South Side Transit Study

FINAL REPORT

April 2013

Office of Planning
6 St. Paul Street
Baltimore, Maryland 21202-1614

[This page is intentionally blank]

TABLE OF CONTENTS

List of Tables ii
List of Figures iii
Executive Summary v
1.0 Summary of Initial and Refined Alternatives 1
2.0 Summary of Evaluation Methodology 7
2.1 Ridership Demand and User Benefits 7
2.2 Cost Estimates 8
2.3 Cost Effectiveness 10
2.4 Existing and Potential Land Use Densities 11
3.0 Evaluation of Ridership and User Benefits 13
3.1 Mixed Traffic Alternatives 13
3.2 At-Grade Dedicated Alternatives 19
3.3 Grade Separated Alternatives 27
4.0 Evaluation of Capital and Operating Costs 37
4.1 Capital Cost Estimates 37
4.2 Operating Cost Estimates 41
5.0 Evaluation of Cost Effectiveness 45
5.1 Mixed Traffic Alternatives 45
5.2 Dedicated Guideway Alternatives 49
5.3 Grade Separated Alternatives 49
6.0 Evaluation of Land Uses 51
6.1 Observed Densities Around Existing Metrorail Stations 52
6.2 Forecast Densities Around Proposed Stations 57
7.0 Conclusions and Recommendations 65
7.1 Cost Effectiveness 65
7.2 Transit and Auto Trips Using the Woodrow Wilson Bridge 69
7.3 Recommendations 69
7.4 Proposed Changes to New Starts Program 70
Appendix A: Capital Cost Methodology A-1
Appendix B: Calculation of Operating Costs B-1

Appendix C: Modeling Procedures for Refined Alternatives C-1
Appendix D: Change in Station Boardings D-1
Appendix E: District-Level Comparison of New Daily Transit Trips, Relative to No-Build E-1
Appendix F: Comments from the Study Technical Committee F-1

LIST OF TABLES

Table E-1: Summary of Key Findings vi
Table 1-1: Key Characteristics of Initial Alternatives 2
Table 1-2: Summary of Screening Recommendations 3
Table 1-3: Summary of Refinements Recommended for Each Alternative 4
Table 1-4: Summary of Operating Characteristics for Refined Alternatives 5
Table 2-1: Capital Cost Categories 9
Table 2-2: Unit Operating Costs Assumptions 10
Table 2-3: Cost Effectiveness Breakpoints, FY 2013 11
Table 3-1: Summary of Ridership and User Benefits for Mixed Traffic Alternatives 14
Table 3-2: Summary of Ridership and User Benefits for Dedicated Guideway Alternatives 19
Table 3-3: Summary of Ridership and User Benefits for Grade Separated Alternatives 27
Table 4-1: Unit Costs ($1,000s, 2012 YOE) 37
Table 4-2: Estimated Units by Standard Cost Category 39
Table 4-3: Estimated Capital Costs by Standard Cost Category ($1,000s, 2012 YOE) 40
Table 4-4: Estimated Annual Operating Costs ($1,000s, 2012 YOE) 44
Table 5-1: Measures of Cost Effectiveness (2012$) 47
Table 6-1: Household, Population, and Employment Densities for Supporting Transit Investments 51
Table 6-2: Population, Household, and Employment Densities at Existing and Committed Metrorail Stations 52
Table 6-3: Summary of Alternatives Serving Each Station within the Study Area 59
Table 6-4: Station Area Densities in Alexandria and Fairfax County 60
Table 6-5: Station Area Densities in National Harbor 61
Table 6-6: Station Area Densities in the Anacostia Corridor 62
Table 6-7: Station Area Densities in Oxon Hill/St. Barnabas 63
Table 6-8: Station Area Densities in the Beltway Corridor 64
Table 7-1: Summary of Findings 67

LIST OF FIGURES

Figure 3-1: Model Results – Alternative 1A 15
Figure 3-2: Model Results – Alternative 1B 16
Figure 3-3: Model Results – Alternative 1C 17
Figure 3-4: Model Results – Alternative 1r 18
Figure 3-5: Model Results – Alternative 2A 21
Figure 3-6: Model Results – Alternative 2B 22
Figure 3-7: Model Results – Alternative 2Br 23
Figure 3-8: Model Results – Alternative 2C 24
Figure 3-9: Model Results – Alternative 2Cr 25
Figure 3-10: Model Results – Alternative 3A 29
Figure 3-11: Model Results – Alternative 3B 30
Figure 3-12: Model Results – Alternative 3Br 31
Figure 3-13: Model Results – Alternative 3C 32
Figure 3-14: Model Results – Alternative 3Cr 33
Figure 6-1: 2040 Population Density by TAZ 53
Figure 6-2: 2040 Household Density by TAZ 54
Figure 6-3: 2040 Employment Density by TAZ 55

[This page is intentionally blank]

EXECUTIVE SUMMARY

The Maryland Transit Administration (MTA) has been tasked with advancing the recommendations of the Capital Beltway South Side Mobility Study and developing transit alternatives that would use the Woodrow Wilson Bridge (WWB). The South Side Transit Study has met these objectives by:

- Developing an initial set of transit alternatives capable of connecting the transit networks on both sides of the Potomac River;
- Using the Maryland Alternatives Analysis II (MDAA II) model to assess the ridership and cost-effectiveness of each of these initial alternatives;
- Refining the most viable alternatives to test variants that may maximize ridership potential, user benefits, and cost-effectiveness; and,
- Working with local jurisdictions to identify station areas, land use plans, and transportation improvements necessary to support the most viable alternatives.

The key metrics used to determine the cost-effectiveness of each alternative are summarized in Table E-1. Based on this analysis, the study team concluded:

- As modeled in this study, Alternative 2Cr represents the most effective alternative for providing service on lanes 11 and 12 over the WWB based on its cost-effectiveness and the number of auto trips it is anticipated to remove from the WWB.
- Alternatives 2C and 2Cr would both be competitive for federal funding under current New Starts guidelines as modeled under this study. However, right-of-way constraints between Eisenhower Metrorail Station and King Street Metrorail Station may make it infeasible to implement the dedicated guideway assumed in the model. Therefore, additional design work and modeling would be necessary to confirm that the travel time savings and service frequencies assumed for these alternatives could be maintained within the constraints of the corridor.
- Alternatives 3Br and 3Cr carry the largest number of transit trips over the WWB, and may warrant further consideration if the Metrorail system requires a new Potomac crossing to relieve pressure from the core system.
- While it may be feasible to implement a demonstration bus service across the WWB, such a service would need an additional investment in ramps from lanes 11 and 12 to local roads on the Maryland side in order to provide direct service from Virginia to potential stations at National Harbor.

TABLE E-1: SUMMARY OF KEY FINDINGS

	Mixed Traffic Alternatives				At-Grade Alternatives					Grade Separated Alternatives				
Alternative	**1A**	**1B**	**1C**	**1r**	**2A**	**2B**	**2Br**	**2C**	**2Cr**	**3A**	**3B**	**3Br**	**3C**	**3Cr**
Systemwide Boardings vs. No Build	1,700	2,200	1,700	2,700	20,100	25,000	28,900	36,400	36,500	20,400	35,400	39,100	26,400	77,000
Systemwide Trips vs. No Build	800	1,000	1,000	1,500	9,800	11,000	14,400	16,700	18,400	14,500	10,600	22,300	19,600	34,800
Daily Transit Trips Crossing WWB	1,500	2,300	2,600	2,100	11,500	11,000	14,300	10,000	14,100	23,800	13,900	25,700	8,400	22,600
Daily Auto Trips Crossing WWB vs. No Build	-191	-333	-121	-647	-1,645	-1,059	-1,630	-1,441	-1,649	-1,175	-661	-1,266	-879	-1,782
Average Weekday User Benefits	500	600	700	1,000	4,900	6,000	7,600	11,400	16,000	11,000	7,700	14,200	12,600	21,900
Total Capital Cost ($M, 2012$)	$85.8	$110	$109	$148	$1,137	$856	$885	$763	$844	$3,238	$3,024	$3,411	$4,721	$4,806
Annual Operating Cost ($M, 2012$)	$3.5	$5.8	$6.8	$12.6	$4.2	$3.6	$3.6	$1.0	$1.3	$7.4	$4.4	$13.4	$0.3	$2.1
Cost Effectiveness Index (CEI)	$69.40	$81.69	$74.16	$81.59	$65.20	$40.32	$32.86	$18.27	$14.44	$81.30	$107.42	$67.69	$100.75	$59.28
CEI Rank	Low	Low	Low	Low	Low	Low	Low	Medium	Medium -High	Low	Low	Low	Low	Low

- While the other alternatives under consideration are not cost-effective under current FTA New Starts guidelines, they should be revisited as local planning and development initiatives intensify population and employment densities around proposed station areas.

This report presents an analysis of the estimated costs, cost-effectiveness, and potential land use issues associated with both the initial and refined alternatives. This document is organized as follows:

- Section 1.0 provides a brief summary of the nine initial and five refined alternatives.
- Section 2.0 describes the methodology used to evaluate the alternatives for this stage of analysis.
- Section 3.0 presents the ridership and user benefits forecast for each alternative in 2040.
- Section 4.0 summarizes the estimated operating and capital costs for each of the initial and refined alternatives.
- Section 5.0 presents the estimated Cost-Effectiveness Index (CEI) for each of the initial and refined alternatives.
- Section 6.0 presents an assessment of the land use and development issues associated with each alternative.
- Section 7.0 summarizes the performance of each of the alternatives and provides recommendations as to which alternatives should be considered for implementation.

[This page is intentionally blank]

1.0 SUMMARY OF INITIAL AND REFINED ALTERNATIVES

The intent of this study was to identify those alternatives that represent the most viable options for implementing transit service across the Woodrow Wilson Bridge in the horizon year 2040. As described in the *South Side Transit Study: Initial Alternatives Report* (November 2011), the nine initial alternatives for the South Side Transit Study were developed by considering transit options put forth by previous studies in the context of the most up-to-date information on the study area. The primary impetus for the study is to determine the most appropriate use of the lanes reserved for high-capacity transit on the Woodrow Wilson Bridge (WWB); therefore, all of the alternatives under consideration use the center lanes of the WWB to cross the Potomac River. In addition, all alternatives connect the Metrorail Green Line in Maryland with the Metrorail Blue/Yellow Line in Virginia, serving as a new link in the regional transit system.

The scope of this study specifically called for a feasibility evaluation of transit alternatives connecting the Metrorail Green Line in Maryland with the Metrorail Blue/Yellow Line in Virginia across the WWB based on potential ridership and cost-effectiveness. An HOV alternative would be considered as a possible Transportation Systems Management (TSM) option should the project proceed to an Alternatives Analysis for the Federal Transit Administration (FTA) New Starts program.

The initial alternatives combined three basic types of guideway (mixed traffic, at-grade dedicated right-of-way (ROW), and grade-separated exclusive ROW with three general travel corridors (I-95 to Branch Avenue Metrorail Station, Oxon Hill Road/St. Barnabas Road, and Indian Head Highway). The study team recognizes that there are physical constraints within the corridor that may make some of the proposed alignments infeasible from an engineering perspective. That being said, the intent of the study is to demonstrate the "best case" scenario for each alternative. Alternatives that do not perform well under these idealized assumptions could not be expect to perform better once subjected to more rigorous engineering analysis, while alternatives with higher ridership potential will need to be advanced into engineering to confirm that the operating characteristics assumed in this study can be achieved in a cost-effective manner. Table 1-1 summarizes these initial alternatives; full descriptions and maps may be found in the *South Side Transit Study: Initial Alternatives Report*.

The nine alternatives were coded into the Maryland Alternatives Analysis Phase II (MDAA II) regional travel demand model, in conjunction with the approved MWCOG Round 8 regional population and employment forecasts for 2040, to determine each alternative's potential ridership, user benefits, and cost-effectiveness.

TABLE 1-1: KEY CHARACTERISTICS OF INITIAL ALTERNATIVES

Alternative	Mixed Traffic*			At-Grade Dedicated			Grade Separated		
	1A Branch Avenue	**1B Suitland Parkway**	**1C Southern Avenue**	**2A Branch Avenue**	**2B Suitland Parkway**	**2C Southern Avenue**	**3A Branch Avenue**	**3B Suitland Parkway**	**3C Anacostia**
Maryland Terminus	Branch Ave Metrorail Station	Suitland Metrorail Station	Southern Ave Metrorail Station	Joint Base Andrews	Suitland Metrorail Station	Southern Ave Metrorail Station	Joint Base Andrews	Branch Ave Metrorail Station	National Harbor
Virginia Terminus	King Street Metrorail Station	King Street Metrorail Station	King Street Metrorail Station	King Street Metrorail Station	King Street Metrorail Station	King Street Metrorail Station	Huntington Metrorail Station	Eisenhower Metrorail Station	Huntington Metrorail Station
Length of Alignment (mi)**	11.4	11.9	9.9	13.1	11.9	9.9	10.7	11.6	10.2
Number of Stations	5	11	11	8	9	9	7	6	8
Average Station Spacing (mi)	2.7	1.2	1.0	1.8	1.6	1.3	2.0	2.3	1.6
Headways (min)									
Peak	10	10	10	10	10	10	7	7	Yellow: 7 Green: 14***
Off-Peak	15	15	15	15	15	15	12	12	Yellow: 12 Green: 24***
Average End-to-End Travel Time (min)	34	50	58	24	25	21	15	18	19
Average Speed (mph)	20.2	16.1	12.1	32.8	28.5	28.2	41.6	39.1	32.8

*Each of the mixed traffic alternatives is assumed to use lanes 11 and 12 of the WWB as an exclusive right-of-way.

**Lengths of initial alternatives reported in November 2011 Initial Alternatives Report originally estimated using Google Earth. Lengths reported here reflect alignments coded using GIS and MDAA-II model.

***Green Line service to National Harbor requires a split of Green Line service between the two branches of the Green Line south of Anacostia, doubling their headways. North of Anacostia, headways on the Green Line are maintained.

The results of this analysis indicated that each of the nine alternatives could be implemented, although the strategy and rationale for implementation varied considerably. For example, Alternatives 1A, 1B, and 1C had low ridership compared to the other alternatives, but could be implemented for a much lower cost than the fixed guideway services proposed. On the other hand, the services proposed under Alternatives 2C and 3C would offer a more direct service between the Yellow and Green Lines, which could encourage existing riders to use this new Potomac River crossing rather than the existing crossings on the Yellow, Blue, Green, and Orange Lines. This being the case, it was decided that rather than screening out alternatives, it would be appropriate to refine five of the existing nine alternatives to see if they could be made more cost-effective and attract greater ridership. The intent of this approach would then be to compare the refined alternatives against one another and the original nine alternatives.

Based on the projected average weekday boardings, total user benefits, and estimated cost-effectiveness of the initial nine alternatives, five alternatives were considered for further refinement. Table 1-2 summarizes the screening recommendations for the initial alternatives; Table 1-3 provides a summary of the proposed refinements; and Table 1-4 summarizes the operating characteristics of each refined alternative. Further detail on the initial evaluation results, the screening recommendations, and the definition of the refined alternatives can be found in the *South Side Transit Study: Evaluation of Initial Alternatives Report* (May 2012) and the *South Side Transit Study: Refined Alternatives Report* (July 2012).

TABLE 1-2: SUMMARY OF SCREENING RECOMMENDATIONS

Alternative	Recommendation	Factors Affecting Recommendation
No Build	Retain	• Basis of comparison
1A	Eliminate	• Low ridership and low user benefits vs. No Build
1B	Retain and consolidate	• Lower ridership and user benefits than fixed guideway alternatives, but could be implemented as Small Start or Very Small Start • Could allow for phased implementation of future fixed guideway alternative
1C		
2A	No further revisions	• Lowest ridership and user benefits of the at-grade dedicated guideway alternatives • Relatively higher capital and O&M costs
2B	Retain	• Ridership, user benefits indicate alternative could be implemented cost-effectively
2C	Retain	• High ridership potential • Highest level of user benefits • Could be cost-effective and potentially competitive for New Starts funding

Alternative	Recommendation	Factors Affecting Recommendation
3A	No further revisions	• Highest transit trips across WWB; may be appropriate use of transit lanes on bridge • Length of corridor increases its capital costs; changes to alignment or operating plan unlikely to result in order-of-magnitude change in its cost-effectiveness
3B	Retain	• Forced transfer may be limiting ridership and user benefits • Ridership for Alt. 2B indicates Alt. 3B could possibly be reconfigured to increase its ridership
3C	Retain	• Forced transfer may be limiting ridership and user benefits • Splits service between two branches of Green Line; revised alternative could work more effectively

TABLE 1-3: SUMMARY OF REFINEMENTS RECOMMENDED FOR EACH ALTERNATIVE

Alternative	Alignment/Route Changes	Operational Changes	Changes to the Transit Network
No Build	None	None	Split National Harbor TAZ to properly reflect walk times to north, south portions of development Constrain Park and Ride capacity of existing Metrorail Stations
1r	Consolidate 1B and 1C into one alternative operating both routes	None: retain same hours, frequency of service on all three routes	Retain Metrobus route NH1 to provide service offered by 1A
2Br	Route to Branch Avenue station to offer better connectivity to MD 5 corridor, which is being considered for long range transit improvements. This would also offer the opportunity to extend the line east to act as a circumferential extension of the Purple Line	None	Discontinue Metrobus route NH1: redundant service
2Cr	Reroute to Anacostia to provide faster service to/from the DC core, provide better connections through Department of Homeland Security campus, Anacostia streetcar	None	Terminate Metrobus routes P17, P19, and W14 at Oxon Hill Park and Ride
3Br	Reconfigure as extension of Yellow Line from Huntington Station	One-seat ride from Yellow Line	Discontinue Metrobus route NH1: redundant service Add shuttle from National Harbor North Station to National Harbor South
3Cr	Reconfigure as single line extension from Yellow Line. Do not look at splitting Green Line. Confirm Metrorail alignment can reach National Harbor South from WWB.	Do not split Green Line service	Terminate Metrobus routes P17, P19 and W14 at National Harbor North Park and Ride

TABLE 1-4: SUMMARY OF OPERATING CHARACTERISTICS FOR REFINED ALTERNATIVES

	Alt. 1r Mixed Traffic - Suitland/Southern Avenue	**Alt. 2Br At-Grade Dedicated - Branch Avenue**	**Alt. 2Cr At-Grade Dedicated - Anacostia**	**Alt. 3Br Grade Separated - Suitland/ Branch Avenue**	**Alt. 3Cr Grade Separated - Anacostia**
Maryland Terminus	Route 1B: Suitland Station Route 1C: Southern Ave Station	Branch Avenue Station	Anacostia Station	Branch Avenue Station	Anacostia Station
Virginia Terminus	King Street Station	King Street Station	King Street Station	Huntington Station	Huntington Station
National Harbor Service	North and South	North and South	North and South	North	North and South
Length of Alignment (mi)	Route 1B: 11.9 Route 1C: 9.9	12.3	11.2	11.9 (rail) 1.2 (shuttle bus)	10.2
Number of Stations	Route 1B: 11 Route 1C: 11	10	11	7	8
Average Station Spacing (mi)	Route 1B: 1.2 Route 1C: 1.0	1.6	1.3	2.3	1.6
Headways (min)					
Peak	10*	10	10	7**	7**
Off-Peak	15*	15	15	12	12
Average End-to-End Travel Time (min)	Route 1B: 52 Route 1C: 56	26	25	20	18
Average Speed (mph)	12.3	28.4	26.9	36	33
Hours of Operation	Monday – Thursday: 5:00 a.m. to 12:00 a.m. Friday – 5:00 a.m. to 1:00 a.m. Saturday – 7:00 a.m. to 1:00 a.m. Sunday – 7:00 a.m. to 12:00 a.m.			Monday – Thursday: 5:00 a.m. to 12:00 a.m. Friday – 5:00 a.m. to 3:00 a.m. Saturday – 7:00 a.m. to 3:00 a.m. Sunday – 7:00 a.m. to 12:00 a.m.	
Fare	Same as Metrobus fare structure			Same as Metrorail fare structure	
Parking	Park and Ride facilities at existing Metrorail stations will be modeled with constrained parking. No expansion of existing Park and Ride facilities.				
Changes to Feeder Service***		Discontinue NH1: redundant service	Terminate P17, P19, W14 at Oxon Hill Park and Ride	Add shuttle service from National Harbor Station to National Harbor South	Terminate P17, P19, W14 at Oxon Hill Park and Ride

*Combined headways of 5 and 7.5 min. between King Street and National Harbor South

**Erroneously reported as 6 minute peak period service in the August 2012 *Refined Alternatives Report.*

***Route numbers listed refer to Metrobus routes.

[This page is intentionally blank]

2.0 SUMMARY OF EVALUATION METHODOLOGY

The original intent of this study was to assess the most cost-effective means of using lanes 11 and 12 of the Woodrow Wilson Bridge as a transit connection between the existing transit systems in Maryland and Virginia. To make this assessment, the study team assessed the four types of metrics for each of the initial and refined alternatives under consideration:

- Ridership demand and user benefits;
- Costs;
- Cost-effectiveness; and,
- Existing and potential land use densities

The following paragraphs discuss each of these metrics and their indicators in greater detail.

2.1 RIDERSHIP DEMAND AND USER BENEFITS

The key measurements of ridership demand are the same for this phase of study as they were for the evaluation of the initial alternatives:

- **Alternative Route Daily Boardings in Study Area (Route Boardings),** the average weekday boardings (initial and transfer) projected for stations on the proposed alignments. (It should be noted that, in the case of the mixed-traffic and dedicated guideway alternatives, the boardings at intermodal connections with the Yellow and Green Lines include transfers from these Metrorail services.)

- **Regional Transit Daily Boardings vs. No Build (Regional boardings),** the average weekday boardings on the regional transit system, including the proposed alternative and all local and regional transit providers (including transfers between services.)

- **Regional Daily Transit Trips vs. No Build,** the change in the average number of weekday trips (peak and off-peak) made using transit.

- **Daily Transit Trips Crossing WWB.** The average number of weekday transit trips across the Woodrow Wilson Bridge. As each alternative is likely to generate new ridership that does not use the WWB for any portion its trip, this evaluation criterion is critical to understanding the degree to which each alternative meets the study objective of maximizing the use of the center lanes of the Woodrow Wilson Bridge.

- **User benefits,** as defined by the FTA as the travel time savings accrued throughout the regional transit network by its users as a result of a transportation improvement.

Each of these measures was developed for each alternative using the 2040 MDAA II regional travel demand forecast. The results for each alternative were then compared against the 2040 No Build Alternative to identify what changes in ridership could be attributed to the proposed improvements.

In addition to these metrics, the study team also examined the change in average weekday auto trips over the WWB for each alternative compared to the No Build. This was done in recognition of the fact that a portion of the transit trips carried over the WWB by each alternative may be existing regional transit trips using the new linkage in the transit network to take advantage of shorter or more direct routes to their destination. Examining the number of auto trips removed from the WWB provides an opportunity to see how each alternative affects the overall utilization of the bridge.

2.2 COST ESTIMATES

As cost-effectiveness is measured by the FTA in terms of base year costs (i.e. 2012), all costs are expressed in 2012 dollars. The following paragraphs summarize how capital and operating costs were estimated for each alternative.

Capital Cost Estimates

As this study is focused on understanding the transit markets in the study area rather than on the engineering feasibility of alternatives, none of the alternatives have been developed beyond a conceptual level of detail sufficient to identify the general location of alignments and preliminary station areas. This being the case, the capital costs to be developed for each alternative were based on major elements of each alternative (e.g. vehicles, miles of track, stations) rather than on detailed quantities (e.g. square feet of concrete, cubic feet of ballast.) These major elements have been defined according to the FTA's Standard Cost Categories (SCC) for Capital Projects, and are listed in Table 2-1.

TABLE 2-1: CAPITAL COST CATEGORIES

Category	Cost Unit
10 Guideway And Track Elements	Route mile
20 Stations, Stops, Terminals, Intermodal Stations	Each
30 Support Facilities	Each
40 Sitework	Route mile
50 Systems	Route mile
60 Right of Way, Land, Existing Improvements	% of Categories 10-50
70 Vehicles	Each
80 Professional Services	% of Categories 10-50
90 Unallocated Contingency	% of Categories 10-80

The unit costs for each category were derived from the unit costs reported to the FTA for five projects currently under development as part of the New Starts program:

- El Camino (Bus Rapid Transit [BRT], Santa Clara, CA)
- E Street (BRT, San Bernardino, CA)
- Broad Street (BRT, Richmond, VA)
- Purple Line (Light Rail Transit [LRT] Montgomery and Prince George's Counties, MD)
- Dulles Corridor Metrorail Project Phases 1 and 2 (Heavy Rail Transit [HRT], Fairfax and Loudoun Counties, VA)

The Broad Street, Purple Line, and Dulles Corridor projects were selected because they provide comparable information on premium transit projects being implemented in Virginia and Maryland. As the costs of BRT projects can vary significantly depending on the level of investment made, the study team also included the unit costs of the El Camino and E Street projects, making it possible to develop an average unit cost for mixed traffic and dedicated guideway alternatives. The unit costs associated with each of these projects are provided in Appendix A.

Operating Cost Estimates

Table 2-2 summarizes the assumptions made regarding operating costs for each alternative. Operating costs were developed by calculating annual revenue hours for each alternative and then multiplying that value by the 2010 National Transit Database (NTD) cost per revenue hour for the appropriate mode. These operating costs were then converted from 2010 dollars into 2012 dollars by assuming 5% annual inflation.

TABLE 2-2: UNIT OPERATING COSTS ASSUMPTIONS

Guideway/Alternatives	Assumed Mode	Cost per Revenue Hour (2010)*	Cost per Revenue Hour (2012)
Mixed traffic (1A, 1B, 1C)	WMATA Metrobus	$153.60	$169.34
At-grade dedicated (2A, 2B, 2C)	MTA Light Rail	$246.73	$272.02
Grade-separated (3A, 3B, 3C)	WMATA Metrorail	$296.70	$327.11

*Source: 2010 National Transit Database

Revenue hours were calculated using a formula that took into account number of peak hours, number of off-peak hours, and vehicle requirements for each time period. Vehicle requirements for peak and off-peak hours were determined by dividing the total travel time by the planned headways for each alternative and rounding up.

The study team also estimated the changes in operating costs associated with modifying the local bus network to serve the new alternatives. Where services were truncated to serve new rail stations or eliminated to remove duplicative services, the cost savings from these changes were estimated. Similarly in the case of Alternative 3Br, the study team estimated the costs of providing a new shuttle service between the National Harbor North station and National Harbor. A detailed calculation of operating costs may be found in Appendix B.

2.3 COST EFFECTIVENESS

The cost effectiveness of each alternative is expressed in terms of its Cost Effectiveness Index (CEI), defined by the FTA as the annualized capital and operating costs of an alternative divided by its annual user benefits. When compared against the No Build alternative, the CEI can be calculated as:

$$CEI = \frac{(C_{ox} - C_{oNB}) + (C_{cx} - C_{cNB})}{UB_x - UB_B}$$

Where:

- C_{ox} represents the annual operating cost of Alternative X in the base year (i.e. 2012);
- C_{oNB} represents the annual operating cost of the No Build in the base year;
- C_{cx} represents the annualized capital cost of Alternative X, expressed in base year dollars;
- C_{cNB} represents the annualized capital cost of the No Build, expressed in base year dollars;
- UB_x represents the annualized user benefits associated with Alternative X in the forecast year (i.e. 2040); and,
- UB_B represents the annualized user benefits associated with a baseline alternative. For the purposes of this report, the baseline is the No Build condition; therefore, $UB_B = 0$.

The CEI index was calculated for each of the nine initial and five refined alternatives using their estimated user benefits, capital costs, and operating costs to determine a rating, as established

by FTA's *Capital Investment Program FY 2013 Annual Report Evaluation and Rating Process*. Table 2-3 summarizes the ratings associated with each range of cost effectiveness.

TABLE 2-3: COST EFFECTIVENESS BREAKPOINTS, FY 2013

Rating	Range of Annualized Costs per Annualized User Benefits
High	$12.49 and under
Medium-High	$12.50-$16.49
Medium	$16.50-$25.49*
Medium-Low	$25.50-$31.49
Low	$31.50 and over

*Note: updated from FY2010 "Medium" threshold reported in Evaluation of Initial Alternatives

Source: FTA, Capital Investment Program FY 2013 Annual Report Evaluation and Rating Process

2.4 EXISTING AND POTENTIAL LAND USE DENSITIES

The study team recognizes that land use decisions are subject to local conditions and policies, and that, while higher densities are more supportive of fixed-guideway transit, local jurisdictions must balance the needs of a transit system against other economic and political considerations. This being the case, the study team has focused its analysis of station area land uses on two types of metrics:

- **Existing and future population, household, and employment densities.** The study team examined the 2010 and 2040 population, household, and employment densities within ½-mile of existing Metrorail Stations within the study area (i.e. those Green Line stations east of the Anacostia River and the Yellow Line stations west of the Potomac.) The same densities were then calculated for the ½-mile radius around each proposed station to provide an initial assessment as to whether land uses may need to be intensified to support future transit services. The intent of this analysis was to use the densities at the existing stations as a benchmark for what densities may be feasible at new stations within the study area.
- **Presence of new development opportunities.** The study team researched proposed developments within the study area to understand what opportunities may exist for coordinating land use activities with implementation of transit improvements.

[This page is intentionally blank]

3.0 EVALUATION OF RIDERSHIP AND USER BENEFITS

Ridership for each of the alternatives examined in this study was forecast using the MDAA-II regional travel demand model. This section presents the ridership and user benefit forecasts for each of the refined alternatives. The ridership forecasts for the initial nine alternatives are also presented to allow comparisons to the refined alternatives.

It should be noted that in modeling the refined alternatives, the study team identified an issue with the way in which the MDAA-II model handles drive access assumptions for light rail and Metrorail alternatives. After updating the model and re-running Alternatives 3Br and 3Cr, it was determined that the impact of the updated drive access assumptions was significant enough to warrant re-running the model for Alternatives 3A, 3B, and 3C. Alternative 2A was also re-run, and it was confirmed that the impacts of the updated drive access assumptions did not impact the dedicated guideway alternatives significantly.

The MDAA-II model was also updated for the refined alternatives (1r, 2Br, 2Cr, 3Br, 3Cr) to split the Traffic Analysis Zone (TAZ) for National Harbor, reflecting a more realistic walking distance to stations at National Harbor North and National Harbor South.

The updated results for Alternatives 2A, 3A, 3B, and 3C are provided in following paragraphs. A detailed account of the modeling procedures and assumptions made as part of this study may be found in Appendix C. Appendix D provides a series of matrices that summarize daily transit trip patterns relative to the No-Build, which helps to illustrate some of the ridership patterns summarized in this section. Appendix E summarizes the boarding changes on existing Metrorail lines in the study area under each alternative.

3.1 MIXED TRAFFIC ALTERNATIVES

The mixed traffic alternatives all assume that a new, limited stop bus service would be put in place using existing roadways to travel between stations. As such, the travel times for these alternatives is greater than for the alternatives using dedicated or grade-separated rights-of-way, limiting their attractiveness to new transit users. Furthermore, the transfer penalties associated with boarding these alternatives from other bus services is higher than the penalty the MDAA-II model assumes for rail-to-rail transfers: a five minute penalty for bus-to-bus transfers, and a two-minute penalty from bus-to-Metrorail, streetcar, or commuter rail services.[1]

[1] If the mixed traffic alternatives could be branded and structured to function like a Bus Rapid Transit (BRT) system, it is possible these transfer penalties could decrease. That being said, the travel times estimated for these services would still limit their attractiveness to new and existing riders.

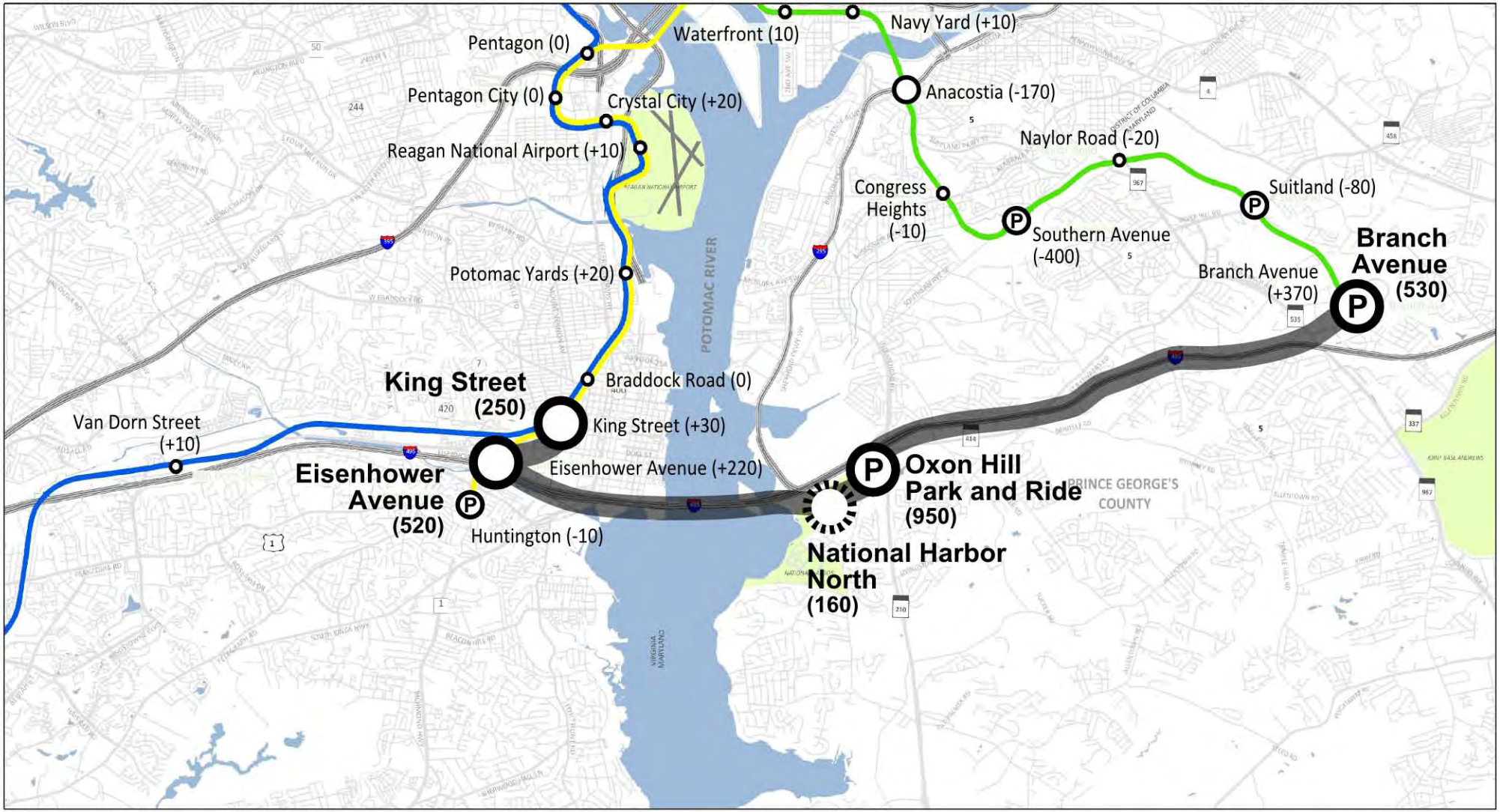
Table 3-1 summarizes the ridership and user benefit forecasts for each of the original alternatives, as well as Alternative 1r. The average weekday station boardings for each of these alternatives are illustrated in Figures 3-1 through 3-4.

TABLE 3-1: SUMMARY OF RIDERSHIP AND USER BENEFITS FOR MIXED TRAFFIC ALTERNATIVES

Alternative	1A	1B	1C	1r
Systemwide Boardings				
Total	2,275,200	2,275,700	2,275,200	2,300,200
vs. No Build	1,700	2,200	1,700	2,700
Alternative Route Boardings in Study Area	2,400	4,200	4,000	7,400
Systemwide Trips				
Total	1,471,600	1,471,800	1,471,800	1,492,920
vs. No Build	800	1,000	1,000	1,500
Daily Trips Crossing WWB				
Transit	1,500	2,300	2,600	2,100
Auto	253,858	253,716	253,928	253,095
Auto Trips vs. No Build	-191	-333	-121	-647
Average Weekday User Benefits	500	600	700	1,000

None of the original mixed traffic alternatives generated more than 1,000 systemwide transit trips more than the No Build Alternative. This is to be expected, as the travel times of these alternatives are limited by the effects of traffic conditions on each of the proposed routes. The highest daily boardings occurred at Eisenhower Station and National Harbor; as illustrated in Appendix D, the highest proportion of trips on the mixed traffic alternatives occur between the Alexandria district (encompassing King Street and Eisenhower Metrorail stations) and National Harbor and Oxon Hill. This makes sense, as the dedicated guideway along the WWB would give the mixed traffic alternatives a travel time advantage versus general traffic for this relatively short trip.

