Chesapeake Bay Crossing Study: Tier I NEPA

Modal and Operational Alternative: Transit Service

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1.0 Introduction

As part of the Chesapeake Bay Crossing Study: Tier I NEPA (Bay Crossing Study), the Maryland Transportation Authority (MDTA) is evaluating potential Modal and Operational Alternatives (MOA) along with a range of potential Corridor Alternatives that could meet the Study's Purpose and Need (P&N). The following three primary needs are identified in the P&N: adequate capacity; dependable and reliable travel times; and flexibility to support maintenance and incident management in a safe manner.

The MOAs include Ferry Service, Transit Service, and Transportation Systems Management/Travel Demand Management (TSM/TDM). For the Transit Service MOA, which is the subject of this Technical Memorandum, the study team conducted a review of MDTA's *2007 Analysis of Transit Only Concepts to Address Traffic Capacity Across the Bay Bridge Report* (2007 Transit Study) to determine if the 2007 findings and conclusions remain valid and can be used to assess the ability of transit service to meet the elements of the P&N as a standalone service.

Transit service across the Chesapeake Bay was considered by Governor O'Malley's Task Force on Traffic Capacity Across the Chesapeake Bay, which was convened in 2005 to examine the multitude of transportation issues related to adding traffic capacity across the Bay and published its report of recommendations in 2006. The Task Force considered multiple modes of travel across the Bay, but ultimately recommended that MDTA examine the effectiveness of transit to address capacity needs of the existing Bay Bridge structures. To address the recommendation of the Task Force, the MDTA developed the 2007 Transit Study in conjunction with the Maryland Department of Transportation Maryland Transit Administration (MDOT MTA). For the purposes of the current Bay Crossing Study, the 2007 Transit Study serves as the basis of the MOA evaluation.

2.0 Summary of the 2007 Transit Study

2.1 Scope

The 2007 Transit Study was initiated to respond to comments regarding transit service. The purpose was to “determine whether transit service across the Bay would be viable, cost effective and able to address the capacity needs at the existing Bay Bridge without any additional highway capacity.” (MDTA, 2007)

The 2007 Transit Study Team assumed that “any transit-only concepts would use the existing Bay Bridge or a newly-constructed crossing at the location of the current bridge to maximize the potential cost-effectiveness of any transit-only concept and to use the information that is already available for the existing Bridge.” (MDTA, 2007) The study considered fixed guideway or dedicated transitway systems such as heavy rail transit (HRT), light rail transit (LRT), and bus rapid transit (BRT) and utilized cost and ridership threshold data to determine the viability of these modes for a crossing of the Chesapeake Bay.

HRT is the traditional rail technology that includes high speed, commuter regional travel, subways and freight. Travel is faster but the number of destinations and stops is limited to achieve the high speeds. The higher speeds and the shared use of the railways (with other operators) require stricter standards for rail construction and transit cars and greater initial construction costs. LRT is sometimes described as the modern version of the street car. Whereas LRT is constrained by lower speeds for shorter distances, it is flexible in design, engineering and operations. It was developed to be a cost-effective intra-city alternative to regional rail. BRT is a transit choice that includes a dedicated lane for buses only and can accommodate express bus service. Each of the three types of transit attracts different types of trips, which results in different levels of ridership. HRT generally serves larger regions with the least flexibility, while BRT service is most flexible in terms of locations and schedules.

2.2 Methodology and Analysis Results from the 2007 Study

To complete the analysis, the 2007 Transit Study was conducted in three stages:

- Analysis of origin and destination patterns at the existing Bay Bridge to understand the potential transit routes and ridership on those routes
- Analysis of the potential traffic relief at the existing Bay Bridge afforded by the transit-only concepts to determine if transit can adequately address the demand
- Research of national transit standards to compute sketch level costs and supporting measures such as land uses and employment and population densities surrounding transit service to determine if transit-only concepts are cost-effective.

2.2.1 Analysis of Potential Transit Routes and Ridership

The 2007 Transit Study team examined the range of origins and destinations for traffic that crosses the Bay Bridge and identified which combinations “might hold potential for a transit concept.” (MDTA, 2007) The study team considered travel patterns for both the typical weekday and summer weekend under both existing and future (2030) conditions. Overall trip patterns were identified using the Integrated Bay/Nice Travel Demand Forecasting Model (IBNM.) (The Maryland Statewide Transportation Model (MSTM), a more detailed model which represents a larger region is being used in the Bay Crossing Study, was not available in 2007.) Person-trip and vehicle-trip numbers were identified using the 2002 Origin-Destination Study Report for the Bay Bridge and Nice Bridge Needs Study. Both sources were used to determine potential transit routes that could serve the highest number of likely transit users.

The first step in the process of developing existing and future potential transit trip data was to develop trip tables for person trip origins and destinations during the AM peak period (6:00 to 9:00 AM) for both existing and future (2030) conditions during a weekday using the IBNM. Next, the densities of person trips with either an origin or destination in each Traffic Analysis Zone (TAZ) were plotted to graphically illustrate how many trips originated or were destined to each TAZ[1]. The results of this analysis showed that trips crossing the Bay Bridge during the AM peak period on a weekday had a wide variety of potential origins and destinations. To narrow down the areas that could best be served by a transit-only concept, the study team identified the specific TAZs, or groups of TAZs, that had the highest densities of trips. Based on an analysis of population densities, land uses, and existing transit capabilities throughout the region, seven groups of TAZs were identified as activity centers that could be served by the potential transit routes. The process of developing transit trip data for summer weekends was identical except that the IBNM had to be adapted since it did not include weekend data.

From these TAZ groups, data from the Baltimore Metropolitan Council (BMC) regional travel demand model, the Journey to Work portion of the 2000 Census, and information collected from the travel surveys at the Bay and Nice Bridges, an assessment was made of the potential ridership and the percentage of travelers who would use transit. The study team also reviewed existing transit ridership data for Baltimore City and Washington, DC, regions where transit service existed. Using this data, and information specific to each of the destination activity centers previously identified, the study team estimated the percent of transit ridership compared to total trips from the model, or ridership factors for the potential transit routes the analysis identified.

