bridge. Current lane and shoulder widths provide little room for maintenance activities along the bridge without closing lanes. The lack of shoulders combined with the frequency of required maintenance limits the amount of work that can be done without impacts to travel conditions on the roadway. Additionally, these conditions can put workers and incident responders at greater risk when working near moving traffic.

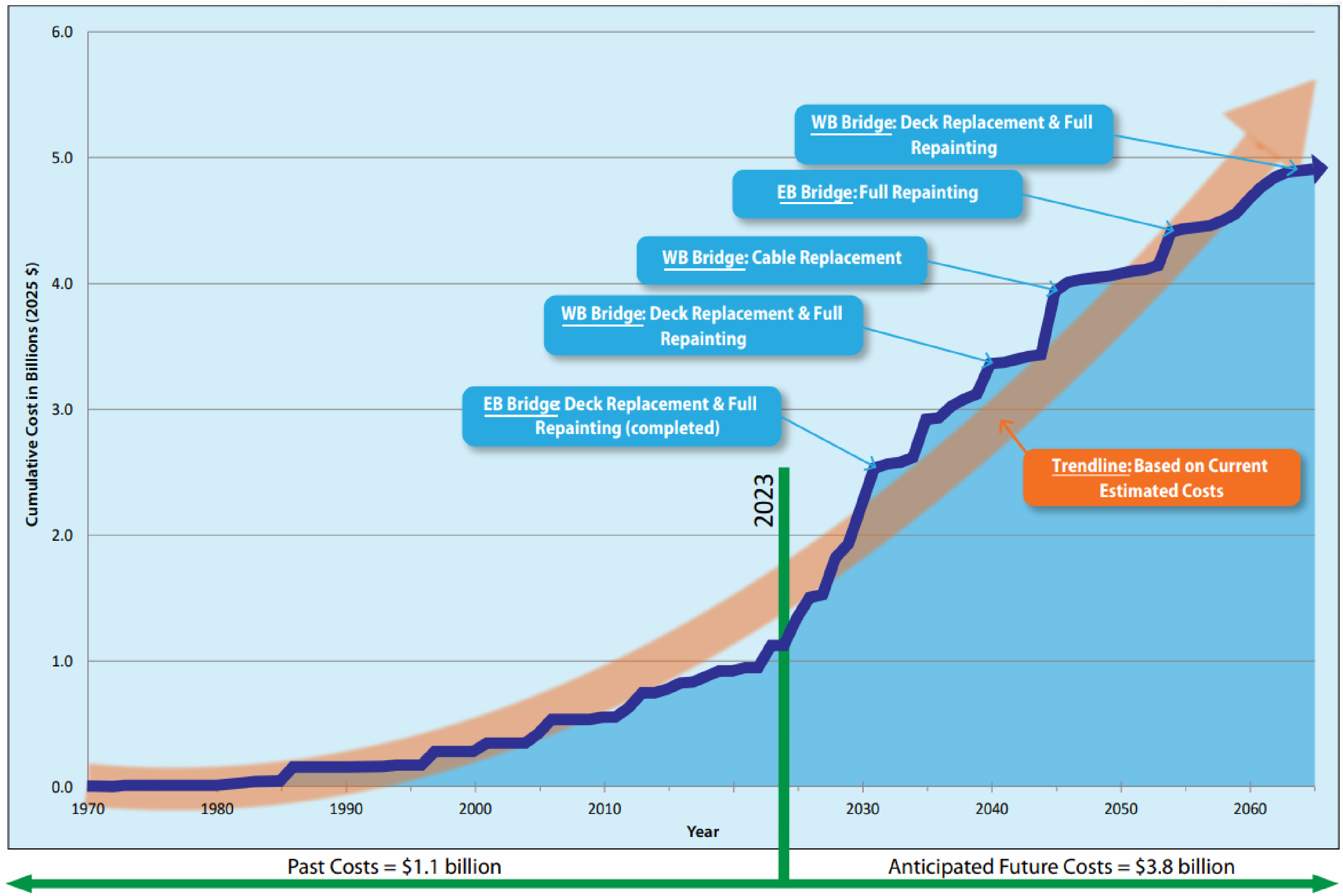
Whenever possible, the MDTA attempts to schedule maintenance activities during periods when they will have the least impact on travel operations. The MDTA utilizes innovative approaches to ensure that maintenance projects do not significantly impact traffic movement, including constructing deck sections off-site and utilizing off-peak lane closures during the day. Many maintenance activities on the Bay Bridge occur during overnight hours when volumes are lowest. Warnings for lane closures (or bridge closures) are displayed on signs on the impacted roadways well in advance of the closures, in accordance with statewide standards for lane/roadway closures. In addition, when possible, the MDTA notifies the public of upcoming maintenance activities through public announcements using various sources (i.e., traditional media and social media).

3.5 Navigation

The existing Bay Bridge serves as a key constraint for ships that travel on the Chesapeake Bay, including to the Port of Baltimore. Accommodating existing and future ship navigation and traffic on the Chesapeake Bay is important to maintaining the vitality of the Port of Baltimore and commerce in Maryland.