Alternative 1r operated both routes proposed under Alternatives 1B and 1C. That the resulting ridership and user benefits were less than the cumulative totals of these two alternatives should not be surprising, as both Alternatives 1B and 1C provide identical service west of Oxon Hill Park and Ride and so some double-counting is present when summing these two initial alternatives for the comparison with Alternative 1r. The key finding is that both ridership and user benefits of Alternative 1r are superior to either Alternative 1B or 1C alone. As shown in Figure 3-4, the highest number of station boardings for Alternative 1r occur between King Street and Oxon Hill Park and Ride, where its two routes provide a combined headway of five minutes between these stations.



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

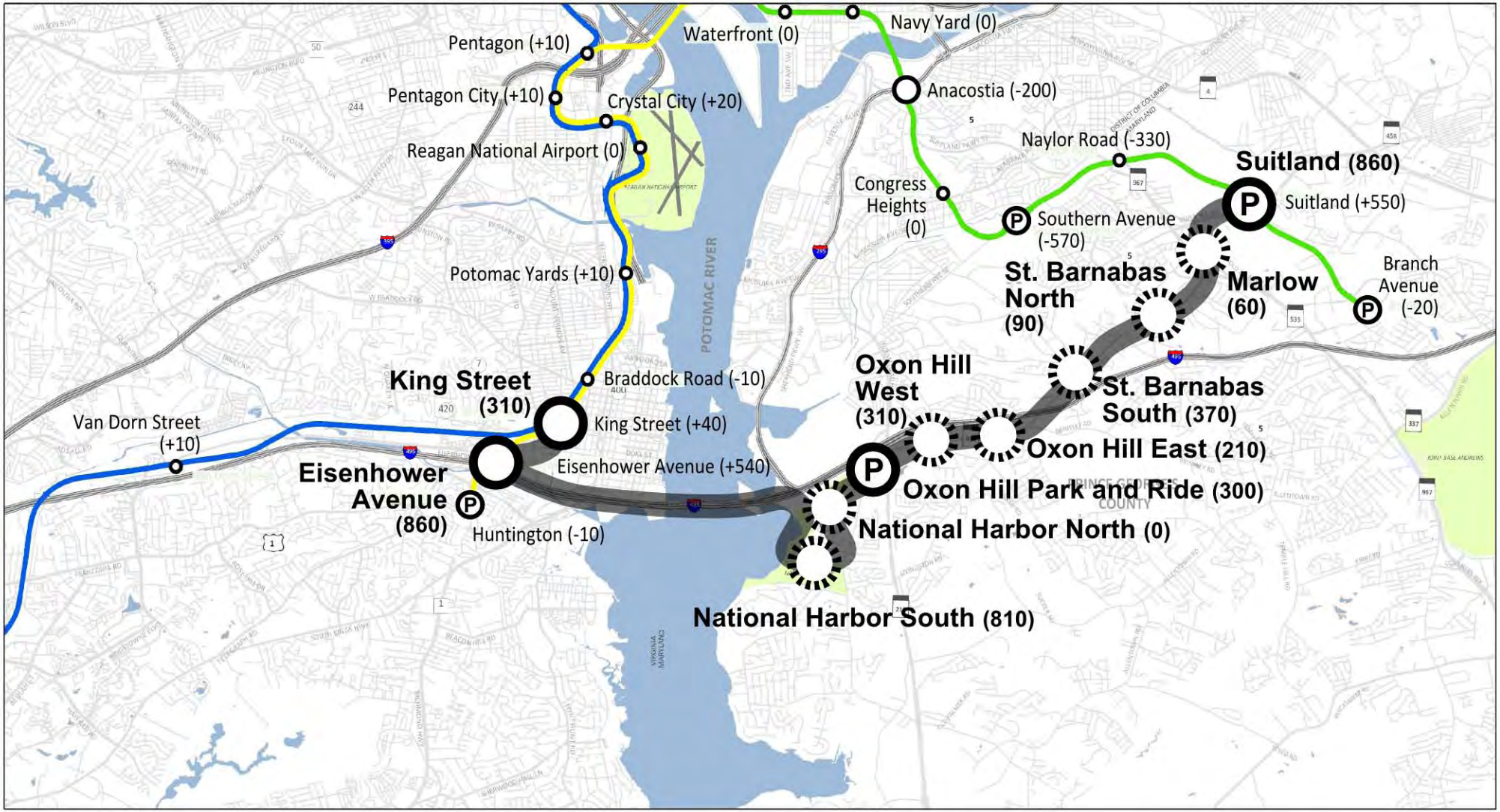
South Side Transit Study

Figure 3-1 Alternative 1A

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

South Side Transit Study

Figure 3-2 Alternative 1B

N

0 0.5 1 2 3 4 Miles

MTA Maryland

Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

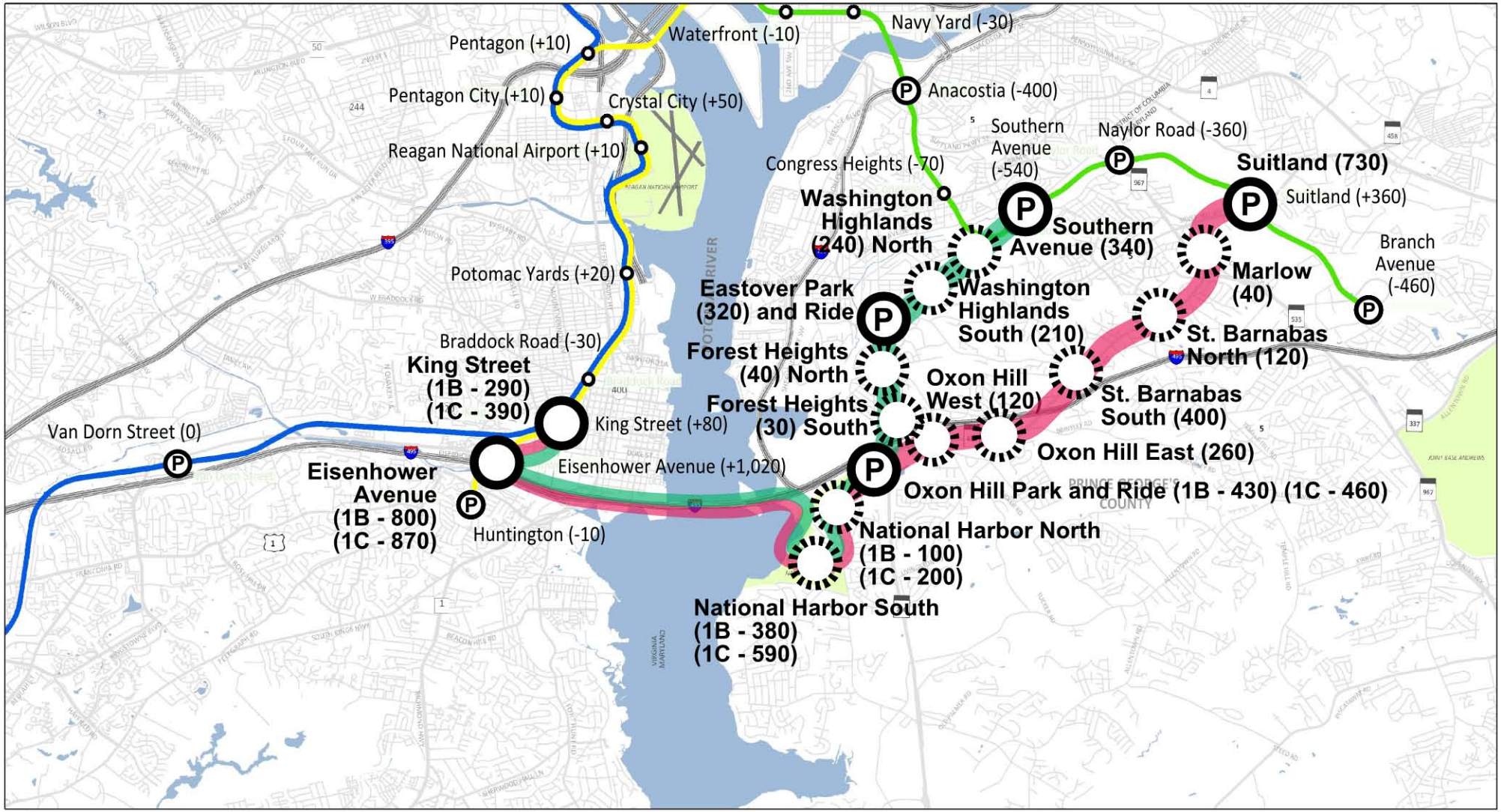
South Side Transit Study

Figure 3-3 Alternative 1C

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Route 1B
- Route 1C

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

South Side Transit Study

Figure 3-4 Alternative 1r

N

0 0.5 1 2 3 4 Miles

MTA Maryland

3.2 AT-GRADE DEDICATED ALTERNATIVES

Alternatives 2A, 2B, and 2C all assume at-grade, dedicated guideways for the transit services they provide (either Bus Rapid Transit (BRT) or light rail transit (LRT)), resulting in higher travel speeds and shorter travel times than the mixed traffic alternatives. Transfer penalties from bus services to these alternatives are less than for the mixed traffic alternatives (two minutes from all modes to this alternative), which would provide additional incentive to transfer from existing bus services onto these alternatives.

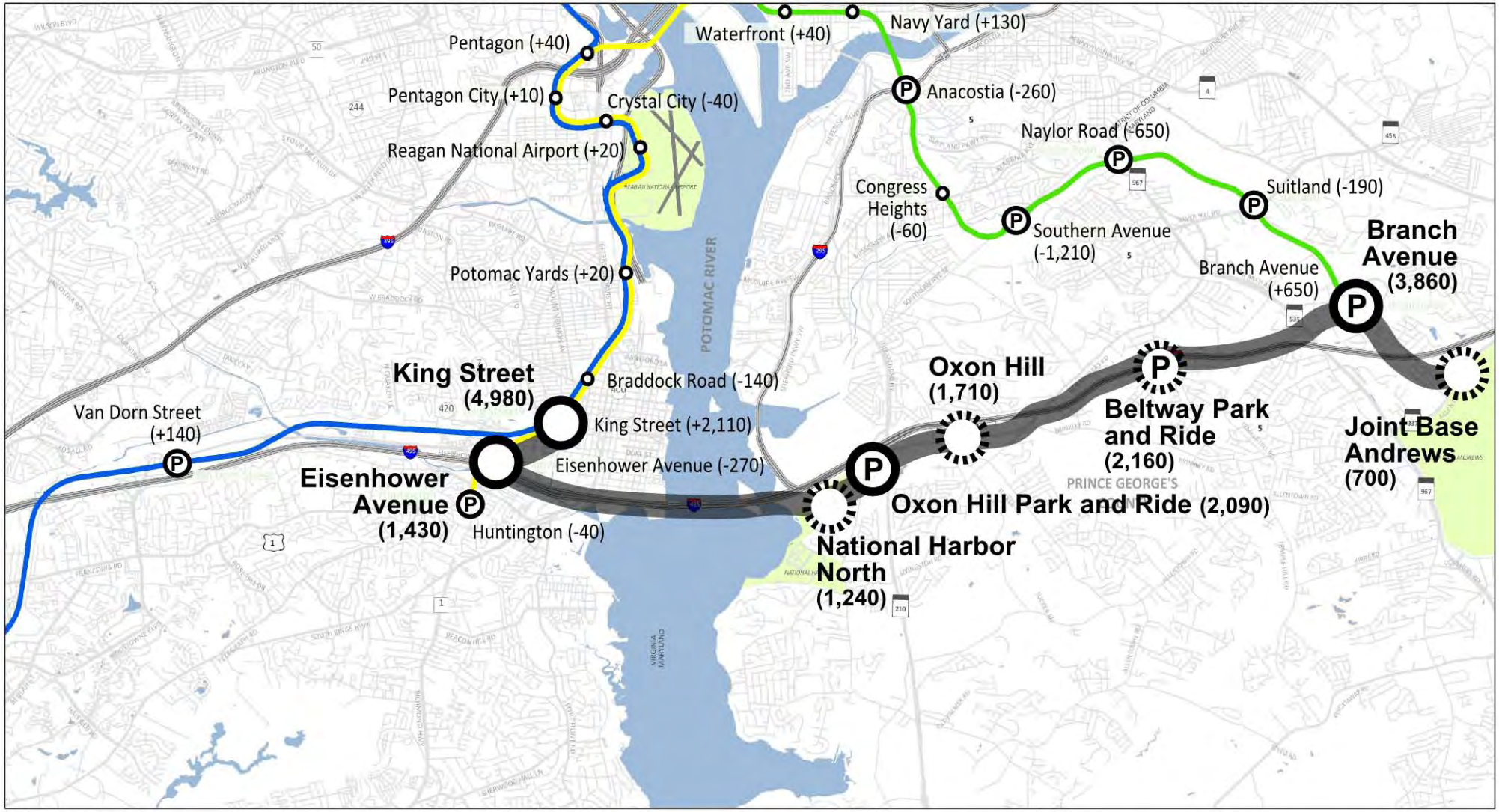
Table 3-2 summarizes the ridership and user benefits forecast for each of the dedicated guideway alternatives; the average weekday station boardings for each of these alternatives are summarized in Figures 3-5 through 3-9.

TABLE 3-2: SUMMARY OF RIDERSHIP AND USER BENEFITS FOR DEDICATED GUIDEWAY ALTERNATIVES

Alternative	2A	2B	2Br	2C	2Cr
Systemwide Boardings					
Total	2,318,100	2,298,600	2,326,500	2,309,900	2,334,000
vs. No Build	20,100	25,000	28,900	36,400	36,500
Alternative Route Boardings in Study Area	18,200	19,800	23,600	32,100	45,400
Systemwide Trips					
Total	1,501,100	1,481,800	1,505,800	1,487,500	1,509,800
vs. No Build	9,800	11,000	14,400	16,700	18,400
Daily Trips Crossing WWB					
Transit	11,500	11,000	14,300	10,000	14,100
Auto	251,664	252,990	252,112	252,609	252,092
Auto Trips vs. No Build	-1,645	-1,059	-1,630	-1,441	-1,649
Average Weekday User Benefits	4,900	6,000	7,600	11,400	16,000

Each of the dedicated guideway alternatives performs better than its mixed traffic counterpart, reflecting the impact of increased travel speeds and reduced travel times on the demand for transit service. Alternatives with a Maryland terminus closer to the DC core tended to perform better than alternatives with their terminus further south on the Green Line, reflecting the strong demand for travel between the DC core and points in Virginia and the western portion of the study area. Alternative 2Cr showed especially strong performance, having more than double the station boardings at National Harbor than Alternative 2C.

[This page is intentionally blank]



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

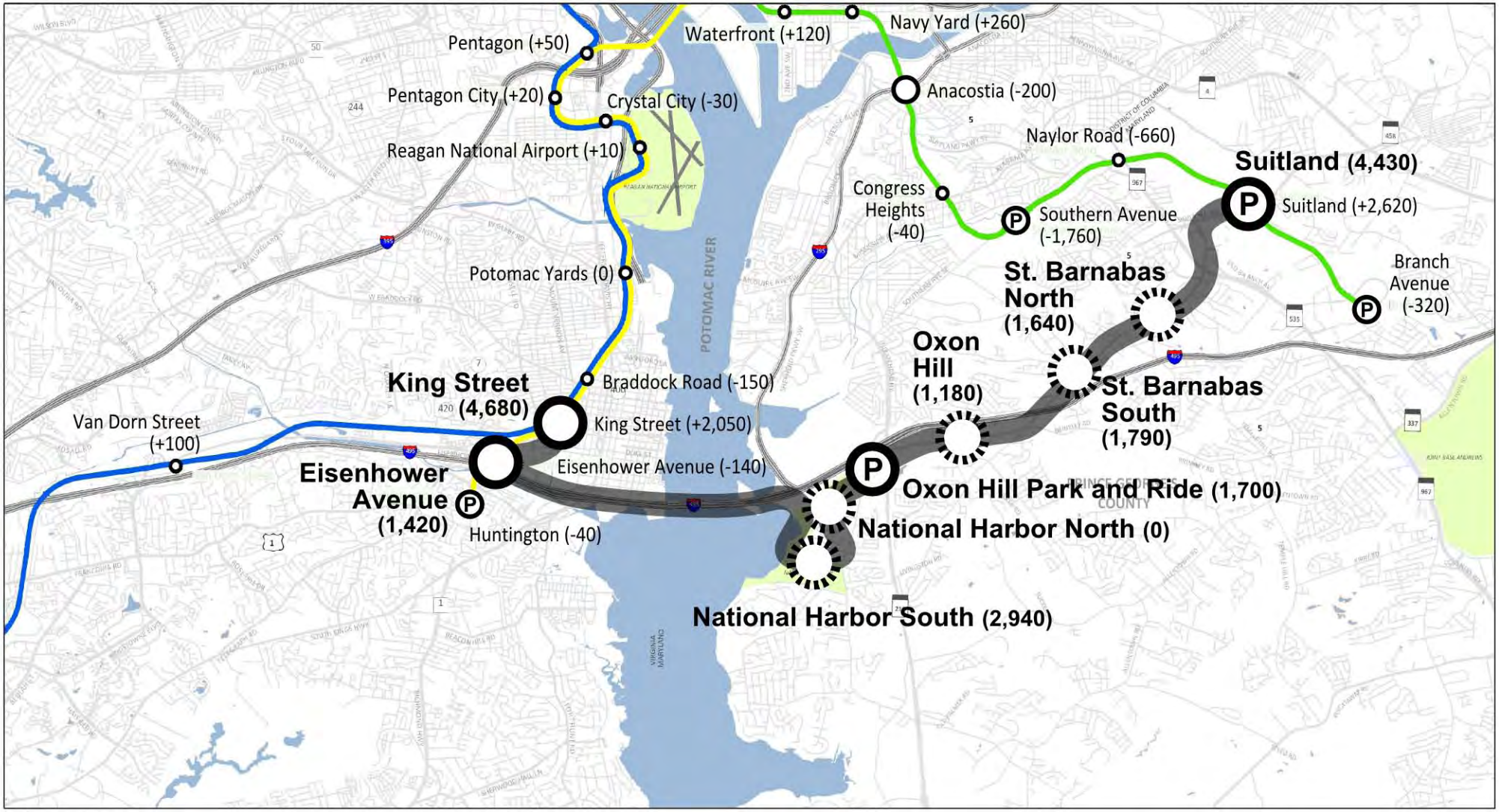
South Side Transit Study

Figure 3-5 Alternative 2A

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

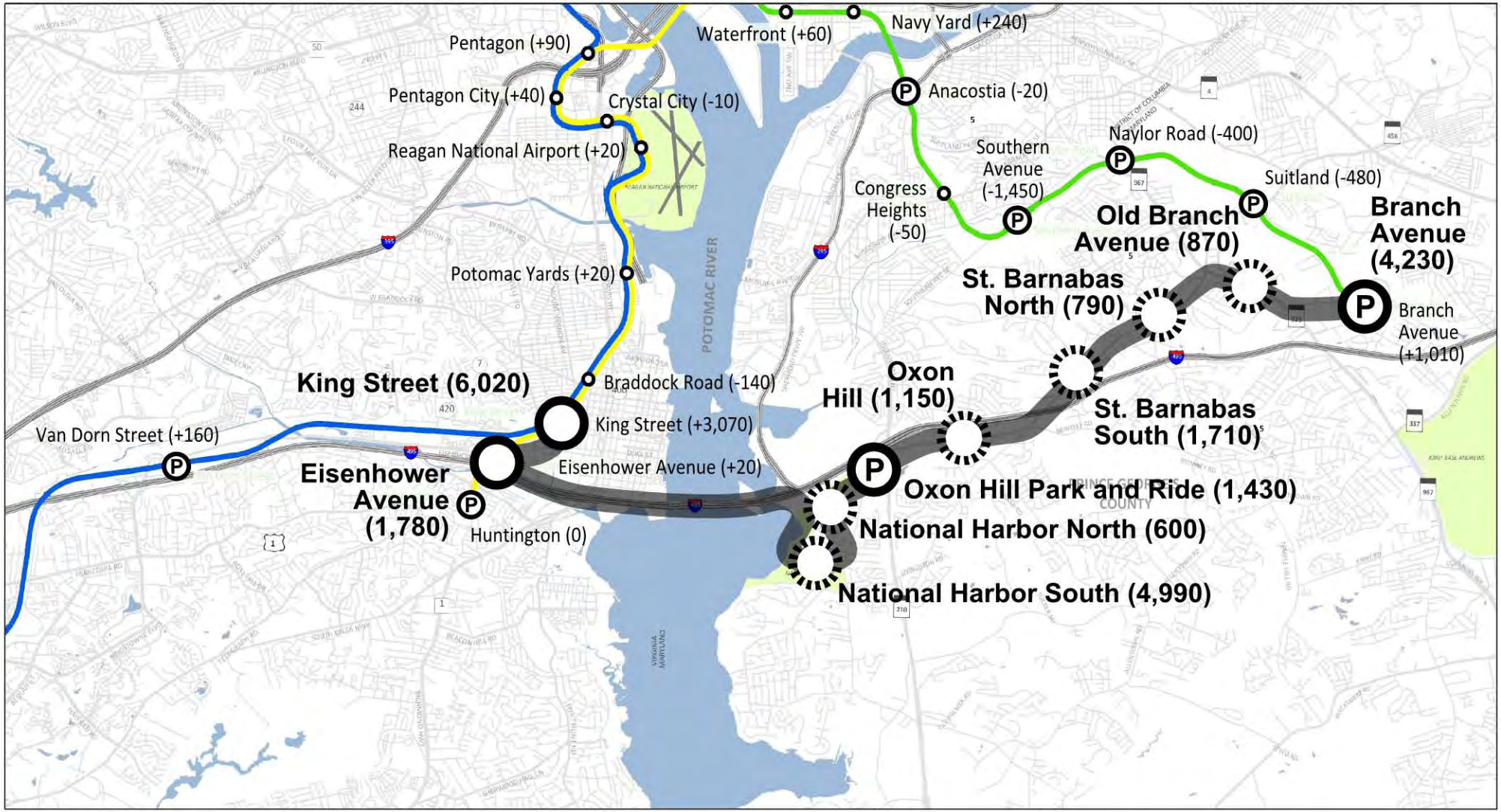
South Side Transit Study

Figure 3-6 Alternative 2B

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

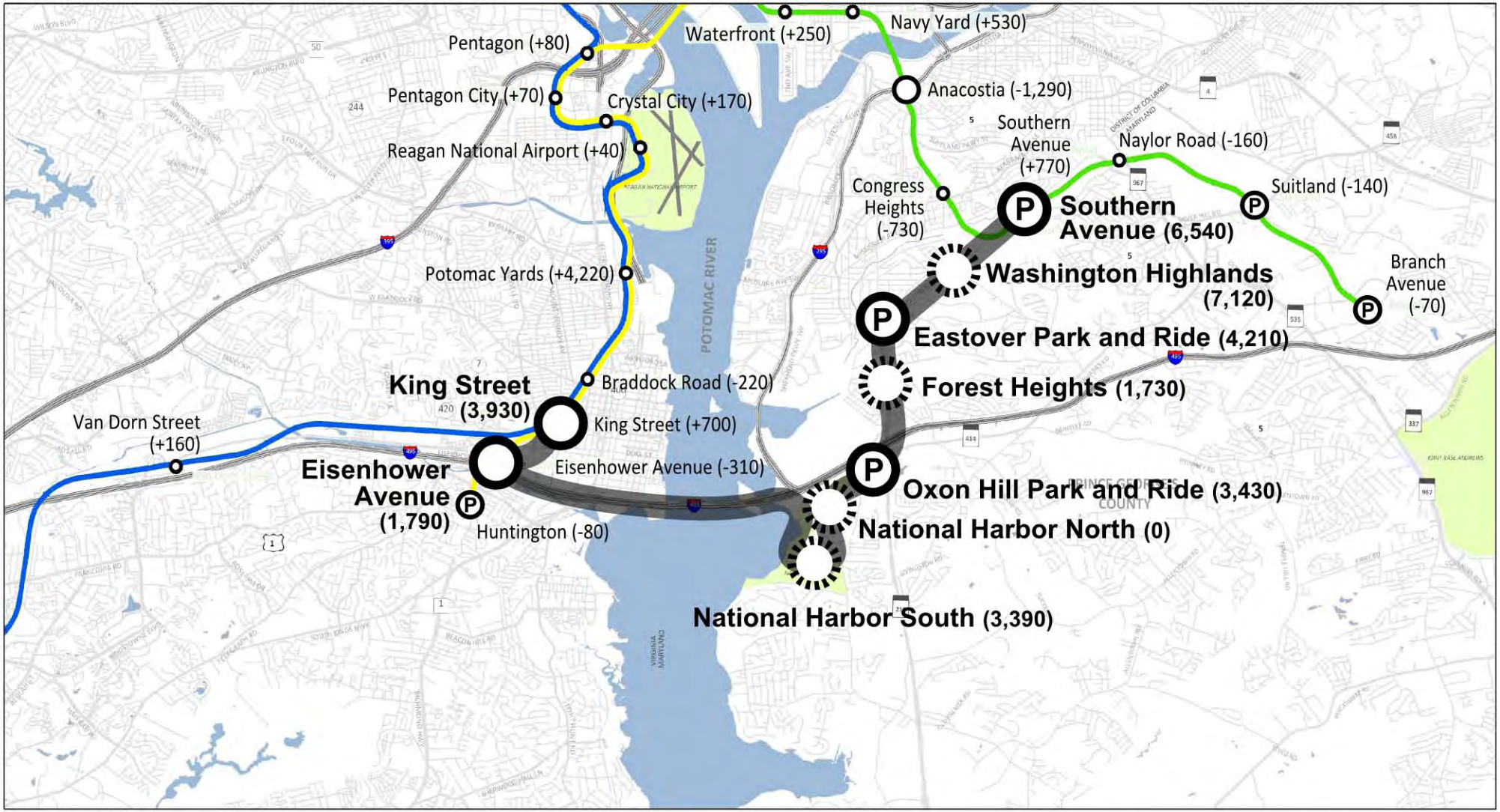
South Side Transit Study

Figure 3-7 Alternative 2Br

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

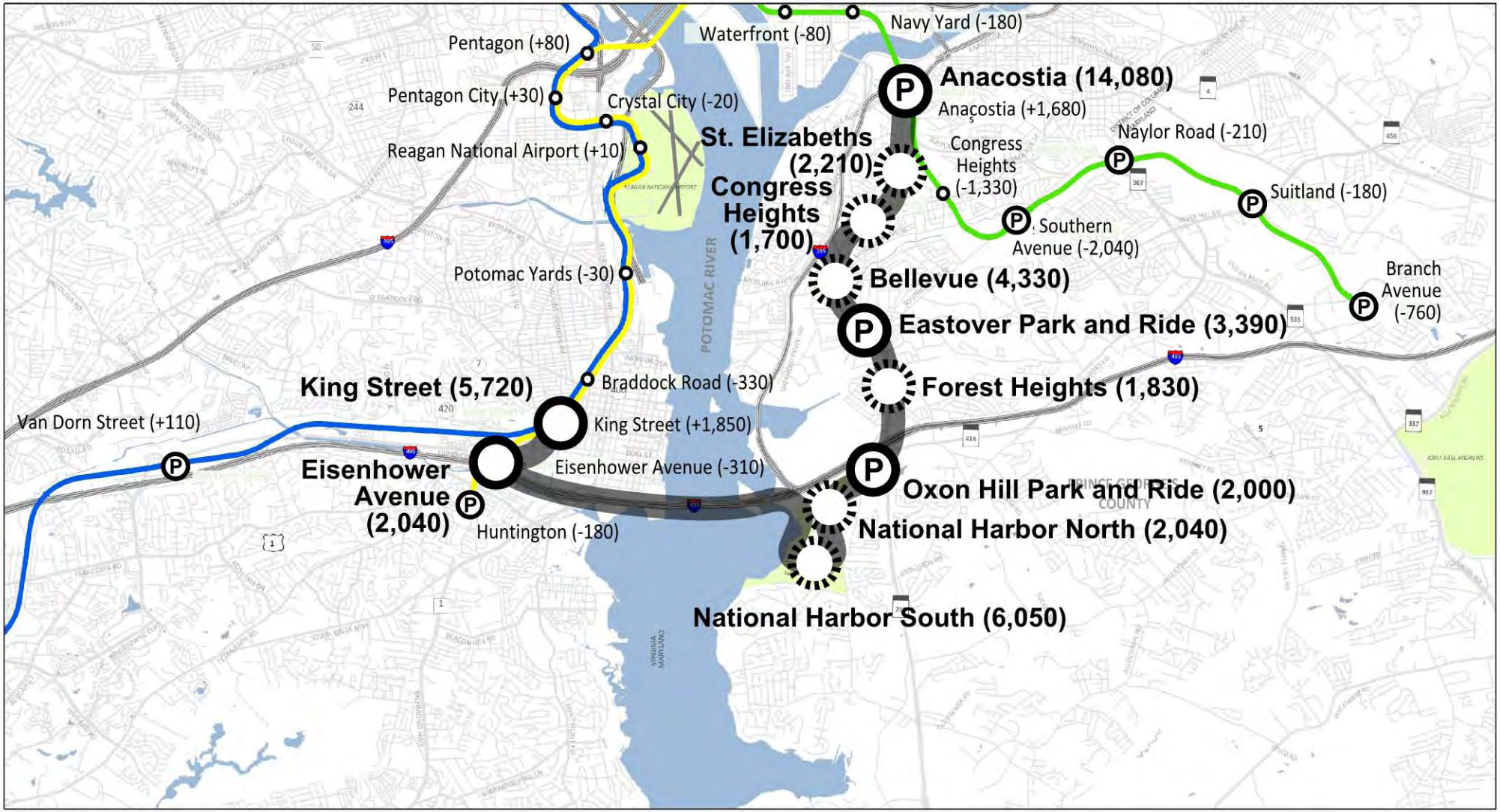
South Side Transit Study

Figure 3-8 Alternative 2C

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

South Side Transit Study

Figure 3-9 Alternative 2Cr

N

0 0.5 1 2 3 4 Miles

MTA Maryland

[This page is intentionally blank]

The dedicated guideway alternatives also resulted in fewer auto trips over the WWB than the mixed traffic alternatives. Based on the distribution of trips shown in Appendix E, it appears that a large portion of these trips were now being made using transit between Alexandria and the areas of Southern DC, Oxon Hill, and National Harbor.

Joint Base Andrews was only anticipated to generate 700 daily boardings under Alternative 2A when compared to the No Build. The majority of these trips were anticipated to come from the Maryland side of the study area.

3.3 GRADE SEPARATED ALTERNATIVES

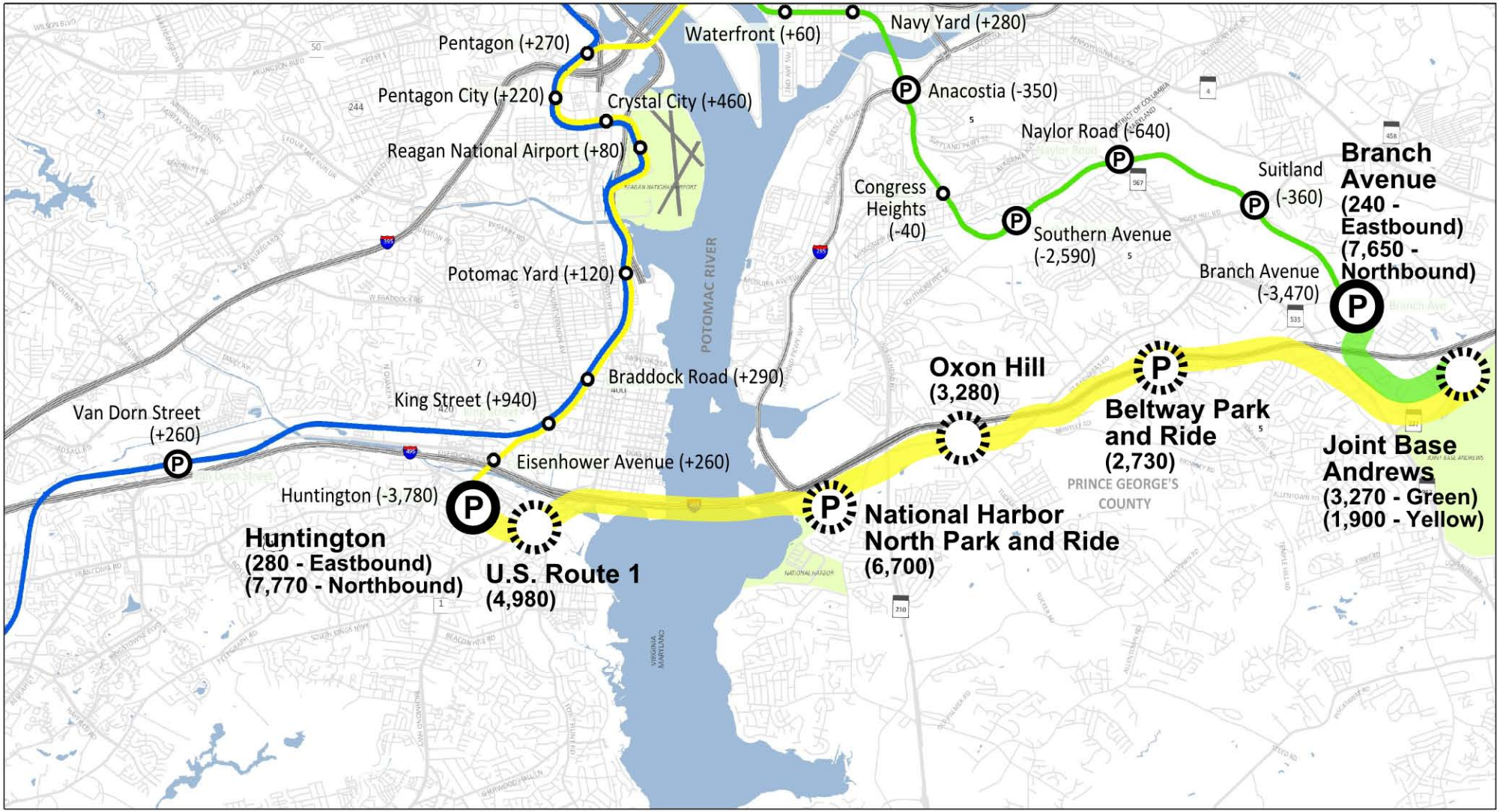
The grade-separated alternatives were designed to operate as extensions of existing Metrorail lines, allowing one-seat rides between the study area and the core of the region (the exception to this is 3B, which was designed to operate as a separate line connecting the Green and Yellow Lines.) As the MDAA-II model assumes no transfer penalty between Metrorail lines, this increases their attractiveness both as transit options to the study area and transit options to existing stations on the Yellow and Green Line. The transfer penalty between Metrorail and other modes is two minutes, offering a substantial improvement over transfers to local bus or mixed traffic alternatives. These benefits, combined with the faster travel times allowed by grade-separation, largely explain the volumes of boardings forecast for these options.

Table 3-3 summarizes the ridership and user benefits for each of the grade separated alternatives; the station boardings for each alternative are illustrated in Figures 3-10 through 3-14.