2.2.2 Analysis of Potential Traffic Relief at the Existing Bay Bridge

The 2007 Transit Study Team evaluated the benefits of the transit-only concepts in terms of their ability to reduce congestion at the existing Bay Bridge and the projected congestion relief that could result from the transit-only concepts. Congestion relief was measured by subtracting the projected transit trips from the total number of vehicle trips projected to use the Bay Bridge.

2.2.3 Analysis of Cost Effectiveness and Supporting Measures

The 2007 Transit Study Team compared the costs and benefits of each type of transit service. Projects either built or in the planning stages at that time were used to develop cost per mile figures for construction costs for HRT, LRT, and BRT to develop sketch level cost estimates for the potential routes. The benefits were based on the potential ridership for transit service that may reduce demand on the existing Bay Bridge.

2.3 Conclusions of 2007 Study

The 2007 Transit Study team drew several conclusions from the analysis including the determination that “transit service will not provide a significant benefit to summer weekend or peak period weekday traffic.” (MDTA, 2007) Other conclusions included ridership projections that would be significantly lower than the minimum thresholds for heavy rail, light rail, and bus rapid transit. They noted that “while transit service would reduce vehicle travel on the Bay Bridge, the reduction would likely be very small

[1] A TAZ is a relatively small geographical area within the limits of a model. Trips are generated and attracted within the model at the TAZ level. The smaller the TAZ is, the finer the resolution of the model’s inputs and outputs. The TAZs used in the 2007 Transit Study are described later in this document, and are shown in Figure 1.

relative to the overall volume of traffic that uses the bridge." (MDTA, 2007) and would still result in failing operations in 2030 on weekdays and summer weekends.

In addition to the traffic and operational concerns, the 2007 Transit Study Team noted that land uses, population, and employment densities would not support a fixed guideway or dedicated transitway service and that "these trends are not likely to change due to existing and planned land uses and population densities." (MDTA, 2007) Construction costs for a new bridge crossing were also cited as a factor since low ridership represents poor value for money given the significant costs of transit infrastructure.

3.0 Overview of the 2019 Update

The objective of updating the 2007 Transit Study is to determine if the previous findings and conclusions remain valid and can be used to assess the ability of transit service to meet the elements of P&N for the current study as a standalone service. Overall traffic patterns and origin-destination data for 2016/2017 are contained in the P&N document for the BCS which may be found on the MDTA Bay Crossing Study website.

The patterns shown in the P&N document have not drastically changed since 2007. Summer weekend peak volumes remain higher than weekday peak period volumes, as was documented in the 2015 Life Cycle Cost Analysis Study conducted by the MDTA. Weekday traffic patterns remain similar to those in 2007 when heavy westbound AM volumes and eastbound PM volumes were primarily commuter-based. Summer weekend traffic patterns also remain similar to those in 2007 when heavy eastbound volumes on Fridays and westbound volumes on Sundays were identified as travel or leisure-based. Therefore, the updates to the 2007 Transit Study are focused on potential transit ridership and reduction of traffic volumes on the existing Bay Bridge. In addition, the sketch level cost estimates for HRT, LRT, and BRT have been updated to evaluate their benefits and costs.

The methodology adopted in this update is very similar to the 2007 Transit Study with the exception of enhanced ridership factors that were calibrated using existing transit routes and ridership information that did not exist in 2007. The following steps were taken to estimate the potential transit ridership in this study.

1) Analysis of Potential Transit Route and Ridership
    a) **Origins and Destinations:** Determine origin-destination zones for the potential transit markets.
    b) **Existing Transit Data:** Compile transit routes, operations, and ridership data for transit currently operating across the Bay Bridge.
    c) **Ridership Factors for Origins and Destinations:** Develop and calibrate "ridership factors" using the existing ridership along the existing transit routes with the specific origin-destination auto person trips from the Bay Bridge Maryland Statewide Transportation Model (MSTM)[2]. Extend ridership factors for all potential transit origins and destinations.
    d) **Estimation of Potential Ridership:** Apply the ridership factors to origin-destination pairs for potential current and future transit ridership based on the auto person-trips from the Bay Bridge MSTM model.

[2] The Bay Bridge MSTM model is an adapted version of MDOT SHA's Maryland Statewide Transportation Model.

2) Level of Traffic Relief to the Bay Bridge Due to Transit
   a) **Potential Congestion Relief at the Bay Bridge:** Compute the estimated ridership and congestion relief from the number of vehicles that would no longer use the existing Bay Bridge.

4.0 Analysis of the Potential Transit Routes and Ridership

4.1 Origins and Destinations

The potential transit routes are assumed to service commuters traveling on Non-Summer Weekdays and for leisure travelers on Summer Weekends traveling to/from the Maryland Eastern Shore beach areas. The assumptions for the transit routes are similar to the 2007 Transit Study. The most recent origin-destination data was used to calibrate the ridership factors and to derive the updated figures for this update.

For Non-Summer Weekdays, transit travel is assumed to occur from the Eastern Shore, i.e. Kent Island and Queen Anne's County, to the Western Shore, i.e. Annapolis, Baltimore, and Washington DC, via the Bay Bridge in the AM Peak Hour. In the PM Peak Hour, reverse travel is assumed to occur from the Western Shore to the Eastern Shore via the Bay Bridge. The ridership factors for Non-Summer Weekdays were developed for the destinations on the Western Shore. For Summer Weekend travel, the destinations for the potential transit routes are focused on the beach areas, such as Ocean City, Maryland, and Sussex County, Delaware. Therefore, the ridership factors for Summer Weekends were developed based on destinations on the Eastern Shore. Table 1 and Figure 1 show the origin and destination zones used for the potential ridership analysis.