Should a build alternative be selected at the end of the Tier 2 Study, bridge permits from the U.S. Coast Guard (USCG) under the General Bridge Act of 1946, 33 USC 525 et seq., and Section 9 of the Rivers and Harbors Appropriation Act of 1899, 33 USC 401, will be required to preserve the public right of navigation and to prevent interference with interstate and foreign commerce along navigable waters. The USCG permits would include the preliminary navigational clearance determination for modified or newly constructed structures over navigable waters, required protective systems, clearance gauges, navigational lighting, and temporary measures for construction.

Figure 16: Future Projected Maintenance and Cost of Existing Spans



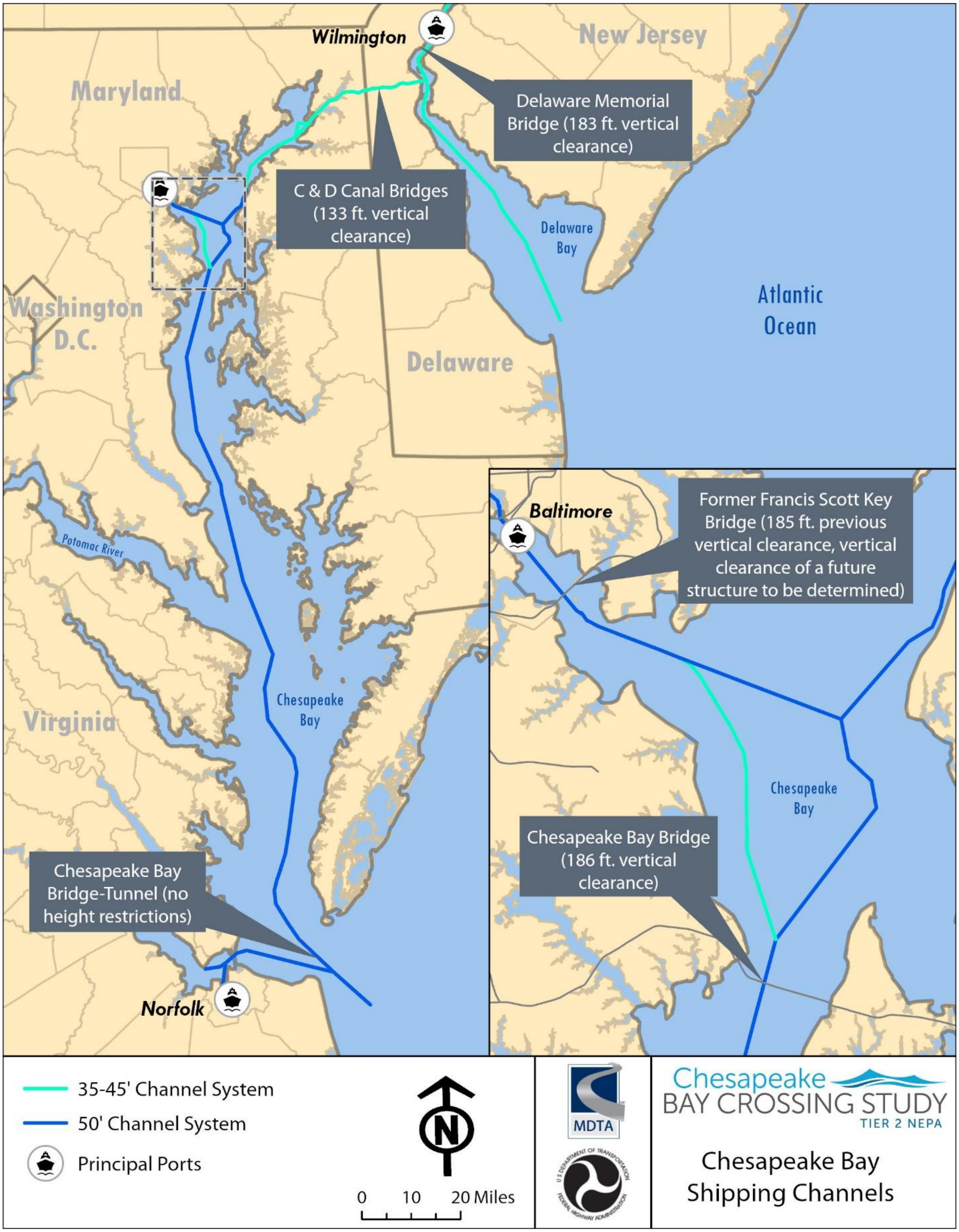
3.5.1 Shipping Operations

The Chesapeake Bay is used by a wide variety of maritime vessels including skiffs, sailboats, fishing boats, research vessels, schooners and other pleasure watercraft. Additionally, it serves as a significant maritime transportation route for cargo and cruise ships accessing Maryland's Port of Baltimore. The Port of Baltimore is recognized as an ideal location for international trade as one of the furthest inland ports on the East Coast of the United States, providing efficient access to nearby metropolitan areas and trade routes to the Midwestern United States. The Port of Baltimore contributes significantly to the local, regional, and national economy.

