GetOnBoardBRT

BUS RAPID TRANSIT IN MONTGOMERY COUNTY

MD 355

Corridor Summary Report

June 2019

MD 355 BRT
Corridor Planning Study Phase 2

MONTGOMERY COUNTY MARYLAND

MCDOT Montgomery County Department of Transportation

RideTheFlash.com

GetOnBoardBRT BUS RAPID TRANSIT IN MONTGOMERY COUNTY — MD 355

MD 355 BRT Corridor Planning Study

Phase 2

Corridor Summary Report

Draft

October 11, 2019

Preface

This *Corridor Summary Report* documents Phase 2 of the MD 355 Bus Rapid Transit (BRT) Planning Study. The project is evaluating detailed alternatives for providing enhanced transit service along MD 355 from Bethesda to Clarksburg in Montgomery County, Maryland. In order to evaluate and compare the alternatives in terms reliability, effectiveness, and cost, key factors were developed and analyzed. These factors included: design criteria, traffic modeling, ridership forecasting, and service planning; siting and evaluating station locations; analyzing and documenting environmental features; and sharing this information and requesting feedback through an extensive public involvement program. The culmination of these detailed evaluations was used to quantitatively measure the effectiveness of each of the alternatives to help identify a Recommended Alternative to carry forward into design and construction. The *Corridor Summary Report* documents the process and products that were undertaken to develop the information necessary to complete this phase of the study.

Rapid: Features like limited stops, off-board fare collection, dedicated lanes (where feasible), and level-boarding through all doors make for a faster ride.

Reliable: You'll never wait long and you'll see real-time travel information on message boards at the station so you'll know exactly when the next BRT arrives.

Relaxing: Avoid the stress associated with driving: use Wi-Fi on-board to be more productive, read a book, or simply use the time to rest.

What is Bus Rapid Transit (BRT)?

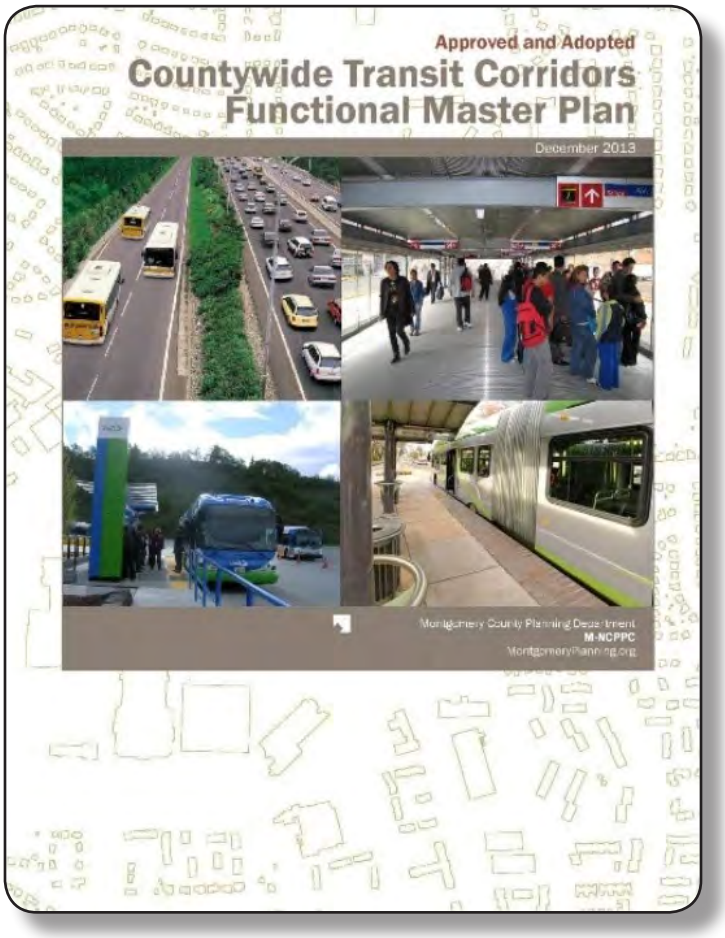
Montgomery County is studying options for a new BRT service along MD 355 called FLASH. BRT is a bus-based rapid transit system with features that improve reliability and capacity, so you can get where you need to go quickly.

MD 355 FLASH Features:

- Frequent, reliable service which means you will never wait long for a bus
- Dedicated lanes, where feasible, to separate buses from traffic, keeping your ride reliable and on-time
- New, enhanced vehicles that include free wi-fi and USB charging ports so you can listen to podcasts, surf the web, or begin your workday during your commute. On-board bike storage lets you bring bicycles right onto the vehicle
- New, comfortable stations that include features to improve efficiency and reliability. BRT stations have SmarTrip-compatible off-board fare collection machines where you pay your fare before the BRT arrives. Real-time transit information screens let you know when the next BRT vehicle is arriving
- Level boarding through all doors, allowing for easy boarding and alighting for all riders, including those with wheelchairs or strollers
- Community-friendly design with enhanced pedestrian and bicycle facilities
- Vehicles equipped with Transit Signal Priority, or TSP, a technology that allows them to communicate with traffic signals to get a little extra green when certain conditions are met
- Uniquely branded FLASH vehicles that look and feel different from local buses

What is the History of the MD 355 BRT Planning Study?