Origin and Destination Zones for the Potential Transit Ridership			
Eastbound		Westbound	
Origin Zone (Western Shore)	Destination Zone (Eastern Shore)	Destination Zone (Western Shore)	Origin Zone (Eastern Shore)
1005, 1019, 1035, 1038, 1043, 1058, 1066, 1067, 1211, 1214, 1215, 1216, 1217, 1219, 4003	1033	1005	1033, 1045, 1082, 1098 1212, 3002, 3003, 3004 3005, 3006, 4006
	1045	1019	
	1082	1035	
	1098	1038	
	1212	1043	
	3002	1058	
	3003	1066	
	3004	1067	
	3005	1211	
	3006	1214	
	4006	1215	
		1216	
		1217	
		1219	
		4003	

Table 1 – Origin and Destination Zones for the Potential Transit Ridership

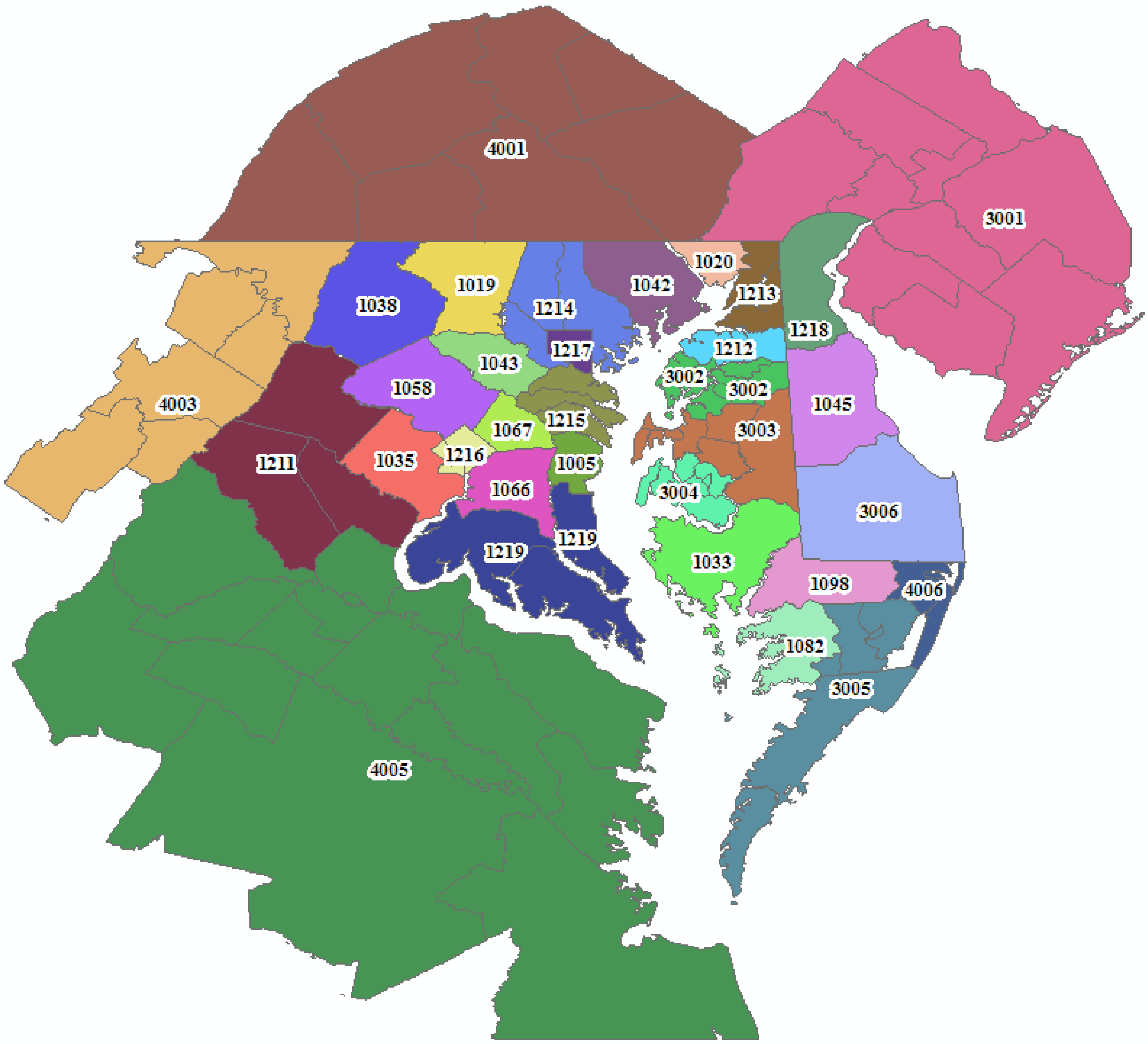

Figure 1 – Origin-Destination Analysis Zones within the study area

4.2 Existing Transit Data

Updates to the 2007 Transit Study include information from existing bus transit service which was not present at the time of the 2007 Transit Study and currently operates across the Bay Bridge.

4.2.1 Non-Summer Weekdays

There are currently three existing weekday bus transit routes on the Bay Bridge that are operated by MDOT MTA through contracts with private companies. The routes are summarized in Table 2 below:

Existing MDOT MTA Bus Routes Operating Across the Bay Bridge			
Route No.	210	240	250
Route	Castle Marina to Annapolis and Baltimore	Kent Island to Washington DC	Kent Island and Davidsonville to Washington DC
AM Westbound Schedule	5:30 to 7:30	5:00 to 7:00	4:45 to 6:50
AM Headway	60 minutes	30 minutes	25 minutes
PM Eastbound Schedule	3:10 to 5:10	3:20 to 5:45	3:10 to 5:20
PM Headway	30 minutes	20-45 minutes	25 minutes
Bus Capacity	53	53	53
Average Weekday Ridership	58	221	396

Table 2 - Existing MDOT MTA Bus Route Information

In addition, there are several private transit companies that operate and provide vehicular (van or bus) service between the Eastern and Western Shores of Maryland that utilize the existing Bay Bridge. However, these services do not operate on a consistent schedule and the overall ridership is much less than the MDOT MTA service.

4.2.2 Summer Weekends

There is no MDOT MTA bus transit service provided on the weekends. Private and charter operators may provide buses to Eastern Shore destinations.