Figure 17: Freighter passing under the Bay Bridge

The main shipping channel, classified for both shallow and deep draft vessels, extends along the west side of the Chesapeake Bay and under the highest suspension section of the Bay Bridge. The channel is 50 feet deep and generally 800 feet wide with a vertical clearance (i.e., air draft) of 186 feet. There is also a secondary channel under the Bay Bridge that is used by smaller vessels located directly east of the main shipping channel. This secondary channel is 90 feet deep and 725 feet wide. The vertical clearance at the secondary channel is 65 feet. The dredging of the channels is managed by the U.S. Army Corps of Engineers and the Maryland Port Administration (MPA). The shipping channels to the Port of Baltimore are displayed on **Figure 18**.

Figure 18: Shipping Channels and Vertical Clearances to the Port of Baltimore



Aside from the mouth of the Chesapeake Bay, the only other maritime point of access to the Atlantic Ocean from the Port of Baltimore is through the Chesapeake & Delaware (C&D) Canal. The C&D Canal is 14 miles long and located northeast of the Port of Baltimore. It connects the Delaware River and Atlantic Ocean with the Elk River and Chesapeake Bay. As an alternative shipping route for the Port of Baltimore, it carries approximately 9.5 percent of all ship traffic in and out of the Port. Aside from various disadvantages to inland water transport compared to open water shipping, at 35 feet deep and 450 feet wide, the canal presents stricter limitations on the size of cargo ships and the amount of cargo that can navigate through it. Thus, the main shipping channel that runs under the Bay Bridge is the primary and essential trade route for the Port of Baltimore.

In 2022, the Port of Baltimore cargo vessels' import and export tons totaled 43.3 million, and the value of foreign cargo marked a record year with a value of $74.3 billion. Most of the domestic waterborne cargo within the Port of Baltimore consists of coal, petroleum products, sand and gravel moving within the Chesapeake Bay or to nearby ports along the U.S. East Coast. Several cruise lines also utilize the Port of Baltimore, including Royal Caribbean, Carnival, American Cruise Lines, Phoenix Reisen and Norwegian Cruise Line.

3.5.2 Channel Limitations

The existing Bay Bridge spans limit vertical clearance through the Chesapeake Bay to 186 feet. The C&D Canal, which already has stricter limitations due to the shipping channel width and depth, has an even shorter clearance of 133 feet, due to several bridges that cross over it. By comparison, the Verrazzano Bridge has a vertical clearance of 230 feet, providing substantially higher clearances for ships entering and exiting the Port of New York and New Jersey. The vertical clearances to the Port of Baltimore are depicted in **Figure 18** and **Table 12.** At 185 feet, the Francis Scott Key Bridge, located closer to the Port of Baltimore, once had a similar vertical clearance to the Bay Bridge. Tragically, on March 26, 2024, a large shipping vessel struck one of the piers, causing the Francis Scott Key Bridge to collapse. As a result, the vertical clearance of the Bay Bridge is the determining factor for the size of ships that are able to access the Port of Baltimore. Furthermore, it is anticipated that any future structure at the site of the former Francis Scott Key Bridge would be constructed with higher vertical clearance than the previous structure. The USCG issued a Preliminary Navigational Clearance Determination (PNCD) in June 2024 that identified a minimum vertical clearance of 230 feet for a replacement bridge.

At and between the former location of the Francis Scott Key Bridge and the Bay Bridge, the Chesapeake Bay Shipping Channel does not allow for simultaneous two-way traffic. Additionally, there are no anchorage areas north of the Bay Bridge for large vessels. Thus, many ships are required to wait south of the Bay Bridge for traffic to clear in order to pass under the Bay Bridge to Port of Baltimore facilities in and around the Baltimore Harbor. The approved navigable width of the main shipping channel for larger vessels that pass under the Bay Bridge is 800 feet. The edge of the navigable channel is approximately 350 feet from the bridge piers on each side. The piers currently have limited vessel impact protection at both the main and secondary channels, as the bridge was designed and constructed before the adoption of more modern design standards to mitigate the risk of a vessel collision.

Table 12: Bridge Crossing Vertical Clearances near Bay Bridge

Bridge Name	Roadway	Body of Water and Location	Vertical Clearance (ft)
Chesapeake Bay Bridge	U.S. 50/301	Chesapeake Bay near Annapolis, MD and Stevensville, MD	186
Former Francis Scott Key Bridge	MD 695	Patapsco River near Baltimore Harbor	185 (previous vertical clearance)
Future Replacement for Francis Scott Key Bridge	MD 695	Patapsco River near Baltimore Harbor	230 (identified minimum)
Chesapeake Bay Bridge-Tunnel	U.S. 13	Mouth of Chesapeake Bay at Atlantic Ocean in Virginia	No height restrictions (partial tunnel)
Chesapeake City Bridge	MD 213	C&D Canal at Chesapeake City	135
Summit Bridge	U.S. 301/DE 896	C&D Canal south of Glasgow, DE	133
Canal Bridge	Delmarva Central Railroad	C&D Canal south of Kirkwood, DE	133
William V. Roth Jr. Bridge (Senator Roth Bridge)	DE 1	C&D Canal at St. Georges, DE	138
St. George's Bridge	U.S. 13	C&D Canal at St. Georges, DE	133
Reedy Point Bridge	DE 9	C&D Canal near Delaware City, DE	134
Delaware Memorial Bridge	I-295/U.S. 40	Delaware River, south of Wilmington, DE	183
Bridges highlighted in yellow are all located on the C&D Canal and fall under the same callout box titled "C&D Canal Bridges" in **Figure 18**.			