TABLE 3-3: SUMMARY OF RIDERSHIP AND USER BENEFITS FOR GRADE SEPARATED ALTERNATIVES

Alternative	3A	3B	3Br	3C	3Cr
Systemwide Boardings					
Total	2,318,400	2,333,400	2,336,700	2,324,300	2,374,500
vs. No Build	20,400	35,400	39,100	26,400	77,000
Alternative Route Boardings in Study Area	23,400	26,100	29,600	40,900	63,600
Systemwide Trips					
Total	1,505,800	1,501,900	1,513,700	1,510,900	1,526,200
vs. No Build	14,500	10,600	22,300	19,600	34,800
Daily Trips Crossing WWB					
Transit	23,800	13,900	25,700	8,400	22,600
Auto	252,133	252,648	252,475	252,430	251,960
Auto Trips vs. No Build	-1,175	-661	-1,266	-879	-1,782
Average Weekday User Benefits	11,000	7,700	14,200	12,600	21,900

[This page is intentionally blank]



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

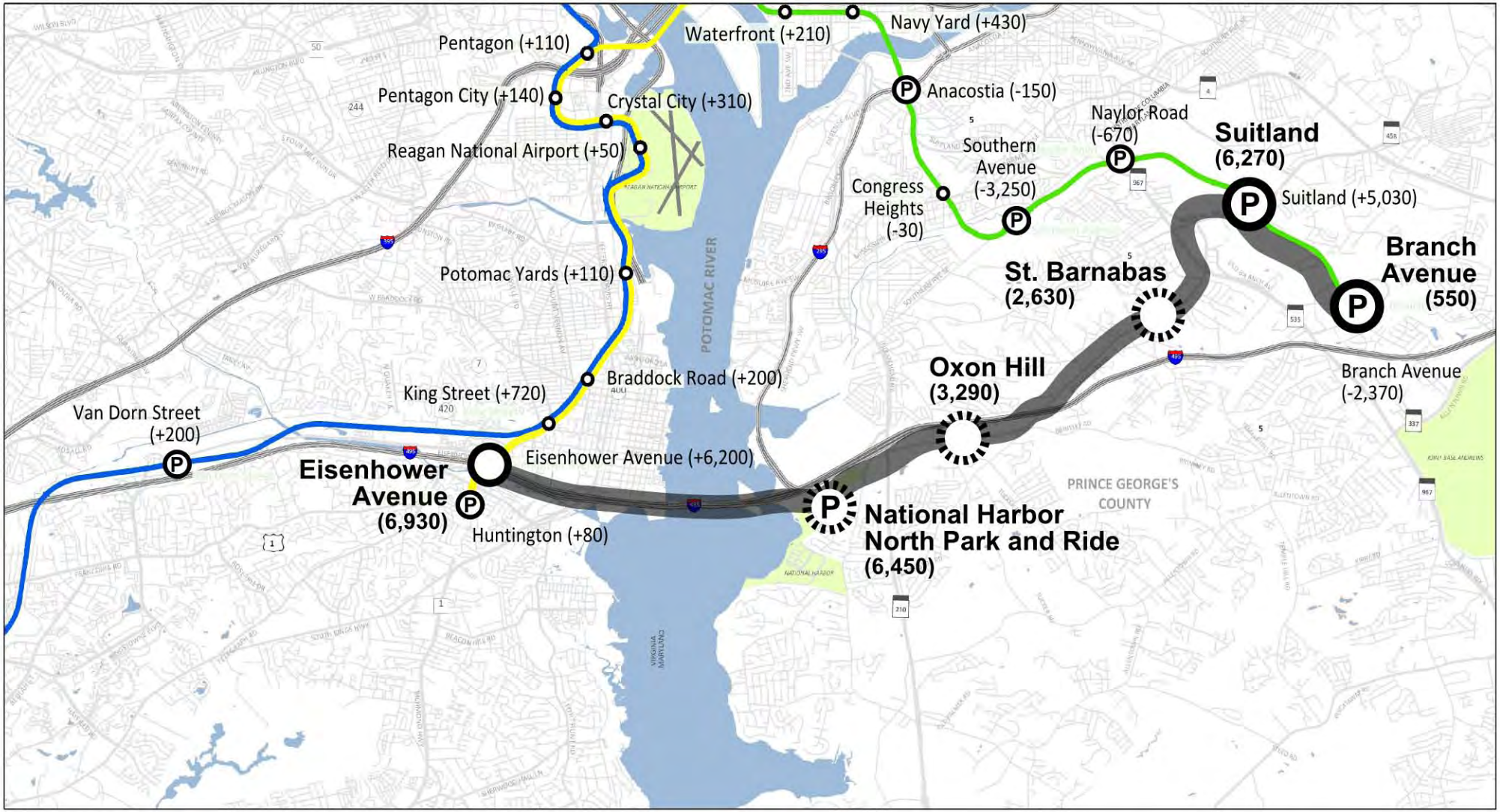
South Side Transit Study

Figure 3-10 Alternative 3A

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

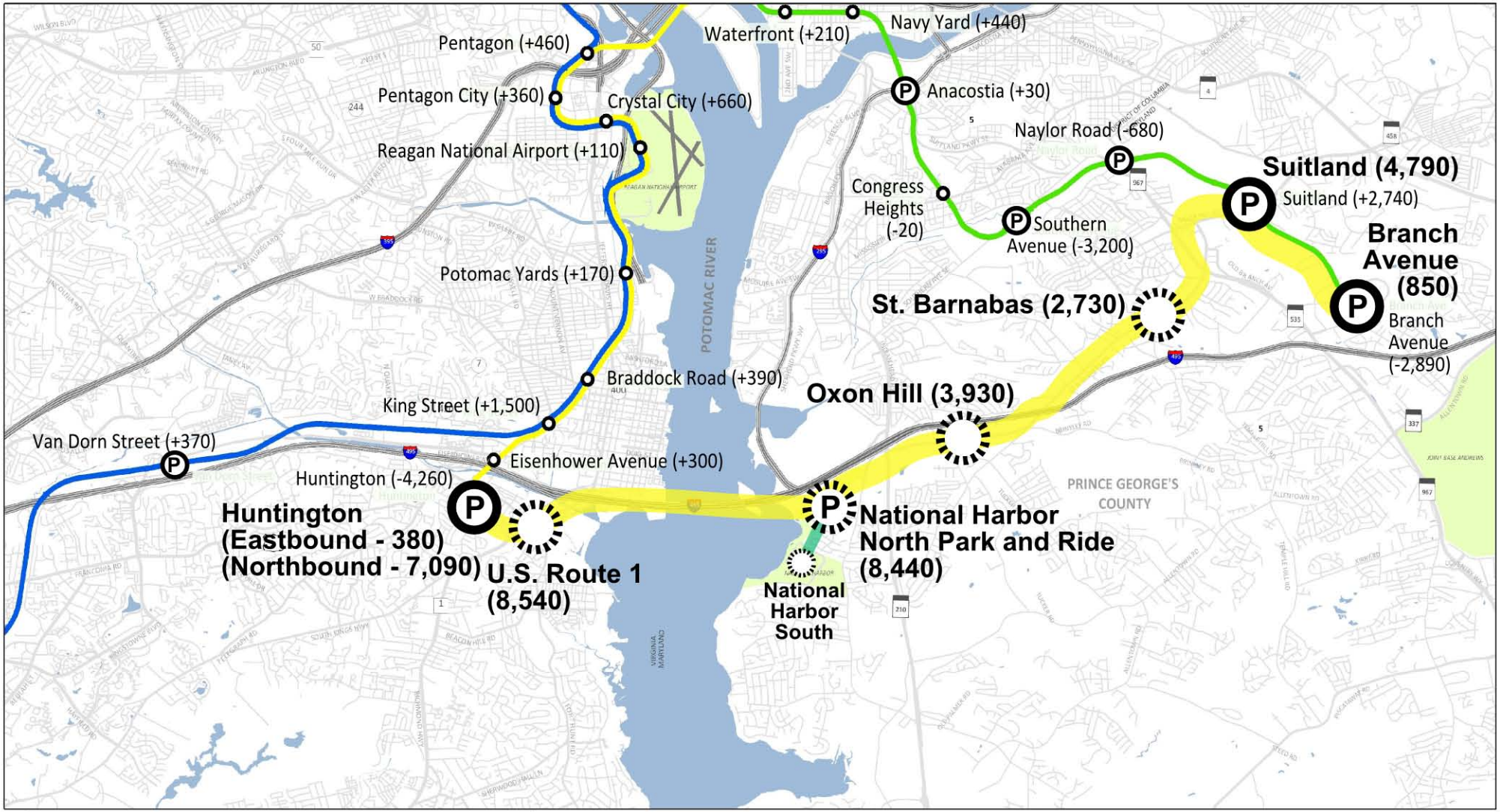
South Side Transit Study

Figure 3-11 Alternative 3B

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor
- Proposed Shuttle Service

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

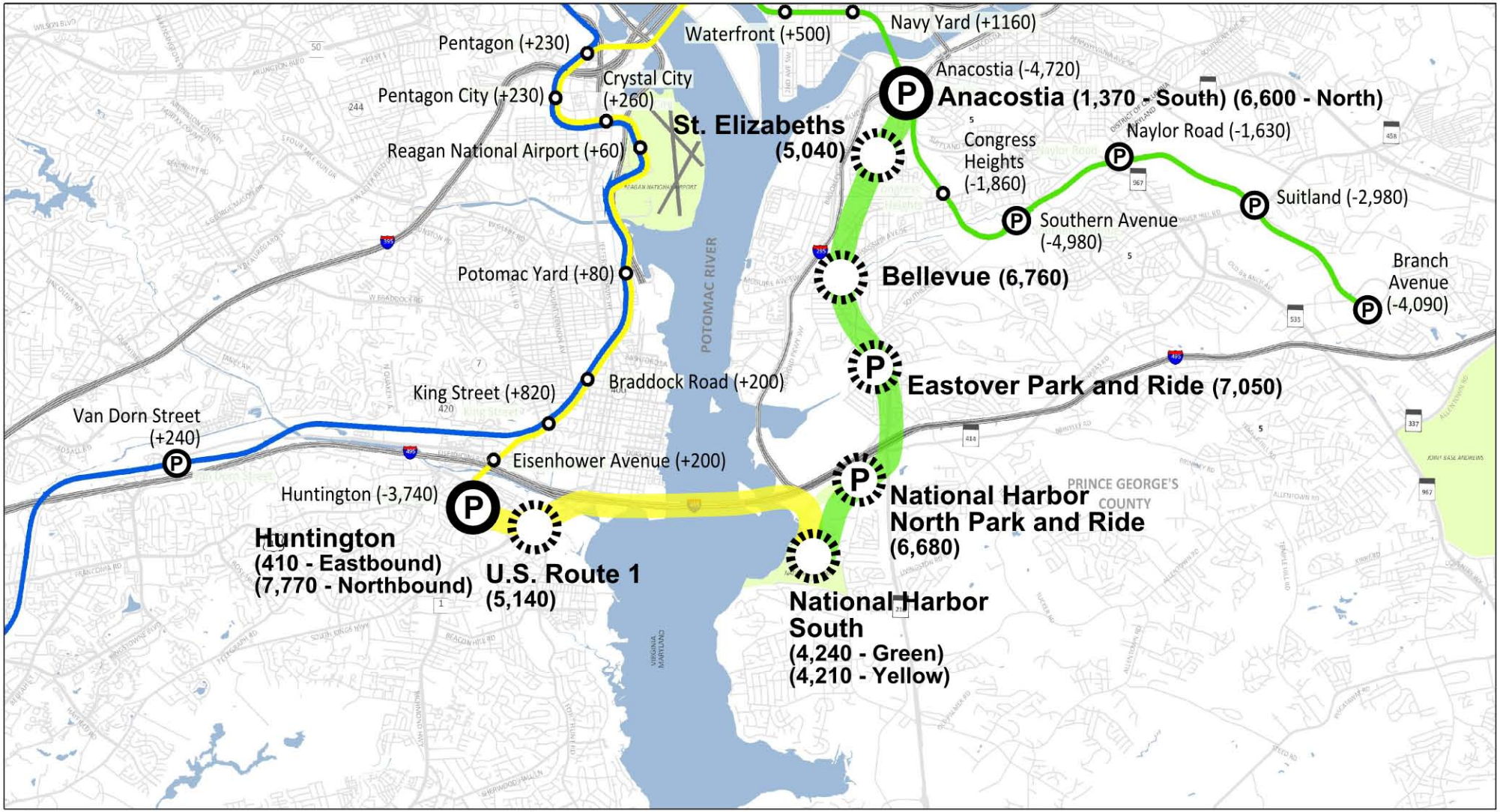
South Side Transit Study

Figure 3-12 Alternative 3Br

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

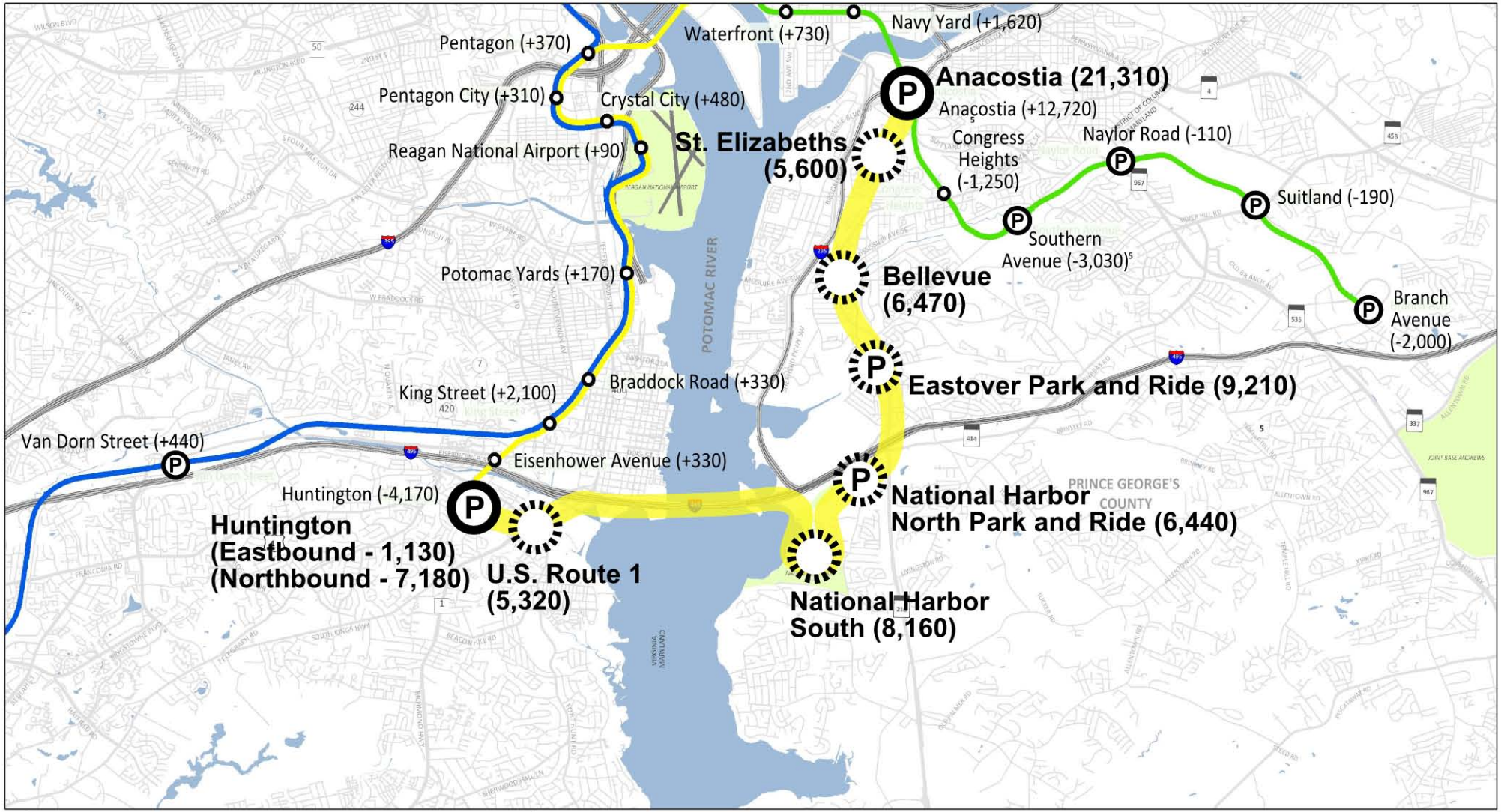
South Side Transit Study

Figure 3-13 Alternative 3C

N

0 0.5 1 2 3 4 Miles

MTA Maryland



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- *Metro Route & Station*
- Proposed Transit Corridor

- Existing Station
- Existing Park and Ride Station
- Proposed Station (Boardings)
- Proposed Park and Ride Station (Boardings)

Huntington
(x,xxx) Route boardings exclusive to new alignment
Huntington
(x,xxx) Change in boardings at existing station vs. 2040 No Build

South Side Transit Study

Figure 3-14 Alternative 3Cr

N

0 0.5 1 2 3 4 Miles

MTA Maryland

[This page is intentionally blank]

Alternative 3A generates the lowest ridership of the grade separated alternatives. This reflects the length of the line, which limits its utility as a new, less congested connection between the Yellow Line and points in the DC core. It also reflects the lower land use densities at station areas along the Beltway (National Harbor being the exception to this statement.)

Both Alternatives 3B and 3C require forced transfers to connect from the Yellow Line to the Green Line, limiting their utility when compared to their refined counterparts, Alternatives 3Br and 3Cr. The fact that Alternatives 3Cr and 3Br generate the two highest reductions in auto trips over the WWB points to the impact of the transfer penalty on cross-Potomac transit trips.

Alternative 3Cr generates the highest levels of daily boardings and user benefits—almost double the levels generated by Alternative 3C. There are two reasons for this. First, unlike Alternative 3Cr, Alternative 3C split service the Green Line into two branches, doubling the headway on the existing Green Line between Anacostia Metrorail and Branch Avenue Metrorail stations. As a result, Alternative 3Cr did not degrade ridership on the existing Green Line. Second, as seen with Alternative 2Cr, Alternative 3Cr presents a new, high-speed linkage between Alexandria and the DC core, as well as providing new service to National Harbor and St. Elizabeths.

[This page is intentionally blank]

4.0 EVALUATION OF CAPITAL AND OPERATING COSTS

As noted in Section 2.0 of this report, the capital and operating costs for each alternative are intended to provide an order-of-magnitude assessment of the cost-effectiveness of each alternative. Should a decision be made to implement any of the alternatives, additional engineering would be necessary to refine these estimates.

4.1 CAPITAL COST ESTIMATES

The capital costs for each alternative were built up using the Standard Cost Categories (SCC) established for the FTA New Starts program. The study team reviewed current New Starts projects around the United States to establish appropriate unit costs for the mixed traffic, at-grade, and grade-separated alternatives. These unit costs are presented in Table 4-1; a detailed explanation of their derivation may be found in Appendix A.

TABLE 4-1: UNIT COSTS ($1,000s, 2012 YOE)

STANDARD COST CATEGORY		Mixed Traffic	Dedicated Guideway	Exclusive Guideway
10 GUIDEWAY AND TRACK ELEMENTS	**Unit**			
Mixed Traffic	mile	$40	$0	$0
Surface (allows cross traffic)	mile	$0	$2,977	$0
Surface (dedicated)	mile	$0	$37,154	$37,154
Retained cut or fill	mile	$12,128	$12,128	$12,128
Tunnel	mile	$0	$0	$213,334
Aerial	mile	$42,226	$42,226	$56,228
20 STATIONS, STOPS, TERMINALS, INTERMODALS	each	$662	$5,182	$69,899
30 SUPPORT FACILITIES	each	$0	$27,563	$57,330
40 SITEWORK	mile	$0	$16,538	$22,050
50 SYSTEMS	mile	$1,654	$7,718	$27,563
60 ROW, LAND, EXISTING IMPROVEMENTS	% of 10-50	10%	20%	20%
70 VEHICLES	each	$1,323	$3,859	$3,859
80 PROFESSIONAL SERVICES	% of 10-50	30%	30%	30%
90 UNALLOCATED CONTINGENCY	% of 10-80	10%	10%	10%

The unit costs for each category were then multiplied by the quantities (miles of guideway, number of stations, number of vehicles, etc.) established by the study team for each alternative. The estimated quantities for each alternative are summarized in Table 4-2. Table 4-3 presents

the capital costs for each of the initial and refined alternatives, both in terms of base year (2012) and future year (2040) dollars (estimated assuming a 5% annual rate of inflation.)

In determining the appropriate type of guideway for each alternative, the study team made basic assumptions based on the conditions along the alignment, taking into account the terrain, availability of right-of-way, and intensity of development adjoining the line. It should be noted that these initial assumptions were based on observations in the field and alignment drawings from previous studies; no alignments or cross sections were developed as part of this study.

Mixed Traffic Alternatives

As would be expected, the mixed traffic alternatives had the lowest capital costs of the initial and refined alternatives, ranging from $85.7 million for Alternative 1A to $110 million for Alternative 1B. Alternative 1r would cost $147 million—while it does incorporate both routes from Alternatives 1B and 1C, it recognizes some cost savings for those segments of the alternative shared by both routes between King Street Metrorail Station and National Harbor.

While it was assumed that each of these alternatives would be implemented without requiring a new guideway, it was also assumed that there would be costs associated with systems and right-of-way, as these alternatives would still require roadway improvements at station areas (e.g. repaving, signage improvements, coordination with traffic signals,) as well as the costs associated with stations and rolling stock.

Furthermore, cost estimates for each of these alternatives assumed that a new set of ramps would be necessary to allow a direct connection between lanes 11 and 12 and the National Harbor stations in each alternative. While it would be possible to offer a lower-cost mixed traffic alternative without this improvement, such a route would be unable to access National Harbor from lanes 11 and 12 efficiently. As the highest proportion of trips on the mixed traffic alternatives occur between Alexandria and National Harbor/Oxon Hill, it is unlikely that these alternatives would generate as much ridership and user benefit without these ramps.

Dedicated Guideway Alternatives

The dedicated guideway alternatives represent the increased capital costs associated with the trackwork and systems associated with light rail transit service, as well as taking into account the likely right-of-way needs to accommodate a dedicated transitway in the study area. Capital costs for these alternatives ranged from $763 million for Alternative 2C to $1.14 billion for Alternative 2A.

As would be expected at this conceptual stage of analysis, the main driver in these cost estimates was the length of the routes being served, as the frequency of service across these alternatives was identical. Alternative 2Br cost $29 million more Alternative 2B as it required an additional 0.4 miles of guideway to reach the Branch Avenue Metrorail Station. Similarly,

TABLE 4-2: ESTIMATED UNITS BY STANDARD COST CATEGORY

		Mixed Traffic Alternatives				At-Grade Alternatives					Grade Separated Alternatives						
													3Br				
	Unit	1A	1B	1C	1r	2A	2B	2Br	2C	2Cr	3A	3B	Rail	Shuttle	3C	3Cr	Notes
10 GUIDEWAY AND TRACK ELEMENTS	**Mile**	11.4	11.9	9.9	15.5	13.1	11.9	12.3	9.9	11.2	10.7	11.6	11.9	1.2	10.2	10.2	
Mixed Traffic	mile	10.9	11.1	9.1	14.7												
Surface (allows cross traffic)	mile					6.1	8.9	9.3	6.9	8.2							
Surface (dedicated)	mile					5.4	2.2	2.2	2.2	2.2							
Retained cut or fill	mile																
Tunnel	mile										0.7		0.7		7.0	7.0	
Aerial	mile	0.6	0.8	0.8	0.8	1.6	0.8	0.8	0.8	0.8	10.0	11.6	11.2		3.3	3.3	Aerial sections for mixed traffic alternatives represent transition from WWB to National Harbor.
20 STATIONS, STOPS, TERMINALS, INTERMODALS	each	5	11	11	17	8	9	10	9	11	7	6	7	1	8	8	
30 SUPPORT FACILITIES	each	0	0	0	0	1	1	1	1	1	1	1	1	0	1	1	Assumes existing bus maintenance facilities have capacity to accommodate rubber-tire vehicles needed by mixed traffic alternatives. Assumes new maintenance facilities needed for all at-grade and grade-separated alternatives
40 SITEWORK	mile	11.4	11.9	9.9	15.5	13.0	11.9	12.3	9.9	11.2	10.7	11.6	11.9	2.4	10.2	10.2	
50 SYSTEMS	mile	11.4	11.9	9.9	15.5	13.0	11.9	12.3	9.9	11.2	10.7	11.6	11.9	2.4	10.2	10.2	
60 ROW, LAND, EXISTING IMPROVEMENTS	% of 10-50	10%	10%	10%	10%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	
70 VEHICLES																	
Rail	each					6	6	6	5	6	68	48	58		28	48	Assumes 8-car trains on Metrorail extensions. Reflects 20% spare ratio for all alternatives. 3-Series rounded to nearest even number to reflect married pairs.
Bus	each	9	12	15	27									3			
80 PROFESSIONAL SERVICES	% of 10-50	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	
90 UNALLOCATED CONTINGENCY	% of 10-80	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	

TABLE 4-3: ESTIMATED CAPITAL COSTS BY STANDARD COST CATEGORY ($1,000s, 2012 YOE)

		Mixed Traffic Alternatives				At-Grade Alternatives					Grade Separated Alternatives				
		1A	1B	1C	1r	2A	2B	2Br	2C	2Cr	3A	3B	3Br	3C	3Cr
10 GUIDEWAY AND TRACK ELEMENTS	**Unit**														
Mixed Traffic	mile	$431	$440	$361	$583										
Surface (allows cross traffic)	mile					$18,239	$26,390	$27,752	$20,487	$24,465					
Surface (dedicated)	mile					$201,710	$82,388	$82,388	$82,388	$82,388					
Retained cut or fill	mile														
Tunnel	mile										$150,030		$150,030	$1,483,566	$1,483,566
Aerial	mile	$24,542	$32,830	$32,830	$32,830	$66,221	$32,830	$32,830	$32,830	$32,830	$560,845	$654,662	$628,984	$182,793	$182,793
20 STATIONS, STOPS, TERMINALS, INTERMODALS	each	$3,308	$7,277	$7,277	$11,246	$41,454	$46,636	$51,818	$46,636	$56,999	$489,290	$419,391	$489,290	$559,188	$559,188
30 SUPPORT FACILITIES	each	$0	$0	$0	$0	$27,563	$27,563	$27,563	$27,563	$27,563	$57,330	$57,330	$57,330	$57,330	$57,330
40 SITEWORK	mile	$0	$0	$0	$0	$217,045	$196,140	$203,705	$163,345	$185,448	$235,446	$256,730	$262,167	$225,024	$225,024
50 SYSTEMS	mile	$18,914	$19,610	$16,340	$25,583	$101,288	$91,532	$95,063	$76,228	$86,542	$294,308	$320,913	$327,709	$281,280	$281,280
60 ROW, LAND, EXISTING IMPROVEMENTS	% of 10-50	$4,719	$6,016	$5,681	$7,024	$134,704	$100,696	$104,223	$89,895	$99,247	$357,450	$341,805	$383,102	$557,836	$557,836
70 VEHICLES															
Rail	each					$23,153	$23,153	$23,153	$19,294	$23,153	$262,395	$185,220	$223,808	$108,045	$185,220
Bus	each	$11,907	$15,876	$19,845	$35,721								$3,969		
80 PROFESSIONAL SERVICES	% of 10-50	$14,158	$18,047	$17,042	$21,072	$202,056	$151,044	$156,335	$134,843	$148,871	$536,174	$512,708	$574,653	$836,754	$836,754
90 UNALLOCATED CONTINGENCY	% of 10-80	$7,798	$10,009	$9,937	$13,406	$103,343	$77,837	$80,483	$69,351	$76,751	$294,327	$274,876	$310,104	$429,182	$436,899
TOTAL		$85,777	$110,104	$109,312	$147,465	$1,136,775	$856,208	$885,312	$762,858	$844,257	$3,237,594	$3,023,635	$3,411,146	$4,720,998	$4,805,890
TOTAL, 2040 YOE		$336,256	$431,622	$428,518	$578,082	$4,456,306	$3,356,444	$3,470,536	$2,990,503	$3,309,595	$12,691,785	$11,853,038	$13,372,134	$18,506,920	$18,839,710

Alternative 2Cr cost $81 million more than Alternative 2C in order to extend the line to Anacostia Metrorail Station.

It should be noted that it is feasible to develop the dedicated guideway alternatives using a BRT service rather than light rail to achieve a lower capital cost. That being said, to achieve the same travel speeds assumed for these alternatives, such a BRT service would most likely require dedicated lanes, either by converting existing general travel lanes into BRT lanes or by widening existing roadways to allow for new dedicated lanes. Because of this, it can be expected that BRT services for any of these three alternatives could result in capital costs of a comparable order of magnitude to light rail costs.

Grade Separated Alternatives

The costs of the grade separated alternatives range from $3.02 billion for Alternative 3B to $4.81 billion for Alternative 3Cr, reflecting the higher capital costs associated with tunneling and aerial structures. The higher capital costs of both Alternative 3C and 3Cr can be attributed to the assumption that it would be necessary to tunnel a new alignment between National Harbor and Anacostia. That being said, it is likely that an aerial alternative along this same alignment would increase the costs associated with rights-of-way, sitework, and mitigation, considering the level of development already present in this corridor.

Alternative 3Br does allow for a one-seat ride between National Harbor and points on the Yellow Line; however, the constraints at Huntington Metrorail Station—not to mention the need to turn this alignment 90 degrees to head east—would likely require a tunnel, hence its higher capital costs compared to Alternative 3B.

4.2 OPERATING COST ESTIMATES

The operating costs for each alternative were developed in a two-step process. First, the study team estimated the operating costs associated with the new service. This was done by using the travel times determined by the MDAA-II model and the operating plan established for each alternative to determine the fleet requirements and annual revenue hours for the new alternative. The annual revenue hours were then multiplied by the cost per revenue hour established for each alternative to determine its annual operating cost. A detailed listing of the operating assumptions and inputs used in these calculations may be found in Appendix B.

Secondly, the study team took into account the impact of changing local bus services to respond to the new service being provided. This involved:

- truncating bus routes headed towards the DC core to terminate at new rail stations on Alternatives 2C, 2Cr, 3C, and 3Cr; and,
- eliminating Metrobus route NH1 where it was duplicative of the services proposed on Alternatives 1A, 2A, 2B, 3A, and 3B.

As the study area is already served by a robust transit network, there were few reasons to add new bus routes to serve the proposed alternatives. The exception to this rule was Alternative 3Br, which would use a new shuttle route to provide service between the National Harbor North station and southern portion of National Harbor. A detailed calculation of the operating costs associated with each service change may be found in Appendix B.

Table 4-4 summarizes the annual operating costs of each alternative compared to the No Build.

Mixed Traffic Alternatives

Annual operating costs for the mixed traffic alternatives ranged from $3.5 million to $5.8 million per year for the initial three alternatives. Alternative 1A was less than half the cost of Alternative 2A due to the shorter travel time it accrued through fewer stations and operating along I-495 for the majority of its route. Alternative 1A also benefited from the elimination of Metrobus route NH1, which provided the same service on the Maryland side of the study area.

As would be expected, Alternative 1r was the most expensive alternative, as it provided service on the same routes as Alternative 1B and 1C while maintaining service on NH1.

Dedicated Guideway Alternatives

Annual operating costs for the dedicated guideway alternatives ranged from $1 million per year for Alternative 2C to $4.2 million per year for Alternative 2A. The operating costs were generally lower than those of the mixed traffic alternatives due to the fact that the mixed traffic alternatives operated under congested conditions, increasing their travel times, vehicle requirements, and revenue hours. The travel time savings accrued through use of dedicated lanes will need to be confirmed through a detailed traffic study if any of these alternatives are advanced further into design.

The operating costs of Alternative 2C and 2Cr were minimized by terminating DC-bound bus routes at Oxon Hill Park and Ride lot, generating some operating cost savings. As Alternative 2Cr was slightly longer than Alternative 2C, its operating costs were also slightly higher. Similarly, the Alternative 2Br was slightly longer than Alternative 2B, increasing its operating costs accordingly. The operating costs of Alternatives 2B and 2Br were offset slightly by eliminating NH1 service which paralleled the line.

Exclusive Guideway Alternatives

The grade separated alternatives generated the greatest range of operating costs among all alternatives: less than $1 million per year for Alternative 3C to $7.3 million per year for Alternative 3A. Several factors contributed to this range.

Alternative 3C originally split existing Green Line service between the new National Harbor branch and the existing Green Line to Branch Avenue. As a result, its operating costs only increased modestly compared to the No Build. In addition, forcing transfers of Metrobus routes P17, P19, and W14 at National Harbor North allowed for some cost savings.

Alternative 3Br required one additional peak vehicle train more than Alternative 3B, which increased the revenue hours and associated costs necessary to operate the service. In addition, Alternative 3Br implemented a shuttle route to provide direct service to the southern portion of National Harbor, adding to its overall operating costs.

Alternative 3A extended service on the Yellow and Green Lines. While service on NH1 was eliminated, other DC-bound routes were not truncated at National Harbor North, as the faster service of the new line require a more circuitous route to access the DC Core. This increase in Metrorail service without a related decrease in bus service resulted in the highest operating costs of any alternative.

TABLE 4-4: ESTIMATED ANNUAL OPERATING COSTS ($1,000s, 2012 YOE)

	Mixed Traffic Alternatives				At-Grade Alternatives					Grade Separated Alternatives				
	1A	**1B**	**1C**	**1r**	**2A**	**2B**	**2Br**	**2C**	**2Cr**	**3A**	**3B**	**3Br**	**3C**	**3Cr**
Annual Revenue Hours	24,440	34,424	39,936	74,360	15,496	15,496	15,496	14,456	15,496	24,440	15,496	19,968	9,984	15,496
2010 NTD Cost/Revenue Hour	$153.60	$153.60	$153.60	$153.60	$246.73	$246.73	$246.73	$246.73	$246.73	$296.70	$296.70	$296.70	$296.70	$296.70
Cost/Revenue Hour (2012$)	$169.34	$169.34	$169.34	$169.34	$272.02	$272.02	$272.02	$272.02	$272.02	$327.11	$327.11	$327.11	$327.11	$327.11
Subtotal: Annual Operating Cost of Alternative	**$4,139**	**$5,829**	**$6,763**	**$12,592**	**$4,215**	**$4,215**	**$4,215**	**$3,932**	**$4,215**	**$7,995**	**$5,069**	**$6,532**	**$3,266**	**$5,069**
Change in Bus Operating Costs														
NH1	-$643					-$643	-$643			-$643	-$643	-$643		
P17								-$1,849	-$1,849				-$1,849	-$1,849
P19								-$1,101	-$1,101				-$1,101	-$1,101
W14*								$0	$0				$0	$0
3B Shuttle												$845		
Subtotal: change in bus operating costs	**-$643**	**$0**	**$0**	**$0**	**$0**	**-$643**	**-$643**	**-$2,950**	**-$2,950**	**-$643**	**-$643**	**$203**	**-$2,950**	**-$2,950**
Total: Annual Operating Cost vs. No Build	**$3,496**	**$5,829**	**$6,763**	**$12,592**	**$4,215**	**$3,572**	**$3,572**	**$982**	**$1,265**	**$7,352**	**$4,426**	**$6,734**	**$316**	**$2,119**

*While the truncated W14 would operate fewer revenue miles than the current service, it would have the same vehicle requirements, which should translate roughly to the same revenue hours. Therefore, there was no change in operating costs associated with this reduction in service.

5.0 EVALUATION OF COST EFFECTIVENESS

The study team developed two measures of cost-effectiveness using the metrics established by the FTA New Starts program. First, the team calculated the Cost Effectiveness Index (CEI) of each alternative based on its estimated annual costs and user benefits compared to the No Build. Second, the team estimated the maximum capital and operating cost each alternative could support if it were to achieve a CEI of $25.49, the maximum cost per hour of user benefit allowed under the FTA's FY 2013 Evaluation and Reporting Process to achieve a "Medium" rating for cost-effectiveness. Providing these two estimates of cost-effectiveness makes it possible to identify how much cost would have to be cut from less cost-effective alternatives in order for them to meet the minimum thresholds for a viable New Starts project. Table 5-1 summarizes the results of these two metrics, as well as listing the estimated costs and user benefits used to calculate each.

5.1 MIXED TRAFFIC ALTERNATIVES

None of the mixed traffic alternatives were estimated to achieve higher than a "Low" rating for cost-effectiveness, with CEI values ranging from $94.55 for Alternative 1C to $103.93 for Alternative 1r. This is to be expected, considering the relatively low ridership generated by each alternative, as well as the capital costs associated with improvements along the alignment (e.g. new stations, sitework improvements, and systems modifications.)

In order to achieve a "Medium" rating and a CEI of $25.49, the mixed traffic alternatives would need to achieve total costs (capital and operating) ranging from $47.4 million for Alternative 1A to $94.9 million for Alternative 1r. While it is indeed feasible to develop a lower-cost bus service within this price range, it is unlikely that such an alternative would be able to afford the cost of adding ramps from lanes 11 and 12 of WWB to connect to stations at National Harbor or Oxon Hill Park and Ride. Therefore, none of the mixed traffic alternatives would meet the primary objective of this study (i.e. providing a cost-effective transit connection that uses lanes 11 and 12.)