4.2.3 Utilization of Existing Transit Service

Based on the existing MDOT MTA bus route schedules and vehicle capacity, the passenger capacity of the existing bus transit routes was compared to the existing ridership information obtained for the current service. Table 3 details existing bus ridership compared to the capacity of the existing service.

Existing Bus Route Capacity			
Route	Actual 2018 Weekday Ridership	Route Capacity	Capacity Currently Used
210	58	322	18%
240	221	460	48%
250	396	552	72%
Total	675	1,334	51%

Table 3 - Existing MDOT MTA Bus Route Capacity

The most utilized bus routes are Routes 240 and 250 serving Kent Island to Washington, DC, operating at 48 and 72 percent capacity, respectively. Service from Kent Island to Baltimore (Route 210) is only operating at 18 percent capacity. Total ridership on all three routes is 675 passengers each weekday.

4.3 Ridership Factors for Origins and Destinations

This update to the 2007 Transit Study leverages existing transit data that was not available to the previous study since there was no transit service in operation at that time. As part of this update, an approach to estimate ridership at a sketch planning level was utilized. In this approach, "ridership factors", defined as a ratio of transit-person-trips[3] over auto-person-trips[4] for a given origin-destination combination, were first calibrated using existing transit data and its service area along with origin-destination demand data from the Bay Bridge MSTM model, and then expanded to cover all potential origin-destination movements in the future. A ridership factor is different from the generally known "transit mode share" term in that the denominator of the ratio for a ridership-factor is auto-person-trips, and that for transit mode share is total-person-trips. Given such ridership factors, the number of transit-person-trips (or transit ridership) can then be obtained by factoring them with their corresponding number of auto-person-trips.

4.3.1 Calibration Using Existing Transit Data

Ridership factors were developed and calibrated to the existing ridership along the existing bus routes and the auto-person-trips for the applicable origin-destination pairs corresponding to the service area of the existing transit routes. These "zones" were initially created as part of the Bay Bridge MSTM model calibration exercise and were aggregated to suit this effort. The origin-destination analysis zones for the MSTM models are presented in Figure 1.

Based on the bus stops of the existing transit routes, specific origin-destination pairs were selected for the ridership factor calibration. Because the existing bus routes are limited to the commuter service to Baltimore and Washington DC including a few stops in Annapolis and Prince George's County, the origins of the existing bus ridership are assumed to be Zones 3002 (Kent and Queen Anne's Counties), 3003 (Queen Anne's, Caroline and Talbot Counties), and 3004 (Talbot County), and the destinations are assumed to be 1215 (Anne Arundel County), 1216 (Washington, DC), 1217(City of Baltimore), 1067 (Prince George's County) and 1066 (Prince George's County) for the AM Peak Hour. The origins and destinations of the existing ridership for the PM Peak Hour was assumed to be the reverse movement of the AM Peak Hour. The auto person trips of the origin-destination pairs for both AM Peak Hour (6-9AM) and PM Peak Hour (4-7PM) were calculated from the existing MSTM model for Non-Summer Weekdays. The ridership factor of each destination zone was calibrated for matching to the total existing transit ridership of 675 (refer to Table 2). Table 4 shows the detail of the ridership factors from the 2007 Transit Study and the calibrated ridership factors for this updated transit study.

The calibrated factors in this study show lower percentages than the factors used in the 2007 Transit Study; however, total ridership numbers are higher. The factors are lower because the estimated zonal auto-person-trips are generally higher in this update than those in the 2007 Transit Study. The ridership factors range from 1 percent for Southern Maryland to 10 percent for Washington DC.

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[3] A transit-person-trip is one person making a transit trip between an origin and destination. Transfers are not counted as additional trips in this definition.

[4] An auto-person-trip is one person making an automobile trip between an origin and destination. Single-occupancy vehicle (SOV) trips directly generate the same number of auto-person-trips. High-occupancy vehicle (HOV) trips are multiplied by an average occupancy of the vehicle to compute auto-persons. Occupancies for HOV2, and HOV3+ are assumed to be 2, and 3.5 respectively.

Existing Ridership Factors for Non-Summer Weekdays (2007 Transit Study and This Update)							
Destination (from Origin Zones 3002, 3003, and 3004)	MSTM Zone	2007 Transit Study			Updated Transit Study		
		Person Trips	Ridership Factor	Ridership	Person Trips	Ridership Factor (Calibrated)	Ridership
Broadneck Peninsula	1215	1,860	5%	90	10,253	2%	205
Annapolis & Vicinity	1215	2,275	5%	115			
BWI & Fort Meade	1215	180	2%	10			
Bowie & Vicinity	1067	370	2%	10	1,817	1%	18
Upper Marlboro	1066	50	2%	-	600	1%	6
Baltimore City	1217	860	10%	85	1,486	3%	45
Washington, DC & Vicinity	1216	1,200	20%	240	4,008	10%	401
Total	-	6,795	-	550	18,164	-	675

Table 4 - Existing Ridership Factors for Non-Summer Weekdays (2007 and 2017 Transit Studies)

4.3.2 Extend Ridership Factors for All Potential Transit Markets

The transit ridership factors developed are applicable to the transit service area of the existing transit service. However, to be able to estimate potential ridership beyond the existing routes, ridership factors need to be developed that are applicable to other potential transit origin-destination movements. To do so, the calibrated ridership factors were extended to cover additional transit travel markets that are not covered by the existing transit routes. The approach to extend the ridership factors to areas beyond the existing transit service area is discussed below.

4.3.2.1 Non-Summer Weekdays

The ridership factors for the destination zones along the existing bus service for Non-Summer Weekdays were calibrated as shown in Table 4. Based on the calibrated ridership factors, destination zones for potential new transit routes were assumed. Washington DC is the destination zone with the highest ridership factor, 10 percent, and it was set for the highest ridership factor to use for the other destination zones. On the other hand, it was assumed that the minimum ridership factor to use was 1 percent. These maximum and minimum ridership factors were applied to both Non-Summer Weekday and Summer Weekend conditions. A few suburban areas of Washington DC and Baltimore City with relatively high auto person trips, Montgomery County, Baltimore County, and Fairfax County in VA, were each assumed to be 3 percent, which is the same as the calibrated ridership factor for Baltimore City. The rest of the destination zones were assumed to have ridership factors of 1 percent for Non-Summer Weekdays. It was assumed that the potential ridership factors will not change from the existing condition to the future condition.