3.5.3 Future Shipping Traffic

Due to the cost savings of utilizing larger ships to move larger quantities of goods, cargo ships are expected to increase in size within the next decade as older vessels are phased out. The largest class of cargo vessel anticipated to call at the Port of Baltimore through 2040 is the Post Panamax (PPX) Generation III Max, which has the following dimensions:

- 16,000 twenty-foot equivalent units (TEU) capacity
- 1,299 ft length overall (LOA)
- 175.6 ft beam
- 52.5 ft design draft
- 175.4 – 181.9 ft air draft

TEUs are standard shipping containers that are 20 feet long, 8 feet wide, and 8.6 feet tall. Studies show a continued increase in total TEUs and an expected increase in the number of PPX III and larger vessels calling at the Port of Baltimore. The estimated number of calls at Seagirt Marine Terminal, within the Port of Baltimore, is expected to increase from 549 in 2030 to 701 by 2040. The total forecasted TEU increase is displayed in **Table 13**.

Table 13: Twenty-Foot Equivalent Unit (TEU) Forecast for Port of Baltimore

	2030	2035	2040
Forecasted Import TEU	859,531	940,512	1,174,405
Forecasted Export TEU	940,512	1,077,154	1,221,111
Forecasted Total TEU	1,800,043	2,017,666	2,395,516

Despite a trend toward even larger vessels, the current cargo vessel forecast is limited to PPX III Max vessels due to limitations imposed by clearance on the existing Chesapeake Bay Bridge. At 186 feet, the Bay Bridge cannot accommodate the navigation of ships exceeding this size. Additionally, the MPA predicts water levels of the Chesapeake Bay may limit PPX III Max vessels at the Bay Bridge starting in 2045.

Currently, there are 12 regularly scheduled container services calling on the Port of Baltimore. Of these services, there are five dedicated to the Asia and South Asia trade routes, four to the Europe/Mediterranean region, two to the Americas, and one to Africa. The largest vessels currently calling Port of Baltimore are approaching the PPX III (14,000 TEU) vessel class. However, Port of Baltimore estimates show that to meet growing demand, three of these services will likely see future upgrades to the average and maximum vessel sizes, including 16,000 TEUs.

Furthermore, cruise ships are also expected to continue to increase in size. Currently only approximately 31 percent of cruise ships have access to the Port of Baltimore due to clearance limitations. Most cruise ships that have been recently built or that are currently under construction exceed the clearance under the existing Chesapeake Bay Bridge and are therefore unable to call at the Port of Baltimore. This trend is expected to continue in the future, as almost all large cruise ships currently under construction exceed the vertical clearance of the Bay Bridge.

3.5.4 Economic Competitiveness and Significance of the Port of Baltimore

The Port of Baltimore annually produces approximately $3.3 billion in total personal income, $395 million in taxes, and $2.6 billion in business income, as well as supporting over 15,300 direct jobs and over 139,000 connected jobs. According to the 2023 Port Performance Freight Statistics Program: Annual Report to Congress from the Bureau of Transportation Statistics, the Port of Baltimore nationally ranks 18th in total tonnage, 13th in dry bulk tonnage, and 15th in TEU. It is one of only five ports in the United States that ranks in the top 25 in each category. In 2022, the Port of Baltimore ranked first nationally in handling automobiles, light trucks, and farm and construction machinery. It also ranked first in imported gypsum, second in exporting coal, and sixth in importing coffee. Over 196,000 passengers departed from Baltimore on cruise ships in 2022 and the MPA estimates the cruise terminal annually brings in over $63 million to Maryland's economy and supports over 400 jobs. In 2022, the Port of Baltimore ranked as the 12th largest port in the United States by foreign cargo tonnage and tenth largest by dollar value.

During the COVID-19 pandemic, the Port of Baltimore played a critical role in the movement of goods along the Eastern United States. Supply chain issues and backups in landside freight transport that were experienced in other large U.S. ports were not experienced at the Port of Baltimore; nearly 100 "ad hoc" ships that were not scheduled to stop at the Port of Baltimore were diverted to there to reduce delays during the pandemic. Maintaining the shipping route through the Chesapeake Bay and providing clearance for large cargo carriers and cruise lines is critical for supporting the present and future needs of the Port and Maryland's economy.

4 ADDITIONAL OBJECTIVES

Beyond the study needs, two objectives will also be considered throughout the process of developing and evaluating NEPA alternatives. The objectives are (1) environmental responsibility and (2) cost and financial responsibility. These objectives provide additional criteria for evaluating the reasonableness of alternatives and represent issues the MDTA has deemed important in light of the sensitivity of the Chesapeake Bay as an environmental resource, the MDTA's goal to balance the potentially substantial benefits and impacts of major infrastructure projects among all users and neighboring communities, and limited availability of funding resources. Including these issues as additional objectives will lead to higher scrutiny and attention to these issues during alternatives development and will allow for greater efficiency in the early stages of alternatives development. Incorporating the objectives in the analysis will help confirm that alternatives evaluated in the EIS are technically feasible and could ultimately be constructed if selected as a result of the NEPA environmental review process. Ultimately, it will also allow for earlier and clearer communication with stakeholders and the public about the decision-making process.