[This page is intentionally blank]

TABLE 5-1: MEASURES OF COST EFFECTIVENESS (2012$)

	Mixed Traffic Alternatives				At-Grade Alternatives					Grade Separated Alternatives				
	1A	1B	1C	1r	2A	2B	2Br	2C	2Cr	3A	3B	3Br	3C	3Cr
User Benefits														
Average Weekday User Benefits	500	600	700	1,000	4,900	6,000	7,600	11,400	16,000	11,000	7,700	14,200	12,600	21,900
Estimated Costs ($1,000s, 2012$ YOE)														
Total Capital Cost	**$85,777**	**$110,104**	**$109,312**	**$147,465**	**$1,136,775**	**$856,208**	**$885,312**	**$762,858**	**$844,257**	**$3,237,594**	**$3,023,635**	**$3,411,146**	**$4,720,998**	**$4,805,890**
Annualized Capital Cost*	$6,914	$8,874	$8,811	$11,886	$91,624	$69,010	$71,356	$61,486	$68,047	$260,950	$243,705	$274,938	$380,512	$387,355
Annual Operating Cost	$3,496	$5,829	$6,763	$12,592	$4,215	$3,572	$3,572	$982	$1,265	$7,352	$4,426	$13,404	$316	$2,119
Total Annualized Cost	**$10,410**	**$14,704**	**$15,573**	**$24,478**	**$95,839**	**$72,583**	**$74,929**	**$62,469**	**$69,312**	**$268,302**	**$248,131**	**$288,342**	**$380,828**	**$389,474**
Measures of Cost Effectiveness (2012$)														
Estimated Cost Effectiveness Index (CEI)**	$69.40	$81.69	$74.16	$81.59	$65.20	$40.32	$32.86	$18.27	$14.44	$81.30	$107.42	$67.69	$100.75	$59.28
CEI Rank	Low	Low	Low	Low	Low	Low	Low	Medium	Medium-High	Low	Low	Low	Low	Low
Cost Reductions Necessary to Achieve a Medium Rating of $25.49 (2012$)														
Max. Total Capital Cost for User Benefits @ $25.49***	**$47,438**	**$56,926**	**$66,413**	**$94,876**	**$464,892**	**$569,256**	**$721,057**	**$1,081,586**	**$1,518,015**	**$1,043,635**	**$730,545**	**$1,347,238**	**$1,195,437**	**$2,077,783**
Capital Cost Reduction Necessary****	$38,339	$53,179	$42,899	$52,589	$671,883	$286,952	$164,255	-$318,727	-$673,758	$2,193,958	$2,293,090	$2,063,908	$3,525,561	$2,728,107
% Capital Cost Reduction Necessary****	45%	48%	39%	36%	59%	34%	19%	-42%	-80%	68%	76%	61%	75%	57%

*Total capital costs of each alternative were annualized at a rate of 7% over a 30-year useful life.

**Assumes user benefits accrued over 300 days within the calendar year, taking into account weekend services.

***$25.49 is the maximum cost per hour of user benefit allowed under FY2013 FTA New Starts guidelines.

****Negative numbers reflect amount capital costs could increase for alternatives already having a rating of "Medium" or higher.

[This page is intentionally blank]

5.2 DEDICATED GUIDEWAY ALTERNATIVES

Calculated CEI values for the dedicated guideway alternatives range from $14.44 for Alternative 2C to $65.20 for Alternative 2A. Both Alternatives 2C and 2Cr could be viable candidates for New Starts funding under the current program, receiving "Medium" and "Medium-High" ratings, respectively. This is consistent with the data developed: the capital costs for these options are lower than their Metrorail counterparts under Alternatives 3C and 3Cr, but they are still generating more user benefits than any other dedicated guideway alternative.

Alternative 2Br is more cost-effective than Alternative 2B, generating 1,600 more hours of average weekday user benefit for $2.3 million more in annualized costs. While Alternative 2Br would receive a "low" rating for cost-effectiveness under the current New Starts program, it may be feasible to revisit this alternative to identify ways to reduce the capital costs sufficiently to make it a viable candidate for federal funding.

Alternative 2A generates the lowest user benefits of any of the dedicated guideway alternatives while serving the longest corridor. As a result, its CEI is likely to be too high to be effectively mitigated through reductions in capital and operating costs. This being the case, this alternative does not meet the objectives of the South Side Transit Study.

5.3 GRADE SEPARATED ALTERNATIVES

Each of the grade separated alternatives received "Low" ratings, due to the higher capital costs associated with the tunneling and aerial structures necessary to provide Metrorail service. The two most promising alternatives--Alternatives 3Cr and 3Br—both have CEIs that are double what is required to receive a "Medium" rating for cost-effectiveness under the current New Starts program. While it is possible that greater use of aerial structures rather than tunnels could reduce the capital costs of Alternatives 3C and 3Cr, the likely impacts of aerial structures on the built-out environment of the Anacostia Corridor may make this option impractical.

In order to warrant a grade separated alternative in the corridor, it may be necessary to intensify development around station areas to generate sufficient ridership to warrant the investment. Section 6.0 provides some guidance as to the land use changes and opportunities that would be appropriate for this strategy.

[This page is intentionally blank]

6.0 EVALUATION OF LAND USES

With the exception of Alternatives 2C and 2Cr, none of the alternatives under consideration as part of the South Side Transit Study would meet the minimum cost-effectiveness criteria established by the FTA for a New Starts project. While the metrics being used to evaluate transit projects are anticipated to change in FY 2014, it is likely that federal, regional, and local stakeholders will still put a premium on projects that are able to demonstrate high enough levels of ridership to justify their capital and operating costs. Furthermore, both existing and future New Starts programs give priority to projects that are able to demonstrate that station area land use and economic development plans are in place that will maximize the utilization of any new transit investment.

This being the case, the study team used the MWCOG 2040 Round 8 land use forecasts of household, population, and employment densities to evaluate land use conditions around the proposed station areas and identify where further intensification of development could improve the viability of transit investments. This was done in two ways. First, the study team examined 2010 household, population, and employment densities in the ½-mile area surrounding existing Metrorail Stations within the study area (i.e. Yellow Line stations west of the Potomac River and Green Line stations south of the Anacostia River.) This was done to provide a baseline as to what densities have worked to date around Metrorail stations in the study area.

Second, the study team evaluated the proposed station areas for each alternative using the metrics established by the August 2010 *Southern Maryland Transit Corridor Preservation Study*. This study drew upon previous studies of transit-supportive land uses to develop a series of thresholds for population, household, and employment densities suitable for supporting transit investments and is being used to coordinate land use and zoning changes along the MD 5/ US 301 Corridor to support future transit improvements in the corridor. The thresholds established by the *Southern Maryland Transit Corridor Preservation Study* are listed in Table 6-1.

TABLE 6-1: HOUSEHOLD, POPULATION, AND EMPLOYMENT DENSITIES FOR SUPPORTING TRANSIT INVESTMENTS

Criterion	Recommended Minimum Densities
Households	12-40 DUs/acre
Population	30-50 people/acre
Employment	30-40 jobs/acre

Source: Southern Maryland Transit Corridor Preservation Study, pp. 28, 32

Figures 6-1, 6-2, and 6-3 illustrate what portions of the study area are forecast to meet the density requirements proposed by the *Southern Maryland Transit Corridor Preservation Study* by 2040. Areas within ½-mile of Eisenhower Avenue, Huntington, and Anacostia Metrorail stations are forecast to meet or exceed the household and population density thresholds, as is the area bounded by Indian Head Highway and Southern Avenue. Some areas within walking distance of Eisenhower Avenue, Anacostia, and Congress Heights will also exceed the proposed employment density thresholds. Currently, those portions of the study area south of the District of Columbia and west of Indian Head Highway are not forecast to meet the density thresholds recommended in Table 6-1; however, as will be discussed in the following sections, there are ongoing plans that may allow these areas to intensify in development.

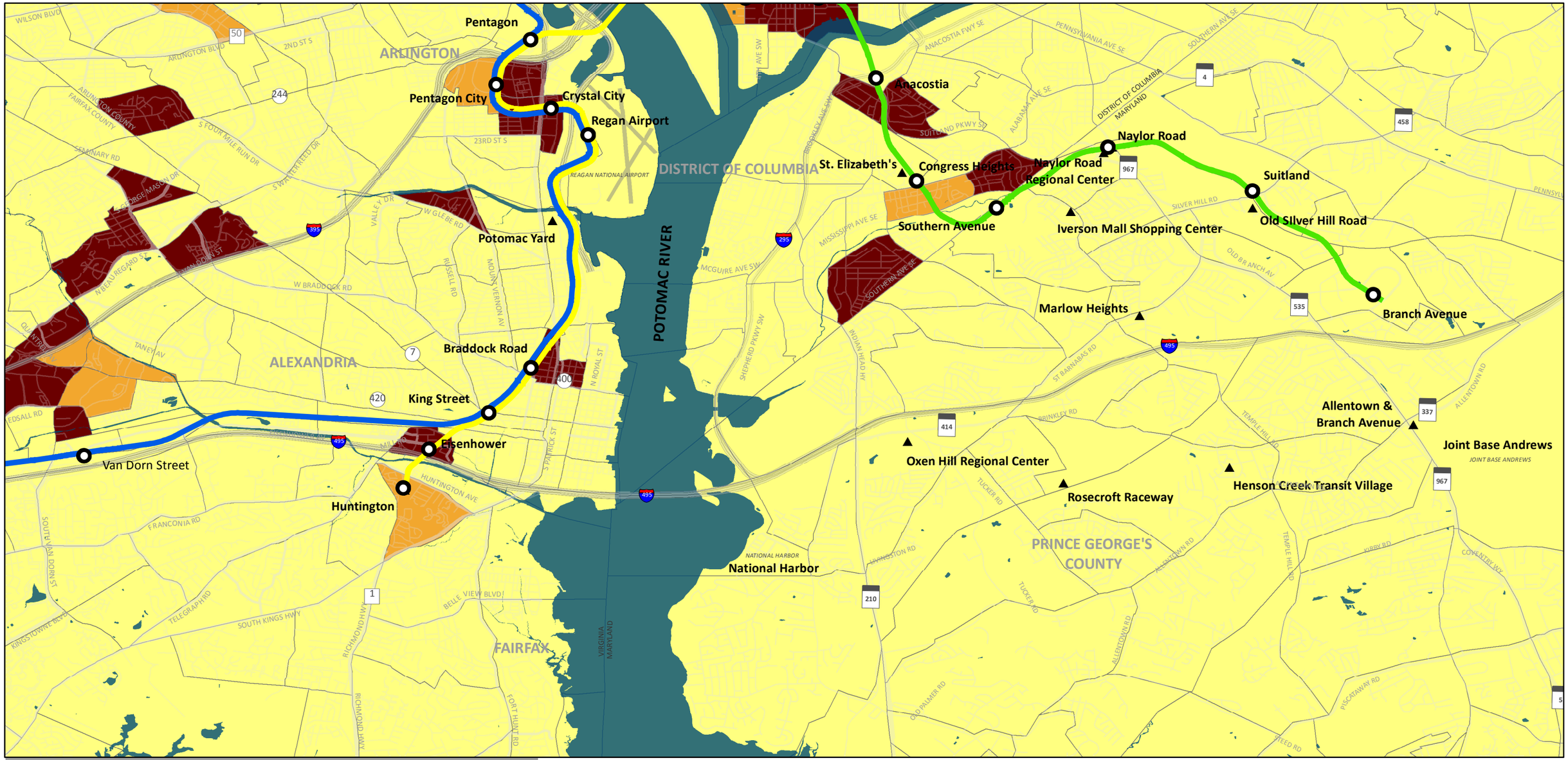
6.1 OBSERVED DENSITIES AROUND EXISTING METRORAIL STATIONS

As shown in Table 6-2, a fairly wide range of densities exist in the study area, depending on the basic nature of the station in question. Some stations, such as Huntington, primarily serve area residents, with few jobs per acre in the ½-mile station vicinity, whereas other stations, such as Pentagon, primarily serve as employment hubs. (As would be expected, the level of employment density seen at Pentagon Station is notably much higher than is typical for the overall study area.)

TABLE 6-2: POPULATION, HOUSEHOLD, AND EMPLOYMENT DENSITIES WITHIN ½-MILE RADIUS OF EXISTING AND COMMITTED METRORAIL STATIONS

Line	Station	Households		Population		Employment	
		2010	2040	2010	2040	2010	2040
Yellow/Blue	Pentagon	1.4	2.2	2.3	3.5	23.9	26.5
Yellow/Blue	Pentagon City	5.0	6.8	8.1	10.8	11.2	15.7
Yellow/Blue	Crystal City	2.8	5.0	4.5	7.9	10.1	18.4
Yellow/Blue	Reagan National Airport	1.3	2.4	2.0	3.7	8.6	14.5
Yellow/Blue	Potomac Yard*	2.2	7.2	4.3	14.5	2.3	12.3
Yellow/Blue	Braddock Road	1.5	2.3	3.4	4.7	4.3	4.7
Yellow/Blue	King Street	2.0	2.7	4.4	5.5	7.7	11.4
Yellow	Eisenhower Avenue	2.6	4.0	5.4	7.9	7.0	12.5
Yellow	Huntington	4.4	5.9	9.7	13.0	2.0	3.9
Green	Anacostia	1.3	3.9	3.6	9.0	2.3	9.1
Green	Congress Heights	1.9	2.5	6.0	7.1	4.2	8.3
Green	Southern Avenue	3.0	3.0	7.7	7.7	1.9	1.9
Green	Naylor Road	3.6	3.7	8.7	8.7	4.3	5.3
Green	Suitland	2.8	2.8	6.9	6.7	7.5	8.7
Green	Branch Avenue	2.9	3.4	7.2	8.1	5.9	9.5
Minimum		1.3	2.2	2.0	3.5	1.9	1.9
Maximum		5.0	7.2	9.7	14.5	23.9	26.5
Average		2.6	3.8	5.6	7.9	6.9	10.9

Source: 2040 MWCOG 2.2 model, Round 8 Land Use *New planned station.



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- Metrorail Line & Station
- Activity Center

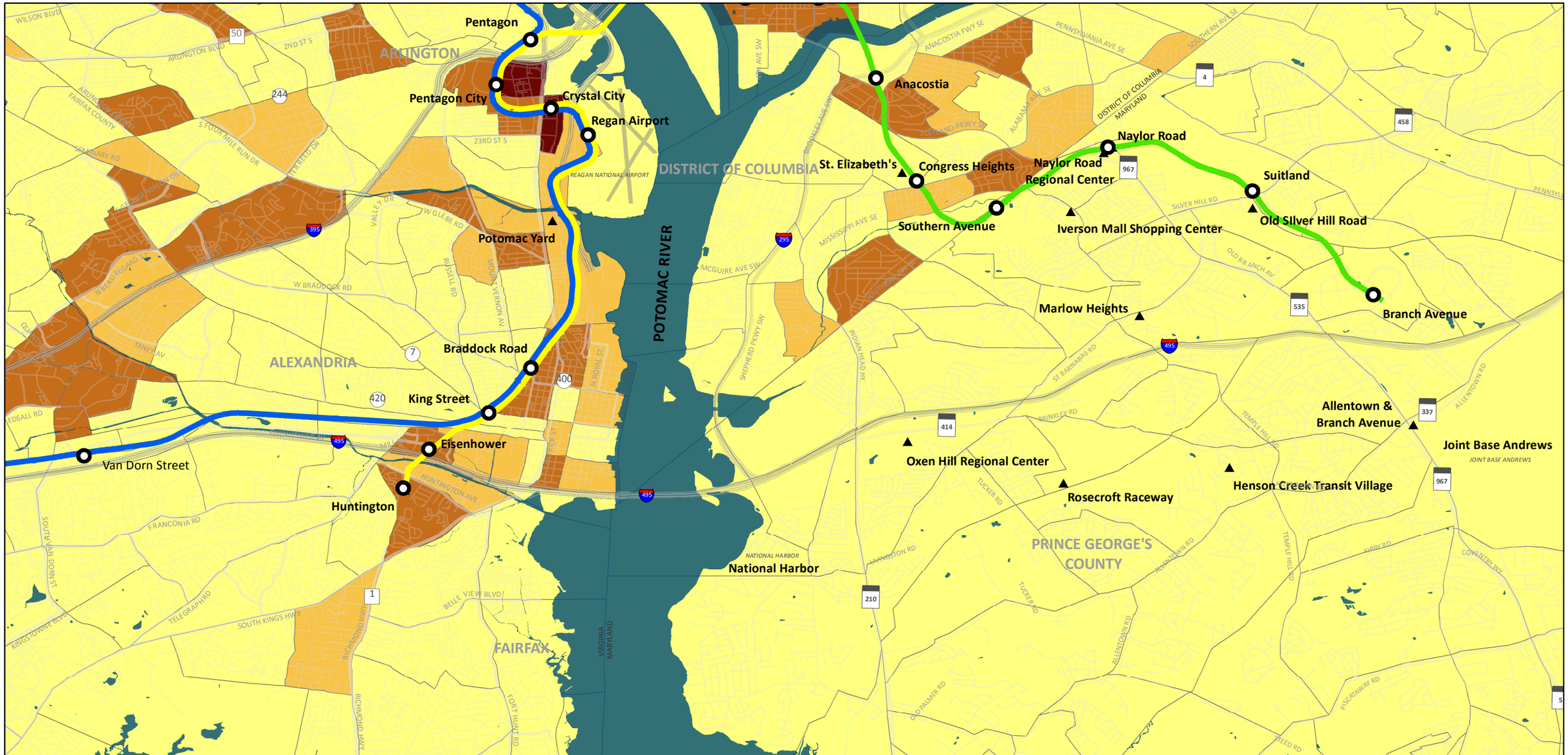
Population/Acre
- 0 - 29.9
- 30 - 49.9
- 50 +

Figure 6-1

2040 Population Density by TAZ

0 0.5 1 2 3 4 Miles

N



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- Metrorail Line & Station
- Activity Center

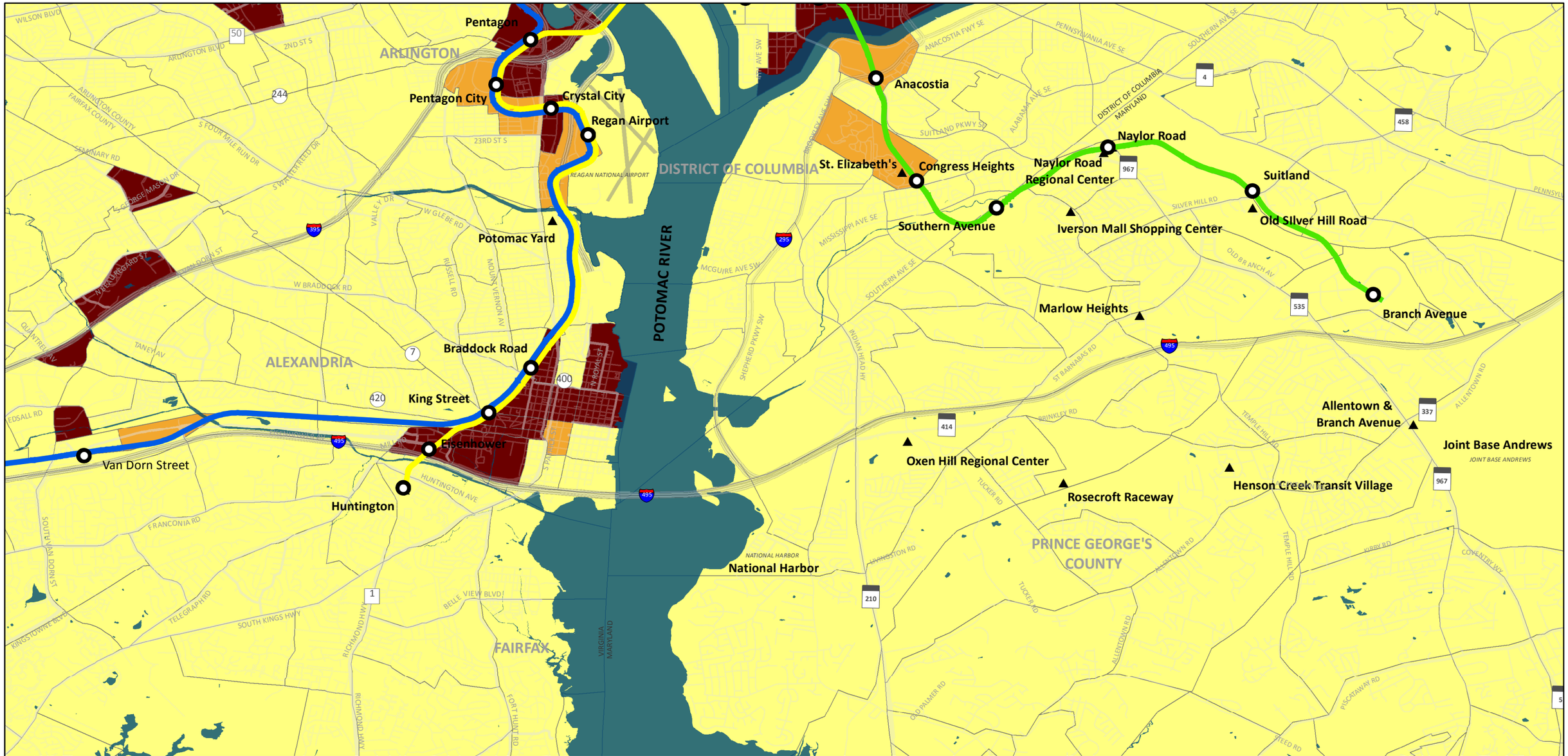
Households/Acre
- 0 - 8.9
- 9 - 11.9
- 12 - 39.9
- 40 +

Figure 6-2

2040 Household Density by TAZ

0 0.5 1 2 3 4 Miles

N



Legend

Roadways
- Divided Highway
- Major Roadway
- Other Roadway
- City- or County-level boundary
- Metrorail Line & Station
- Activity Center

Jobs/Acre
- 0 - 29.9
- 30 - 39.9
- 40 +

Figure 6-3

2040 Employment Density by TAZ

N

0 0.5 1 2 3 4 Miles

[This page is intentionally blank]

Based on forecasts for the 2040 horizon year, the majority of the existing and committed Metrorail stations in the study area can be expected to see a further intensification of population and employment densities. In cases such as Anacostia and Potomac Yard, this may be directly attributed to ongoing developments in these study areas: the new Department of Homeland Security campus at St. Elizabeths is anticipated to increase the density of land uses in the vicinity of Anacostia Metrorail Station, while the new Metrorail station at Potomac Yard is being coordinated with a new development in this area.

The lowest growth in densities is anticipated at the station areas surrounding Southern Avenue, Naylor Road, and Suitland Metrorail Stations. This situation is being addressed as part of Prince George's County's *Southern Green Line Station Area Plan*[2], which is developing "will create future development concepts for the areas within walking distance" of these stations and Branch Avenue Metrorail Station.

It should be noted that the densities shown in Table 6-2 are lower than those shown in Figures 6-1 through 6-3 because they are averaged over a ½-mile radius around each station. As seen in Alexandria and portions of the District of Columbia, densities may exceed the thresholds established by the *Southern Maryland Transit Corridor Preservation Study* by 2040, which may be sufficient to make transit investments in these areas viable.

6.2 FORECAST DENSITIES AROUND PROPOSED STATIONS

Figures 6-1, 6-2, and 6-3 confirm that, while there are major activity centers developing at National Harbor, St. Elizabeths, and Eisenhower Avenue, the majority of the study area has lower densities than are typically considered supportive of fixed-guideway transit investments. In the areas southeast of the District of Columbia, this may be attributed to lower-density residential and commercial development, some of which may be intensified as part of future development activities. Within the established urbanized areas of the study area (i.e. Alexandria, Anacostia), there are densities that meet and exceed the thresholds established by *Southern Maryland Transit Corridor Preservation Study;* however, the overall densities of the station areas are reduced when averaged out across a ½-mile area. The best example of the impact of height restrictions on densities is the station area surrounding the Pentagon: even though the Pentagon itself is the world's largest office building by floor area, the ½-mile around it includes parking areas, highway ramps, and other features that reduce the average employment density of the station area.

While it is beyond the scope of this study to develop station area plans and recommend changes in land uses and zoning codes, the study team has worked with the local jurisdictions in the study area to identify planned and ongoing development initiatives that could be used to improve the ridership potential of each station area. Should these developments increase the population and employee densities of one or more station areas to those recommended by the

[2] http://www.pgplanning.org/Projects/Ongoing_Plans_and_Projects/Community_Plans_and_Studies/Green_Line_TOD.htm. Downloaded October 24, 2012.

Southern Maryland Transit Corridor Preservation Study, it would be appropriate to revisit the alternatives presented in this study to determine if their cost-effectiveness has improved.

The following sections describe the major planning and development initiatives being proposed within the study area. As multiple alternatives share stations, this discussion has been organized by subareas of the study area:

- Alexandria and Fairfax County
- National Harbor (including National Harbor and the Oxon Hill Park and Ride)
- Anacostia Corridor (including those station areas between Anacostia and National Harbor)
- Oxon Hill/St. Barnabas Road (including station areas between Southern Avenue Metrorail Station, Suitland Metrorail Station, and Oxon Hill)
- Beltway Corridor (including Branch Avenue and Joint Base Andrews)

Table 6-3 summarizes which alternatives serve the station areas in each of these five subareas.

TABLE 6-3: SUMMARY OF ALTERNATIVES SERVING EACH STATION WITHIN THE STUDY AREA

		Mixed Traffic Alternatives				At-Grade Alternatives					Grade Separated Alternatives				
Area	**Station**	**1A**	**1B**	**1C**	**1r**	**2A**	**2B**	**2Br**	**2C**	**2Cr**	**3A**	**3B**	**3Br**	**3C**	**3Cr**
Alexandria and Fairfax County	King Street	x	x	x	x	x	x	x	x	x	x		x	x	x
	Eisenhower Avenue	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Huntington										x		x	x	x
	U.S. Route 1										x		x	x	x
National Harbor	National Harbor North	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	National Harbor South		x	x	x		x	x	x	x				x	x
	Oxon Hill P&R	x	x	x	x	x	x	x	x	x					
Anacostia	Anacostia									x				x	x
	St. Elizabeths									x				x	x
	Congress Heights									x					
	Bellevue									x				x	x
	Eastover P&R			x	x				x	x				x	x
	Forest Heights			x	x				x	x					
Oxon Hill/St. Barnabas Road	Oxon Hill		x		x	x	x	x			x	x	x		
	St. Barnabas											x	x		
	St. Barnabas North		x		x		x	x							
	St. Barnabas South		x		x		x	x							
	Old Branch Avenue							x							
	Suitland		x		x		x						x		
	Southern Ave			x	x				x						
	Washington Highlands			x	x				x						
Beltway	Beltway P&R					x					x				
	Branch Ave	x				x		x				x	x		
	Joint Base Andrews					x					x				

X = Station area shown in the row is served by the alternative listed in the column

Alexandria and Fairfax County

Table 6-4 summarizes the 2040 household, population, and employment densities forecast for the station areas in Alexandria and Fairfax County. The highest employment densities forecast for this subarea may be found at King Street and Eisenhower Avenue, both of which are well-established employment centers. Huntington Metrorail Station and the proposed U.S. Route 1 Metrorail Station have the highest household and population densities in this portion of the study area.

TABLE 6-4: 2040 DENSITIES WITHIN ½-MILE RADIUS OF STATIONS IN ALEXANDRIA AND FAIRFAX COUNTY

	Household Density (DUs/acre)		Population Density (persons/acre)		Employment Density (jobs/acre)	
Station	2040	Additional density needed to achieve 12DUs/ acre*	2040	Additional density needed to achieve 30 people/ acre*	2040	Additional density needed to achieve 30 jobs/acre*
King Street	2.5	9.5	5.3	24.7	10.5	19.5
Eisenhower Avenue	4.2	7.8	8.3	21.7	13.3	16.7
Huntington	5.9	6.1	13.0	17.0	3.9	26.1
U.S. Route 1	4.7	7.3	10.5	19.5	4.5	25.5

Source: 2010 and 2040 MWCOG 2.2 model, Round 8 Land Use.

*Minimum density established by the *Southern Maryland Corridor Preservation Study.*

The densities listed in Table 6-4 are lower than those recommended by the *Southern Maryland Transit Corridor Preservation Study*; however, there are opportunities for further development around these station areas. For example, in Eisenhower Valley, home of the U.S. Patent and Trademark Office, there is an ongoing Small Area Plan being implemented by the City of Alexandria. In addition, the MV1-Huntington Community Planning Sector of the *Fairfax County Comprehensive Plan* (amended through June 19, 2012) calls for redevelopment of the Huntington Metrorail Station area to include mixed land uses and residential densities up to 20 DUs/acre. When implemented, these plans may increase the ridership and cost-effectiveness of transit connections to these station areas.

In addition to the potential developments in this portion of the study area, it should be noted that Virginia Department of Rail and Public Transportation has recently initiated the Route 1 Transit Study, which is considering transit improvements along a 27-mile portion of U.S. Route 1. Should this study result in premium transit service being introduced to the corridor, it may be appropriate to consider how the alternatives presented in the South Side Transit Study could be affected or refined to take advantage of this new link in the regional transit network.

National Harbor

Table 6-5 summarizes the densities in the station areas of National Harbor North, National Harbor South, and the Oxon Hill Park and Ride facility. These station areas feature some of the highest densities in the study area, with National Harbor South coming closest to meeting the density thresholds *Southern Maryland Transit Corridor Preservation Study*.

TABLE 6-5: 2040 DENSITIES WITHIN ½-MILE RADIUS OF STATIONS IN NATIONAL HARBOR

	Households (DUs/acre)		Population (people/acre)		Employment (jobs/acre)	
Station	2040	Additional density needed to achieve 12DUs/ acre*	2040	Additional density needed to achieve 30 people/ acre*	2040	Additional density needed to achieve 30 jobs/acre*
National Harbor North	6.5	5.5	17.6	12.4	13.8	16.2
National Harbor South	9.6	2.4	25.9	4.1	23.2	6.8
Oxon Hill P&R	4.1	7.9	11.0	19.0	8.2	21.8

Source: 2040 MWCOG 2.2 model, Round 8 Land Use.

*Minimum density established by the *Southern Maryland Corridor Preservation Study.*

National Harbor is slated for development that at completion will include 7.3 million square feet of mixed-use community space, 4,000 hotel rooms, 2,500 residential units, 500,00 square feet of class A office space, 1 million square of retail, dining and entertainment space, and 10,000 onsite parking spaces. The 12 million square foot development site is designated as a "metropolitan center" by the *Approved Master Plan and SMA for Henson Creek and South Potomac.* The master plan for National Harbor does include a provision for a Metrorail station at the same locations as the proposed National Harbor North station; however, the location of a station in the southern portion of the development would need to be discussed and coordinated with the developer.

The *Approved Master Plan and SMA for Henson Creek and South Potomac* also outlines strategies to redevelop Oxon Hill area as a major center of regional activity with a moderate- to high-intensity mix of residential and nonresidential uses organized including a new transit station. And, as an extension of Oxon Hill, the plan recommends preparing a detailed small area plan or development application for the undeveloped 200-acre area north of Rosecroft Raceway that conforms to best practices for compact community design. While the Raceway is located south of the proposed alternatives, it may be appropriate to consider revisiting the alternatives should the density of the redeveloped Raceway warrant premium transit connections.

Anacostia Corridor

Table 6-6 summarizes the household, population, and employment densities in the corridor between National Harbor and Anacostia Metrorail Station. The highest concentrations of

population are located in the areas surrounding the Anacostia Metrorail Station and the Eastover Park and Ride facility. Employment density increases steadily moving from the south of the corridor to the stations at Anacostia and St. Elizabeths, where the new campus for the Department of Homeland Security (DHS) is being implemented. Plans for the St. Elizabeths campus call for the relocation of 14,000 DHS employees to the campus from other existing offices in the region; if completed, this project could be anticipated to increase the demand for transit ridership to this area.

TABLE 6-6: 2040 DENSITIES WITHIN ½-MILE RADIUS OF STATIONS IN THE ANACOSTIA CORRIDOR

	Households (DUs/acre)		Population (people/acre)		Employment (jobs/acre)	
Station	**2040**	**Additional density needed to achieve 12DUs/ acre***	**2040**	**Additional density needed to achieve 30 people/ acre***	**2040**	**Additional density needed to achieve 30 jobs/acre***
Anacostia	3.9	8.1	9.0	21.0	9.1	20.9
St. Elizabeths	1.9	10.1	5.2	24.8	15.7	14.3
Congress Heights	2.0	10.0	5.2	24.8	2.4	27.6
Bellevue	3.3	8.7	8.3	21.7	2.0	28.0
Eastover P&R	4.5	7.5	11.2	18.8	0.9	29.1
Forest Heights	3.4	8.6	8.2	21.8	0.8	29.2

Source: 2040 MWCOG 2.2 model, Round 8 Land Use.

*Minimum density established by the *Southern Maryland Corridor Preservation Study.*

Oxon Hill/St. Barnabas Road

Table 6-7 summarizes the household, population, and employment densities in the St. Barnabas corridor. This area is characterized by detached single-family dwellings and auto-oriented commercial districts, explaining its relatively lower densities compared to other portions of the study area. (The exception to this is the Washington Highlands area, which features multi-family dwelling units that boost its population density to 14.4 people/acre.)

TABLE 6-7: 2040 DENSITIES WITHIN ½-MILE RADIUS OF STATIONS IN OXON HILL/ST. BARNABAS

Station	Households (DUs/acre)		Population (people/acre)		Employment (jobs/acre)	
	2040	Additional density needed to achieve 12DUs/ acre*	2040	Additional density needed to achieve 30 people/ acre*	2040	Additional density needed to achieve 30 jobs/acre*
Oxon Hill	3.6	8.4	8.9	21.1	6.1	23.9
St. Barnabas	3.2	8.8	7.7	22.3	6.6	23.4
St. Barnabas North	3.2	8.8	7.7	22.3	6.6	23.4
St. Barnabas South	3.4	8.6	8.2	21.8	0.6	29.4
Old Branch Avenue	1.7	10.3	4.1	25.9	5.2	24.8
Suitland	2.8	9.2	6.7	23.3	8.7	21.3
Southern Ave	3.8	8.2	9.6	20.4	1.5	28.5
Washington Highlands	5.5	6.5	14.4	15.6	1.2	28.8

Source: 2040 MWCOG 2.2 model, Round 8 Land Use.

*Minimum density established by the *Southern Maryland Corridor Preservation Study.*

Developments described in the *Branch Avenue Corridor Plan* may help to improve the cost-effectiveness of new transit services in this area. The *Branch Avenue Corridor Plan* includes a re-zoning of residential properties within walking distance of the Suitland Metro Station from medium multi-family density to high multi-family densities, and the designation of the areas between Old Silver Hill Road and Branch Avenue and on St. Barnabas Road as mixed-use, medium density developments. All proposed developments within the area are to be developed with pedestrian- and transit-oriented development guidelines in mind. The *Branch Avenue Corridor Plan also* recommends designating the Iverson-Marlow Heights Mixed-Use Center as a mixed-use, medium-density residential/office/retail land use classification in order to achieve a vertical and horizontal mix emphasizing retail- and pedestrian-oriented strategies.

As noted before, the Metrorail stations at Suitland and Southern Avenue have both been included in Prince George's County's *Southern Green Line Station Area Plan*. When implemented, these development plans may intensify development around these stations and create activity centers that would attract ridership along the proposed 2A, 2B, 2Br, 3A, 3B, and 3Br alignments.

Beltway Corridor

Table 6-8 summarizes the 2040 household, population, and employment densities for the three stations associated with Alternatives 1A, 2A, and 3A, all of which are located along the Beltway on the eastern edge of the study corridor. Both Branch Avenue and Joint Base Andrews are anticipated to continue as large employment centers in the area. However, both are forecast to have densities below those recommended by the *Southern Maryland Transit Corridor Preservation*

Study. There are two opportunities for these densities to increase. First, as noted above, the *Southern Green Line Station Area Plan* is being used to develop a station area plan for Branch Avenue, which could help to encourage future development around the station. Second, the *Branch Avenue Corridor Plan* designates the area around the intersection of Allentown Road and Branch Avenue for a mix of low- to moderate-density residential land uses with higher density housing located along the Branch Avenue frontage and lower densities along the boundaries of existing neighborhoods. This could improve the densities around the station area at Joint Base Andrews.