4.3.2.2 Summer Weekends

The ridership factors for Summer Weekends are different from the factors for Non-Summer Weekdays because the trip purposes and destination zones are different. The ridership factors used in the 2007 Transit Study were utilized for the basis of the ridership factor determination. The ridership factors used for Summer Weekends were 5 percent for major beach area destinations (including Ocean City and Sussex County, DE) and 2 percent for other destinations on the Eastern Shore of the Chesapeake Bay in the 2007 Transit Study. Based on the ridership factor calibrations and the existing bus routes and ridership for Non-Summer Weekdays, it was assumed that the ridership factor would also be reduced in the same pattern on Summer Weekends. The ridership factors for the major beach areas were assumed to be 2 percent and other destination zones in the Eastern Shore were assumed to have ridership factors of 1 percent.

4.4 Estimation of Potential Ridership

Given the expanded ridership factors, an estimation of the *potential* ridership was calculated for present and future conditions.

4.4.1 Non-Summer Weekdays

The potential transit ridership was calculated for existing and 2040 future conditions for Non-Summer Weekdays. The ridership for Non-Summer Weekdays represents commuter trip patterns as described in Section 4.1. Sixteen zones were selected for the destinations on the Western Shore including the destinations of the existing transit service. It should be noted that the auto-person-trips and ridership to the destination zones are more than the values from the limited existing commuter origins seen in the Table 4 because the potential ridership includes all possible origin zones on the Eastern Shore including beach areas where transit service is currently not available. Table 5 shows the potential transit ridership for 2017 (existing) and 2040 future conditions for Non-Summer Weekdays.

In both 2017 and 2040 future conditions, two major destinations of the potential ridership were Washington DC and Anne Arundel County (North). Washington DC has the high calibrated ridership factor of 10 percent and Anne Arundel County (North) has a very large number of auto-person-trips that is almost 40 percent of the total auto-person-trips in both existing and 2040 future conditions. Baltimore City, Baltimore County, and Montgomery County also have moderate amounts of potential ridership. In 2017, the total ridership of AM and PM Peak Hours for Non-Summer Weekday was estimated as 1,081. In 2040, the total ridership was estimated as 1,410.

Potential Ridership for Existing and Future Non-Summer Weekdays							
Destination (from All East Shore Zones)	MSTM Zone	2017 Existing			2040 Future		
		Person Trips	Ridership Factor	Potential Ridership	Person Trips	Ridership Factor	Potential Ridership
Anne Arundel Co. (N)	1215	15,050	2%	301	18,296	2%	366
Prince Georges Co. (N)	1067	2,593	1%	26	3,407	1%	34
Prince Georges Co. (S)	1066	778	1%	8	1,036	1%	10
Baltimore City	1217	2,107	3%	63	2,444	3%	73
Washington DC	1216	4,419	10%	442	6,266	10%	627
Anne Arundel Co. (S)	1005	394	1%	4	489	1%	5
Carroll Co.	1019	158	1%	2	201	1%	2
Fairfax Co., VA	1035	1,467	3%	44	2,016	3%	60
Frederick Co.	1038	260	1%	3	336	1%	3
Howard Co.	1043	1,855	1%	19	2,392	1%	24
Montgomery Co.	1058	2,375	3%	71	3,092	3%	93
Loudoun & Prince William Co., VA	1211	420	1%	4	570	1%	6
Baltimore Co.	1214	2,324	3%	70	2,679	3%	80
Southern MD	1219	303	1%	3	384	1%	4
Western VA	4003	2,593	1%	1	103	1%	1
Southern VA	4005	778	1%	20	2,203	1%	22
Total	-	36,570	-	1,081	45,914	-	1,410

Table 5 - Potential Ridership for Existing and Future Non-Summer Weekdays

4.4.2 Summer Weekends

The ridership for Summer Weekends represents leisure trip patterns that are different from weekday commute patterns. The potential transit ridership for both existing and 2040 future conditions for Summer Weekends was calculated using the potential ridership factors for eleven zones on the Eastern Shore. The zones selected for the destinations included major destinations for leisure (including, but not limited to, Ocean City and Sussex County, DE). Table 6 shows the potential transit ridership for 2017 and 2040 conditions for Summer Weekends.

In both 2017 and 2040 conditions, two major destinations of the potential ridership were Queen Anne's County (South) / Caroline County and Sussex County, DE. Queen Anne's County has a very large number of person-trip-ends that is approximately 34 percent of the total auto-person-trips in both 2017 and 2040 conditions. Sussex County, DE has relatively high number of trip-ends and a ridership factor of 2 percent. Talbot County and Ocean City with Worcester County (North) have moderate numbers of trip-ends following the two major destinations. Under 2017 conditions, the total daily ridership for Summer Weekends was estimated to be 3,543. Under 2040 conditions, the total daily ridership was estimated to be 4,485.