4.1 Environmental Responsibility

The MDTA recognizes the significance of the Bay Bridge and the Chesapeake Bay. "Environmental Responsibility" in the context of this study is understanding the significance of the natural, built, and human environment and endeavoring to make decisions to meet the purpose and needs while limiting negative impacts to these resources.

The inclusion of environmental responsibility as an additional objective will encourage the development and screening of alternatives that reflect the MDTA's commitment to protect the local community and natural environmental resources. The Tier 2 Study EIS will assess a broad range of natural, cultural, and socioeconomic impacts associated with potential alternatives. The objective of environmental responsibility will be considered in evaluating alternatives with potentially divergent direct, indirect, and cumulative effects to sensitive resources. For instance, assume the MDTA was evaluating two alternatives that could both meet the study's transportation needs. One of those alternatives would result in limited usage of high-quality wetlands and/or tidal resources, while the other alternative would result in extensive damage to those same resources. The importance of protecting those resources would provide an important distinguishing factor in making decisions concerning the reasonableness of those alternatives for detailed consideration or identification of a preferred alternative. Similarly, the preliminary design of build alternatives would be reviewed for means to avoid and minimize impacts to sensitive resources. In short, the environmental responsibility objective means that the MDTA will not merely assess potential effects as part of the Tier 2 Study, but will also make decisions aiming to affirmatively advance environmental interests.

The Bay Bridge is an iconic landmark within the built environment. The original span was the world's longest continuous over-water steel structure and, at the time, the third longest bridge in the world. The 3,200 ft. long suspension section makes the bridge distinctive and a beacon for tourists and photographers. With suspension towers that are 354 feet tall on the eastbound span and 379 feet tall on the westbound span, the Bay Bridge is highly visible from many areas and destinations around the Chesapeake Bay, including Sandy Point Park, Matapeake Park, Greenbury Point Conservation Area, and Terrapin Nature Park, as shown in **Figure 20**. The MDTA understands the symbolic nature of the bridge, the value of the bridge's architectural and aesthetic merit and the importance of its visual impact.

The Chesapeake Bay is one of the most biologically diverse estuaries in the world and maintains a functioning ecosystem that filters water and provides a suitable habitat for over 3,600 species of plants and animals. In addition to its ecological importance, the Chesapeake Bay also plays a major role in Maryland's economy, including commercial fishing, recreation, and educational and tourism opportunities. Each year, 500 million pounds of seafood, including blue crabs, clams and oysters, are harvested from the Chesapeake Bay, contributing nearly $600 million to Maryland's economy. Recreational boating and fishing are also popular activities in Maryland. According to the Chesapeake Bay Foundation and the 2009 Economic Impact of Maryland Boating report, the recreational boating industry generates roughly $2 billion and 32,000 jobs each year in Maryland.

The MDTA and FHWA recognize the importance of the Chesapeake Bay and the major role it plays in the lives of those living in its watershed, and beyond. The study will identify potential environmental impacts to the Chesapeake Bay and surrounding areas and develop opportunities to avoid, minimize and mitigate those impacts. Central to the MDTA's environmental stewardship commitment, any proposed build alternative must consider the sensitive resources of the Chesapeake Bay, including existing environmental conditions, and the potential for adverse impacts to the Bay and the important natural, recreational, socio-economic, and cultural resources it supports. As touched on previously, this Tier 2 Study will consider the full range of environmental issues at the project level, such as:

- natural resources (e.g., floodplain, wetlands, water quality, flora, fauna, prime farmland);
- coastal zone management policies;
- resiliency;
- cultural resources (e.g., archaeology, historic properties);

- community resources;
- socio-economics (e.g., land use compatibility, economics);
- Section 4(f) properties (e.g., parks, historic sites, wildlife refuges);
- eair quality;
- noise;
- hazardous materials; and
- indirect and cumulative effects.

This study will consider community resources within the Study Area, including the Bay Bridge Airport, Sandy Point State Park, Terrapin Nature Park, Captain John Smith Chesapeake National Historic Trail, and the Star-Spangled Banner National Historic Trail. In addition, the study will consider other resources, such as the National Park Service Chesapeake Gateways Program which connects people to experiences of the natural and cultural heritage of the Chesapeake Bay and its rivers. Consistent with State priorities, counties neighboring the Chesapeake Bay including those within and neighboring the Study Area have planning documents with goals that address resource protection, growth, and development. Preservation and restoration of natural resources, including forests, steep slopes, wetlands, floodplains, watersheds, and waterways are a high priority as evident in programs (e.g., Chesapeake Bay Critical Area, Heritage Areas, Open Space, Priority Preservation Areas, Adequate Public Facilities) that limit and manage development.

Figure 19: The Bay Bridge viewed from above Terrapin Nature Park

Maryland State legislation and local land use planning policies guide development patterns throughout each county by structuring projects around designated growth areas where planned growth is suitable. This is a particularly important principle in those counties dominated by agriculture where improved access and population growth have led to increased development pressure. In these counties, development is limited to specific areas to maintain the agricultural and cultural character unique to each place. Additionally, residential and business development is typically limited to urban growth areas, with countryside preservation areas surrounding towns and villages.