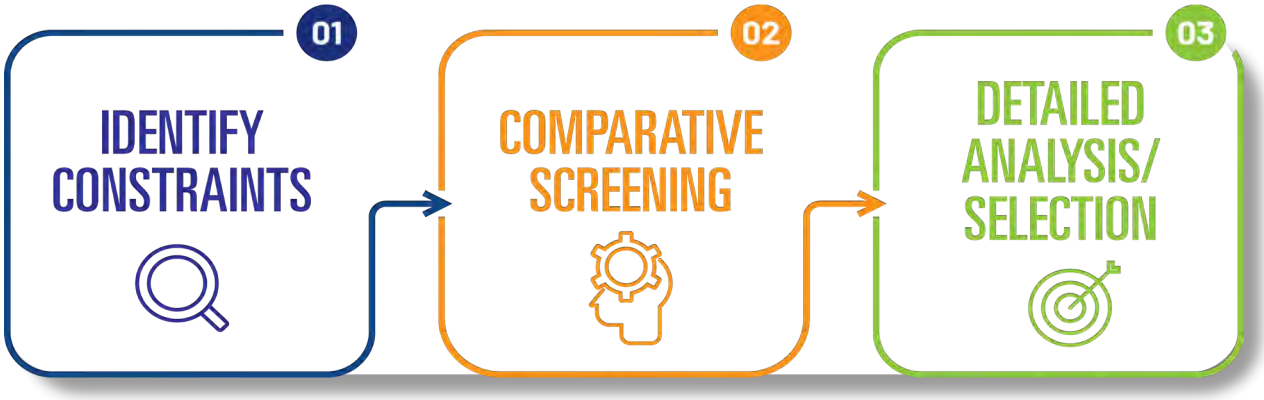
Montgomery County first proposed BRT as the most appropriate mode for improving transit in the MD 355 corridor as part of the 1993 Strategic Transit Plan. In 2011, MCDOT completed the Countywide BRT Study which identified BRT as the preferred mode of transit due to its ability to provide better service to existing transit passengers and attract potential new riders. BRT can provide a fast, convenient, and reliable alternative to driving on congested roadways, and a bus can carry more people in the same space as a car. Acting upon the findings from the 2011 Countywide BRT Study, the Maryland-National Capital Park and Planning Commission (M-NCPPC) developed the Countywide Transit Corridors Functional Master Plan, which was approved and adopted by the Montgomery County Council in December 2013.



The *Functional Master Plan* proposes the development of a BRT network throughout Montgomery County to support mobility, land use, and economic development goals. To ensure network integrity and achieve the County's vision, it recommends and provides the basis for right-of-way reservations required to accommodate BRT along with the allocation of space for vehicular traffic, pedestrians and bicycles in individual transit corridors. The Functional Master Plan contains recommendations for ten BRT corridors in the County, including along MD 355. The first BRT corridor in the county is being implemented along US 29 and will be open in 2020.

What is the MD 355 BRT Planning Study Process?

The MD 355 BRT Corridor Planning Study utilized the recommendations from the Countywide Transit Corridors Functional Master Plan to help inform the three-step process developed to recommend an alternative:



Step 1 - Identify Constraints (Complete): This process included data collection of existing transit operations, traffic volumes, crash statistics, environmental information, and aerial mapping. This information was used to prepare a Draft Preliminary Purpose and Need document, which is discussed in more detail in **Chapter 2**.

Step 2 - Comparative Screening (Complete): Using the information developed in Step 1, a set of Conceptual Alternatives was developed for testing purposes. The analysis performed during this step was used to screen out elements that showed the least benefit, to improve the alternatives, and to develop a refined set of alternatives that would be analyzed in further detail during the next step. This work was completed by the Maryland Department of Transportation Maryland Transit Administration (MDOT MTA) in Phase 1 of the MD 355 BRT Corridor Study.

Step 3 - Detailed Analysis / Selection (Current Phase): This is the current step in the corridor planning process, called Phase 2 of the MD 355 BRT Planning Study. It builds upon the Conceptual Alternatives developed in Phase 1, refining and analyzing alternatives in further detail. Additional engineering was done for each Build Alternative to better identify constraints and potential impacts. The traffic and travel demand modeling were refined to reflect the latest design and operating assumptions. Station locations were examined through a two-step process to further assess their viability. The result is a set of detailed measures providing quantitative results for comparison of the alternatives against themselves.