Potential Ridership for Existing and Future Summer Weekends							
Destination (from All West Shore Zones)	MSTM Zone	2017 Existing			2040 Future		
		Person Trips	Ridership Factor	Potential Ridership	Person Trips	Ridership Factor	Potential Ridership
Queen Anne's Co. (S) & Caroline Co.	3003	94,727	1%	947	118,290	1%	1,183
Talbot Co.	3004	43,500	1%	435	51,642	1%	516
Dorchester Co.	1033	13,605	1%	136	17,074	1%	171
Wicomico Co.	1098	11,533	1%	115	14,380	1%	144
Ocean City & Worcester Co. (N)	4006	21,854	2%	437	26,173	2%	523
Queen Anne's Co. (N)	3002	11,244	1%	112	13,798	1%	138
Somerset Co.	1082	765	1%	8	936	1%	9
Worcester Co. (S)	3005	10,171	1%	102	12,067	1%	121
Kent Co.	1212	1,439	1%	14	1,730	1%	17
Kent Co., DE	1045	12,620	1%	126	16,153	1%	162
Sussex Co., DE	3006	55,536	2%	1,111	75,062	2%	1,501
Total	-	276,994	-	3,543	347,305	-	4,485

Table 6 - Potential Ridership for Existing and Future Summer Weekends

5.0 Level of Traffic Relief at the Bay Bridge Due to Transit

5.1 Converting Ridership to Vehicle Trips

The potential ridership was estimated for the existing and future years for both Non-Summer Weekdays and Summer Weekends. In order to assess the level of traffic relief at the Bay Bridge, it was necessary to convert the estimated transit ridership to the number of vehicles that would no longer travel on the existing Bay Bridge. The outputs from the future 2040 MSTM models were utilized to estimate the occupancy conversion factors from auto person trips to numbers of vehicles. The occupancy conversion factors were calculated separately for Non-Summer Weekdays and Summer Weekends. As shown in Table 7, 2.4 persons per car for Non-Summer Weekdays and 2.9 persons per car for Summer Weekends were determined.

Conversion Factors from Auto Person Trips to Vehicles (2040 Future)						
Season	Time	Direction	Cars (no trucks)	Person Trips	Persons per Car	Occupancy Factor Used for Conversion
Non-Summer Weekdays	AM Peak	WB	9,910	22,589	2.279	2.4
	PM Peak	EB	9,445	23,327	2.470	
	AM+PM	EB+WB	19,355	45,916	2.372	
Summer Weekends	Day	EB	58,633	171,751	2.929	2.9
	Day	WB	59,723	175,555	2.939	
	Day	EB+WB	118,356	347,306	2.934	

Table 7 – Occupancy Factors for Converting Auto Person Trips to Vehicles (2040 Future)

5.2 Non-Summer Weekdays

Utilizing the occupancy factor of 2.4 persons per vehicle, the transit ridership was converted to the reduction in traffic on the Bay Bridge. The traffic conditions for the westbound direction on the existing Bay Bridge during the AM Peak Period from 6 AM to 9 AM are shown in Table 8. The westbound direction is assumed to have three lanes during the AM Peak Period. It should be noted that the ridership in Table 5 includes daily trips and accounts for both directions with an assumption that half of the trips occur in the morning in one direction, and the other half occur in the other direction in the evening.

5.2.1 Westbound Traffic

In 2017, the westbound traffic during the AM Peak Period was 9,354 vehicles. It was approximately 90 percent of bridge capacity for the westbound direction with three lanes. The transit ridership was 675 for a weekday. Therefore, half of that value, 338, was assumed to be the ridership in the AM Peak Period. Transit users are already in the existing buses and the ridership does not change the traffic volume.

In 2040 future conditions, the westbound traffic is expected to increase to 11,805 vehicles during the AM Peak Period, which represents approximately 114 percent of the bridge capacity for the westbound direction during that three-hour period. Thus, westbound traffic is expected to be over capacity in 2040. The transit ridership is 1,410 for a weekday. Half of that, 705, is expected to be the ridership in the AM Peak Period in 2040. The ridership was converted to the number of vehicles which would be subtracted from the westbound traffic. The estimated reduction in the traffic volume is 294 vehicles and it is approximately 2.5 percent of the westbound traffic in the AM Peak Period. However, the reduction of the traffic by the ridership does not change the overcapacity condition. The percent of capacity used is expected to be 111 percent.

5.2.2 Eastbound Traffic

Results for eastbound traffic are shown in Table 9. Eastbound traffic during the PM Peak Period was 9,395 vehicles in 2017. The eastbound direction was assumed to have three lanes under the contra-flow operation during the entire PM Peak Period in both 2017 and 2040. Under the contraflow operation, the eastbound traffic was almost 100 percent of the bridge capacity during the PM Peak Period in 2017. The transit ridership was 338 as the reverse movement of the ridership in the AM Peak Period. As was the case in the AM Peak Period, the transit users are already in the existing buses and the ridership does not change the traffic volume.

In 2040, the eastbound traffic is expected to increase to 11,118 vehicles during the PM Peak Period, which represents approximately 119 percent of the bridge capacity. As was the case for the AM Peak Period, eastbound is expected to be over capacity in 2040. The transit ridership is expected to be 705 and the estimated reduction in the traffic volume is 294 vehicles, which is the same as the AM Peak period in 2040. The reduction in the eastbound traffic volume is approximately 2.6 percent in the PM Peak Period. The percent of capacity used is expected to drop to 116 percent, but it is still over capacity.

Effect of Transit on the Bay Bridge Westbound Trips in AM Peak Period (Non-Summer Weekdays)		
	2017 Existing Vehicle Trips	2040 Future Vehicle Trips
All Vehicle Trips (including trucks)	9,354	11,805
Percent of Capacity Used	90%	114%
Estimated Transit Ridership	338 (observed)	705
Equivalent Vehicle Trips	-	294
Percent Reduction in Vehicle Trips Due to Transit	-	2.5%
Percent of Capacity Used with Transit	90%	111%

Table 8 – Effect of Transit on the Westbound Trips in AM Peak Period (Non-Summer Weekdays)

Effect of Transit on the Bay Bridge Eastbound Trips in PM Peak Period (Non-Summer Weekdays)		
	2017 Existing Vehicle Trips	2040 Future Vehicle Trips
All Vehicle Trips (including trucks)	9,395	11,118
Percent of Capacity Used	100%	119%
Estimated Transit Ridership	338 (actual ridership)	705
Equivalent Vehicle Trips	-	294
Percent Reduction in Vehicle Trips Due to Transit	0 (already subtracted in the count)	2.6%
Percent of Capacity Used with Transit	100%	116%

Table 9 – Effect of Transit on the Eastbound Trips in PM Peak Period (Non-Summer Weekdays)

5.3 Summer Weekends

For the Summer Weekend case, it was assumed that the transit trips occur during several hours in the mid-day on both directions of the travels. The best hours to reduce the traffic during a day is when the traffic volume exceeds the bridge capacity. After reviewing the projected 2040 hourly traffic volumes, the 10-hour period from 10 AM until 8 PM was selected for the transit operation hours for 2040 Summer Weekends. The transit operation hours were applied to both eastbound and westbound directions.