The existing Bay Bridge plays an important role supporting the diverse regional economic environment. This study will also consider potential beneficial and adverse effects to regional economic activities, such as the recreational and tourism industries. Potential alternatives will be evaluated for their ability to support planned economic development. Local land uses, existing and planned development patterns, and economics will be critical elements in the evaluation of any build alternative.

4.2 Cost and Financial Responsibility

To assess potential build alternatives, as well as the implications of taking no action, the MDTA will consider financial responsibility as an objective. This objective requires an assessment of how the agency will pay for the development, operation, and maintenance of the facilities (old or new). As an independent State agency, the MDTA does not receive funding from tax dollars, the Maryland General Fund or the Maryland Transportation Trust Fund. The MDTA relies solely on revenues generated from its transportation facilities. The MDTA facilities are fully financed, operated, maintained, improved, and protected with toll revenues paid by customers using those facilities.[4]

During the Tier 2 Study, the MDTA will explore funding strategies for any potential Bay Crossing improvements. The Tier 1 Study FEIS/ROD provided an estimated range of project costs for the Tier 1 Selected Corridor Alternative (Corridor 7), assuming either a bridge facility or a combined bridge-tunnel facility. The bridge assumption resulted in a range of costs from a low-end of $5.4 billion to a high end of $8.9 billion. For a bridge-tunnel, the range was from $8.0 billion to $13.1 billion. Where the Tier 1 Study was limited in its analysis of cost and financial responsibility given its scope, the analysis in the Tier 2 Study will consider specific build options and will include a greater level of detail.

For any investment of this magnitude, improvements must be deemed financially viable for them to be advanced. The MDTA will further identify potential costs based on preliminary project-level engineering and the likely timing of project construction for potential build options. In light of the already substantial difference between estimated costs depending on the proposed engineering solution, the MDTA must consider project affordability and financing in its alternatives development and screening. Engineering solutions, considered for alternatives such as the type of structure and the size of the structure, may present obstacles to fully funding a

[4] See https://mdta.maryland.gov/About/Finances.html

proposed action. This factor will influence identification of a reasonable range of alternatives and/or identification of a preferred alternative.

In the near term, this study is funded for planning and preliminary engineering of alternatives through NEPA, as well as post-NEPA planning activities. Funding for a subsequent study phase or phases (e.g., final design, right-of-way (ROW) acquisition, or construction) would be required in the fiscally-constrained Maryland Statewide Improvement Program prior to the FHWA issuing a NEPA decision for a build alternative resulting from this study.

The cost and financial viability of potential build alternatives will be based on, among other factors:

- the potential amount of new or upgraded approach transportation network facilities that may be required;
- the range of structure lengths required to cross the Bay (if appropriate);
- the type of structure crossing the Bay (if appropriate);
- the capacity of the Bay Crossing; and
- the anticipated operating and maintenance costs associated with the crossing improvements (i.e., amount of infrastructure required).

Costs associated with the No-Build Alternative must also be considered. As described in **Section 3.4**, approximately $3.8 billion will be required to maintain the existing structures through 2065.

5 References

American Association of State Highway and Transportation Officials. 2018. A Policy on Geometric Design of Highways and Streets, 7th Edition. Washington, DC: American Association of State Highway and Transportation Officials.

American Association of State Highway and Transportation Officials. August 2016. Practitioner's Handbook: Defining the Purpose and Need and Determining the Range of Alternatives for Transportation Projects. https://environment.transportation.org/wp-content/uploads/2021/05/ph07-2.pdf

Canal de Panamá. January 1, 2022. OP Notice to Shipping No. N-1-2022: Vessel Requirements. https://pancanal.com/wp-content/uploads/2022/03/N01-2022.pdf

Chesapeake Bay Foundation. No Date. What is the Chesapeake Clean Water Blueprint? https://www.cbf.org/how-we-save-the-bay/chesapeake-clean-water-blueprint/what-is-the-chesapeake-clean-water-blueprint.html

DriveEZMD. No date. E-ZPass Discount Plans. https://driveezmd.com/acct-types/e-zpass-discount-plans/

Delaware Department of Transportation (DelDOT). No date. Evacuation Routes. https://deldot.maps.arcgis.com/apps/webappviewer/index.html?id=dfa83d46ba27493bbebb642ff0733c40

Earthstar Geographics. World Imagery.

Esri Federal Datasets. June 22, 2021. Interstate.

General Assembly of Maryland Department of Legislative Services. January 2020. A Report to the Maryland General Assembly, Senate Budget and Taxation Committee and House Appropriations Committee regarding Publicly Operated Ferry Service for the Chesapeake Bay Crossings (2019 JCR, p. 86) https://dlslibrary.state.md.us/publications/JCR/2019/2019_86-87.pdf

Federal Highway Administration (FHWA). August 2012. Environment NEPA Regulatory Framework and Process: Purpose & Need, and Alternatives. https://highways.dot.gov/sites/fhwa.dot.gov/files/41purpose.pdf

FHWA. No date. National Highway Freight Network. https://ops.fhwa.dot.gov/freight/infrastructure/nfn/index.htm

FHWA. No date. National Statistics: All Areas, Urban and Rural. https://explore.dot.gov/t/FHWA/views/FHWAFMMNational5_1/NationalStatsDash?%3Aembed=y&%3Aiid=3&%3AisGuestRedirectFromVizportal=y