TABLE 6-8: 2040 DENSITIES WITHIN ½-MILE RADIUS OF STATIONS IN THE BELTWAY CORRIDOR

	Households (DUs/acre)		Population (people/acre)		Employment (jobs/acre)	
Station	**2040**	**Additional density needed to achieve 12DUs/ acre***	**2040**	**Additional density needed to achieve 30 people/ acre***	**2040**	**Additional density needed to achieve 30 jobs/acre***
Beltway P&R	1.8	10.2	4.4	25.6	2.5	27.5
Branch Ave	3.3	8.7	7.9	22.1	9.9	20.1
Joint Base Andrews	1.4	10.6	3.6	26.4	13.9	16.1

Source: 2040 MWCOG 2.2 model, Round 8 Land Use.

*Minimum density established by the *Southern Maryland Corridor Preservation Study*.

In addition, it should be noted that the Branch Avenue Metrorail Station is envisioned to serve as the northern terminus for the transit services being planned as part of the *Southern Maryland Transit Corridor* initiative. Implementation of this service may encourage transit trips from the travelshed south of the study area, which may improve the utility of an east-west transit service from Branch Avenue across the Woodrow Wilson Bridge.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The primary objective of this study was to identify the most cost-effective means of using lanes 11 and 12 on the Woodrow Wilson Bridge to connect the transit systems on both sides of the bridge. Therefore, while each of the corridors that were studied may have other merits that warrant further investments in transit, the focus of this analysis is on three metrics: the cost-effectiveness index of each alternative, the number of auto trips using the bridge, and the number of transit trips using the bridge. Table 7-1 presents these three metrics, as well as the modeling inputs, outputs, and cost estimates used to produce them.

7.1 COST EFFECTIVENESS

As calculated as a measure of annualized costs over annualized user benefits, there were only two alternatives that would be considered viable under the current FTA definition of cost-effectiveness: Alternatives 2C and 2Cr. Both of these alternatives provide travel times at least twice as fast as their mixed traffic alternatives at a quarter of the cost estimated for their Metrorail equivalents. The remaining alternatives had CEIs that were between two to four times higher than the $25.49 necessary to achieve a "Medium" rating under the New Starts program. While the cost methodology employed by this study is only capable of providing order-of-magnitude estimates of capital and operating costs, it is unlikely that the alternatives that received a "Low" rating could be engineered to achieve a cost-effective solution. The exception to this was Alternative 2Br, whose CEI of $32.86 could possibly be decreased through further refinement of the alternative, possibly as a Bus Rapid Transit service.

For each alternative, the study team estimated the maximum capital cost that could still receive a "Medium" rating of $25.49. This approach confirms that the majority of alternatives currently receiving a "Low" rating would be infeasible to build for less money. For example, 3C and 3Cr alternatives could be cost-effective if they could be built for $1.2 billion and $2.1 billion, respectively. That being said, as each alternative was estimated to cost over $4 billion in 2012 dollars, it is unlikely that they could be engineered to be less than a quarter of this price in future years, let alone today. The more likely approach to implementing these alternatives would be to intensify development densities around their station areas to improve their ridership potential.

[This page is intentionally blank]

TABLE 7-1: SUMMARY OF FINDINGS

Alternative	1A	1B	1C	1r	2A	2B	2Br	2C	2Cr	3A	3B	3Br	3C	3Cr
Length of Guideway (mi.)	**11.4**	**11.9**	**9.9**	**15.5**	**13.1**	**11.9**	**12.3**	**9.9**	**11.2**	**10.7**	**11.6**	**11.9**	**10.2**	**10.2**
Number of Stations	5	11	11	17	8	9	10	9	11	7	6	7	8	8
Headways (min)														
Peak	10	10	10	10	10	10	10	10	10	7	7	7	Y: 7 G: 14***	7
Off-Peak	15	15	15	15	15	15	15	15	15	12	12	12	Y: 12 G: 24***	12
Average End-to-End Travel Time (min)	34	50	58	108	24	25	26	21	25	Y: 16 G: 4	19	20	Y: 6 G: 12	18
Average Speed (mph)*	20	14	10	12	33	29	28	28	27	Y: 39 G: 41	38	36	Y: 41 G: 31	33
Modeling Results														
Systemwide Boardings														
Total	2,275,200	2,275,700	2,275,200	2,300,200	2,318,100	2,298,600	2,326,500	2,309,900	2,334,000	2,318,400	2,333,400	2,336,700	2,324,300	2,374,500
vs. No Build	1,700	2,200	1,700	2,700	20,100	25,000	28,900	36,400	36,500	20,400	35,400	39,100	26,400	77,000
Alternative Route Boardings in Study Area**	2,400	4,200	4,000	7,400	18,200	19,800	23,600	32,100	45,400	23,400	26,100	29,600	40,900	63,600
Systemwide Trips														
Total	1,471,600	1,471,800	1,471,800	1,492,920	1,501,100	1,481,800	1,505,800	1,487,500	1,509,800	1,505,800	1,501,900	1,513,700	1,510,900	1,526,200
vs. No Build	800	1,000	1,000	1,500	9,800	11,000	14,400	16,700	18,400	14,500	10,600	22,300	19,600	34,800
Daily Trips Crossing WWB														
Transit	1,500	2,300	2,600	2,100	11,500	11,000	14,300	10,000	14,100	23,800	13,900	25,700	8,400	22,600
Auto	253,858	253,716	253,928	253,095	251,664	252,990	252,112	252,609	252,092	252,133	252,648	252,475	252,430	251,960
Auto Trips vs. No Build	-191	-333	-121	-647	-1,645	-1,059	-1,630	-1,441	-1,649	-1,175	-661	-1,266	-879	-1,782
Average Weekday User Benefits	500	600	700	1,000	4,900	6,000	7,600	11,400	16,000	11,000	7,700	14,200	12,600	21,900
Annualized User Benefits	**150,000**	**180,000**	**210,000**	**300,000**	**1,470,000**	**1,800,000**	**2,280,000**	**3,420,000**	**4,800,000**	**3,300,000**	**2,310,000**	**4,260,000**	**3,780,000**	**6,570,000**
Estimated Costs ($1,000s, 2012$ YOE)														
Total Capital Cost	$85,777	$110,104	$109,312	$147,465	$1,136,775	$856,208	$885,312	$762,858	$844,257	$3,237,594	$3,023,635	$3,411,146	$4,720,998	$4,805,890
Capital Cost Annualized @ 7%	$6,914	$8,874	$8,811	$11,886	$91,624	$69,010	$71,356	$61,486	$68,047	$260,950	$243,705	$274,938	$380,512	$387,355
Annual Operating Cost	$3,496	$5,829	$6,763	$12,592	$4,215	$3,572	$3,572	$982	$1,265	$7,352	$4,426	$13,404	$316	$2,119
Total Annualized Cost	$10,410	$14,704	$15,573	$24,478	$95,839	$72,583	$74,929	$62,469	$69,312	$268,302	$248,131	$288,342	$380,828	$389,474
Measures of Cost Effectiveness (2012$)														
Cost Effectiveness Index (CEI)	$69.40	$81.69	$74.16	$81.59	$65.20	$40.32	$32.86	$18.27	$14.44	$81.30	$107.42	$67.69	$100.75	$59.28
CEI Rank	Low	Low	Low	Low	Low	Low	Low	Medium	Medium-High	Low	Low	Low	Low	Low
Cost Reductions Necessary to Achieve a Medium Rating of $25.49 (2012$)														
Max. Total Capital Cost for User Benefits @ $25.49******	**$47,438**	**$56,926**	**$66,413**	**$94,876**	**$464,892**	**$569,256**	**$721,057**	**$1,081,586**	**$1,518,015**	**$1,043,635**	**$730,545**	**$1,347,238**	**$1,195,437**	**$2,077,783**
Capital Cost Reduction Necessary	$38,339	$53,179	$42,899	$52,589	$671,883	$286,952	$164,255	-$318,727	-$673,758	$2,193,958	$2,293,090	$2,063,908	$3,525,561	$2,728,107
% Capital Cost Reduction Necessary	45%	48%	39%	36%	59%	34%	19%	-42%	-80%	68%	76%	61%	75%	57%

*3A: Travel time for Yellow Line only; 3C: Travel time for both Yellow and Green Lines. This does not include transfer time. **Boardings for 3A, 3C estimated from stations on alignment, excluding inbound King Street and Anacostia Station trips. May underestimate boardings generated from outside of the study area. ***3C: Green Line frequency split between National Harbor and Branch Avenue branches. ****$25.49 established as "Medium" cost-effectiveness rating for FY 2013 by FTA for New Starts program

[This page is intentionally blank]

The mixed traffic alternatives could feasibly be implemented for under $94.8 million. While it is feasible to use amenities, vehicles, and traffic signal adjustments to assemble an alternative less costly than this, these alternatives would still need new infrastructure put in place to allow them to travel from lanes 11 and 12 and the Maryland side of the corridor. This being the case, it is unlikely that a viable bus-only alternative could be developed that could use lanes 11 and 12 while still serving the highest-density activity centers in the study area.

7.2 TRANSIT AND AUTO TRIPS USING THE WOODROW WILSON BRIDGE

The grade separated alternatives carry the most transit trips over the Woodrow Wilson Bridge, with Alternative 3Br carrying 25,700 daily transit trips over the bridge and Alternative 3Cr carrying 22,600 daily transit trips. These may not necessarily be new transit trips; instead, it is feasible that these are existing Metrorail trips using the new link in the system to connect between Alexandria and points in the downtown of the District of Columbia. While Alternatives 3Br and 3Cr are not cost-effective under current FTA criteria, the additional capacity these alternatives could provide to the Metrorail system should be taken into account when ultimately deciding the appropriate use for lanes 11 and 12 of the Woodrow Wilson Bridge.

The dedicated guideway alternatives demonstrate some of the best potential for reducing the number of auto trips using the Woodrow Wilson Bridge, with each alternative taking at least 1,000 daily auto trips off the bridge. The fact that Alternative 2Cr takes more auto trips off the bridge than any alternative except 3Cr reinforces the case that it is the best candidate for providing connecting transit service between Virginia and Maryland along the Woodrow Wilson Bridge.

7.3 RECOMMENDATIONS

Based on the cost-effectiveness and ridership data developed as part of this study, it is recommended that Alternative 2Cr be considered the most viable transit alternative for using lanes 11 and 12 of the Woodrow Wilson Bridge to connect the transit networks in Maryland and Virginia. Alternative 2Cr generates the second highest level of user benefits of any of the alternatives considered, and its CEI would receive a “Medium-High” rating if the current alternative were accepted into the New Starts program. This would make Alternative 2Cr competitive not only against other alternatives within the study area, but also against many of the other candidate New Starts projects across the United States.

It should be noted that the right-of-way constraints within the study corridor (especially between Eisenhower Metrorail Station and King Street Metrorail Station) may make it infeasible to provide a dedicated guideway for the entire length of Alternative 2Cr (or any of the dedicated guideway alternatives). Recognizing this constraint, it is recommended that any effort to advance Alternative 2Cr into design and implementation begin by first confirming that the operating characteristics assumed in this study can be achieved in a

cost-effective manner. If further engineering of the alternative indicates that it is not possible to achieve the travel speeds and anticipated user benefits forecast by this study, it will may necessary to revisit the cost-effectiveness of the alternative under the New Starts program.

As noted before, the scope of this study was focused exclusively on the issue of how best to use the existing investment made in lanes 11 and 12 of the Woodrow Wilson Bridge to connect transit networks in Virginia and Maryland. There may be other regional goals that would warrant considering the other alternatives presented in this study. For example:

- It would be appropriate to consider a low-cost mixed traffic alternative to test the east-west transit market within the study area. However, such an alternative may not be able to make effective use of lanes 11 and 12 while still serving activity centers closest to the Potomac.
- If there were a need to provide additional Metrorail capacity across the Potomac, it may be appropriate to consider Alternative 3Cr as a means of relieving pressure from the core system. As the cost estimates have indicated; however, such an investment would need to be coordinated with station area land uses to maximize its ridership and cost-effectiveness.
- There are several ongoing planning and development initiatives underway that may require enhanced transit services to be viable. As these plans are adopted and implemented, it would be appropriate to revisit the transit alternatives presented here to determine whether they could be reengineered to better serve local development strategies.

7.4 PROPOSED CHANGES TO NEW STARTS PROGRAM

FTA recently issued a Notice of Proposed Rulemaking to announce several proposed changes to the criteria it uses to evaluate rail and bus rapid transit projects seeking federal funding. The changes are intended to streamline the approval process and take into account a broader set of transit project benefits in the evaluation.

The key changes that may affect the development and evaluation of the South Side Transit Study alternatives are as follows:

- No Baseline Alternative would be required.
- Cost effectiveness would be evaluated based on costs per project trip, rather than costs per user benefit.
- Ridership would be weighted to encourage service to transit dependent populations. Each trip by a transit-dependent individual would be counted twice.
- The evaluation would place more emphasis on land use and development.

Given that several of these changes may make several of the South Side Transit Study alternatives more cost-effective or competitive, it may be appropriate to time future phases of project development to take advantage of the proposed rulemaking.

[This page is intentionally blank]

APPENDIX A: CAPITAL COST METHODOLOGY

This technical memorandum summarizes the cost methodology to be applied to the South Side Transit Study (SSTS), an assessment of transit alternatives connecting Maryland and Virginia via the Woodrow Wilson Bridge. As the SSTS is a preliminary assessment of ridership and cost-effectiveness rather than a full Alternatives Analysis under the Federal Transit Administration's (FTA) New Starts program, the purpose of this cost methodology is to provide a consistent means of developing order-of-magnitude capital costs for each of the alternatives being considered as part of this study. It is assumed that these cost estimates will be revisited and refined should the alternatives be carried forward into future phases of planning and design.

STUDY APPROACH TO CAPITAL COST ESTIMATES

The primary objective of the SSTS is to assess the cost-effectiveness of the transit alternatives under consideration, using the FTA definition of cost effectiveness:

$$CEI = \frac{(C_{oA}-C_{oB}) + (C_{cA}-C_{cB})}{UB_A-UB_B}$$

Where:

- CEI is the Cost Effectiveness Index for Alternative A compared to a Baseline Alternative
- C_{oA} represents the annualized operating cost of Alternative A
- C_{oB} represents the annualized operating cost of a Baseline Alternative
- C_{cA} represents the annualized capital cost of Alternative A
- C_{cB} represents the annualized capital cost of a Baseline Alternative
- UB_A represents the annualized user benefits generated by Alternative A
- UB_B represents the annualized user benefits generated by a Baseline Alternative

Under this definition, an alternative that is capable of generating one hour of user benefit for less than $24.99 worth of annualized capital and operating costs is considered to have a "Medium" cost-effectiveness rating as of FY 2012. While a "Medium" cost-effectiveness rating is no longer a requirement to receive funding for design and construction under the New Starts program, achieving a "Medium" rating would ensure that an alternative is competitive versus the 200+ other projects across the United States that are seeking New Starts funding.

Knowing that $24.99 is the maximum CEI an alternative can achieve and still be competitive, it is possible to approach the costs of an alternative from two different methods:

Method 1: Identify the user benefits of a project and "reverse engineer" a maximum cost for the project. If it is assumed that the Baseline Alternative is a "No Build" Alternative (meaning no improvements are made except those already committed to be in place in the horizon year), the equation presented on page 1 simplifies to:

$$CEI = \frac{C_{oA} + C_{cA}}{UB_A}$$

For a "Medium" CEI of $24.99, this becomes:

$$\$24.99 \times UB_A = C_{oA} + C_{cA}$$

Using this equation, it is possible to determine the maximum annualized capital and operating cost a project can have and still be competitive for a given level of user benefit. Table A-1 below shows the maximum cost an alternative could afford for different levels of user benefit.

TABLE A-1: MAXIMUM COSTS FEASIBLE TO ACHIEVE A MEDIUM COST EFFECTIVENESS RATING

	Total Daily User Benefit (Hours)			
	500	**1,000**	**5,000**	**10,000**
Medium FTA Cost-effectiveness Rating	$24.99	$24.99	$24.99	$24.99
Maximum Weekday Cost	$12,245	$24,990	$124,950	$249,900
Annualized Cost*	$3.7M	$7.5M	$37.5M	$75.0M
Max. Cost (Capital* + Operating)	$53.6M	$107.1M	$535.5M	$1,071.0M

* Based on 7% annualization over a 30-year useful life. Dollars are expressed in base year (2012).

As FTA typically requires a Baseline Alternative that introduces some new service to a study area, it can be assumed that the actual CEI would be reduced by the user benefits generated by a Baseline service. Therefore, the cost estimated using this method could be considered a "best case" scenario.

Method 2: Develop a "ground up" cost estimate and apply it to the CEI calculation. The conventional method of calculating the CEI for an alternative is to develop a design and operating plan for an alternative, then to apply typical unit costs against quantities derived from these inputs. This is a more data-intensive approach than Method #1; however, it does allow cost estimates to be refined throughout a project as the design and operating plans for an alternative are refined.

This study will use both approaches to develop a range of costs for the alternatives under consideration. Each of the nine alternatives will be coded and analyzed using the MDAA-II regional travel demand model, making it possible to estimate the annual user benefits each can be expected to generate. The study team will then use the model results to "reverse engineer" (Method 1) the maximum capital and operating cost that each alternative can afford in order to be considered a candidate for further study.

The study team will apply its experience planning comparable transit systems to make an initial determination as to which alternatives could realistically be developed within the cost constraints dictated by this methodology. Those alternatives considered to be feasible will then be refined in sufficient detail to allow the study team to develop a "ground up" (Method 2), order-of-magnitude estimate of capital costs.

CLASSIFICATION AND SOURCES OF UNIT COSTS

As the SSTS is focused on understanding the transit markets in the study area rather than on the engineering feasibility of alternatives, none of the alternatives have been developed beyond a conceptual level of detail sufficient to identify the general location of alignments and preliminary station areas. This being the case, the capital costs to be developed for each alternative will be based on major elements of each alternative (e.g. vehicles, miles of track, stations) rather than on detailed quantities (e.g. square feet of concrete, cubic feet of ballast.) These major elements have been defined according to the FTA's Standard Cost Categories (SCC) for Capital Projects, and are listed in Table A-2.

TABLE A-2: CAPITAL COST CATEGORIES

Category	Cost Unit
10 Guideway And Track Elements	Route mile
20 Stations, Stops, Terminals, Intermodal Stations	Each
30 Support Facilities	Each
40 Sitework	Route mile
50 Systems	Route mile
60 Right of Way, Land, Existing Improvements	% of Categories 10-50
70 Vehicles	Each
80 Professional Services	% of Categories 10-50
90 Unallocated Contingency	% of Categories 10-80

The unit costs for each category were derived from the unit costs reported to the FTA for five projects currently under development as part of the New Starts program:

- El Camino (Bus Rapid Transit [BRT], Santa Clara, CA)
- E Street (BRT, San Bernardino, CA)
- Broad Street (BRT, Richmond, VA)
- Purple Line (Light Rail Transit [LRT] Montgomery and Prince George's Counties, MD)
- Dulles Corridor Metrorail Project Phases 1 and 2 (Heavy Rail Transit [HRT], Fairfax and Loudoun Counties, VA)

The Broad Street, Purple Line, and Dulles Corridor projects were selected because they provide comparable information on premium transit projects being implemented in Virginia and Maryland. As the costs of BRT projects can vary significantly depending on the level of investment made, the study team also included the unit costs of the El Camino and E Street projects, making it possible to develop an average unit cost for mixed traffic and dedicated guideway alternatives. Table A-3 lists the unit costs associated with each of these projects.

DERIVATION OF PROJECT UNIT COSTS

As noted in the scope, each of the alternatives under consideration is assumed to use one of three types of guideway:

1. **Mixed-traffic operations**. Mixed-traffic operations use existing general traffic lanes to connect stations along an alternative. Such services are currently provided by local and commuter bus services in the region; they could also be provided by limited-stop Bus Rapid Transit (BRT) services or by streetcar services.

2. **At-grade dedicated right-of-way (ROW).** Guideways using at-grade, dedicated ROW assume that transit services operate along existing roadways in dedicated lanes physically separated from general traffic lanes, crossing other roadways at signalized intersections. At-grade dedicated ROW is typically used by BRT and LRT systems.

3. **Grade-separated, dedicated ROW.** Grade-separated guideways use aerial or tunnel segments to connect stations, bypassing local roadways to maximize travel speeds. Such guideways are used for the current Metrorail system, and are typically designed to place stations only at high-density activity centers to maximize ridership potential and minimize travel times. Where appropriate, such alternatives will be considered as extensions of the current Metrorail system in order to minimize transfers for travelers.

TABLE A-3: ACTUAL PROJECT UNIT COSTS

Category		Project	El Camino	E Street	Broad Street	Purple Line	Dulles Corridor Metrorail Project	
							Phase 1	Phase 2
		Mode	BRT	BRT	BRT	LRT	HRT	HRT
		Year of Expenditure	2010	2010	2011	2010	2010	2010
10	**Guideway And Track Elements**	**Unit**						
	Mixed Traffic	mile	n/a	$70	$2	n/a	n/a	n/a
	Surface (Allows Cross Traffic)	mile	$2,400	$4,400	$1,200	$2,900	n/a	n/a
	Surface (Dedicated)	mile	n/a	n/a	n/a	$33,700	n/a	n/a
	Retained Cut Or Fill	mile	n/a	n/a	n/a	$11,000	n/a	n/a
	Tunnel	mile	n/a	n/a	n/a	$94,700	n/a	$292,300
	Aerial	mile	n/a	n/a	n/a	$38,300	$0	$0
20	**Stations, Stops, Terminals, Intermodals**	each	$3,100	$900	$300	$6,300	$63,400	$120,800
30	**Support Facilities**	each	$2,000	$5,000	n/a	$90,300	$52,000	$262,000
40	**Sitework**	mile	$2,600	$2,800	$1,300	$13,600	$20,100	$19,200
50	**Systems**	mile	$2,800	$700	$1,300	$6,800	$24,000	$23,700
60	**Right of Way, Land, Existing Improvements**	% of 10-50	2%	5%	7%	23%	11%	1%
70	**Vehicles**	each	$1,100	$1,000	$1,100	$3,400	$3,300	$3,600
80	**Professional Services**	% of 10-50	40%	42%	30%	32%	45%	24%
90	**Unallocated Contingency**	% of 10-80	2%	6%	5%	4%	5%	4%

Working in this context, the study team developed typical unit costs for each of these three types of guideway. The team assessed the unit costs available from each of the five New Starts projects listed in Table A-3 and then used professional judgment to ascertain typical unit costs that would be appropriate for the SSTS's area of analysis. These costs were then escalated to 2012 dollars assuming a 5% annual rate of inflation. Table A-4 summarizes the proposed unit costs for each of the types of alternatives, as well as provides a basic rationale for each unit cost.

TABLE A-4: PROPOSED UNIT COSTS (2012$)

Category		Unit	Mixed Traffic	Dedicated Guideway	Exclusive Guideway	Notes
10	**Guideway And Track Elements**					
	Mixed Traffic	mile	$40	$0	$0	Average of Broad Street and E Street BRT guideway costs per mile
	Surface (Allows Cross Traffic)	mile	$0	$2,977	$0	Average of Broad Street, El Camino, and E Street BRT guideway costs per mile
	Surface (Dedicated)	mile	$0	$37,154	$37,154	Appropriate for median of I-495
	Retained Cut Or Fill	mile	$12,128	$12,128	$12,128	Appropriate for transitions to WWB, I-495
	Tunnel	mile			$213,334	Average of Purple Line, Dulles Phase 2
	Aerial	mile	$42,226	$42,226	$56,228	Average of Purple Line, Dulles Phases 1 and 2
20	**Stations, Stops, Terminals, Intermodals**	each	$662	$5,182	$69,899	Mixed Traffic: Average of Broad Street and E Street BRT stations. Dedicated Guideway: Average of El Camino BRT and Purple Line LRT. Exclusive Guideway: Dulles Phase 1 (Dulles Phase 2 included cost of underground station at Dulles International)
30	**Support Facilities**	each	$0	$27,563	$57,330	Mixed Traffic: assumed that this option could use existing garages. Dedicated Guideway: assumed new maintenance facility needed. Exclusive Guideway: assumed existing WMATA maintenance facilities could be expanded
40	**Sitework**	mile	$0	$16,538	$22,050	Increased to reflect costs of transitions to, from WWB
50	**Systems**	mile	$1,654	$7,718	$27,563	Assume comparable to Purple Line system requirements
60	**Right of Way, Land, Existing Improvements**	% of 10-50	10%	20%	20%	Assume comparable to Purple Line ROW requirements
70	**Vehicles**	each	$1,323	$3,859	$3,859	
80	**Professional Services**	% of 10-50	30%	30%	30%	
90	**Unallocated Contingency**	% of 10-80	10%	10%	10%	Higher contingency for longer time horizon, absence of conceptual design

INFLATION AND CONTINGENCIES

The unit costs have been expressed in 2012 dollars to allow for calculation of the CEI; however, the study team recognizes the utility in providing costs in year of expenditure (YOE) dollars to understand the total likely cost in 2040. Therefore, this study assumes a constant 5% inflation rate will be applied to the unit costs to develop YOE costs, and that the alternatives will be constructed in the horizon year 2040.

A 10% unallocated contingency will be applied to each capital cost estimate to account for changes that may occur between now and the implementation of each alternative. As with the inflation rate, this assumption will need to be revisited as the study progresses and one or more alternatives is advanced into design and implementation.

[This page is intentionally blank]

APPENDIX B: CALCULATION OF OPERATING COSTS

[This page is intentionally blank]

TABLE B-1: OPERATING CHARACTERISTICS

	Units	No Build Green	No Build Yellow	1A	1B	1C	1r	2A	2B	2Br	2C	2Cr	3A Green	3A Yellow	3A Green vs. No Build	3A Yellow vs. No Build	3A	3B	Ref. 3B	3Br vs. No Build	3C* Green Nat Harbor	3C* Green Branch Ave	3C Yellow	3C Green vs. No Build	3C Yellow vs. No Build	3C	3Cr	3Cr vs. No Build
Cars/Train	vehicles	8	8	1	1	1	1	1	1	1	1	1	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Headways																												
Peak	minutes	7	7	10	10	10	10	10	10	10	10	10	7	7	7	7	7	7	7	7	14	14	7	7	7	7	7	7
Off-Peak	minutes	14	14	15	15	15	15	15	15	15	15	15	12	12	12	12	12	12	12	12	24	24	12	12	12	12	12	12
Hours of Operation																												
Peak hours/weekday		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Off-Peak hours																												
Monday-Thursday	hours	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Friday	hours	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16
Saturday	hours	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Sunday	hours	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Travel Time																												
Eastbound	minutes	47.0	25.0	30.4	48.1	60.4	108.5	24.0	25.0	26.0	21.0	25.0	51.0	41.0	4.0	16.0		19.0	45.0	20.0	48.0	47.0	31.0		6.0		43.0	18.0
Westbound	minutes	47.0	25.0	38.0	51.4	55.8	107.2	24.0	25.0	26.0	21.0	25.0	51.0	41.0	4.0	16.0		19.0	45.0	20.0	48.0	47.0	31.0		6.0		43.0	18.0
Total Travel Time	minutes	94.0	50.0	68.4	99.5	116.2	215.7	48.0	50.0	52.0	42.0	50.0	102.0	82.0	8.0	32.0		38.0	90.0	40.0	96.0	94.0	62.0		12.0		86.0	36.0
Outputs																												
Vehicle Requirements																												
Peak	trains	13	7**	7**	10	12	22	5	5	5	4	5	15	12	2	5	7	5	13	6	7	7	9	1	2	3	12	5
Off-Peak	trains	7	4	5	7	8	14	3	3	3	3	3	9	7	2	3	5	3	8	4	4	4	5	1	1	2	7	3
Annual Revenue Hours	hours	37,544	21,008	24,440	34,424	39,936	74,360	15,496	15,496	15,496	14,456	15,496	46,488	36,504	8,944	15,496	24,440	15,496	40,976	19,968	21,008	21,008	26,520	4,472	5,512	9,984	36,504	15,496

*3C: Green Line service split at Anacostia; service south 1/2 No Build frequency

** Calculated values for No Build: WMATA RFMP shows 7 Yellow Line, 12 Green Line peak trains

TABLE B-2: BASE YEAR OPERATING COSTS ($1,000S)

	No Build Green	No Build Yellow	1A	1B	1C	1r	2A	2B	2Br	2C	2Cr	3A Green	3A Yellow	3A Green vs. No Build	3A Yellow vs. No Build	3A	3B	Ref. 3B	3Br vs. No Build	3C* Green Nat Harbor	3C* Green Branch Ave	3C Yellow	3C Green vs. No Build	3C Yellow vs. No Build	3C	3Cr	3Cr vs. No Build
2010 NTD Cost/Revenue Hour	$296.70	$296.70	$153.60	$153.60	$153.60	$153.60	$246.73	$246.73	$246.73	$246.73	$246.73	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70	$296.70
2011 inflation	$311.54	$311.54	$161.28	$161.28	$161.28	$161.28	$259.07	$259.07	$259.07	$259.07	$259.07	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54	$311.54
2012 inflation	$327.11	$327.11	$169.34	$169.34	$169.34	$169.34	$272.02	$272.02	$272.02	$272.02	$272.02	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11	$327.11
Subtotal: Annual Operating Cost of Alternative	$12,281	$6,872	$4,139	$5,829	$6,763	$12,592	$4,215	$4,215	$4,215	$3,932	$4,215	$15,207	$11,941	$2,926	$5,069	$7,995	$5,069	$13,404	$6,532	$6,872	$6,872	$8,675	$1,463	$1,803	$3,266	$11,941	$5,069
Change in Bus Operating Costs																											
NH1			-$643					-$643	-$643							-$643	-$643		-$643								
P17										-$1,849	-$1,849														-$1,849		-$1,849
P19										-$1,101	-$1,101														-$1,101		-$1,101
W14										$0	$0														$0		$0
3B Shuttle																			$845								
Subtotal: Annual Operating Cost, new and modified bus routes			-$643	$0	$0	$0	$0	-$643	-$643	-$2,950	-$2,950					-$643	-$643		$203						-$2,950		-$2,950
Total: Annual Operating Cost vs. No Build			$3,496	$5,829	$6,763	$12,592	$4,215	$3,572	$3,572	$982	$1,265	$15,207	$11,941	$2,926	$5,069	$7,352	$4,426	$13,404	$6,734	$6,872	$6,872	$8,675	$1,463	$1,803	$316	$11,941	$2,119

APPENDIX C: MODELING PROCEDURES FOR INITIAL AND REFINED ALTERNATIVES

C.0 PURPOSE

This memorandum documents key inputs and assumptions tied to the Maryland Alternatives Analysis Phase II (MDAA-II) travel model's forecast ridership for the Capital Beltway South Side Transit Study's (CBSSTS) transit alternatives. Thus, it describes how inputs to the MDAA-II travel model are specified or modified to support the study alternatives. This includes items such as: roadway and transit network modifications, socioeconomic/land use data assumptions, transit speeds for the build alternatives, transit fares, etc. In a sense, this is a companion document to the *Detailed Definition of Alternatives Report*, with emphasis on further detailing how the alternatives are modeled. Some general familiarity with travel demand models is helpful, but not necessary to understanding this document.

C.1 MDAA-II MODEL OVERVIEW

The MDAA-II is the travel demand model currently being used to study two fixed-guideway transit alternatives analyses/draft environmental impact statements (AA/DEIS) for the Maryland Transit Administration (MTA): Purple Line and the Corridor Cities Transitway. The original Phase I model, MDAA-I, was developed to evaluate these two corridors for potential new fixed-guideway transit service. MDAA-II represents an enhancement of the Metropolitan Council of Governments (MWCOG) regional travel demand model version 2 with respect to its ability to generate transit forecasts for major investments, all the while maintaining the integrity of the MWCOG modeling process. MTA directed Parsons to use the MDAA-II model for the CBSSTS.

C.2 MODEL RESULTS SUMMARY

The MDAA-II model is applied to both the initial nine build alternatives (1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, and 3C) as well as the five refined build alternatives (1r, 2Br, 2Cr, 3Br, and 3Cr). However, there are some differences in how the model is applied between the two sets of build alternatives. This section broadly explains these differences and provides a summary of the alternatives' performance against the key metrics to help gauge the impacts of these differences. More detailed information about the differences is provided in Section C.3 Model Modifications.

Model runs for the No-Build and initial nine build alternatives were completed and presented to the Study Technical Committee in June 2012. Their results formed the basis for developing the refined alternatives, for which model runs were completed in October 2012. In commencing the refined alternatives, it was decided that additional traffic analysis zone detail be afforded the zone comprising National Harbor. The purpose of this is to try to better discern transit demand activity in this area (specifically to be able to differentiate transit boardings between the proposed National Harbor North and National Harbor South stations since they were located within the same zone), as the initial alternatives could not make this distinction.

While performing the model runs for the refined alternatives, it was discovered that the MDAA-II model was incorrectly executing two items with regard to drive-to-transit trip-making:

- The MDAA-II model was not properly assigning drive-to-Metrorail trips at new, Metrorail-only park-and-ride lots. This directly affects the Grade-Separated (Metrorail) alternatives, as each alternative has at least one new park-and-ride lot dedicated for Metrorail users. Previous applications of the MDAA-II model, such as for the Purple Line and CCT Studies, have not had alternatives defining new park-and-ride lots serving Metrorail only. Instead, they serve LRT and Metrorail jointly. Consequently, there was no guidance to specify its proper representation for the CBSSTS Grade-Separated alternatives (keeping in mind that the MDAA-II model was not previously designed to test Metrorail alternatives). Refer to Section C.3.2 "Inclusion of Certain Characteristics of the Build Alternatives in the No-Build" for additional details.

- The MDAA-II model was calculating drive-access distances to park-and-ride lots differently depending upon whether the park-and-ride lot serves LRT or Metrorail. This inconsistency affects both the At-Grade and Grade-Separated Guideway alternatives. Refer to Section C.3.2 "Drive-to-Transit Access Distances" for further information.

Corrections were made to both items and the model runs for the refined alternatives then executed properly. However, it was also decided that certain alternatives that were not proposed for refinement should be re-examined, to ensure that this course of action remains appropriate. Thus, this re-running of selected initial alternatives (from June 2012) would be in addition to completing the model runs for the set of refined alternatives. The affected initial alternatives and the reasons for re-examining them follow:

- Alternative 2A – The recommendation was for this alternative to undergo no further revisions, based on it having the lowest ridership and user benefits of the three At-Grade Dedicated Guideway alternatives while also having relatively higher costs. As it is a light rail alternative, the anticipated impacts of the first correction above (which mostly affects Metrorail) was judged to be small. The second correction identified above is more likely to be impactful. Thus, the modeling team thought it important to re-examine Alternative 2A in light of the above corrections, to see if this alternative would fare better.

- Alternative 3A/3B/3C – Being Metrorail alternatives, these are most affected by the change in drive-to-Metrorail station trip-making. The modeling team felt that the improvements experienced with the refined 3B and 3C alternatives (due to the correction) were significant enough that measurable improvements would also be likely with the initial 3A/3B/3C alternatives.

The remaining initial alternatives were at first judged to not be significantly impacted by the corrective actions. But if the results of re-running Initial Alternatives 2A would prove otherwise, then 2B and 2C could be re-run as well.

Table C-1 provides travel model summary results for the nine initial alternatives (June 2012), along with the five refined alternatives and the re-running of selected initial alternatives. The following themes stand out when reviewing Table C-1:

1. **The refined alternatives perform better than their initial alternative counterparts.** This is because the alignment changes that constitute the refinements generally provide a better level of service for the demand (more direct routing reduces in-vehicle time, one-seat ride reduces time spent transferring, etc). Alternative 1r is unique in that it contains two routes—1B and 1C—which provide overlapping service west of Oxon Hill Park and Ride. Therefore, it is not possible to simply compare Alternative 1r results to the combined results of Alternative 1B and Alternative 1C. Rather, the comparison of Alternative 1r results was made to the maximum metric value of either Alternative 1B or 1C. For this comparison, Alternative 1 shows measureable improvements over either Alternatives 1B or 1C alone.

2. **The re-run of Alternative 2A is only marginally better with similar results expected for Alternative 2B and 2C, and would likely be inferior to the refined Alternatives 2B and 2C.** Re-running Alternative 2A to address the drive-access corrections results in only small improvements. Similar small improvements in the metrics would be expected if Alternatives 2B and 2C are re-run. However, more substantial improvements are gained through the refined alternatives, primarily due to improved levels of service.