5.3.1 Eastbound Traffic

Results for eastbound travel are shown in Table 10. The eastbound traffic between 10 AM and 8 PM was counted as 41,026 vehicles in the summer of 2017. The volume had already reached 105 percent of the bridge capacity for the eastbound direction even with contra-flow operations. There was no transit service in either direction on weekends in 2017.

The eastbound traffic during the ten hours on a typical day in 2040 is estimated to increase to 45,280 vehicles. The potential transit ridership is 2,243 for the eastbound direction. At an average occupancy of 2.9, the potential transit riders could remove 774 eastbound vehicles, which would be approximately 1.7

percent of the traffic volume during the ten-hour period. The percent of capacity used is expected to drop to 114 percent, which is still over capacity.

5.3.2 Westbound Traffic

Results for westbound travel are shown in Table 11. The 2017 existing westbound traffic between 10 AM and 8 PM was counted as 38,536 vehicles. This volume was 101 percent of the bridge capacity. There was no transit service on weekends in 2017 summer, as described previously.

The westbound traffic on a typical Summer Weekend in 2040 is estimated to increase to 43,876 vehicles for the ten hours from 10 AM to 8 PM. The potential transit ridership is 2,243 for the westbound direction as well as the eastbound direction. The reduction of the vehicles by the transit users is estimated to be 774 vehicles in the westbound direction. The reduction of the volume is approximately 1.8 percent of the traffic volume during the ten-hour period. The percent of capacity used is expected to drop to 113 percent.

Effect of Transit on the Bay Bridge Eastbound Trips between 10 AM and 8 PM (Summer Weekends)		
	2017 Existing Vehicle Trips	2040 Future Vehicle Trips
All Vehicle Trips (including trucks)	41,026	45,280
Percent of Capacity Used	105%	116%
Estimated Transit Ridership	-	2,243
Equivalent Vehicle Trips	-	774
Percent Reduction in Vehicle Trips Due to Transit	-	1.7%
Percent of Capacity Used with Transit	-	114%

Table 10 – Effect of Transit on the Eastbound Trips between 10AM and 8PM (Summer Weekends)

Effect of Transit on the Bay Bridge Westbound Trips between 10 AM and 8 PM (Summer Weekends)		
	2017 Existing Vehicle Trips	2040 Future Vehicle Trips
All Vehicle Trips (including trucks)	38,536	43,876
Percent of Capacity Used	101%	115%
Estimated Transit Ridership	-	2,243
Equivalent Vehicle Trips	-	774
Percent Reduction in Vehicle Trips Due to Transit	-	1.8%
Percent of Capacity Used with Transit	-	113%

Table 11 – Effect of Transit on the Westbound Trips between 10AM and 8PM (Summer Weekends)

5.4 Summary of Traffic Relief Due to Transit

From Table 8 and Table 9, the number of daily equivalent vehicles trips due to transit for Non-Summer Weekdays in 2040 is expected to be 588 (294 from each of the two Peak Periods), which corresponds to about 2.5 percent of the combined Peak Period traffic. Similarly, from Table 10 and Table 11, the number of daily equivalent vehicles trips due to transit for Summer Weekends is expected to be 1,548 (774 from each of the two directions for a ten-hour period from 10 AM to 8 PM), which is about 1.7 percent of the traffic in the corresponding time periods. Table 12 compares these daily equivalent trips with the baseline traffic on the Bay Bridge for 2040, where the traffic is expected to grow by about 15,700 on Non-Summer Weekdays, and by about 16,700 on Summer Weekends. However, the daily equivalent vehicles or traffic relief due to transit is only about 0.70 percent of the daily traffic in Non-Summer Weekdays, and about 1.14 percent of the daily traffic in Summer Weekends. Hence, the traffic relief due to transit at the Bay Bridge in 2040 is negligible.

Comparison of Daily Existing and Projected Bay Bridge Traffic Volumes and Traffic Relief				
	Existing 2017	Projected 2040 No-Build	Traffic Relief due to Transit	Traffic Relief due to Transit as a percentage of 2040
Average Weekday	68,600	84,300	588	0.70%
Average Summer Weekend	118,600	135,300	1548	1.14%

Table 12: Comparison of Daily Existing and Projected Traffic Volumes and Traffic Relief due to Transit

Another way to look at these numbers is to consider how much of the anticipated growth in traffic volumes would be accommodated by transit. On non-summer weekdays, with an increase of 15,700 vehicles per day being forecast, transit would accommodate 588 trips—less than 4 percent of the anticipated growth. On summer weekends, with an increase of 16,700 vehicles per day being forecast, transit would accommodate 1,548 trips—less than 10 percent of the anticipated growth.

Therefore, transit is not a viable standalone option to accommodate the projected traffic growth.

6.0 Analysis of Cost Effectiveness and Supporting Measures

The 2007 transit study considered that any potential transit service – if it were implemented – would likely utilize buses on existing roadways. Since the scope of that study also stipulated a consideration of a new transit-only crossing, the team considered the prospective viability and cost of fixed-guideway and transitway systems. In considering fixed route transit as a potential solution to traffic congestion on the existing Bay Bridge, the analysis undertaken by the 2007 study team identified the following general rules of thumb for minimum ridership thresholds as shown in Table 13:

Minimum Ridership Thresholds for Transit Route Viability	
Transit Mode	Minimum Ridership Threshold (riders per line mile)
Bus Rapid Transit (BRT)	4,000 to 5,000
Light Rail Transit (LRT)	7,000 to 8,000
Heavy Rail Transit (HRT)	13,000 to 15,000

Table 13 - Minimum Ridership Thresholds for Transit Route Viability

6.1.1 Cost for New Transit Service Infrastructure

A review of constructed and planned transit projects in the Mid-Atlantic region revealed the cost information contained in Table 14. As was the case for the 2007 study, any transit concepts consider the utilization of the location of the current bay crossing. The cost estimates below do not include costs associated with right-of-way, operation and maintenance of the system, or a new bridge structure across the Chesapeake Bay.