This *Corridor Summary Report* represents the culmination of Step 3 and presents the results and the findings of the analysis of each alternative. This report will document the County Council's selection of a Recommended Alternative, which will be the basis of detailed design. The outcomes of the study can be used in the future for final design and environmental analysis and documentation.

Why are We Doing the MD 355 BRT Planning Study?

The purpose of the project is to provide a new transit service with greater travel speed and frequency along MD 355 between Bethesda and Clarksburg that will help accomplish the following:

- **Enhance transit connectivity and multimodal integration along the corridor as part of a coordinated regional transit network;**
- **Improve the ability for buses to move along the corridor (bus mobility) with increased operational efficiency, on-time performance/reliability, and travel times;**
- **Address current and future bus ridership demands;**
- **Attract new riders and provide improved service options for existing riders as an alternative to congested automobile travel through the corridor;**
- **Support approved Master Planned residential and commercial growth along the corridor;**
- **Improve transit access to major employment and activity centers;**
- **Achieve Master Planned non-auto driver modal share;**
- **Provide a sustainable and cost-effective transit service; and**
- **Improve the safety of travel for all modes along the corridor.**

BRT on MD 355 will help address:

MOBILITY ALONG CORRIDOR

Traffic delay and poor transit reliability are significant challenges for travelers along the corridor today and this is likely to worsen in the future.

Traffic congestion is a major issue on MD 355, with slow peak period and peak direction travel speeds and multiple failing intersections and roadway segments. Future traffic projections show that the significant growth in population and employment along the MD 355 Corridor will further degrade traffic conditions. This congestion is a contributing factor affecting the reliability of existing transit service. BRT on MD 355 would increase the efficiency with which the roadway space is used, allowing more people to traverse the corridor in a reliable, affordable, and safe way.

HIGH TRANSIT DEMAND ALONG COORIDOR

The MD 355 corridor has some of the highest ridership bus routes in the Ride On system. However, the on-time performance of Ride On and Metrobus routes (at 72 percent and 77 percent, respectively) suffers due to congestion. BRT priority treatments would significantly improve the speed and reliability of bus service along the corridor.

GROWTH (POPULATION AND ECONOMIC)

Montgomery County is the most populous county in Maryland with over 300,000 people living in the study area and home to over 280,000 jobs. Increases in both population and jobs within the study area are expected to outpace growth in the county overall, with areas of concentrated growth forecast to occur in the segment north of I-495 (Capital Beltway) through Rockville to Gaithersburg.

BRT along MD 355 will accommodate this growth by providing an option for people to get around aside from driving a car. BRT can also support the growth of pedestrian-friendly places, reducing the need to drive.

The following goals and objectives were developed to assess the ability of each alternative to meet the Purpose and Need of the MD 355 BRT Planning Study:

What are the Alternatives for the MD 355 BRT Planning Study?

Four Build Alternatives plus the No-Build Alternative were initially identified for analysis:

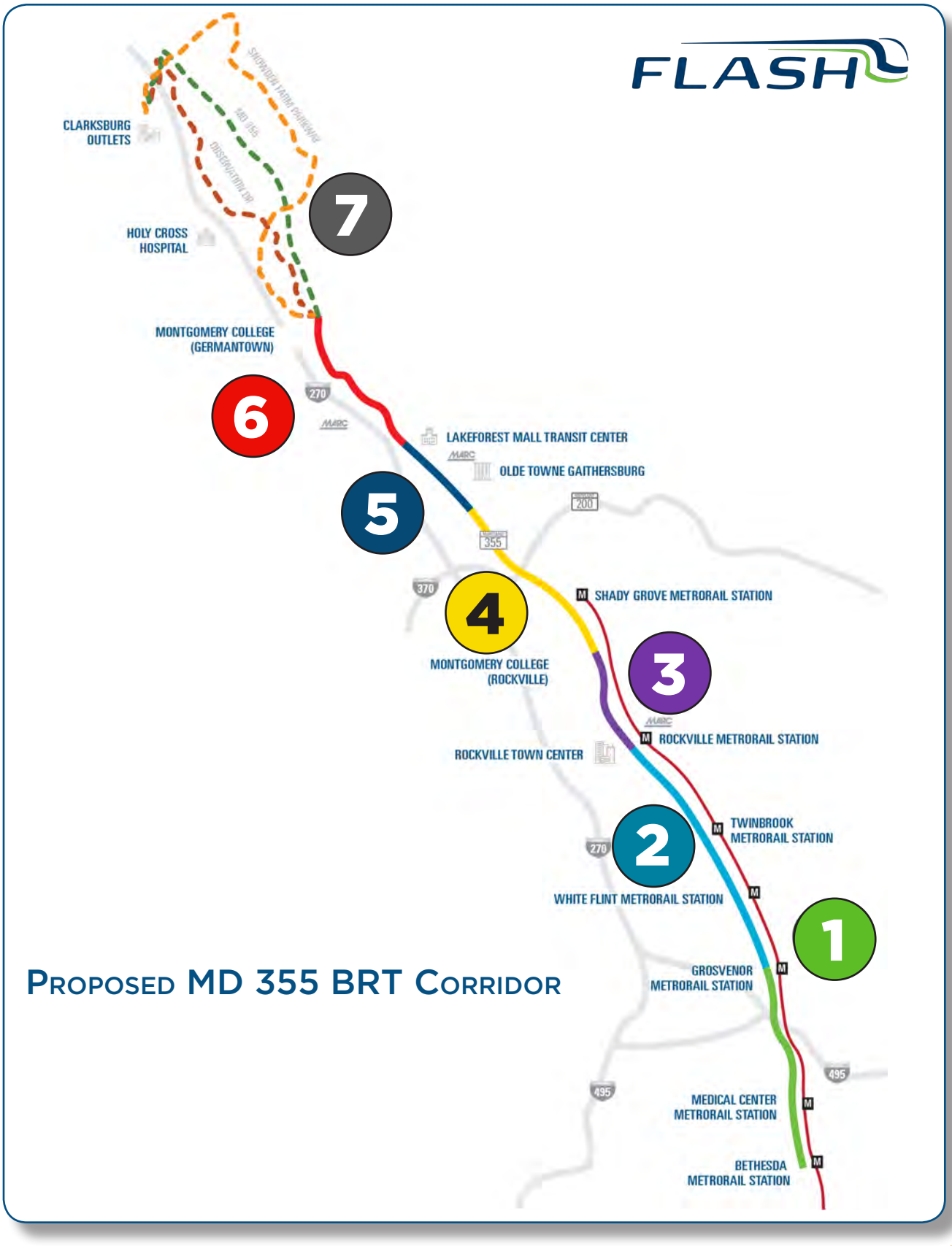
- **TSM Alternative**
- **Alternative A (mixed traffic)**
- **Alternative B (mostly median-running)**
- **Alternative C (mostly curb-running)**