3. **The re-runs of Alternatives 3A, 3B, and 3C are measurably better as a result of the drive-access corrections, but remain inferior to the performance of their refined alternative counterparts.** Significant gains are realized through the correction of drive-access trip-making. This is to be expected, since it is Metrorail trips that overall stand to benefit the most from the correction and that these are Metrorail alternatives. However, the corresponding refined alternatives each perform significantly better than the Alternative 3A, 3B, and 3C re-runs. Again, this is primarily due to the alignment changes resulting in improved service levels.

[This page is intentionally blank]

TABLE C-1: TRAVEL MODEL SUMMARY RESULTS FOR INITIAL AND REFINED ALTERNATIVES

		ROUND 1 (June 2012)			ROUND 2 (October 2012)						Impacts of Modeling Revisions					
		Initial alternative definitions →			Corrected Metrorail drive-access →			Refined alternative definitions → / Natl. Harbor zone detail added →			Impact of Metrorail Drive-Access Correction (Where Applicable)			Impact of Refinements on Initial Alternative Definitions (Where Applicable)		
Mixed Traffic Alternatives (1-Series)		**Initial Alternatives**			**Initial Alternatives (Re-run)**			**Refined Alternatives**			**Change (Re-run - Initial)**			**Change (Refined - Initial)**		
Metric		**1A**	**1B**	**1C**	**1A**	**1B**	**1C**	**1A**	**1B**	**1 (1B+1C)**	**1A**	**1B**	**1C**	**1A**	**1B**	**1 - (1B+1C)[1]**
Average Weekday Regional Boardings	Total	2,275,200	2,275,700	2,275,200	Not re-run because Refined Alt. 1 is a superior definition and drive-access correction will have a relatively minor impact			Eliminated	Combined with Alt. 1C to create Refined Alt. 1	2,300,200	--	--	--	--	--	24,500
	vs. No-Build	1,700	2,200	1,700						2,700	--	--	--	--	--	500
	Alternative Daily Boardings on Alternative	2,400	4,200	4,000						7,400	--	--	--	--	--	3,200
Average Weekday Regional Transit Trips	Total	1,471,600	1,471,800	1,471,800						1,492,920	--	--	--	--	--	21,120
	vs. No-Build	800	1,000	1,000						1,500	--	--	--	--	--	500
	Crossing WWB	1,500	2,300	2,600						2,100						-500
Average Weekday User Benefits (hours)		500	600	700						1,000	--	--	--	--	--	300
Max. Allowable Cost to Meet User Benefits for $25.49 Cost Effectiveness (2012$ 1000's)		$47,446	$56,935	$66,424						$94,892	--	--	--	--	--	$28,467
At-Grade Dedicated Alternatives (2-Series)		**Initial Alternatives**			**Initial Alternatives (Re-run)**			**Refined Alternatives**			**Change (Re-run - Initial)**			**Change (Refined - Initial)**		
Metric		**2A**	**2B**	**2C**	**2A**	**2B**	**2C**	**2A**	**2Br**	**2Cr**	**2A**	**2B**	**2C**	**2A**	**2B**	**2C**
Average Weekday Regional Boardings	Total	2,294,200	2,298,600	2,309,900	2,318,100	Not re-run because Refined Alt. 2B & 2C are superior definitions and drive-access correction will have a relatively minor impact		No further revisions to the Alt. 2A definition were specified	2,326,500	2,334,000	23,900	--	--	--	27,900	24,100
	vs. No-Build	20,700	25,000	36,400	20,100				28,900	36,500	-600	--	--	--	3,900	100
	Alternative Daily Boardings on Alternative	17,300	19,800	32,100	18,200				23,600	45,400	900	--	--	--	3,800	13,300
Average Weekday Regional Transit Trips	Total	1,480,300	1,481,800	1,487,500	1,501,100				1,505,800	1,509,800	20,800	--	--	--	24,000	22,300
	vs. No-Build	9,500	11,000	16,700	9,800				14,400	18,400	300	--	--	--	3,400	1,700
	Crossing WWB	11,000	11,000	10,000	11,500				14,300	14,100	500	--	--	--	3,300	4,100
Average Weekday User Benefits (hours)		4,800	6,000	11,400	4,900				7,600	16,000	100	--	--	--	1,600	4,600
Max. Allowable Cost to Meet User Benefits for $25.49 Cost Effectiveness (2012$ 1000's)		$455,480	$569,350	$1,081,765	$464,969				$721,176	$1,518,266	$9,489	--	--	--	$151,827	$436,501
Grade-Separated Alternatives (3-Series)		**Initial Alternatives**			**Initial Alternatives (Re-run)**			**Refined Alternatives**			**Change (Re-run - Initial)**			**Change (Refined - Initial)**		
Metric		**3A**	**3B**	**3C**	**3A**	**3B**	**3C**	**3A**	**3Br**	**3Cr**	**3A**	**3B**	**3C**	**3A**	**3B**	**3C**
Average Weekday Regional Boardings	Total	2,282,700	2,292,200	2,278,800	2,318,400	2,333,400	2,324,300	No further revisions to the Alt. 3A definition were specified	2,336,700	2,374,500	35,700	41,200	45,500	--	3,300	50,200
	vs. No-Build	9,100	18,600	5,300	20,400	35,400	26,400		39,100	77,000	11,300	16,800	21,100	--	3,700	50,600
	Alternative Daily Boardings on Alternative	11,700	15,100	25,200	23,400	26,100	40,900		29,600	63,600	11,700	11,000	15,700	--	3,500	22,700
Average Weekday Regional Transit Trips	Total	1,477,400	1,476,400	1,477,700	1,505,800	1,501,900	1,510,900		1,513,700	1,526,200	28,400	25,500	33,200	--	11,800	15,300
	vs. No-Build	6,600	5,600	6,900	14,500	10,600	19,600		22,300	34,800	7,900	5,000	12,700	--	11,700	15,200
	Crossing WWB	11,800	4,900	7,200	23,800	13,900	8,400		25,700	22,600	12,000	9,000	1,200		11,800	14,200
Average Weekday User Benefits (hours)		4,500	3,800	4,000	11,000	7,700	12,600		14,200	21,900	6,500	3,900	8,600	--	6,500	9,300
Max. Allowable Cost to Meet User Benefits for $25.49 Cost Effectiveness (2012$ 1000's)		$427,012	$360,588	$379,566	$1,043,808	$730,665	$1,195,634		$1,347,461	$2,078,127	$616,796	$370,077	$816,068	--	$616,796	$882,492

[1]The change in Refined Alternative 1 is compared to the maximum metric value of either Initial Alternative 1B or 1C.

Color Key: Re-run of Initial Alternative Refined Alternative

[This page is intentionally blank]

C.3 MODEL MODIFICATIONS

Application of the MDAA-II model for the CBSSTS alternatives is generally the same as its application in the Purple Line and Corridor Cities Transitway studies. However, the CBSSTS represents the first time the MDAA model has been used to test a Metrorail alternative. As such, there are certain modifications that are unique to the Metrorail alternatives only. MDAA-II model modifications common to all CBSSTS alternatives (including the no-build) are discussed initially. Documentation of alternative-specific inputs and assumptions then follows.

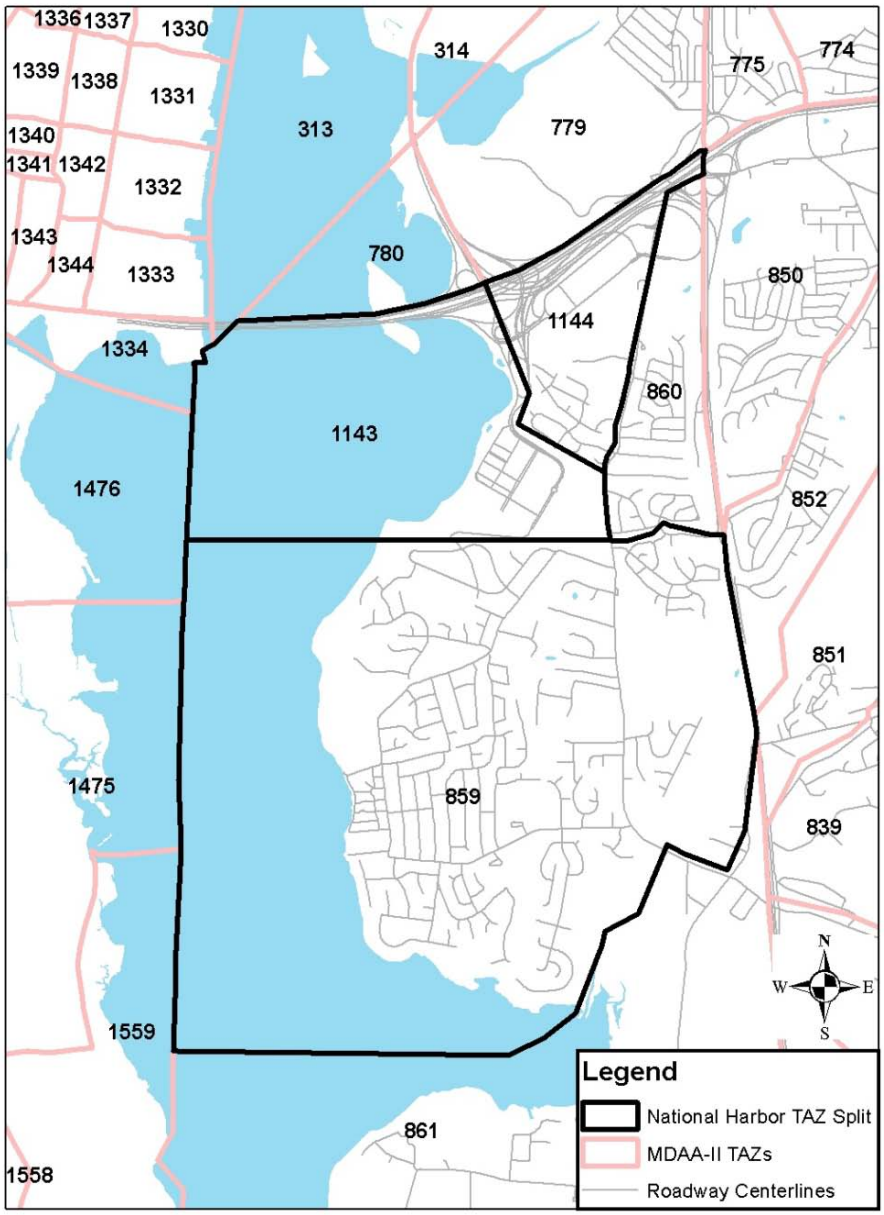
C.2.1 Modifications Common to All Alternatives

Modifications common to all CBSSTS alternatives, including the No-Build, are discussed in this section. These include changes to the model's traffic analysis zone structure and underlying socioeconomic data, as well as the transportation network.

Traffic Analysis Zone Structure

MDAA-II model zones that were split for Purple Line and Corridor Cities Transitway studies remain split for CBSSTS alternatives. One additional zone—the area encompassing National Harbor—is split into three smaller zones specifically for the five CBSSTS refined alternatives (the original alternatives maintain the zone system used in Purple Line and Corridor Cities Transitway Studies). The splitting of the National Harbor zone is done to afford more detail about transit activity within the National Harbor area and specifically, to be able to differentiate between this activity at proposed National Harbor North and National Harbor South stations. Figure C-1 below illustrates how the existing National Harbor zone is split.

FIGURE C-1: NATIONAL HARBOR ZONE SPLITTING



Socioeconomic Data

The model uses the approved MWCOG Round 8 2040 land use forecasts. Because of the additional zone split at National Harbor, this socioeconomic data is also split into the respective zones. At the time of the modeling, development plans for National Harbor remained fluid, but for purposes of this study, the data reflect the approved MWCOG Round 8 land use forecasts. Table C-2 below lists the assumed zone splitting percentages for the socioeconomic variables involved at National Harbor.

TABLE C-2: ALLOCATION OF SOCIOECONOMIC DATA TO THE NATIONAL HARBOR SPLIT ZONES

Socioeconomic Variable	Fort Foote (Zone 859)	Nat'l Harbor South (Zone 1143)	Nat'l Harbor North (Zone 1144)
Households	92%	4%	4%
Household Population	92%	4%	4%
Group Quarters Population	92%	4%	4%
Industrial Employment	2%	38%	60%
Retail Employment	2%	93%	5%
Office Employment	2%	93%	5%
Other Employment	4%	91%	5%

Transportation Network

The background roadway and transit networks are updated to reflect the MWCOG 2011 Constrained Long-Range Transportation Plan (CLRP), which was the most current approved CLRP at the time the modeling activities were initiated. Only updates in the CBSSTS study area are considered. The *South Side Transit Study Initial Alternatives Report*, dated November 2011, details the committed improvements within the study area that are incorporated into the MDAA-II transportation network. These improvements are also summarized in Table C-3 below.

TABLE C-3: MAJOR COMMITTED IMPROVEMENTS IN THE STUDY AREA INCORPORATED INTO MDAA-II

Jurisdiction	Project	Implementation Date
District of Columbia	Anacostia Streetcar Project Phases I	2012
	11th Street Bridge reconstruction	2013
	I-295, reconstruct interchange at Malcolm X Blvd to improve access to Saint Elizabeths Campus	2014
	South Capitol Street Corridor, bridge reconstruction, including interchange at Suitland Parkway and Martin Luther King Jr. Blvd	2016*
Maryland	I-95/495, Branch Avenue Metrorail access improvements	2020
	MD 210, upgrade 6 lanes and interchanges	2030*
	MD 5, upgrade, widen to 6 lanes, including interchanges	2020*
	Suitland Parkway, interchange at Rena/Forestville Rd	2025
Virginia	Crystal City/Potomac Yard Busway (2013), to be replaced by streetcar service (2018), Arlington and Alexandria	2018*
	I-395/95 HOV and HOT Lanes from 2 miles north of I-495 to VA 610	2015*
	Potomac Yard Metro Station	2017
	US-1 bus right turn lanes	2035
	VA 244 Columbia Pike Streetcar from Skyline to Pentagon City	2016
	I-95, construct approaches to Woodrow Wilson Bridge	2011
	I-95/495, reconstruct interchange at VA 613	2015
	I-95/I-395/I-495, interchange access ramps to I-495 HOV	2013
	I-395 HOV lanes south reversible ramp from/to Seminary Road	2015

*Multiple projects; final completion date listed.

Source: MWCOG Financially Constrained Long Range Transportation Plan, approved on November 16, 2011

Transit Fare

Transit fare policy for the CBSSTS transit alternatives are updated to 2011 conditions, which is consistent with the fare policy used in the Purple Line and Corridor Cities Transitway Studies. Tables C-4 and C-5 present boarding fares for the modes characterizing the CBSSTS transit alternatives under the updated fare policy. Note that the fares represent cash fares and are

expressed in year 2011 dollars for reader comparison (the fares are adjusted internally within the model to reflect usage rates of the different fare media and user type).

TABLE C-4: TRANSIT BOARDING FARES (NON-METRORAIL)

Build Alternatives	Transit Mode	Boarding Fare[1]
Mixed Traffic	Metrobus Express	$3.85
Dedicated Guideway	LRT	$1.70
Exclusive Guideway	Metrorail	Varies (Distance-Based)

[1]Fares listed are in year 2011 dollars and represent cash fare. Metrorail fares vary by peak/off-peak period and boarding and alighting station-to-station pair (see Table C-5).

TABLE C-5: TRANSIT BOARDING FARES (METRORAIL)

Metrorail Fare Structure	Peak Fare[1]	Off-Peak Fare[1]
First 3 composite[2] miles	$2.15	--
Each additional composite mile > 3 and <= 6	$0.299	--
Each composite mile > 6	$0.265	--
Maximum regular fare	$5.20	--
First 7 composite[2] miles	--	$1.60
Composite > 7 & <=10 miles	--	$2.15
Composite > 10 miles	--	$2.75

[1]Source: WMATA Tariff Number 31, Effective October 21, 2011. Fares listed are in year 2011 dollars and represent regular cash fare.

[2] A composite mile is the average of the straight-line (airline) distance between stations and the actual over-the-rail distance.

Because the Metrorail fares are distance-based, the system-wide fare matrix for Metrorail is updated for each Metrorail alternative. For example, adding Metrorail service across the Woodrow Wilson Bridge shortens trip distances for selected station pairs. Trip distances on Metrorail are re-computed and fares recalculated based on the information in Table C-5 above for each Metrorail alternative.

Metrorail Park-and-Ride Capacity Restraint Shadow Price Iterations

Standard application of the MDAA-II model constrains Metrorail park-and-ride demand (home-based work peak only) by available lot capacity. This is accomplished through an iterative procedure whereby travel costs are increased until park-and-ride demand is less than or equal to 105% of each lot's capacity. This travel cost is referred to as a "shadow price."

One consequence of this procedure is that it greatly increases the model execution times. For the CBSSTS Build Alternatives, the starting point for the iterative parking restraint procedure is set equal to the final (41st) iteration generated by the No Build Alternative. Doing this resulted in faster convergence for each of the CBSSTS Build Alternatives, as the number of iterations ranged between one and ten additional iterations, depending upon the location and amount of park-and-ride capacity added.

C.2.2 Alternative-Specific Modifications

The uniqueness of the CBSSTS alternatives requires additional modifications that are tailored to each alternative. These are discussed below.

Inclusion of Certain Characteristics of the Build Alternatives in the No-Build

In order to properly model drive-to-transit trips to new Metrorail stations (i.e. for any Metrorail alternative), these Metrorail park-and-ride lots must be coded in the No-Build network as well. (Note: however, these stations remain not active in the sta_tpp.bse file, so that park-and-ride trips are not attracted to them). Having these "ghost" new Metrorail stations in the No-Build allows the model to properly build paths to the lots when they are active in the Build Alternatives.

Travel Times for the Alternatives

The MDAA-II model requires alternatives operating in their own guideway (dedicated or exclusive) to have the travel times between stations as an input. Detailed station-to-station travel times are calculated for each of the dedicated guideway alternatives (2A, 2B, 2Br, 2C, and 2Cr) and exclusive guideway alternatives (3A, 3B, 3Br, 3C, and 3Cr). Initially, potential transit route alignments and stations are coded into a GIS base map of regional street centerlines. The station-to-station distances are then measured within the GIS base map to provide a high degree of precision. The station-to-station travel times are then determined using basic kinematic equations, assumed acceleration and deceleration rates, and approximate maximum cruise speeds. The maximum cruise speed is the speed which the vehicle will attempt to reach between stations. The maximum cruise speed assumptions are:

- 35 mph for dedicated guideway operations adjacent to local roadways
- 55 mph for operating within exclusive lanes either parallel to or within the median of the Beltway
- 45 mph for Metrorail outside of the Beltway ROW

The overall travel time estimates also include station stop dwell times of ½-minute. Table 6 summarizes the modeled distances, travel times, and average speeds for the guideway alternatives. This information is detailed at the station-to-station level in Tables C-10 through C-21 located at the end of this appendix.

For the mixed flow bus alternatives, the modeled speeds and travel times are calculated by the MDAA-II model. In general, the bus speeds reflect the highway congested travel times estimated by the model plus additional link level bus time delay. The bus speed model, as implemented within the MDAA-II model, calculates the additional bus delay based on the traversed roadway's facility type and area type. The distances, travel times, and speeds for the mixed flow bus alternatives are summarized in Table C-6 also, while the more detailed information estimated by the model at the bus route segment level are reported in Tables C-22 through C-31 at the end of this appendix.

TABLE C-6: MODELED DISTANCE, TRAVEL TIME, AND AVERAGE SPEED BY ALTERNATIVE

Alternative	Distance (miles)	Travel Time (minutes)	Average Speed (mph)
1A Mixed Traffic Peak (eastbound/westbound)	11.8 / 11.2	30.4 / 38.0	23 / 18
1A Mixed Traffic Off-Peak (eastbound/westbound)	11.8 / 11.2	26.6 / 25.8	27 / 26
1B Mixed Traffic Peak (eastbound/westbound)	13.4 / 13.4	48.1 / 51.4	17 / 16
1B Mixed Traffic Off-Peak (eastbound/westbound)	13.4 / 13.4	37.9 / 37.9	21 / 21
1C Mixed Traffic Peak (eastbound/westbound)	11.7 / 11.7	60.4 / 55.8	12 / 13
1C Mixed Traffic Off-Peak (eastbound/westbound)	11.7 / 11.7	43.0 / 43.7	16 / 16
1Br Mixed Traffic Peak (eastbound/westbound)	11.3 / 11.8	36.8 / 41.5	18 / 17
1Br Mixed Traffic Off-Peak (eastbound/westbound)	11.3 / 11.8	28.7 / 30.2	24 / 23
1Cr Mixed Traffic Peak (eastbound/westbound)	9.6 / 10.1	48.8 / 45.5	12 / 13
1Cr Mixed Traffic Off-Peak (eastbound/westbound)	9.6 / 10.1	33.9 / 36.0	17 / 17
2A At-Grade Dedicated ROW	13.1	24.3	32
2B At-Grade Dedicated ROW	11.9	24.8	29
2C At-Grade Dedicated ROW	9.9	21.4	28
2Br At-Grade Dedicated ROW	12.3	26.4	28
2Cr At-Grade Dedicated ROW	11.2	25.3	27
3A Grade Separated ROW	10.7	16.2	39
3A Grade Separated ROW Green Line Extension	3.0	4.4	41
3B Grade Separated ROW	11.7	18.8	38
3C Grade Separated ROW	3.9	5.7	41
3C Grade Separated ROW Green Line Extension	6.3	12.2	31
3Br At-Grade Dedicated ROW	12.0	20.0	36
3Cr At-Grade Dedicated ROW	10.2	18.4	33

Updated Walk-to-Transit Coverage Files

Walk accessibility to transit is represented, in part, by a walk coverage file. This input data file contains the percentage of each zone that is within a specified distance of any transit stop. The MDAA-II model uses one mile as the walk coverage distance. Thus, one mile buffers are drawn (using GIS) around each transit stop and the proportion of each zone's area that is within any buffer is calculated and reported for each zone as a percentage. The standard GIS-based walk coverage procedure is applied to each alternative, including the no-build, yielding walk coverage files tailored to the unique set of transit stops associated with each alternative.

Drive-to-Transit Access Distances

The MDAA-II model provided to the study team calculates drive-access distances to park-and-ride lots differently depending upon whether the park-and-ride lot serves LRT or Metrorail.

For LRT, the distance to the park-and-ride lot is computed to the centroid of the zone where the lot is located, whereas for Metrorail this distance is computed directly to the lot. This inconsistency, which affects both the dedicated guideway and exclusive guideway alternatives, was brought to the attention of the developers of the MDAA-II model, Parsons Brinckerhoff, who subsequently made the modification. (Note: this is not an issue in the Purple Line and CCT Studies because there are no Metrorail alternatives being compared to light rail). The drive-access distance calculation procedure for light rail is changed to match the Metrorail procedure, so now both modes use the same procedure.

Park-and-Ride Lot Catchment Areas

The MDAA-II model has parameters that define the catchment areas for park-and-ride lots. One of the key parameters is maximum drive-to-transit distance, which, as the name suggests, defines the maximum distance one is willing to drive to a park-and-ride lot. The MDAA-II model specifies these maximum drive distances by mode and by lot location. Table C-7 shows the maximum drive distances allowed for the three relevant modes in the CBSSTS.

TABLE C-7: PARK-AND-RIDE MAXIMUM DRIVE DISTANCES

Type Code[1]	Maximum Drive Distance (miles)		
	Metrorail	Light Rail	Bus
1	45.0	5.0	5.0
2	30.0	N/A	N/A
3	15.0	N/A	N/A
4	7.5	N/A	N/A
0	3.0	3.0	3.0

Source: *New Starts Travel Forecasting Model Calibration Report for Evaluating the Purple Line and the Corridor Cities Transitway Projects*, November 2010.

[1]Type code describes the location of the park-and-ride lot with respect to the transit network. Generally, code 1 describes lots located at the end of the line; codes 2 and 3 are used for intermediate stations, with code 3 representing park-and-ride lots closer to the CBD; and code 0 (or null) describes a kiss-and-ride only station.

New park-and-ride stations for the CBSSTS alternatives closely follow the type code conventions shown in Table C-7 and are consistent with previous applications of the MDAA-II model. Table C-8 lists the type codes for the new park-and-ride lot stations associated with the various CBSSTS alternatives. It also lists existing park-and-ride stations where a new fixed-guideway mode is introduced (e.g. an existing park-and-ride facility serving Metrorail that introduces light rail as part of the alternative definition). In cases where a single park-and-ride lot serves multiple modes, the MDAA-II model recognizes this as one lot serving the demand of each mode, and the drive-shed is based on the type code for the "higher" mode (e.g. if both Metrorail and light rail serve a lot, then the Metrorail type code would be used for both modes). Accordingly, the Table C-7 type code at a park-and-ride facility need not be the same for each mode utilizing that lot. Again, this follows the coding conventions for previous MDAA-II model applications.

TABLE C-8: PARK-AND-RIDE TYPE CODE FOR CBSSTS ALTERNATIVE NEW PARK-AND-RIDE STATIONS

New Park-and-Ride Station	Applicable Alternative(s)[1]	Type Code
Oxon Hill Park-and-Ride	2A, 2B, 2C, 2Br, 2Cr	1 (LRT)
Beltway Park-and-Ride	2A	1 (LRT)
	3A	2 (Metrorail)
Branch Avenue	2A, 2Br	1 (LRT)
Suitland	2B	1 (LRT)
Eastover Park-and-Ride	2C, 2Cr	1 (LRT)
	3C, 3Cr	2 (Metrorail)
Southern Avenue	2C	1 (LRT)
National Harbor North	3A, 3B, 3C, 3Br, 3Cr	2 (Metrorail)
Anacostia	2Cr	1 (LRT)

[1]A description of the alternatives can be found in the August 2012 *Refined Alternatives Final Report*.

Walk Time from Park-and-Ride Lot and Assumed Lot Capacities

As part of pathbuilding for mode choice calculations, the MDAA-II model assigns an average walk time between each park-and-ride lot and the transit station it serves according to the underlying theory that the size of the lot directly influences the amount of time needed to walk between the location of the parked vehicle and the transit station. Because the lot size is in direct relation to the resulting walk time, attempts to provide unconstrained (i.e. very large) capacity at proposed new park-and-ride lots under the CBSSTS alternatives are not without consequences. Specifically, an "infinitely" large lot capacity would attempt to accommodate all the demand but would also subject this demand to longer walk-across-the-lot times than perhaps is necessary. This would, in turn, result in lessening the park-and-ride demand at this lot.

Table C-9 shows the walk times between the park-and-ride lot and the transit station used by the model, based on the input lot size. All proposed new park-and-ride lots for the CBSSTS alternatives are assumed to have a capacity of 4,000 spaces, which results in a 3.5 minute walk time. This value is chosen as a compromise between providing a sufficient number of spaces such that most new lots would not be constrained while still minimizing the impact of the additional walk time on all lot users, such that park-and-ride demand would generally be maximized. The uniform use of 4,000 spaces ensures no bias across alternatives. Subsequent study phases can refine this lot capacity assumption based on refined demand estimates.

TABLE C-9: AVERAGE WALK TIME BETWEEN THE PARK-AND-RIDE LOT AND TRANSIT STATION AS A FUNCTION OF LOT SIZE

Parking Lot Capacity (Spaces)	Assigned Average Minutes of Access Time
1 - 350	2.0
351 - 1,269	3.0
1,270 – 4,000	3.5
4,001 – 5,800	4.5
5,801 – 99,999	7.0

Source: *New Starts Travel Forecasting Model Calibration Report for Evaluating the Purple Line and the Corridor Cities Transitway Projects*, November 2010.

Walk Time to Platform (Metrorail Only)

The MDAA-II model recognizes that some Metrorail stations are very deep and therefore can require a significant amount of access time spent on escalators and walking along long platforms, compared to other stations. Thus, the model includes a walk time between the entrance to the Metrorail station and the platform as one component of the overall Metrorail path impedance. The times, which are determined based on field data collected at each station, range between 1.0 and 5.0 minutes (and are specified to the nearest 0.5 minute). Hence, each new Metrorail station as part of the CBSSTS alternatives needs to be assigned a walk-to-platform time. A value of 1.5 minutes is chosen for each new Metrorail station, to promote consistent evaluation across the Metrorail alternatives while also recognizing the early planning stages of this study. Lower values also tend to be typical of Metrorail stations near the periphery of the Beltway, which characterize the CBSSTS fixed-guideway alternative station locations.

Tables C-10 through C-21: Guideway Alternative Modeled Station-to-Station Distances, Travel Times and Average Speeds

Note that for each table, the information is the same in both directions, but is shown for one direction only.

TABLE C-10: ALTERNATIVE 2A – AT-GRADE DEDICATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
King Street	Eisenhower Avenue	0.871	4,597	35	1.20	29	1.78	0.50	2.28	23
Eisenhower Avenue	Enter Exclusive Lane	0.895	4,724	35	1.39	32	1.68		1.68	32
Enter Exclusive Lane	Exit Exclusive Lane	2.331	12,307	55	2.54	55	2.54		2.54	55
Exit Exclusive Lane	National Harbor North	0.581	3,069	35	0.85	31	1.14	0.50	1.64	21
National Harbor North	Oxon Hill P&R	0.470	2,481	35	0.51	26	1.10	0.50	1.60	18
Oxon Hill P&R	Oxon Hill	0.928	4,899	35	1.30	30	1.88	0.50	2.38	23
Oxon Hill	Enter Exclusive Lane	0.987	5,212	35	1.55	32	1.84		1.84	32
Enter Exclusive Lane	Beltway P&R	1.286	6,792	55	1.17	47	1.63	0.50	2.13	36
Beltway P&R	Exit Exclusive Lane	1.812	9,566	55	1.75	49	2.21		2.21	49
Exit Exclusive Lane	Branch Avenue	1.290	6,810	35	2.07	33	2.36	0.50	2.86	27
Branch Avenue	Joint Base Andrews	1.674	8,840	35	2.58	32	3.16		3.16	32
	Totals	13.12	69,297		16.91	37	21.32	3.00	24.32	32

TABLE C-11: ALTERNATIVE 2B – AT-GRADE DEDICATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
King Street	Eisenhower Avenue	0.871	4,597	35	1.20	29	1.78	0.50	2.28	23
Eisenhower Avenue	Enter Exclusive Lane	0.895	4,724	35	1.39	32	1.68		1.68	32
Enter Exclusive Lane	Exit Exclusive Lane	2.217	11,708	55	2.42	55	2.42		2.42	55
Exit Exclusive Lane	National Harbor South	0.777	4,105	35	1.19	32	1.48	0.50	1.98	24
National Harbor South	National Harbor North	1.028	5,428	35	1.47	30	2.05	0.50	2.55	24
National Harbor North	Oxon Hill P&R	0.480	2,536	35	0.53	26	1.12	0.50	1.62	18
Oxon Hill P&R	Oxon Hill	0.931	4,915	35	1.30	30	1.89	0.50	2.39	23
Oxon Hill	St. Barnabas South	1.383	7,302	35	2.08	31	2.66	0.50	3.16	26
St. Barnabas South	St. Barnabas North	1.489	7,864	35	2.26	31	2.85	0.50	3.35	27
St. Barnabas North	Suitland P&R	1.789	9,444	35	2.77	32	3.36		3.36	32
	Totals	11.86	62,623		16.62	33	21.28	3.50	24.78	29

TABLE C-12: ALTERNATIVE 2C – AT-GRADE DEDICATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
King Street	Eisenhower Avenue	0.871	4,597	35	1.20	29	1.78	0.50	2.28	23
Eisenhower Avenue	Enter Exclusive Lane	0.895	4,724	35	1.39	32	1.68		1.68	32
Enter Exclusive Lane	Exit Exclusive Lane	2.217	11,708	55	2.42	55	2.42		2.42	55
Exit Exclusive Lane	National Harbor South	0.777	4,105	35	1.19	32	1.48	0.50	1.98	24
National Harbor South	National Harbor North	1.028	5,428	35	1.47	30	2.05	0.50	2.55	24
National Harbor North	Oxon Hill P&R	0.480	2,536	35	0.53	26	1.12	0.50	1.62	18
Oxon Hill P&R	Forest Heights	1.189	6,279	35	1.75	31	2.33	0.50	2.83	25
Forest Heights	Eastover P&R	0.440	2,321	35	0.46	25	1.05	0.50	1.55	17
Eastover P&R	Washington Highlands	0.764	4,035	35	1.02	29	1.60	0.50	2.10	22
Washington Highlands	Southern Avenue P&R	1.216	6,419	35	1.79	31	2.38		2.38	31
	Totals	9.88	52,152		13.22	33	17.88	3.50	21.38	28

TABLE C-13: ALTERNATIVE 3A – GRADE-SEPARATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
Huntington	U.S. Route 1	0.703	3,713	55	0.31	34	1.23	0.50	1.73	24
U.S. Route 1	National Harbor North P&R	3.115	16,445	55	2.94	48	3.86	0.50	4.36	43
National Harbor North P&R	Oxon Hill	1.276	6,739	55	0.93	41	1.85	0.50	2.35	33
Oxon Hill	Beltway P&R	2.391	12,622	55	2.15	47	3.07	0.50	3.57	40
Beltway P&R	Joint Base Andrews	3.193	16,859	50	3.41	45	4.25		4.25	45
	Totals	10.68	56,379		9.75	45	14.25	2.00	16.25	39

TABLE C-14: ALTERNATIVE 3A – GRADE-SEPARATED ROW – GREEN LINE EXTENSION

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
Branch Avenue	Joint Base Andrews	3.006	15,870	45	3.63	41	4.38		4.38	41
	Totals	3.01	15,870		3.63	41	4.38	0.00	4.38	41

TABLE C-15: ALTERNATIVE 3B – GRADE-SEPARATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
Eisenhower	National Harbor North P&R	3.571	18,856	55	3.44	49	4.35	0.50	4.85	44
National Harbor North P&R	Oxon Hill	1.279	6,752	55	0.94	41	1.85	0.50	2.35	33
Oxon Hill	St. Barnabas	2.968	15,669	45	3.58	41	4.33	0.50	4.83	37
St. Barnabas	Suitland	2.141	11,306	45	2.48	40	3.23	0.50	3.73	34
Suitland	Branch Avenue	1.780	9,398	40	2.34	36	3.00		3.00	36
	Totals	11.74	61,983		12.77	42	16.77	2.00	18.77	38

TABLE C-16: ALTERNATIVE 3C – GRADE-SEPARATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
Huntington	U.S. Route 1	0.693	3,658	55	0.30	34	1.21	0.50	1.71	24
U.S. Route 1	National Harbor South	3.251	17,165	55	3.09	49	4.00		4.00	49
	Totals	3.94	20,823		3.39	45	5.22	0.50	5.72	41

TABLE C-17: ALTERNATIVE 3C – GRADE-SEPARATED ROW – GREEN LINE EXTENSION

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
Anacostia P&R	St. Elizabeths	0.998	5,271	45	0.96	35	1.71	0.50	2.21	27
St. Elizabeths	Bellevue	1.466	7,740	45	1.58	38	2.33	0.50	2.83	31
Bellevue	Eastover P&R	0.850	4,487	45	0.76	34	1.51	0.50	2.01	25
Eastover P&R	National Harbor North P&R	1.706	9,005	45	1.90	39	2.65	0.50	3.15	32
National Harbor North P&R	National Harbor South	1.242	6,558	45	1.28	37	2.03		2.03	37
	Totals	6.26	33,060		6.47	37	10.22	2.00	12.22	31

TABLE C-18: ALTERNATIVE 2Br – AT-GRADE DEDICATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
King Street	Eisenhower Avenue	0.871	4,597	35	1.20	29	1.78	0.50	2.28	23
Eisenhower Avenue	Enter Exclusive Lane	0.895	4,724	35	1.39	32	1.68		1.68	32
Enter Exclusive Lane	Exit Exclusive Lane	2.217	11,708	55	2.42	55	2.42		2.42	55
Exit Exclusive Lane	National Harbor South	0.777	4,105	35	1.19	32	1.48	0.50	1.98	24
National Harbor South	National Harbor North	1.028	5,428	35	1.47	30	2.05	0.50	2.55	24
National Harbor North	Oxon Hill P&R	0.480	2,536	35	0.53	26	1.12	0.50	1.62	18
Oxon Hill P&R	Oxon Hill	0.931	4,915	35	1.30	30	1.89	0.50	2.39	23
Oxon Hill	St. Barnabas South	1.383	7,302	35	2.08	31	2.66	0.50	3.16	26
St. Barnabas South	St. Barnabas North	1.489	7,864	35	2.26	31	2.85	0.50	3.35	27
St. Barnabas North	Old Branch Ave	0.984	5,196	35	1.40	30	1.98	0.50	2.48	24
Old Branch Ave	Branch Ave	1.262	6,663	35	1.87	31	2.46		2.46	31
	Totals	12.32	65,038		17.11	33	22.36	4.00	26.36	28