Construction Costs for Existing and Planned Projects			
Project and Status	Total Cost ($ Billion)	Distance (miles)	Cost/Mile ($ Million)
Constructed Projects			
Silver Line Phase 1 (HRT)	$3.0	12	$250
Projects Under Construction			
Purple Line (LRT)	$5.6	16	$350
Silver Line Phase 2 (HRT)	$2.8	11	$255
Planned Projects			
Corridor Cities Transitway (BRT)	$0.545	15	$36
Southern Maryland Rapid Transit (BRT)	$1.4*	19	$74
Southern Maryland Rapid Transit (LRT)	$1.9*	19	$100
Richmond Highway Widening (BRT)	$0.205	3	$68

**Represents the upper limit of estimate for a conservative cost per mile amount*

Table 14 - Construction Costs for Existing and Planned Projects

The 2007 study team assumed cost-per-mile values for BRT, LRT, and HRT and used costs for the Silver and Purple Lines while those projects were in the planning stages. The Purple Line is currently under construction and Phase 1 of the Silver Line is complete; Phase 2 is currently under construction. The cost-per-mile values in Table 15 below include updated values that reflect the actual costs for LRT and HRT projects either constructed or under construction.

Cost-per-Mile (Million)		
	2007	2018
Bus Rapid Transit (BRT)	$22	$60
Light Rail Transit (LRT)	$52	$225
Heavy Rail Transit (HRT)	$175	$250

Table 15 - Cost-per-Mile for Fixed Route Transit Modes

Using the potential route data from the 2007 study, Table 16 below details potential construction costs for transit routes across the Chesapeake Bay based on 2018 cost data:

Construction (Only) Costs for Potential Transit Routes				
Potential Route	No. Miles	HRT Cost $ billions	LRT Cost $ billions	BRT Cost $ billions
Kent Island to Washington DC	59	$15	$13	$4
Kent Island to Annapolis	20	$5	$5	$1
Kent Island to Baltimore	59	$15	$13	$4
Baltimore to Ocean City	145	$36	$33	$9
Annapolis to Ocean City	118	$30	$27	$7
Washington DC to Ocean City	168	$42	$38	$10

Table 16 - Construction Costs for Potential Ridership Routes

With existing LRT and HRT transit servicing Baltimore and Washington D.C., a likely connection would be for BRT or LRT service from the Kent Island Park and Ride to either the Glen Burnie LRT station or the New Carrolton Metro station. Details are provided in Table 17.

Transit Connection Details			
Route	Length (miles)	LRT Cost	BRT Cost
Kent Island to Glen Burnie	30	$7 billion	$2 billion
Kent Island to New Carrolton	35	$8 billion	$2 billion

Table 17 - Likely Transit Connection Details

7.0 Summary

The 2007 Analysis of Transit Only Concepts to Address Traffic Across the Chesapeake Bay considered many aspects related to transit demand, ridership, capacity, and cost. It identified potential routes between the Eastern and Western Shores where transit is possible and determined what ridership along those routes could be. Considering the low projected ridership, high cost of construction, and minimal relief of traffic congestion on the existing structure, the study concluded that transit-only methods of providing transportation links across the Chesapeake Bay were not viable.

The update focused on existing transit ridership, projected ridership on the same routes, projected summer weekend ridership, the construction cost of prospective new transit routes, and the level of congestion relief that a new transit crossing could provide.

Transit is projected to remove some vehicles from the bridge on Non-Summer Weekdays in 2040, however, the estimated reduction in traffic volume is only 294 vehicles; approximately 2.5 percent of the westbound traffic and approximately 2.6 percent in the eastbound direction on a typical weekday. Overall traffic volumes are still projected to be above 111 percent of the existing bridge's capacity.

Transit is also projected to remove some vehicles from the bridge on Summer Weekends in 2040.

Eastbound traffic volumes are estimated to increase to 45,280 vehicles. Potential transit ridership would be expected to remove 774 vehicles, representing approximately 1.7 percent of the eastbound traffic and 1.8 percent of traffic in the westbound direction. Overall traffic volumes are still projected to be above 113 percent of the existing bridge's capacity. Thus, transit does not meet the "adequate capacity" component of the P&N.

Transit Summary			
2040 Ridership			
Weekday Ridership	% Reduction in Trips (AM/PM)	705	2.5%/2.6%
Weekend Ridership	% Reduction in Trips (AM/PM)	774	1.7%/1.8%
Costs			
Heavy Rail Transit (HRT)		$5-$42 Billion	
Light Rail Transit (LRT)		$5-$38 Billion	
Bus Rapid Transit (BRT)		$1-$10 Billion	

Table 18 - Summary of Potential Transit Service

The cost of new transit infrastructure is considerable due to the length of the routes that would be required, and the potential impacts associated with large-scale infrastructure improvements. Projected ridership also fails to meet the accepted minimum level for the viability of fixed guideway and transitway systems as shown in Table 13.

Given the high capital cost of rail (including the need for a new structure across the Bay to accommodate rail), and the fact that LRT and HRT transit service do not meet the “adequate capacity” component of the P&N, it is suggested that LRT and HRT be eliminated from further consideration as a standalone alternative and also as a component of any travel demand management measures considered during the Tier II study.

BRT can operate at a lower capital cost than LRT and HRT, utilizing the existing bridge bay crossing structure and operating in mixed traffic, but does not receive any travel time saving without separated BRT lanes. As a standalone alternative BRT does not provide enough capacity to reduce transportation demand for the existing bay crossing and therefore does not meet the “adequate capacity” component of the P&N. However, because of its ability to contribute to congestion reduction without requiring its own crossing structure, BRT should be considered as part of any travel demand management measures considered during the Tier II study.