FHWA. June, 2011. Integrating Road Safety into NEPA Analysis: A Practitioner's Primer. https://highways.dot.gov/safety/zero-deaths/integrating-road-safety-nepa-analysis-primer-safety-and-environmental-4

Maryland Manual On-Line. No Date. Maryland at a Glance: Waterways: Port of Baltimore. https://msa.maryland.gov/msa/mdmanual/01glance/html/port.html

Maryland Department of Emergency Management (MDEM). No date. Know Your Zone Maryland. https://mdem.maryland.gov/action/Pages/know-your-zone-md.aspx

Maryland Department of Transportation (MDOT). No date. Capital Programming. https://mdot.maryland.gov/tso/Pages/Index.aspx?PageId=27

MDOT. 2023. Maryland Consolidated Transportation Program (FY2023-FY2028). https://mdot.maryland.gov/OPCP/CTP_2023/FY23_FY28_CTP_Full_Final_Report_Regular_Resolution_for_viewing.pdf

MDOT. November 2022. Maryland State Freight Plan. https://www.mdot.maryland.gov/OPCP/MDOT_State_Freight_Complete_2022_12_06.pdf

MDOT. August 7, 2023. Statewide Crash Summary. https://zerodeathsmd.gov/wp-content/uploads/2023/08/StatewideBR-2022Aug07-2023.pdf

MDOT. No date. Policy Manual, Bridge: Width. https://policymanual.mdot.maryland.gov/mediawiki/index.php?title=Bridge:_Width

MDOT State Highway Administration (SHA). 2021. Maryland State Highway Mobility Report 2021, Tenth Edition. https://www.roads.maryland.gov/OPPEN/2021_mobility_report.pdf

MDOT State Highway Administration (SHA). January 13, 2020. Structural Design Guidance: Design Section. https://www.roads.maryland.gov/OBD/GPM-OOS-01-Design.pdf

Maryland iMap GIS Catalog. 2019. Six-inch aerial imagery.

Maryland Port Administration (MPA). No date. Port Operations: Dredging. https://mpa.maryland.gov/greenport/Pages/dredging.aspx

MPA. No date. Vision2025. https://mpa.maryland.gov/Documents/VisionPlan2025.pdf#:~:text=The%20Maryland%20Port%20Administration%20%28MPA%29%20has%20prepared%20Vision2025,visions%20will%20focus%20the%20efforts%20of%20the%20MPA

MPA. May 2019. Strategic Plan 2019. https://mpa.maryland.gov/Documents/Strategic_Plan2019.pdf

MPA. March 2019. 2018 Foreign Commerce Statistical Report. https://mpa.maryland.gov/Documents/2018FCSR.pdf

Maryland Transportation Authority (MDTA). No date. All Electronic (Cashless) Tolling - Frequently Asked Questions. https://mdta.maryland.gov/cashless-tolling-faq

MDTA. 2004. Bay Bridge Transportation Needs Report. https://mdta.maryland.gov/Capital_Projects/BayCrossingStudies/NeedsReport.html

MDTA. 2007. Bay Bridge Transit Study Complete. https://mdta.maryland.gov/Capital_Projects/BayCrossingStudies/baycrossing.html

MDTA. No date. Bay Bridge Eastbound Deck Replacement Project. https://mdta.maryland.gov/BayBridgeEastboundDeckReplacementProject

MDTA. 2006. Bay Crossing Task Force Report. https://mdta.maryland.gov/Capital_Projects/BayCrossingStudies/NeedsReport.html

MDTA. September7, 2016. Comprehensive Rehabilitation Project Begins on Westbound Bay Bridge Suspension Span. https://mdta.maryland.gov/blog-category/mdta-traffic-advisories/comprehensive-rehabilitation-project-begins-on-westbound-bay-bridge-suspension-span

MDTA. No date. Francis Scott Key Bridge (I-695). https://mdta.maryland.gov/Toll_Facilities/FSK.html

MDTA. No date. Rewrapping and Dehumidification of Main Cables Project. https://mdta.maryland.gov/Capital_Projects/US_50_Bay_Bridge_Cable_Wrapping/Project_Home.html

MDTA. 2020. Spring 2020 Bay Bridge All Electronic (Cashless) Tolling Frequently Asked Questions. https://mdta.maryland.gov/sites/default/files/Files/Projects_and_Studies/AET/Spring%202020%2

0Bay%20Bridge%20All-Electronic%20(Cashless)%20Tolling%20Frequently%20Asked%20Questions%20(FAQs).pdf

MDTA. No date. Toll Rates for the William Preston Lane Jr. Memorial (Bay) Bridge (U.S. 50/301). https://mdta.maryland.gov/Toll_Rates/Bay_Bridge_Rates.html

MDTA. October 3, 2022. William Preston Lane Jr. Memorial (Bay) Bridge. https://mdta.maryland.gov/sites/default/files/Files/BRAGG/BBRAG%20Bay%20Bridge%20Contra-flow%20update%20Presentation%2010-2022.pdf

MDTA. 2015. U.S. 50/301 William Preston Lane Jr. Memorial (Bay) Bridge: Life Cycle Cost Analysis. https://mdta.maryland.gov/sites/default/files/Files/Bay_Bridge_LCCA_Report_12-2015.pdf