TABLE C-19: ALTERNATIVE 2Cr – AT-GRADE DEDICATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
King Street	Eisenhower Avenue	0.871	4,597	35	1.20	29	1.78	0.50	2.28	23
Eisenhower Avenue	Enter Exclusive Lane	0.895	4,724	35	1.39	32	1.68		1.68	32
Enter Exclusive Lane	Exit Exclusive Lane	2.217	11,708	55	2.42	55	2.42		2.42	55
Exit Exclusive Lane	National Harbor South	0.777	4,105	35	1.19	32	1.48	0.50	1.98	24
National Harbor South	National Harbor North	1.028	5,428	35	1.47	30	2.05	0.50	2.55	24
National Harbor North	Oxon Hill P&R	0.480	2,536	35	0.53	26	1.12	0.50	1.62	18
Oxon Hill P&R	Forest Heights	1.189	6,279	35	1.75	31	2.33	0.50	2.83	25
Forest Heights	Eastover P&R	0.440	2,321	35	0.46	25	1.05	0.50	1.55	17
Eastover P&R	Bellevue	0.849	4,483	35	1.16	29	1.75	0.50	2.25	23
Bellevue	Congress Heights	0.909	4,800	35	1.27	29	1.85	0.50	2.35	23
Congress Heights	St. Elizabeths	0.560	2,957	35	0.67	27	1.25	0.50	1.75	19
St. Elizabeths	Anacostia	0.998	5,271	35	1.42	30	2.00		2.00	30
	Totals	11.21	59,209		14.92	32	20.76	4.50	25.26	27

TABLE C-20: ALTERNATIVE 3Br – GRADE-SEPARATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
Huntington	U.S. Route 1	0.703	3,713	55	0.31	34	1.23	0.50	1.73	24
U.S. Route 1	National Harbor North P&R	3.115	16,445	55	2.94	48	3.86	0.50	4.36	43
National Harbor North P&R	Oxon Hill	1.279	6,752	55	0.94	41	1.85	0.50	2.35	33
Oxon Hill	St. Barnabas	2.968	15,669	45	3.58	41	4.33	0.50	4.83	37
St. Barnabas	Suitland	2.141	11,306	45	2.48	40	3.23	0.50	3.73	34
Suitland	Branch Avenue	1.780	9,398	40	2.34	36	3.00		3.00	36
	Totals	11.99	63,284		12.58	41	17.50	2.50	20.00	36

TABLE C-21: ALTERNATIVE 3Cr – GRADE-SEPARATED ROW

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Distance (feet)	Max Cruise Speed (mph)	Cruise Time (minutes)	Average Running Speed (mph)	Total Running Time (minutes)	Station Dwell Time (minutes)	Total Travel Time (minutes)	Average Overall Speed (mph)
Huntington	U.S. Route 1	0.693	3,658	55	0.30	34	1.21	0.50	1.71	24
U.S. Route 1	National Harbor South	3.251	17,165	55	3.09	49	4.00	0.50	4.50	43
National Harbor South	National Harbor North P&R	1.242	6,558	45	1.28	37	2.03	0.50	2.53	29
National Harbor North P&R	Eastover P&R	1.706	9,005	45	1.90	39	2.65	0.50	3.15	32
Eastover P&R	Bellevue	0.850	4,487	45	0.76	34	1.51	0.50	2.01	25
Bellevue	St. Elizabeths	1.466	7,740	45	1.58	38	2.33	0.50	2.83	31
St. Elizabeths	Anacostia	0.998	5,271	45	0.96	35	1.71		1.71	35
	Totals	10.21	53,883		9.86	40	15.44	3.00	18.44	33

Tables C-22 through C-31: Mixed Flow Bus Alternative Modeled Segment Distances, Travel Times, and Average Speeds

TABLE C-22: ALTERNATIVE 1A – MIXED TRAFFIC – BRANCH AVENUE – PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	5.94	13.0	Branch Avenue	Oxon Hill P&R	5.450	10.09	32.4
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.44	15.0	Oxon Hill P&R	National Harbor North	1.070	3.42	18.8
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.30	60.8	National Harbor North	Enter Exclusive Lane	0.240	0.87	16.6
Exit Exclusive Lane	National Harbor North	0.240	0.85	16.9	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.82	49.6
National Harbor North	Oxon Hill P&R	1.070	3.42	18.8	Exit Exclusive Lane	Eisenhower Avenue	0.850	7.68	6.6
Oxon Hill P&R	Branch Avenue	6.010	14.49	24.9	Eisenhower Avenue	King Street	1.290	13.10	5.9
	Totals	11.80	30.44	23.3		Totals	11.23	37.98	17.7

TABLE C-23: ALTERNATIVE 1A – MIXED TRAFFIC – BRANCH AVENUE – OFF-PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	6.57	11.8	Branch Avenue	Oxon Hill P&R	5.450	8.66	37.8
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.87	13.3	Oxon Hill P&R	National Harbor North	1.070	3.42	18.8
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.34	59.7	National Harbor North	Enter Exclusive Lane	0.240	0.87	16.6
Exit Exclusive Lane	National Harbor North	0.240	0.85	16.9	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.33	60.0
National Harbor North	Oxon Hill P&R	1.070	3.42	18.8	Exit Exclusive Lane	Eisenhower Avenue	0.850	3.83	13.3
Oxon Hill P&R	Branch Avenue	6.010	9.51	37.9	Eisenhower Avenue	King Street	1.290	6.65	11.6
	Totals	11.80	26.56	26.7		Totals	11.23	25.76	26.2

TABLE C-24: ALTERNATIVE 1B – MIXED TRAFFIC – SUITLAND – PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	5.94	13.0	Suitland P&R	Marlow	1.190	2.85	25.1
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.44	15.0	Marlow	St. Barnabas North	0.320	0.81	23.7
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.30	60.8	St. Barnabas North	St. Barnabas South	1.930	4.82	24.0
Exit Exclusive Lane	National Harbor South	1.360	4.32	18.9	St. Barnabas South	Oxon Hill East	0.500	1.26	23.8
National Harbor South	National Harbor North	1.120	6.25	10.8	Oxon Hill East	Oxon Hill West	0.910	2.74	19.9
National Harbor North	Oxon Hill P&R	1.070	3.42	18.8	Oxon Hill West	Oxon Hill P&R	0.500	1.26	23.8
Oxon Hill P&R	Oxon Hill West	0.500	1.16	25.9	Oxon Hill P&R	National Harbor North	1.070	3.42	18.8
Oxon Hill West	Oxon Hill East	0.910	2.12	25.8	National Harbor North	National Harbor South	1.120	3.47	19.4
Oxon Hill East	St. Barnabas South	0.500	4.76	6.3	National Harbor South	Enter Exclusive Lane	1.360	7.12	11.5
St. Barnabas South	St. Barnabas North	1.930	8.08	14.3	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.82	49.6
St. Barnabas North	Marlow	0.320	1.86	10.3	Exit Exclusive Lane	Eisenhower Avenue	0.850	7.68	6.6
Marlow	Suitland P&R	1.190	4.48	15.9	Eisenhower Avenue	King Street	1.290	13.10	5.9
	Totals	13.38	48.13	16.7		Totals	13.37	51.35	15.6

TABLE C-25: ALTERNATIVE 1B – MIXED TRAFFIC – SUITLAND – OFF-PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	6.57	11.8	Suitland P&R	Marlow	1.190	2.90	24.6
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.87	13.3	Marlow	St. Barnabas North	0.320	0.86	22.3
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.34	59.7	St. Barnabas North	St. Barnabas South	1.930	4.89	23.7
Exit Exclusive Lane	National Harbor South	1.360	4.36	18.7	St. Barnabas South	Oxon Hill East	0.500	1.47	20.4
National Harbor South	National Harbor North	1.120	3.84	17.5	Oxon Hill East	Oxon Hill West	0.910	2.14	25.5
National Harbor North	Oxon Hill P&R	1.070	3.42	18.8	Oxon Hill West	Oxon Hill P&R	0.500	1.16	25.9
Oxon Hill P&R	Oxon Hill West	0.500	1.18	25.4	Oxon Hill P&R	National Harbor North	1.070	3.42	18.8
Oxon Hill West	Oxon Hill East	0.910	2.20	24.8	National Harbor North	National Harbor South	1.120	3.51	19.1
Oxon Hill East	St. Barnabas South	0.500	1.65	18.2	National Harbor South	Enter Exclusive Lane	1.360	4.71	17.3
St. Barnabas South	St. Barnabas North	1.930	4.77	24.3	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.33	60.0
St. Barnabas North	Marlow	0.320	0.83	23.1	Exit Exclusive Lane	Eisenhower Avenue	0.850	3.83	13.3
Marlow	Suitland P&R	1.190	2.87	24.9	Eisenhower Avenue	King Street	1.290	6.65	11.6
	Totals	13.38	37.90	21.2		Totals	13.37	37.87	21.2

TABLE C-26: ALTERNATIVE 1C – MIXED TRAFFIC – SOUTHERN AVENUE – PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	5.94	13.0	Southern Avenue P&R	Wash. Highlands North	1.230	9.26	8.0
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.44	15.0	Wash. Highlands North	Wash. Highlands South	0.680	4.52	9.0
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.30	60.8	Wash. Highlands South	Eastover P&R	0.430	1.32	19.5
Exit Exclusive Lane	National Harbor South	1.360	4.32	18.9	Eastover P&R	Forest Heights North	0.430	1.04	24.8
National Harbor South	National Harbor North	1.120	6.25	10.8	Forest Heights North	Forest Heights South	0.590	1.34	26.4
National Harbor North	Oxon Hill P&R	1.070	3.42	18.8	Forest Heights South	Oxon Hill P&R	0.320	0.74	25.9
Oxon Hill P&R	Forest Heights South	0.320	1.41	13.6	Oxon Hill P&R	National Harbor North	1.070	3.42	18.8
Forest Heights South	Forest Heights North	0.590	1.69	20.9	National Harbor North	National Harbor South	1.120	3.47	19.4
Forest Heights North	Eastover P&R	0.430	15.96	1.6	National Harbor South	Enter Exclusive Lane	1.360	7.12	11.5
Eastover P&R	Wash. Highlands South	0.430	1.35	19.1	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.82	49.6
Wash. Highlands South	Wash. Highlands North	0.680	5.52	7.4	Exit Exclusive Lane	Eisenhower Avenue	0.850	7.68	6.6
Wash. Highlands North	Southern Avenue P&R	1.230	8.79	8.4	Eisenhower Avenue	King Street	1.290	13.10	5.9
	Totals	11.71	60.39	11.6		Totals	11.70	55.83	12.6

TABLE C-27: ALTERNATIVE 1C – MIXED TRAFFIC – SOUTHERN AVENUE – OFF-PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	6.57	11.8	Southern Avenue P&R	Wash. Highlands North	1.230	8.30	8.9
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.87	13.3	Wash. Highlands North	Wash. Highlands South	0.680	4.57	8.9
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.34	59.7	Wash. Highlands South	Eastover P&R	0.430	1.32	19.5
Exit Exclusive Lane	National Harbor South	1.360	4.36	18.7	Eastover P&R	Forest Heights North	0.430	2.97	8.7
National Harbor South	National Harbor North	1.120	3.84	17.5	Forest Heights North	Forest Heights South	0.590	1.37	25.8
National Harbor North	Oxon Hill P&R	1.070	3.42	18.8	Forest Heights South	Oxon Hill P&R	0.320	0.75	25.6
Oxon Hill P&R	Forest Heights South	0.320	0.76	25.3	Oxon Hill P&R	National Harbor North	1.070	3.42	18.8
Forest Heights South	Forest Heights North	0.590	1.37	25.8	National Harbor North	National Harbor South	1.120	3.51	19.1
Forest Heights North	Eastover P&R	0.430	2.36	10.9	National Harbor South	Enter Exclusive Lane	1.360	4.71	17.3
Eastover P&R	Wash. Highlands South	0.430	1.32	19.5	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.33	60.0
Wash. Highlands South	Wash. Highlands North	0.680	4.53	9.0	Exit Exclusive Lane	Eisenhower Avenue	0.850	3.83	13.3
Wash. Highlands North	Southern Avenue P&R	1.230	8.30	8.9	Eisenhower Avenue	King Street	1.290	6.65	11.6
	Totals	11.71	43.04	16.3		Totals	11.70	43.73	16.1

TABLE C-28: ALTERNATIVE 1Br – MIXED TRAFFIC – SUITLAND – PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	5.90	13.1	Suitland P&R	Marlow	1.190	2.86	25.0
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.43	15.0	Marlow	St. Barnabas North	0.320	0.81	23.7
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.30	60.8	St. Barnabas North	St. Barnabas South	1.930	4.86	23.8
Exit Exclusive Lane	National Harbor South	0.240	0.86	16.7	St. Barnabas South	Oxon Hill East	0.500	1.25	24.0
National Harbor South	National Harbor North	1.070	1.00	64.2	Oxon Hill East	Oxon Hill West	0.910	3.12	17.5
National Harbor North	Oxon Hill P&R	0.170	0.42	24.3	Oxon Hill West	Oxon Hill P&R	0.500	1.32	22.7
Oxon Hill P&R	Oxon Hill West	0.500	1.14	26.3	Oxon Hill P&R	National Harbor North	0.170	0.41	24.9
Oxon Hill West	Oxon Hill East	0.910	2.10	26.0	National Harbor North	National Harbor South	1.560	2.77	33.8
Oxon Hill East	St. Barnabas South	0.500	5.24	5.7	National Harbor South	Enter Exclusive Lane	0.240	0.86	16.7
St. Barnabas South	St. Barnabas North	1.930	7.94	14.6	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.67	52.4
St. Barnabas North	Marlow	0.320	1.90	10.1	Exit Exclusive Lane	Eisenhower Avenue	0.850	7.45	6.8
Marlow	Suitland P&R	1.190	4.54	15.7	Eisenhower Avenue	King Street	1.290	13.09	5.9
	Totals	11.31	36.77	18.5		Totals	11.79	41.47	17.1

TABLE C-29: ALTERNATIVE 1Br – MIXED TRAFFIC – SUITLAND – OFF-PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	6.56	11.8	Suitland P&R	Marlow	1.190	2.90	24.6
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.84	13.4	Marlow	St. Barnabas North	0.320	0.88	21.8
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.34	59.7	St. Barnabas North	St. Barnabas South	1.930	4.88	23.7
Exit Exclusive Lane	National Harbor South	0.240	0.86	16.7	St. Barnabas South	Oxon Hill East	0.500	1.48	20.3
National Harbor South	National Harbor North	1.070	1.15	55.8	Oxon Hill East	Oxon Hill West	0.910	2.14	25.5
National Harbor North	Oxon Hill P&R	0.170	0.40	25.5	Oxon Hill West	Oxon Hill P&R	0.500	1.17	25.6
Oxon Hill P&R	Oxon Hill West	0.500	1.18	25.4	Oxon Hill P&R	National Harbor North	0.170	0.40	25.5
Oxon Hill West	Oxon Hill East	0.910	2.19	24.9	National Harbor North	National Harbor South	1.560	2.65	35.3
Oxon Hill East	St. Barnabas South	0.500	1.74	17.2	National Harbor South	Enter Exclusive Lane	0.240	0.86	16.7
St. Barnabas South	St. Barnabas North	1.930	4.76	24.3	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.33	60.0
St. Barnabas North	Marlow	0.320	0.83	23.1	Exit Exclusive Lane	Eisenhower Avenue	0.850	3.84	13.3
Marlow	Suitland P&R	1.190	2.87	24.9	Eisenhower Avenue	King Street	1.290	6.65	11.6
	Totals	11.31	28.72	23.6		Totals	11.79	30.18	23.4

TABLE C-30: ALTERNATIVE 1Cr – MIXED TRAFFIC – SOUTHERN AVENUE – PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	5.90	13.1	Southern Avenue P&R	Wash. Highlands North	1.230	9.29	7.9
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.43	15.0	Wash. Highlands North	Wash. Highlands South	0.680	4.51	9.0
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.30	60.8	Wash. Highlands South	Eastover P&R	0.430	1.32	19.5
Exit Exclusive Lane	National Harbor South	0.240	0.86	16.7	Eastover P&R	Forest Heights North	0.430	1.02	25.3
National Harbor South	National Harbor North	1.070	1.00	64.2	Forest Heights North	Forest Heights South	0.590	1.34	26.4
National Harbor North	Oxon Hill P&R	0.170	0.42	24.3	Forest Heights South	Oxon Hill P&R	0.320	0.74	25.9
Oxon Hill P&R	Forest Heights South	0.320	2.01	9.6	Oxon Hill P&R	National Harbor North	0.170	0.41	24.9
Forest Heights South	Forest Heights North	0.590	1.57	22.5	National Harbor North	National Harbor South	1.560	2.77	33.8
Forest Heights North	Eastover P&R	0.430	15.68	1.6	National Harbor South	Enter Exclusive Lane	0.240	0.86	16.7
Eastover P&R	Wash. Highlands South	0.430	1.35	19.1	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.67	52.4
Wash. Highlands South	Wash. Highlands North	0.680	5.51	7.4	Exit Exclusive Lane	Eisenhower Avenue	0.850	7.45	6.8
Wash. Highlands North	Southern Avenue P&R	1.230	8.79	8.4	Eisenhower Avenue	King Street	1.290	13.09	5.9
	Totals	9.64	48.82	11.8		Totals	10.12	45.47	13.4

TABLE C-31: ALTERNATIVE 1Cr – MIXED TRAFFIC – SOUTHERN AVENUE – OFF-PEAK

EASTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)	WESTBOUND From Station *or Transition*	To Station *or Transition*	Distance (miles)	Total Travel Time (minutes)	Average Speed (mph)
King Street	Eisenhower Avenue	1.290	6.56	11.8	Southern Avenue P&R	Wash. Highlands North	1.230	8.30	8.9
Eisenhower Avenue	Enter Exclusive Lane	0.860	3.84	13.4	Wash. Highlands North	Wash. Highlands South	0.680	4.57	8.9
Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.34	59.7	Wash. Highlands South	Eastover P&R	0.430	1.32	19.5
Exit Exclusive Lane	National Harbor South	0.240	0.86	16.7	Eastover P&R	Forest Heights North	0.430	2.96	8.7
National Harbor South	National Harbor North	1.070	1.15	55.8	Forest Heights North	Forest Heights South	0.590	1.37	25.8
National Harbor North	Oxon Hill P&R	0.170	0.40	25.5	Forest Heights South	Oxon Hill P&R	0.320	0.74	25.9
Oxon Hill P&R	Forest Heights South	0.320	0.79	24.3	Oxon Hill P&R	National Harbor North	0.170	0.40	25.5
Forest Heights South	Forest Heights North	0.590	1.37	25.8	National Harbor North	National Harbor South	1.560	2.65	35.3
Forest Heights North	Eastover P&R	0.430	2.40	10.8	National Harbor South	Enter Exclusive Lane	0.240	0.86	16.7
Eastover P&R	Wash. Highlands South	0.430	1.32	19.5	Enter Exclusive Lane	Exit Exclusive Lane	2.330	2.33	60.0
Wash. Highlands South	Wash. Highlands North	0.680	4.53	9.0	Exit Exclusive Lane	Eisenhower Avenue	0.850	3.84	13.3
Wash. Highlands North	Southern Avenue P&R	1.230	8.30	8.9	Eisenhower Avenue	King Street	1.290	6.65	11.6
	Totals	9.64	33.86	17.1		Totals	10.12	35.99	16.9

APPENDIX D: CHANGE IN STATION BOARDINGS

[This page is intentionally blank]

TABLE D-1: CHANGE IN AVERAGE WEEKDAY BOARDINGS VS. NO BUILD: GREEN LINE

Station	Refined Alternative[1]					Original Alternative[1]								
	1r	2Br	2Cr	3Br	3Cr	1A	1B	1C	2A	2B	2C	3A	3B	3C
Greenbelt	0	0	50	50	150	0	0	0	0	0	50	50	50	100
College Park	0	0	50	50	150	0	0	0	0	0	50	50	50	100
PG Plaza	0	0	0	50	50	0	0	0	0	0	0	0	0	50
West Hyattsville	0	0	0	0	50	0	0	0	0	0	0	0	0	50
Fort Totten	0	0	50	50	50	0	0	0	0	0	0	50	0	100
Georgia Ave	0	0	0	0	100	0	0	0	0	0	50	0	0	100
Columbia Heights	0	0	0	0	100	0	0	0	0	0	0	0	0	50
U Street-Cardozo	0	0	0	0	100	0	0	0	0	0	0	0	0	50
Shaw-Howard Univ	0	0	0	0	150	0	0	0	0	0	50	0	0	100
Mt Vernon Square	0	50	0	50	150	0	0	0	0	50	0	50	0	150
Gallery Place	-250	-250	-150	-1,350	2,000	0	-100	-150	-250	-50	-450	-1,500	-400	900
Archives	-50	-50	-50	-300	400	0	0	-50	-50	0	-100	-350	-100	200
L'Enfant Plaza	-1,000	-1,400	-1,750	-3,800	0	-300	-450	-550	-1,550	-1,000	-2,650	-3,600	-1,950	1,300
Waterfront	0	50	-100	200	750	0	0	0	50	100	250	50	200	500
Navy Yard	-50	250	-200	450	1,600	0	0	0	150	250	550	300	450	1,150
Anacostia[2]	-400	0	1,700	50	12,700	-150	-200	-500	-250	-200	-1,300	-350	-150	-4,700
Congress Heights	-50	-50	-1,350	0	-1,250	0	0	-50	-50	-50	-750	-50	-50	-1,850
Southern Avenue	-550	-1,450	-2,050	-3,200	-3,050	-400	-550	-150	-1,200	-1,750	750	-2,600	-3,250	-5,000
Naylor Road	-350	-400	-200	-700	-100	0	-350	0	-650	-650	-150	-650	-650	-1,650
Suitland[2]	350	-500	-200	2,750	-200	-100	550	-50	-200	2,600	-150	-350	5,050	-3,000
Branch Avenue[2]	-450	1,000	-750	-2,900	-2,000	350	0	0	650	-300	-50	-3,450	-2,350	-4,100
Total Change	**-2,850**	**-2,650**	**-4,900**	**-8,600**	**11,950**	**-600**	**-1,150**	**-1,550**	**-3,350**	**-900**	**-3,850**	**-12,350**	**-3,100**	**-15,300**

[1] The changes in station boardings are rounded to the nearest multiple of 50. The sum of the station boarding changes may not equal the total change reported due to rounding.

[2] The changes in station boardings shown for the applicable 3-Series Alternatives are exclusive of new alignment boardings.

TABLE D-2: CHANGE IN AVERAGE WEEKDAY BOARDINGS VS. NO BUILD: YELLOW LINE

Station	Refined Alternative[1]					Original Alternative[1]								
	1r	2Br	2Cr	3Br	3Cr	1A	1B	1C	2A	2B	2C	3A	3B	3C
Fort Totten	0	0	0	50	0	0	0	0	0	0	0	50	0	0
Georgia Ave	0	0	0	50	0	0	0	0	0	0	0	0	0	0
Columbia Heights	0	0	0	50	0	0	0	0	0	0	0	0	0	0
U Street-Cardozo	0	0	0	50	0	0	0	0	0	0	0	0	0	0
Shaw-Howard Univ	0	0	0	50	0	0	0	0	0	0	0	0	0	0
Mt Vernon Square	50	100	0	450	150	0	0	0	0	50	50	350	50	100
Gallery Place	250	550	200	3,500	1,650	50	150	150	300	350	900	3,100	1,450	800
Archives	50	150	50	700	350	0	50	50	50	100	200	650	300	200
L'Enfant Plaza	-200	-150	-1,200	3,650	-250	-200	-50	-50	-600	-350	-500	3,200	750	800
Pentagon	0	0	0	450	450	0	0	0	0	0	-50	300	200	200
Pentagon City	0	0	-50	450	400	0	0	0	-50	-50	-50	300	200	200
Crystal City	50	-50	-50	750	550	50	50	0	-100	-50	0	500	350	300
National Airport	0	0	0	150	100	0	0	0	0	0	0	100	50	50
Potomac Yards	0	0	-50	200	200	0	0	0	0	0	0	150	100	100
Braddock Road	0	-150	-250	400	400	0	0	0	-150	-150	-150	300	200	250
King Street	-50	1,450	600	1,000	1,350	0	0	0	950	950	300	650	450	550
Eisenhower Avenue[2]	1,000	0	-300	300	350	200	550	600	-250	-150	-300	250	6,200	200
Huntington[2]	0	0	-200	-4,250	-4,150	0	0	0	-50	-50	-100	-3,800	100	-3,750
Total Change	**1,250**	**1,950**	**-1,250**	**7,900**	**1,650**	**100**	**750**	**800**	**150**	**700**	**2,300**	**6,150**	**10,450**	**50**

[1] The changes in station boardings are rounded to the nearest multiple of 50. The sum of the station boarding changes may not equal the total change reported due to rounding.

[2] The changes in station boardings shown for the applicable 3-Series Alternatives are exclusive of new alignment boardings.

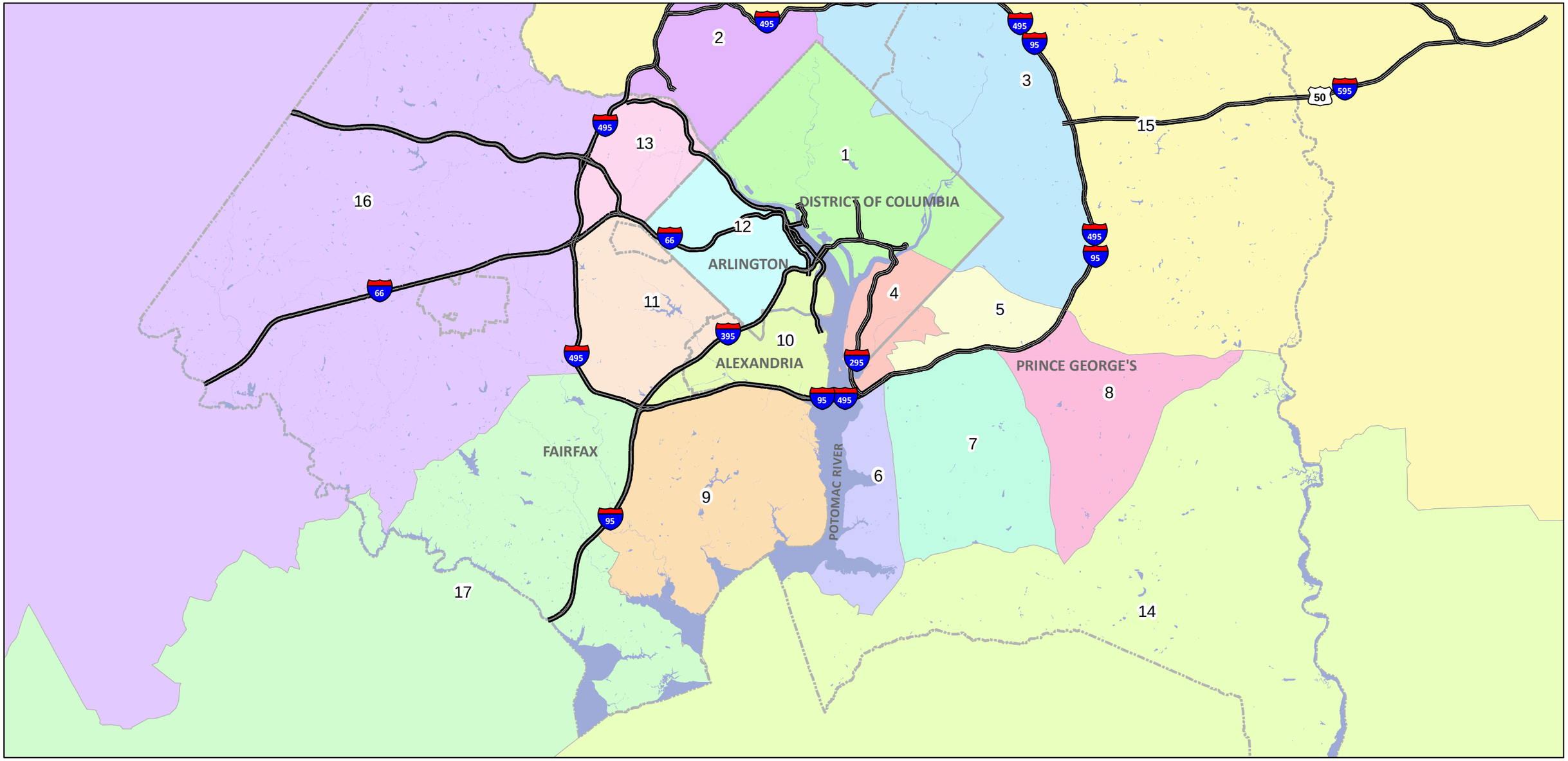
TABLE D-3: CHANGE IN AVERAGE WEEKDAY BOARDINGS VS. NO BUILD: BLUE LINE

Station	Refined Alternative[1]					Original Alternative[1]								
	1r	2Br	2Cr	3Br	3Cr	1A	1B	1C	2A	2B	2C	3A	3B	3C
Franconia-Springfield	50	150	200	200	250	0	0	0	100	100	200	100	100	100
Van Dorn Street	0	150	100	350	450	0	0	0	150	100	150	250	200	250
King Street	100	1,600	1,250	500	750	50	50	50	1,150	1,100	400	300	300	250
Braddock Road	0	0	-100	0	-50	0	0	0	0	0	-50	0	0	-50
Potomac Yard	0	50	0	-50	-50	0	0	0	50	0	0	0	0	0
National Airport	0	0	0	0	0	0	0	0	0	0	50	0	0	0
Crystal City	0	50	50	-100	-100	0	0	0	50	50	150	-50	-50	0
Pentagon City	0	50	50	-50	-100	0	0	0	50	50	100	-100	-50	0
Pentagon	0	100	50	0	-100	0	0	0	50	50	100	-50	-50	0
Arlington Cemetery	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rosslyn	0	250	150	150	50	0	0	0	150	150	450	100	50	50
Foggy Bottom-GWU	0	50	0	50	100	0	0	0	50	50	50	50	50	50
Farragut West	0	50	50	100	200	0	0	0	50	50	100	100	50	200
McPherson Square	0	50	0	50	100	0	0	0	0	50	50	0	0	100
Metro Center	0	50	0	50	50	0	0	0	50	50	50	50	0	400
Federal Triangle	0	0	0	0	0	0	0	0	0	0	0	0	0	50
Smithsonian	0	0	0	50	50	0	0	0	0	0	50	50	50	50
L'Enfant Plaza	-150	100	-200	-100	450	-50	-50	-100	-100	50	100	-200	-250	800
Federal Center SW	0	0	0	50	50	0	0	0	0	0	0	0	0	50
Capitol South	0	0	0	50	50	0	0	0	0	0	0	50	0	50
Eastern Market	0	0	0	0	50	0	0	0	0	0	0	0	0	50
Potomac Avenue	0	0	0	0	0	0	0	0	0	0	0	0	0	50
Stadium Armory	0	0	0	0	50	0	0	0	0	0	0	0	0	50
Benning Road	0	0	-50	50	100	0	0	0	0	0	0	0	0	100
Capitol Heights	0	0	0	0	0	0	0	0	0	0	0	0	0	100

Station	Refined Alternative[1]					Original Alternative[1]								
	1r	**2Br**	**2Cr**	**3Br**	**3Cr**	**1A**	**1B**	**1C**	**2A**	**2B**	**2C**	**3A**	**3B**	**3C**
Addison Road	0	0	0	0	50	0	0	0	0	0	0	-50	0	450
Morgan Boulevard	0	0	0	0	50	0	0	0	0	0	0	0	0	50
Largo Town Center	0	0	0	0	50	0	0	0	0	0	0	-50	-50	300
Archives	0	50	50	0	0	0	0	0	50	50	100	0	0	0
Gallery Place	0	200	150	0	0	0	0	0	150	150	400	0	0	0
Mt Vernon Square	0	50	0	100	0	0	0	0	0	0	0	50	0	0
Shaw-Howard Univ	0	0	0	0	0	0	0	0	0	0	0	0	0	0
U Street-Cardozo	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Columbia Heights	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Georgia Ave	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fort Totten	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Hyattsville	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PG Plaza	0	0	0	0	0	0	0	0	0	0	0	0	0	0
College Park	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greenbelt	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Change	**0**	**3,100**	**1,950**	**1,550**	**2,450**	**0**	**50**	**50**	**1,950**	**2,050**	**4,600**	**700**	**400**	**3,400**

APPENDIX E: DISTRICT-LEVEL COMPARISON OF NEW DAILY TRANSIT TRIPS, RELATIVE TO NO-BUILD

[This page is intentionally blank]



Legend

- 1 - Washington DC Core
- 2 - MD Bethesda
- 3 - MD Inside NE Beltway
- 4 - Southern DC/MD Indian Head Hwy
- 5 - MD Suitland/Branch
- 6 - MD National Harbor
- 7 - MD (PG Co Oxon Hill)
- 8 - MD (PG Co Joint Base Andrews Area)
- 9 - VA (Outside Beltway)
- 10 - VA Alexandria
- 11 - VA Annandale Area
- 12 - VA Arlington
- 13 - VA McLean
- 14 - MD Southwest
- 15 - MD Northeast
- 16 - VA Northwest
- 17 - VA Southwest

South Side Transit Study

Figure E-1 Districts Used to Assess 2040 Travel Patterns

N

0 0.5 1 2 3 4 Miles

MTA Maryland

[This page is intentionally blank]

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

Original Alignment Alt 1A	DC Wash DC Core	MD Bethesda	MD Inside Beltway (Northeast)	DC/MD Southern DC / MD Indian Head Hwy	MD Suitland / Branch	MD National Harbor	MD PG County Oxon Hill	MD PG County Joint base Andrews	VA Outside Beltway (South)	VA Alexandria	VA Annandale	VA Arlington	VA McLean	MD Outside Beltway (Southeast)	MD Outside Beltway (Northeast)	VA Outside Beltway (Northwest)	VA Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	0	0	2	-5	0	0	0	0	0	0	0	0	0	0	**-3**
2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
3	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	**2**
4	0	0	0	0	-6	0	-2	0	3	41	0	0	0	0	0	0	0	**36**
5	0	0	0	-2	-4	1	-6	0	7	61	3	0	0	0	0	1	0	**61**
6	89	2	4	3	3	-1	-2	0	16	153	5	14	1	0	1	3	1	**292**
7	-5	1	3	2	-3	-1	-3	0	26	236	8	13	0	1	0	2	2	**282**
8	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
9	2	0	0	5	2	2	11	0	0	-1	-2	0	0	0	0	0	0	**19**
10	5	0	0	18	9	7	19	0	-1	-11	0	-1	0	0	0	0	0	**45**
11	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	**4**
12	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	**2**
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
14	0	0	0	0	0	0	4	0	1	16	0	1	0	0	0	0	0	**22**
15	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
16	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
17	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	**3**
Total	**91**	**3**	**7**	**27**	**2**	**10**	**26**	**0**	**52**	**498**	**14**	**27**	**1**	**1**	**1**	**6**	**3**	**769**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