Following the completion of the alternatives analysis, an additional alternative, **Alternative B Modified**, was developed in an attempt to reduce costs and right-of-way needs. More detailed information can be found in **Chapter 3** of this *Corridor Summary Report* and in the *Alternatives Technical Report*.

Alignment Segments

MD 355 is a roadway thats changes character as it transitions from the urban setting of downtown Bethesda to the exurban setting in Clarksburg. The roadway was divided into seven segments because of this varying character in an effort to provide for the different design types. The seven segments are described in the table below and shown in the following map. Segments may be referenced when describing the alternative results.

Segment	Geographic Description
7	Clarksburg to Middlebrook Road
6	Middlebrook Road to MD 124
5	MD 124 to Summit Avenue
4	Summit Avenue to College Parkway
3	College Parkway to Dodge Street
2	Dodge Street to Grosvenor Metrorail
1	Grosvenor Metrorail to Bethesda Metrorail



Proposed MD 355 BRT Corridor

Alternatives

NO-BUILD ALTERNATIVE:

- Ride On extRa service, including Transit Signal Priority (TSP), as implemented in October 2017
- As the baseline for comparison, the No-Build Alternative includes no improvements beyond existing services and projects in the Financially Constrained Long-Range Transportation Plan

TRANSPORTATION SYSTEMS MANAGEMENT (TSM) ALTERNATIVE:

- Ride On extRa service extended south to Bethesda and north to Clarksburg
- Extension of TSP introduced as part of the Ride On extRa service
- Travels in mixed traffic

Alternatives A, B, B Modified and C all include BRT features such as: **TSP** in additional locations (see descriptions on following board), **off-board fare collection**, **level boarding, new BRT vehicles**, **upgraded stations** and **FLASH branding**.

ALTERNATIVE A

- Mixed traffic and queue jumps

ALTERNATIVE B

- Mostly Median-Running and dedicated lanes where feasible

ALTERNATIVE B MODIFIED

- Mostly Median-Running dedicated lanes where feasible
- Segments 4, 5, and 6 would include a single, one-way peak period median busway

ALTERNATIVE C

- Mostly Curb-Running dedicated lanes where feasible and queue jumps

The MD 355 BRT Project may employ a variety of treatments along the length of the corridor to best fit within the surrounding area. Some of the options under consideration are described below.

MIXED TRAFFIC

The BRT would travel with general traffic. It would not have lanes dedicated for its use.

TWO MEDIAN BRT LANES

Two lanes located in the center of the roadway would be dedicated for use by the BRT, and may be physically separated from traffic by a raised curb or median. Median BRT lanes would minimize conflicts with general traffic and allow the BRT to operate faster and more reliably. However, the BRT lanes would interact with other traffic at intersecting cross streets. To avoid conflicts, general traffic could only make left turns at signalized intersections.