MDTA. No date. William Preston Lane Jr. Memorial (Bay) Bridge (U.S. 50/301). https://mdta.maryland.gov/Toll_Facilities/WPL.html

MDTA. No date. William Preston Lane Jr. Memorial (Bay) Bridge All Electronic (Cashless) Tolling. https://mdta.maryland.gov/Bay-Bridge

MDTA. No date. William Preston Lane Jr. Memorial (Bay) Bridge Automated Lane Closure System Project. https://mdta.maryland.gov/Capital_Projects/BayBridgeALCS

Maryland Transit Administration (MTA). No date. Schedules. https://www.mta.maryland.gov/schedule

Maryland Upper Shore Transit (MUST) Bus. No date. MUST Bus. https://www.mustbus.org/index

National Oceanic and Atmospheric Administration. No date. Tides and Currents. https://tidesandcurrents.noaa.gov/map/index.html

Port Authority NY NJ. June 14, 2019. Iconic Bayonne Bridge Rededication Caps Port Authority's $1.7 Billion Project. https://www.panynj.gov/port-authority/en/press-room/press-release-archives/2019_press_releases/iconic_bayonne_bridgerededicationcapsportauthoritys17billionproj.html

Sussex County. No Date. Know Your Zone: Sussex County Hurricane Evacuation Lookup Tool. https://sussexcounty.maps.arcgis.com/apps/webappviewer/index.html?id=3f03225051b44c7d957d67953b0563e6

Transportation Research Board (TRB). 2002. NCHRP Report 480 A Guide to Best Practices for Achieving Context Sensitive Solutions. Washington, D.C.

Queen Anne's County. No Date. History of Matapeake. https://www.qac.org/1022/History-of-Matapeake

Queen Anne's County. No Date. County Ride. https://www.qac.org/181/County-Ride

UPS Supply Chain Solutions. No date. Twenty-foot Equivalent Unit (TEU). https://www.ups.com/us/en/supplychain/resources/glossary-term/teu-container.page

U.S. Army Corps of Engineers. January 2006. Baltimore Harbor & Channels, Maryland and Virginia: Fact Sheet. https://www.nab.usace.army.mil/Portals/63/docs/Navigation/1DE/Map/map.pdf

U.S. Army Corps of Engineers. No date. Chesapeake & Delaware Canal. https://www.nap.usace.army.mil/Missions/Civil-Works/Chesapeake-Delaware-Canal/lang/en/

U.S. Army Corps of Engineers. No date. Chesapeake & Delaware Canal – Bridges. https://www.nap.usace.army.mil/Portals/39/docs/Civil/CandD/C-D-Bridge-Facts-Updated-2020.pdf

U.S. Army Corps of Engineers. February 22, 2023. Delaware River Main Channel Deepening. https://www.nap.usace.army.mil/Missions/Factsheets/Fact-Sheet-Article-View/Article/490804/delaware-river-main-channel-deepening/

U.S. Census Bureau. 2022. American Community Survey (ACS) 5-Year Estimates, 2017-2021. Accessed via QuickFacts. https://www.census.gov/quickfacts/fact/table/US/PST045222

U.S. Census Bureau. 2018. Cartographic Boundary Files – Shapefile (State Boundaries, County Boundaries).

U.S. Census Bureau. 2023. Decennial Census by Decade. https://www.census.gov/programs-surveys/decennial-census/decade.html

U.S. Coast Guard. January 6, 2023. Public Notice D05PN-01-2023. https://www.navcen.uscg.gov/sites/default/files/pdf/bridges/publicNotices/D05PN-01-23_DelawareMemorialBridge_NewCastleDelaware.pdf

U.S. Department of Transportation (USDOT) Bureau of Transportation Statistics (BTS). January 1, 2023. 2023 Port Performance Freight Statistics Program: Annual Report to Congress. https://rosap.ntl.bts.gov/view/dot/65990

USDOT BTS. 2023. USDOT: ArcGIS Online (Principal Ports, Navigable Waterway Network Lines).

Washington Post. September, 7, 2022. A suicidal son, an iconic bridge and the struggle to keep people from jumping. https://www.washingtonpost.com/dc-md-va/2022/09/07/chesapeake-bay-bridge-suicide-son-prevention/

Washington Post. April 17, 2022. Container ship stuck in Chesapeake Bay for more than a month is free. https://www.washingtonpost.com/dc-md-va/2022/04/17/cargo-ship-ever-forward-chesapeake-bay-stuck/

Washington Post. No Date. Facts About the Bay Bridge. https://www.washingtonpost.com/archive/local/2006/01/19/facts-about-the-bay-bridge/82c7a593-4595-4de3-819f-6ff016e9ee3e/

Washington Post. February 1, 1989. Westbound Bay Bridge Toll Ending. https://www.washingtonpost.com/archive/local/1989/02/01/westbound-bay-bridge-toll-ending/82181e67-d90e-48f0-b3d3-f9e111731782/

WBAL-TV 11. April 18, 2013. Plans made to enhance two-way traffic operations on the Chesapeake Bay Bridge. https://www.wbaltv.com/article/plans-made-to-enhance-two-way-traffic-operations-on-chesapeake-bay-bridge/7080062