Original Alignment Alt 1B	DC Wash DC Core	MD Bethesda	MD Inside Beltway (Northeast)	DC/MD Southern DC / MD Indian Head Hwy	MD Suitland / Branch	MD National Harbor	MD PG County Oxon Hill	MD PG County Joint base Andrews	VA Outside Beltway (South)	VA Alexandria	VA Annandale	VA Arlington	VA McLean	MD Outside Beltway (Southeast)	MD Outside Beltway (Northeast)	VA Outside Beltway (Northwest)	VA Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	0	-2	30	-4	0	0	1	0	0	0	0	0	0	0	**25**
2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
3	0	0	0	-1	-4	5	1	0	0	10	0	0	0	0	0	0	0	**11**
4	0	0	0	0	-8	8	-2	0	1	29	0	0	0	0	0	0	0	**28**
5	-15	-2	-1	-6	-14	12	-22	-3	10	74	3	-2	0	0	0	1	0	**35**
6	203	4	9	-13	14	0	1	-1	21	187	10	34	2	0	3	7	1	**482**
7	-33	2	1	2	-5	6	-1	-1	30	260	10	12	0	0	2	3	2	**290**
8	0	0	0	0	-1	0	2	0	0	4	0	0	0	0	0	0	0	**5**
9	1	0	0	4	4	10	11	0	0	-1	-2	0	0	0	0	0	0	**27**
10	4	0	0	14	12	19	23	1	-1	-11	0	-1	0	0	0	0	0	**60**
11	0	0	0	1	1	2	2	0	0	0	0	0	0	0	0	0	0	**6**
12	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	**5**
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
14	1	0	0	0	1	1	7	0	0	5	0	1	0	0	0	0	0	**16**
15	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	**3**
16	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	**2**
17	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	**4**
Total	**161**	**4**	**9**	**1**	**-2**	**101**	**25**	**-4**	**61**	**558**	**21**	**44**	**2**	**0**	**5**	**11**	**3**	**1000**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

	DC	MD	MD	DC/MD	MD	MD	MD	MD	VA	VA	VA	VA	VA	MD	MD	VA	VA	
Original Alignment Alt 1C	Wash DC Core	Bethesda	Inside Beltway (Northeast)	Southern DC / MD Indian Head Hwy	Suitland / Branch	National Harbor	PG County Oxon Hill	PG County Joint base Andrews	Outside Beltway (South)	Alexandria	Annandale	Arlington	McLean	Outside Beltway (Southeast)	Outside Beltway (Northeast)	Outside Beltway (Northwest)	Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	0	0	34	-3	0	2	8	0	0	0	0	0	0	0	**41**
2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
3	0	0	0	-2	0	3	1	0	0	1	0	0	0	0	0	0	0	**3**
4	-36	-2	-4	-26	-23	21	0	0	25	114	7	-8	0	0	-1	-2	1	**66**
5	-22	-2	-1	-17	-2	3	-2	0	4	37	1	-2	0	0	0	1	0	**-2**
6	208	3	7	-17	-2	0	2	0	21	187	10	35	2	0	3	7	1	**467**
7	3	1	2	-24	-2	5	-1	0	20	191	7	16	0	0	0	1	2	**221**
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
9	2	0	0	18	0	10	9	0	0	-1	-2	0	0	0	0	0	0	**36**
10	19	0	0	46	3	19	17	0	-1	-11	0	-1	0	0	0	0	0	**91**
11	0	0	0	4	0	2	2	0	0	0	0	0	0	0	0	0	0	**8**
12	0	0	0	1	0	3	1	0	0	0	0	0	0	0	0	0	0	**5**
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
14	1	0	0	1	0	0	1	0	0	5	0	1	0	0	0	0	0	**9**
15	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	**3**
16	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	**2**
17	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	**4**
Total	**175**	**0**	**4**	**-16**	**-26**	**105**	**32**	**0**	**71**	**531**	**23**	**41**	**2**	**0**	**2**	**7**	**4**	**955**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

	DC	MD	MD	DC/MD	MD	MD	MD	MD	VA	VA	VA	VA	VA	MD	MD	VA	VA	
Alt 1r	Wash DC Core	Bethesda	Inside Beltway (Northeast)	Southern DC / MD Indian Head Hwy	Suitland / Branch	National Harbor	PG County Oxon Hill	PG County Joint base Andrews	Outside Beltway (South)	Alexandria	Annandale	Arlington	McLean	Outside Beltway (Southeast)	Outside Beltway (Northeast)	Outside Beltway (Northwest)	Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	0	-3	74	-8	0	2	12	0	0	0	0	0	0	0	**77**
2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	**2**
3	0	0	0	0	-4	27	-1	0	0	14	0	0	0	0	0	0	0	**36**
4	-38	-1	-4	-27	-47	-7	-2	-4	38	148	14	-4	0	0	0	-1	0	**65**
5	-21	-2	-1	-27	-12	8	-18	-1	18	104	5	-1	0	0	-1	0	1	**52**
6	131	1	8	-18	1	-7	-4	1	26	240	13	37	1	0	4	6	2	**442**
7	-26	1	2	-13	-9	1	-4	0	40	358	15	26	1	0	1	3	3	**399**
8	0	0	0	0	0	8	2	0	1	5	0	0	0	0	0	0	0	**16**
9	2	0	0	32	10	89	16	0	0	-1	-2	0	0	0	0	0	0	**146**
10	31	0	1	59	16	109	23	0	-1	1	-1	0	0	0	0	0	0	**238**
11	0	0	0	5	1	19	2	0	0	-1	0	-1	0	0	0	0	0	**25**
12	0	0	0	0	0	15	2	0	0	0	0	0	0	0	0	0	0	**17**
13	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**1**
14	0	0	0	1	1	6	4	0	0	15	0	0	0	0	0	0	0	**27**
15	0	0	0	0	-1	14	2	0	0	0	0	0	0	0	0	0	0	**15**
16	0	0	0	1	0	15	3	0	0	0	0	0	0	0	0	0	0	**19**
17	0	0	0	0	-1	27	4	0	0	0	0	0	0	0	0	0	0	**30**
Total	**79**	**-1**	**6**	**13**	**-48**	**400**	**22**	**-4**	**124**	**895**	**44**	**57**	**2**	**0**	**4**	**8**	**6**	**1607**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

	DC	MD	MD	DC/MD	MD	MD	MD	MD	VA	VA	VA	VA	VA	MD	MD	VA	VA	
Original Alignment Alt 2A	Wash DC Core	Bethesda	Inside Beltway (Northeast)	Southern DC / MD Indian Head Hwy	Suitland / Branch	National Harbor	PG County Oxon Hill	PG County Joint base Andrews	Outside Beltway (South)	Alexandria	Annandale	Arlington	McLean	Outside Beltway (Southeast)	Outside Beltway (Northeast)	Outside Beltway (Northwest)	Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	0	3	1	48	14	0	2	0	0	0	0	0	0	0	**68**
2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	**2**
3	0	0	0	3	4	1	18	9	4	47	1	0	0	0	0	0	0	**87**
4	18	0	1	0	66	1	30	50	34	452	17	8	0	0	0	1	3	**681**
5	149	4	8	21	66	4	46	95	61	520	34	43	2	0	3	5	4	**1065**
6	166	2	7	4	41	0	9	20	39	444	18	63	1	0	2	5	3	**824**
7	756	14	45	82	179	2	72	110	134	1372	73	176	6	1	18	23	10	**3073**
8	0	0	0	13	22	2	23	24	16	146	6	2	0	0	0	0	1	**255**
9	0	0	1	30	70	5	55	34	0	12	1	-1	0	0	0	0	0	**207**
10	1	0	1	30	66	10	58	37	0	80	0	0	0	0	0	0	-1	**282**
11	-1	0	0	2	7	0	11	5	0	5	0	0	0	0	0	0	0	**29**
12	0	0	0	1	2	0	8	2	0	1	0	0	0	0	0	0	0	**14**
13	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
14	5	0	0	11	52	0	47	75	23	289	1	1	0	0	0	0	1	**505**
15	0	0	0	10	13	1	33	26	8	98	5	0	0	0	0	0	1	**195**
16	0	0	0	0	4	0	12	4	0	0	0	0	0	0	0	0	0	**20**
17	0	0	0	2	10	3	22	6	0	0	0	0	0	0	0	0	0	**43**
Total	**1094**	**20**	**63**	**209**	**606**	**30**	**493**	**512**	**319**	**3468**	**156**	**292**	**9**	**1**	**23**	**34**	**22**	**7351**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

Original Alignment Alt 2B	DC Wash DC Core	MD Bethesda	MD Inside Beltway (Northeast)	DC/MD Southern DC / MD Indian Head Hwy	MD Suitland / Branch	MD National Harbor	MD PG County Oxon Hill	MD PG County Joint base Andrews	VA Outside Beltway (South)	VA Alexandria	VA Annandale	VA Arlington	VA McLean	MD Outside Beltway (Southeast)	MD Outside Beltway (Northeast)	VA Outside Beltway (Northwest)	VA Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	1	12	89	68	0	0	11	0	0	0	0	0	0	0	**181**
2	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	**3**
3	0	0	0	5	26	32	41	0	13	135	4	1	0	0	0	0	1	**258**
4	16	0	2	0	57	100	36	0	31	426	13	5	0	0	1	0	1	**688**
5	174	4	17	23	208	81	61	3	67	562	37	40	2	0	4	6	3	**1292**
6	934	13	58	86	116	12	50	7	72	675	45	148	8	0	22	28	7	**2281**
7	897	15	77	79	210	61	57	4	104	1161	61	173	6	0	23	23	9	**2960**
8	0	0	0	1	6	4	9	0	3	32	0	0	0	0	0	0	0	**55**
9	3	0	6	28	61	38	50	5	0	12	2	0	0	0	0	0	0	**205**
10	2	0	5	26	57	47	59	4	1	74	2	0	0	0	1	0	0	**278**
11	0	0	0	1	6	5	9	0	0	4	0	0	0	0	0	0	0	**25**
12	0	0	0	0	4	9	8	0	0	0	0	0	0	0	0	0	0	**21**
13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**
14	11	0	0	1	28	6	21	0	2	70	0	2	0	0	0	0	0	**141**
15	0	0	0	1	11	13	26	0	2	32	1	0	0	0	0	0	0	**86**
16	0	0	0	0	4	9	11	0	0	0	0	0	0	0	0	0	0	**24**
17	0	0	0	3	12	8	14	0	0	0	0	0	0	0	0	0	0	**37**
Total	**2037**	**32**	**165**	**255**	**819**	**515**	**522**	**23**	**295**	**3194**	**165**	**369**	**16**	**0**	**51**	**57**	**21**	**8536**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

	DC	MD	MD	DC/MD	MD	MD	MD	MD	VA	VA	VA	VA	VA	MD	MD	VA	VA	
Alt 2Br	Wash DC Core	Bethesda	Inside Beltway (Northeast)	Southern DC / MD Indian Head Hwy	Suitland / Branch	National Harbor	PG County Oxon Hill	PG County Joint base Andrews	Outside Beltway (South)	Alexandria	Annandale	Arlington	McLean	Outside Beltway (Southeast)	Outside Beltway (Northeast)	Outside Beltway (Northwest)	Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	0	7	286	45	0	0	2	0	0	0	0	0	0	0	**340**
2	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	**5**
3	0	0	0	2	12	126	20	0	2	48	1	0	0	0	0	0	0	**211**
4	15	1	0	0	76	242	19	13	33	407	13	5	0	0	1	2	0	**827**
5	142	3	8	22	157	255	43	38	59	516	36	38	2	0	3	5	5	**1332**
6	1121	12	57	102	123	36	65	33	75	697	45	158	8	0	22	24	7	**2585**
7	999	16	51	55	231	256	69	40	121	1266	64	180	5	1	20	21	10	**3405**
8	1	0	1	10	29	71	20	4	12	111	5	2	0	0	0	0	1	**267**
9	-6	-1	0	25	70	258	47	17	0	11	0	-1	0	0	0	0	0	**420**
10	0	0	0	23	66	258	52	18	0	79	1	0	0	0	0	0	0	**497**
11	-1	0	0	2	6	47	6	1	0	5	0	-1	0	0	0	0	0	**65**
12	0	0	0	1	2	47	6	0	0	1	0	0	0	0	0	0	0	**57**
13	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	**5**
14	14	0	0	10	90	88	48	3	16	223	1	2	0	0	0	0	0	**495**
15	0	0	0	9	29	130	29	1	6	83	4	1	0	0	0	0	1	**293**
16	0	0	0	1	5	66	10	1	0	0	0	0	0	0	0	0	0	**83**
17	0	0	0	3	12	98	18	3	0	0	0	0	0	0	0	0	0	**134**
Total	**2285**	**31**	**117**	**265**	**915**	**2273**	**498**	**172**	**324**	**3449**	**170**	**384**	**15**	**1**	**46**	**52**	**24**	**11021**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

Original Alignment Alt 2C	DC Wash DC Core	MD Bethesda	MD Inside Beltway (Northeast)	DC/MD Southern DC / MD Indian Head Hwy	MD Suitland / Branch	MD National Harbor	MD PG County Oxon Hill	MD PG County Joint base Andrews	VA Outside Beltway (South)	VA Alexandria	VA Annandale	VA Arlington	VA McLean	MD Outside Beltway (Southeast)	MD Outside Beltway (Northeast)	VA Outside Beltway (Northwest)	VA Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	66	3	107	70	0	2	42	0	0	0	0	0	0	0	**290**
2	0	0	0	2	0	1	2	0	0	0	0	0	0	0	0	0	0	**5**
3	0	0	0	72	1	25	21	0	7	103	1	3	0	0	0	0	1	**234**
4	506	13	52	273	65	196	158	4	118	988	86	132	10	0	23	20	12	**2656**
5	280	5	14	171	15	60	22	0	56	526	27	72	3	0	4	8	5	**1268**
6	1598	18	72	414	54	12	31	2	71	702	49	192	12	0	24	39	7	**3297**
7	1387	18	69	416	43	39	12	1	86	1089	51	213	9	0	26	27	7	**3493**
8	0	0	0	13	0	4	2	0	4	20	0	0	0	0	0	0	0	**43**
9	21	0	2	241	25	38	38	3	0	21	1	-1	0	0	0	-1	0	**388**
10	21	0	3	189	26	47	48	1	2	101	2	0	0	0	0	0	0	**440**
11	-1	0	0	24	3	5	8	0	0	4	0	0	0	0	0	0	0	**43**
12	0	0	0	19	2	9	8	0	0	1	0	0	0	0	0	0	0	**39**
13	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	**3**
14	19	0	0	76	4	6	12	0	3	95	0	5	0	0	0	0	0	**220**
15	0	0	0	48	1	14	18	0	1	9	0	0	0	0	0	0	0	**91**
16	0	0	0	28	1	9	9	0	0	0	0	-1	0	0	0	0	-1	**45**
17	0	0	0	62	5	8	11	0	0	0	0	0	0	0	0	0	0	**86**
Total	**3831**	**54**	**212**	**2116**	**249**	**580**	**470**	**11**	**350**	**3701**	**217**	**615**	**34**	**0**	**77**	**93**	**31**	**12641**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

	DC	MD	MD	DC/MD	MD	MD	MD	MD	VA	VA	VA	VA	VA	MD	MD	VA	VA	
Alt 2Cr	Wash DC Core	Bethesda	Inside Beltway (Northeast)	Southern DC / MD Indian Head Hwy	Suitland / Branch	National Harbor	PG County Oxon Hill	PG County Joint base Andrews	Outside Beltway (South)	Alexandria	Annandale	Arlington	McLean	Outside Beltway (Southeast)	Outside Beltway (Northeast)	Outside Beltway (Northwest)	Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	-20	0	0	210	8	430	72	0	8	73	0	-1	0	0	-1	0	0	**779**
2	0	0	0	11	0	4	1	0	0	0	0	0	0	0	0	0	0	**16**
3	0	0	0	115	1	119	16	0	0	35	0	1	0	0	0	0	0	**287**
4	1024	15	54	678	29	668	152	2	137	943	95	103	8	0	20	17	7	**3952**
5	460	6	14	256	0	148	7	0	25	285	13	42	4	0	5	6	3	**1274**
6	1749	13	71	769	20	42	51	3	76	700	45	162	8	0	24	26	7	**3766**
7	1776	13	50	1040	7	151	18	0	91	997	45	154	4	0	15	15	7	**4383**
8	1	0	0	25	0	17	3	0	1	13	0	0	0	0	0	0	0	**60**
9	78	-1	1	387	8	258	36	0	0	12	0	-1	0	0	0	0	0	**778**
10	84	0	0	252	9	258	37	0	0	77	1	0	0	0	0	0	0	**718**
11	5	0	0	40	0	47	5	0	0	4	0	-1	0	0	0	0	0	**100**
12	1	0	0	30	0	47	4	0	0	1	0	0	0	0	0	0	0	**83**
13	0	0	0	3	0	5	0	0	0	0	0	0	0	0	0	0	0	**8**
14	38	0	0	153	0	29	8	0	2	60	0	2	0	0	0	0	0	**292**
15	2	0	0	139	1	92	14	0	0	18	1	1	0	0	0	0	0	**268**
16	0	0	0	50	1	66	10	0	0	0	0	0	0	0	0	0	0	**127**
17	0	0	0	90	1	98	14	0	0	0	0	0	0	0	0	0	0	**203**
Total	**5198**	**46**	**190**	**4248**	**85**	**2479**	**448**	**5**	**340**	**3218**	**200**	**462**	**24**	**0**	**63**	**64**	**24**	**17094**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

Original Alignment Alt 3A	DC Wash DC Core	MD Bethesda	MD Inside Beltway (Northeast)	DC/MD Southern DC / MD Indian Head Hwy	MD Suitland / Branch	MD National Harbor	MD PG County Oxon Hill	MD PG County Joint base Andrews	VA Outside Beltway (South)	VA Alexandria	VA Annandale	VA Arlington	VA McLean	MD Outside Beltway (Southeast)	MD Outside Beltway (Northeast)	VA Outside Beltway (Northwest)	VA Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	0	0	13	59	24	12	-1	0	0	0	0	0	0	0	**107**
2	0	0	0	0	2	0	1	2	0	0	0	0	0	0	0	0	0	**5**
3	14	0	2	4	4	3	19	17	5	9	0	1	0	0	0	1	0	**79**
4	11	0	1	-1	-10	-2	21	20	25	107	4	8	0	0	0	1	3	**188**
5	291	12	27	6	10	-1	16	52	46	234	14	64	7	0	15	19	4	**816**
6	1104	19	63	24	15	-1	15	14	58	461	32	161	13	0	26	36	6	**2046**
7	2263	50	179	190	76	2	67	62	161	1119	81	352	29	1	91	90	16	**4829**
8	186	6	17	33	12	1	16	9	16	99	5	22	2	0	9	4	2	**439**
9	470	7	16	59	39	9	53	26	70	241	18	91	21	0	14	53	3	**1190**
10	12	0	1	13	18	8	39	17	20	13	0	1	1	0	1	1	0	**145**
11	0	0	0	0	3	0	6	4	3	1	0	0	0	0	0	0	0	**17**
12	0	0	0	0	1	0	8	2	8	0	0	0	0	0	0	0	0	**19**
13	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	**3**
14	633	7	27	35	29	2	53	53	57	456	14	102	2	0	15	18	4	**1507**
15	108	3	6	19	6	2	38	25	12	4	1	0	0	0	4	2	1	**231**
16	0	0	0	0	5	0	15	9	6	-1	0	0	0	0	0	0	0	**34**
17	0	0	0	1	5	3	20	7	30	-2	0	0	0	0	0	0	0	**64**
Total	**5092**	**104**	**339**	**383**	**217**	**39**	**446**	**344**	**529**	**2740**	**169**	**802**	**75**	**1**	**175**	**225**	**39**	**11719**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

	DC	MD	MD	DC/MD	MD	MD	MD	MD	VA	VA	VA	VA	VA	MD	MD	VA	VA	
Original Alignment Alt 3B	Wash DC Core	Bethesda	Inside Beltway (Northeast)	Southern DC / MD Indian Head Hwy	Suitland / Branch	National Harbor	PG County Oxon Hill	PG County Joint base Andrews	Outside Beltway (South)	Alexandria	Annandale	Arlington	McLean	Outside Beltway (Southeast)	Outside Beltway (Northeast)	Outside Beltway (Northwest)	Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	1	0	0	-1	12	7	47	0	0	0	0	0	0	0	0	0	0	**66**
2	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	**3**
3	0	0	0	2	16	4	18	1	5	22	0	0	0	0	0	0	0	**68**
4	14	0	1	1	23	2	25	0	13	79	3	6	0	0	0	1	2	**170**
5	288	11	31	34	168	4	24	11	44	260	13	60	6	0	16	14	5	**989**
6	1076	16	56	86	44	0	15	5	47	424	26	139	9	0	24	28	5	**2000**
7	1551	30	113	174	117	2	38	13	105	886	50	226	13	1	57	48	10	**3434**
8	8	0	0	1	14	1	10	1	9	61	1	3	0	0	0	0	0	**109**
9	-4	0	2	15	43	5	35	6	0	-2	0	-1	0	0	0	0	0	**99**
10	-1	0	1	10	26	8	30	5	0	0	0	0	0	0	0	0	-1	**78**
11	-1	0	0	0	4	0	5	0	0	0	0	0	0	0	0	0	0	**8**
12	0	0	0	0	2	0	6	0	0	0	0	0	0	0	0	0	0	**8**
13	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**
14	563	6	19	66	87	2	50	16	43	421	12	80	2	0	10	9	3	**1389**
15	1	0	0	1	30	1	31	4	1	6	1	-1	0	0	0	0	1	**76**
16	0	0	0	0	7	0	10	1	0	0	0	0	0	0	0	0	0	**18**
17	0	0	0	1	9	3	15	1	0	0	0	0	0	0	0	0	0	**29**
Total	**3496**	**63**	**223**	**390**	**605**	**39**	**360**	**64**	**267**	**2157**	**106**	**512**	**30**	**1**	**107**	**100**	**25**	**8545**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

	DC	MD	MD	DC/MD	MD	MD	MD	MD	VA	VA	VA	VA	VA	MD	MD	VA	VA	
Alt 3Br	Wash DC Core	Bethesda	Inside Beltway (Northeast)	Southern DC / MD Indian Head Hwy	Suitland / Branch	National Harbor	PG County Oxon Hill	PG County Joint base Andrews	Outside Beltway (South)	Alexandria	Annandale	Arlington	McLean	Outside Beltway (Southeast)	Outside Beltway (Northeast)	Outside Beltway (Northwest)	Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	0	0	0	0	11	192	47	0	94	15	0	0	0	0	0	-1	0	**358**
2	0	0	0	0	0	3	1	0	4	0	0	0	0	0	0	0	0	**8**
3	0	0	0	0	15	76	19	0	41	44	0	1	0	1	0	0	1	**198**
4	20	1	2	0	24	104	22	0	79	152	4	8	0	0	2	2	1	**421**
5	331	12	33	33	162	85	19	13	105	348	23	78	8	0	18	17	10	**1295**
6	1331	19	81	75	49	-5	30	7	74	493	35	168	9	0	37	32	7	**2442**
7	1998	37	137	193	121	76	43	11	159	982	64	283	15	1	72	54	13	**4259**
8	4	0	2	1	14	24	8	4	17	80	1	7	0	0	0	0	1	**163**
9	2452	41	190	339	179	231	83	34	212	1003	126	576	71	0	81	167	15	**5800**
10	146	4	14	35	53	152	40	11	69	51	6	29	4	0	6	10	0	**630**
11	0	0	1	0	3	25	4	0	9	1	0	0	0	0	0	0	0	**43**
12	0	0	0	0	3	30	6	0	37	2	0	0	0	0	0	0	0	**78**
13	0	0	0	0	0	3	0	0	2	0	0	0	0	0	0	0	0	**5**
14	721	9	34	67	86	44	50	11	59	436	13	91	5	1	20	18	4	**1669**
15	-1	0	0	1	31	94	29	4	34	14	2	-1	0	0	0	-1	1	**207**
16	0	0	0	1	7	45	12	1	29	3	-1	-2	-1	0	-1	-39	0	**54**
17	0	0	0	4	15	60	14	2	179	7	0	0	0	0	0	-1	0	**280**
Total	**7002**	**123**	**494**	**749**	**773**	**1239**	**427**	**98**	**1203**	**3631**	**273**	**1238**	**111**	**3**	**235**	**258**	**53**	**17910**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

Original Alignment Alt 3C	DC Wash DC Core	MD Bethesda	MD Inside Beltway (Northeast)	DC/MD Southern DC / MD Indian Head Hwy	MD Suitland / Branch	MD National Harbor	MD PG County Oxon Hill	MD PG County Joint base Andrews	VA Outside Beltway (South)	VA Alexandria	VA Annandale	VA Arlington	VA McLean	MD Outside Beltway (Southeast)	MD Outside Beltway (Northeast)	VA Outside Beltway (Northwest)	VA Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	-15	-1	-6	208	-53	128	53	-20	69	3	0	-2	1	0	-1	0	-1	**363**
2	1	0	0	10	0	2	-1	-1	5	0	0	0	0	-1	0	0	0	**15**
3	-207	-4	-11	88	-10	25	9	-8	25	-13	-3	-20	-2	0	-8	-3	0	**-142**
4	2154	46	279	642	-16	216	124	-9	124	655	75	354	34	0	87	63	14	**4842**
5	430	7	70	52	-50	33	3	-6	31	125	6	58	3	0	-4	9	1	**768**
6	2150	27	106	484	8	9	8	0	71	536	42	217	16	0	46	50	6	**3776**
7	1640	27	111	526	-8	31	8	-1	74	504	29	184	12	0	42	45	6	**3230**
8	-223	-3	-9	9	-7	5	2	-2	5	-7	-2	-16	-1	0	-6	-2	0	**-257**
9	492	7	16	246	3	45	24	-2	107	257	18	96	7	0	14	25	3	**1358**
10	15	0	1	81	-4	40	16	-4	48	19	0	3	1	0	1	2	0	**219**
11	1	0	0	20	-3	5	4	0	8	2	0	0	0	0	0	0	0	**37**
12	0	0	0	27	-5	8	3	-2	27	1	0	0	0	0	0	0	0	**59**
13	0	0	0	4	0	0	0	0	2	0	0	0	0	0	0	0	0	**6**
14	139	-2	-11	419	-21	27	20	-3	21	99	-2	-9	-1	-1	1	-6	0	**670**
15	-191	-5	-15	188	-39	28	15	-8	20	-20	-2	-37	-3	-1	-17	-5	0	**-92**
16	0	0	-1	47	-13	13	6	-3	15	0	0	0	0	0	0	0	0	**64**
17	0	0	-1	45	-12	13	10	-3	159	1	0	0	0	0	0	0	0	**212**
Total	**6386**	**99**	**529**	**3096**	**-230**	**628**	**304**	**-72**	**811**	**2162**	**161**	**828**	**67**	**-3**	**155**	**178**	**29**	**15128**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

District-Level Comparison of New Daily Transit Trips, Relative to No-Build

Source: Summit Roll-up Reports (Rollup_PT_19.rpt, Table 1-4)

	DC	MD	MD	DC/MD	MD	MD	MD	MD	VA	VA	VA	VA	VA	MD	MD	VA	VA	
Alt 3Cr	Wash DC Core	Bethesda	Inside Beltway (Northeast)	Southern DC / MD Indian Head Hwy	Suitland / Branch	National Harbor	PG County Oxon Hill	PG County Joint base Andrews	Outside Beltway (South)	Alexandria	Annandale	Arlington	McLean	Outside Beltway (Southeast)	Outside Beltway (Northeast)	Outside Beltway (Northwest)	Outside Beltway (Southwest)	
From \ To	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**Total**
1	-19	0	0	318	26	390	49	0	75	9	-1	-1	0	0	-1	0	0	**845**
2	0	0	0	13	0	7	1	0	3	0	0	0	0	0	0	0	0	**24**
3	0	0	0	192	14	133	12	0	27	6	0	0	0	0	0	0	0	**384**
4	2717	60	408	1272	202	766	166	45	210	961	123	454	40	0	113	71	22	**7630**
5	927	19	108	356	39	194	8	12	63	284	29	126	10	0	27	24	6	**2232**
6	2404	27	131	757	34	63	33	4	90	633	50	235	15	0	58	47	11	**4592**
7	1933	28	108	847	18	177	31	1	112	781	47	219	10	0	50	37	10	**4409**
8	-1	0	0	80	3	49	3	0	9	36	0	2	0	0	0	0	1	**182**
9	512	5	15	619	27	349	37	3	108	257	19	91	7	0	12	25	4	**2090**
10	16	0	0	216	12	253	27	0	48	17	1	3	1	0	1	1	0	**596**
11	0	0	0	43	2	49	4	0	8	0	0	-1	0	0	0	0	0	**105**
12	0	0	0	45	0	51	4	0	29	2	0	0	0	0	0	0	0	**131**
13	0	0	0	4	0	5	0	0	2	0	0	0	0	0	0	0	0	**11**
14	746	6	22	734	6	137	25	0	42	298	8	65	4	0	14	10	3	**2120**
15	0	0	0	286	11	193	20	0	26	16	2	1	0	0	0	0	1	**556**
16	0	0	0	78	3	97	9	0	23	3	0	0	0	0	0	0	0	**213**
17	0	0	0	127	4	117	13	0	165	5	0	0	0	0	0	0	0	**431**
Total	**9235**	**145**	**792**	**5987**	**401**	**3030**	**442**	**65**	**1040**	**3308**	**278**	**1194**	**87**	**0**	**274**	**215**	**58**	**26551**

Note: The new trips exclude new non-home-based direct demand trips, which is why the total differs (is lower) from that reported in the summary results table.

APPENDIX F: COMMENTS FROM THE STUDY TECHNICAL COMMITTEE

Comment Number	Stakeholder Agency and Representative	Relevant Page Number in November Draft Report	Comment Summary	Response
1	Jim Maslanka, City of Alexandria	General comment	Concern with the type of transitway assumed between the Eisenhower Metro and the King Street Metro. The study's assumption is that this would be a dedicated transitway. There is no way that such a facility could be accommodated in this area. Concern that the total demand across the bridge for this alternative might be overstated, since one of the key transit links has a lower capacity. Request to either (a) model this segment as a mixed traffic guideway to properly reflect ridership; or, (b) provide statement in the report that indicates that if a different assumption is made, the numbers of people on the Virginia side may change considerably.	The study team recognizes that there are physical constraints within the corridor that may make some of the proposed alignments infeasible from an engineering perspective. That being said, the intent of the study was to demonstrate the "best case" scenario for each alternative, with the understanding that alternatives that did not perform well under these idealized assumptions could not be expect to perform better once subjected to more rigorous engineering analysis. The study team has revised the language in the Executive Summary, Section 1, and Section 7.3 to clarify the intent and constraints of the methodology used in this study.
2	Robert Moore, VDOT	General Comment	Alternative 2Cr incorporates an assumption that BRT/LRT service will occupy dedicated right-of-way on local streets in the City of Alexandria, eliminating the use of those streets by autos. This is a key feature of the alternative that contributes to its relatively good performance. This assumption should be more clearly stated in the report.	This assumption has been stated more clearly in Section 7.3 of the report.
3	Robert Moore, VDOT	General Comment	The study appears to assume that buses will have exclusive use of Lanes 11 and 12 on the Wilson Bridge in the mixed-traffic alternatives. Thus, for this segment of these alternatives, buses will operate on exclusive rights-of-way. It would be helpful for this point to be clarified in the report.	This assumption has been noted in Table 1-1.

Comment Number	Stakeholder Agency and Representative	Relevant Page Number in November Draft Report	Comment Summary	Response
4	Robert Moore, VDOT	General Comment	The Figures showing the various alternative alignments in Section 3 all contain information about the boardings at each station. Thus, for grade-separated (Metrorail) alternatives, passengers do not need to change modes and therefore do not "board," whereas passengers on at-grade dedicated alternatives (BRT / LRT) are identified as boardings, as shown in the Table below. This information can provide a false sense of the utilization of the alternative. It would be desirable for these points to be clearly noted on the figures and / or the text of the report.	This point has been clarified in Section 2.1of the report.
5	Robert Moore, VDOT	59	See comments below. There is no mention in the scope or objectives of serving National Harbor, maximizing the use of lanes 11 and 12, or reducing auto trips on the Woodrow Wilson Bridge.	As each alternative serves new transit markets (e.g. National Harbor), it was possible for an alternative's cost-effectiveness to be due to the new area it serves rather than its utilization of lanes 11 and 12 of WWB. The additional metrics were included to provide some means of determining what proportion of the user benefits accrued were due to cross-Potomac traffic. This point has been elaborated on in Section 2.1 of the report.
	Robert Moore, VDOT	1		
6	Robert Moore, VDOT	7	The use of the center lanes of the bridge (by transit riders) is one factor in determining cost-effectiveness, but it is not the primary evaluation tool.	
7	Robert Moore, VDOT	7	None of these measures include auto trips using the bridge (see below), and auto trips are not mentioned in the more detailed descriptions of these metrics on p. 7	The focus of this study has been on the utilization of lanes 11 and 12 for transit alternatives. That being said, it is insufficient to look at transit trips crossing WWB as the sole measure of effectiveness, as many of the transit trips using lanes 11 and 12 may be existing riders taking advantage of the shorter trip times and/or additional capacity in the system. Auto trips over the WWB were included as metrics in both the Initial Screening and Final Report to show the differences between alternatives that were reallocating existing transit trips versus new transit trips that could be reduce auto traffic on WWB. This point has been clarified in Section 2.1 of the report.
	Robert Moore, VDOT	7		
8	Robert Moore, VDOT	59	The reference to auto trips using the bridge is a particularly surprising statement. Auto trips on the bridge are not mentioned in the objective or scope. Moreover, this metric is absent from a cursory review of previous documents and presentations to the Technical Advisory Committee, other than as an additional data point supporting other measures (identified above).	

Comment Number	Stakeholder Agency and Representative	Relevant Page Number in November Draft Report	Comment Summary	Response
9	Robert Moore, VDOT	34	Nothing in the objective or scope appears to directly refer to serving National Harbor	This is correct. Direct service to National Harbor is not an objective of the study; however, as the stations in this area (including the Oxon Hill Park and Ride) draw some of the highest volumes of boardings on the mixed-traffic alternatives, it is reasonable to expect an indirect route to these locations to make these alternatives even less cost-effective. This point has been clarified in Section 4.1 of the report.
10	Robert Moore, VDOT	32	Description of Alternative 3Cr's cost-effectiveness appears to suggest that model travel times are unrealistic. This point should be clarified.	Travel times at this level of conceptual analysis are designed to reflect a "best case" scenario, subject to further investigation during design. This has been discussed in Section 2.1; the description of Alternative 3Cr has been edited in Section 3.
11	Robert Moore, VDOT	Tables 6-2, 6-3, etc.	The titles and legends of these tables should clearly indicate that the data represent a ½-mile radius from the stations.	The table titles have been edited to clarify this point.
12	Robert Moore, VDOT	Figs. 3-10, 3-12, 3-13, 3-4	Clarify ridership Legends on figures: • @ Huntington (E vs. W) • @ Eisenhower, King, several stations in MD (B vs. C) which branch is B vs. C?	The legends will be clarified.
13	Robert Moore, VDOT	Figs. 3-9, 3-14	These alternatives provide identical alignments (although 2Cr provides more stations in MD). However, Alternative 3Cr provides a 1-seat ride whereas Alternative 2Cr requires a mode transfer. For this reason it would seem that 3Cr would achieve more exclusive boardings at King St. This counter-intuitive finding should be explained.	What may be confusing to the reader is that, consistent with the legend, the bold number in larger font refers to the number of boardings at the station that are exclusive to the new alignment, whereas the smaller font number indicates the change in total boardings at the Metrorail station relative to the No-Build. The overall intent of the legend is to convey boardings onto the new alignment *at the stations served by the alignment alternative* (large, bold number) and what impact the alternative would have on background Metrorail boardings at existing (and committed, in the case of Potomac Yard) Metrorail stations in the larger study area (small, non-bold number). As the figures show, the King Street station boardings for Alternative 3Cr (Figure 3-14) represent a 2,100 increase

Comment Number	Stakeholder Agency and Representative	Relevant Page Number in November Draft Report	Comment Summary	Response
				over the No-Build, while the boardings under Alternative 2Cr (Figure 3-9) represent a 1,850 increase over the No-Build. Hence, Alternative 3Cr is forecast to have 250 (2,100 - 1,850) more Metrorail boardings than Alternative 2Cr. That Alternative 2Cr shows 5,720 boardings exclusive to the alignment means that there are forecast to be 5,720 boardings of the LRT at the King St station, some of which may be initial transit boardings and some of which may be transfer boardings from Metrorail or other transit modes. That Alternative 3Cr (Figure 3-14) shows zero route boardings exclusive to the new alignment at King Street station is because this station is not physically located on any portion of that alternatives' new alignment (i.e. it is not a new station (like U.S. Route 1) or an extension terminus (like Huntington and Anacostia). Again, this is not to say that the King Street station does not capture any boardings for travel on the new alignment under Alternative 3Cr. In fact, the 2,100 increase (relative to the No-Build) in boardings there represent boardings attributable to the new alignment.