ONE MEDIAN BRT LANE (REVERSIBLE OR BI-DIRECTIONAL)

This configuration could allow for two different types of operations: bi-directional or reversible direction operations. With reversible operations, the direction of the BRT in the one median lane would vary depending on the time of day. BRT vehicles traveling in the peak direction would use the median BRT lane and BRT vehicles traveling in the non-peak direction would be in mixed traffic. In bi-directional operations, BRT vehicles traveling in both directions would share a single dedicated lane in the center of the roadway.

ONE MEDIAN BRT LANE (FIXED)

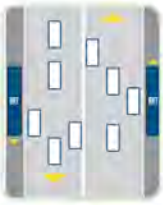
In fixed-direction operations, a single median BRT lane would be used solely by the southbound BRT at all times of the day. The northbound BRT would travel in mixed traffic.

ONE CURB BRT LANE (FIXED SOUTHBOUND)

The lane adjacent to the curb along southbound MD 355 would be used exclusively by the BRT, local buses and right-turning vehicles. BRT vehicles heading northbound on MD 355 would travel with general traffic.

ONE CURB BRT LANE (PEAK DIRECTION ONLY)

A curb BRT lane would be created by re-purposing the peak direction curb lane to accommodate BRT buses, local buses, and right-turning vehicles. The two center general traffic lanes would have a reversible operation with different AM/PM lane configurations. BRT vehicles heading in the off-peak direction would travel with general traffic.



TWO CURB BRT LANES

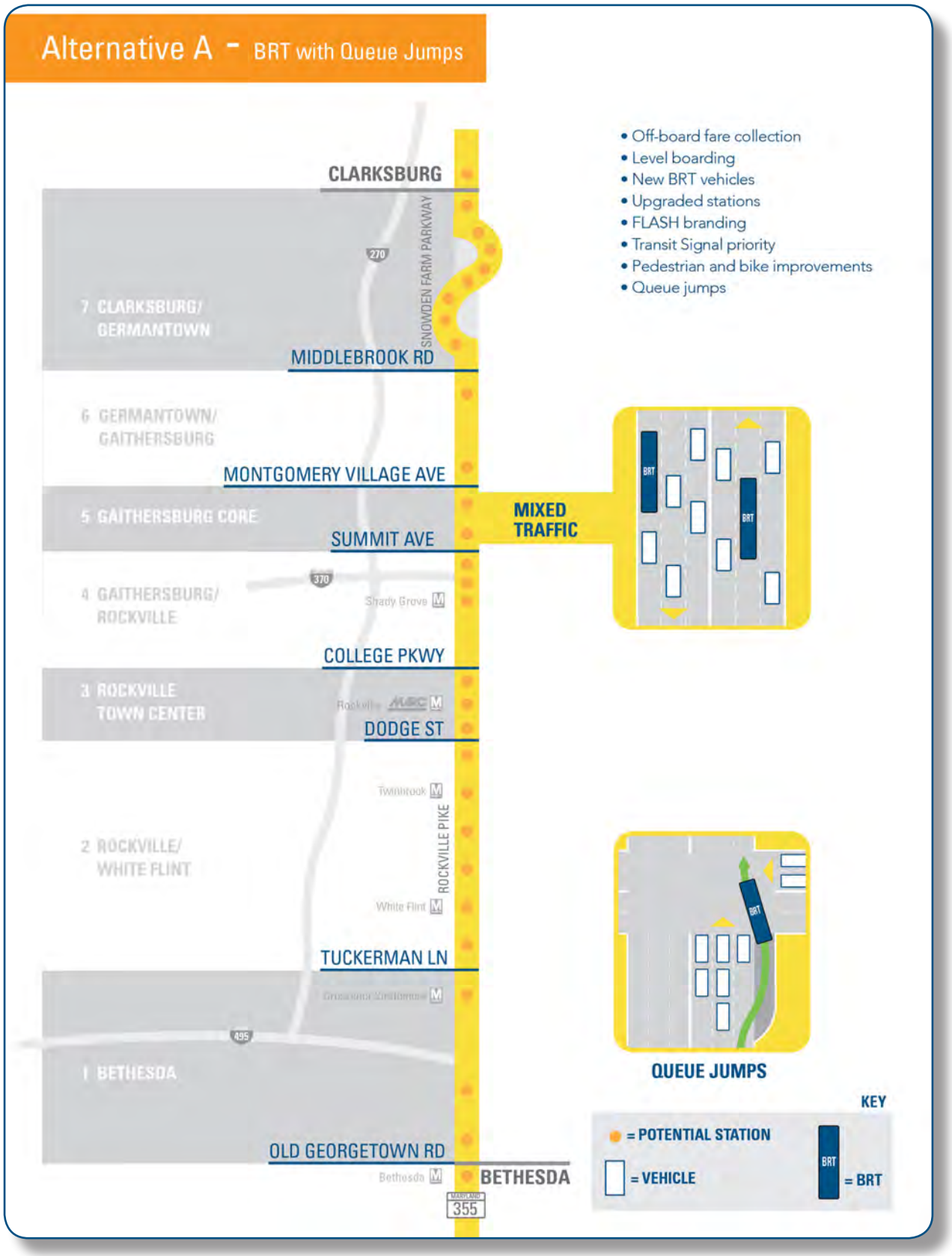
The two lanes adjacent to the curb (one on each side of the roadway) would be used exclusively by the BRT, local buses and right-turning vehicles.

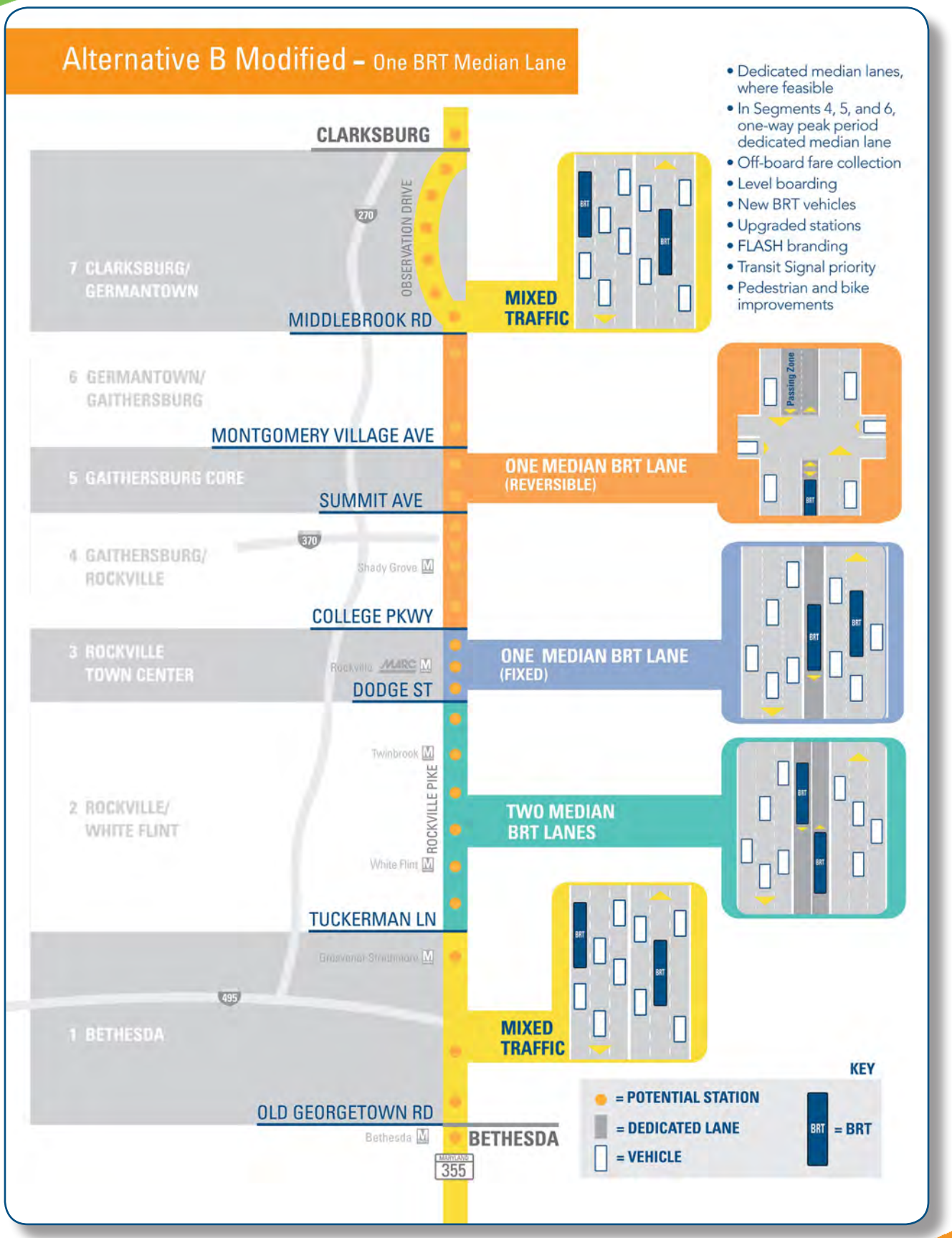
TRANSIT SIGNAL PRIORITY

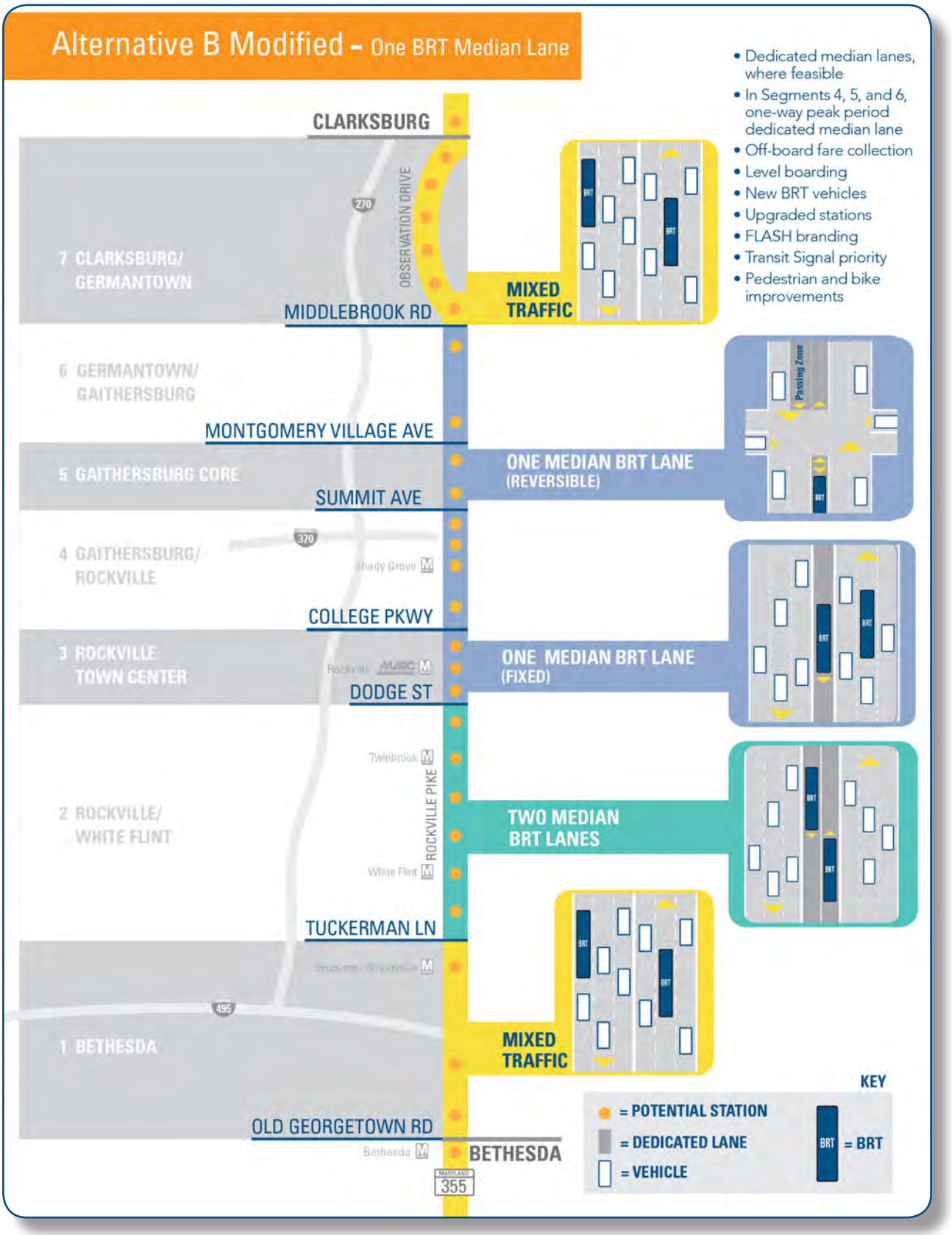
Transit Signal Priority (TSP) would give priority to BRT vehicles when certain conditions are met by either extending a green light or shortening a red light to allow an approaching BRT to pass through the intersection. TSP was implemented on the MD 355 corridor between the Lakeforest Transit Center and Medical Center as part of the new Ride On extRa service in October 2017.

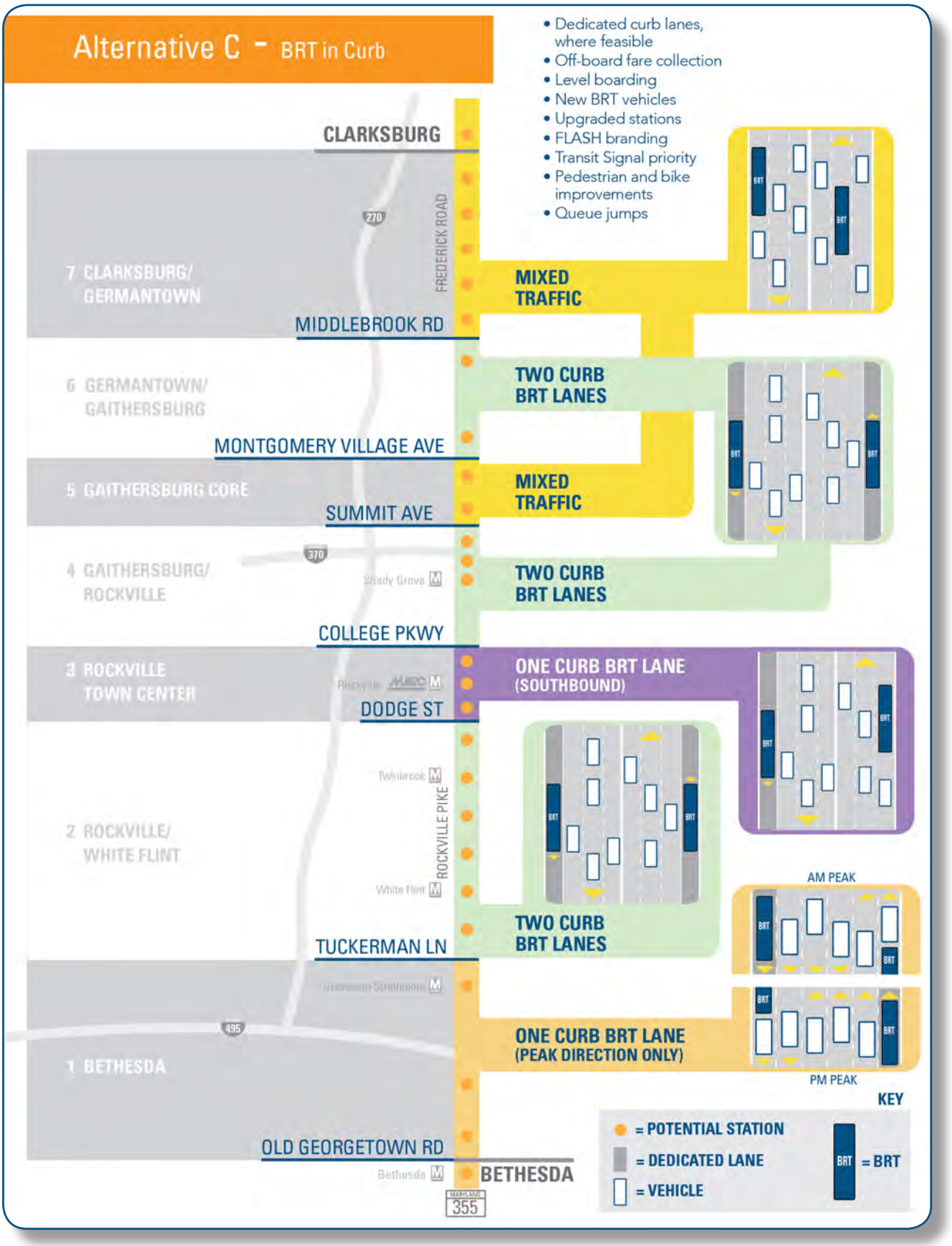
QUEUE JUMP

A queue jump is a short section of roadway widening on an approach to an intersection designated for exclusive use of the BRT. A queue jump allows BRT vehicles to bypass congestion or delays at intersections. In most applications, queue jumps are used in conjunction with TSP to allow vehicles to enter an intersection with a special signal ahead of other vehicles.


Alternative A - BRT with Queue Jumps
• Off-board fare collection
• Level boarding
• New BRT vehicles
• Upgraded stations
• FLASH branding
• Transit Signal priority
• Pedestrian and bike improvements
• Queue jumps
CLARKSBURG
SNOWDEN FARM PARKWAY
270
7 CLARKSBURG/ GERMANTOWN
MIDDLEBROOK RD
6 GERMANTOWN/ GAITHERSBURG
MONTGOMERY VILLAGE AVE
5 GAITHERSBURG CORE
SUMMIT AVE
MIXED TRAFFIC
BRT
BRT
370
4 GAITHERSBURG/ ROCKVILLE
Shady Grove
COLLEGE PKWY
3 ROCKVILLE TOWN CENTER
DODGE ST
Twinbrook
ROCKVILLE PIKE
2 ROCKVILLE/ WHITE FLINT
White Flint
TUCKERMAN LN
495
1 BETHESDA
OLD GEORGETOWN RD
Bethesda
BETHESDA
MARYLAND 355
BRT
QUEUE JUMPS
KEY
= POTENTIAL STATION
= VEHICLE
BRT
= BRT


Alternative B Modified – One BRT Median Lane
• Dedicated median lanes, where feasible
• In Segments 4, 5, and 6, one-way peak period dedicated median lane
• Off-board fare collection
• Level boarding
• New BRT vehicles
• Upgraded stations
• FLASH branding
• Transit Signal priority
• Pedestrian and bike improvements
CLARKSBURG
7 CLARKSBURG/ GERMANTOWN
OBSERVATION DRIVE
270
MIDDLEBROOK RD
MIXED TRAFFIC
6 GERMANTOWN/ GAITHERSBURG
MONTGOMERY VILLAGE AVE
5 GAITHERSBURG CORE
SUMMIT AVE
ONE MEDIAN BRT LANE (REVERSIBLE)
Passing Zone
370
4 GAITHERSBURG/ ROCKVILLE
Shady Grove
COLLEGE PKWY
3 ROCKVILLE TOWN CENTER
Rockville MARC
DODGE ST
ONE MEDIAN BRT LANE (FIXED)
Twinbrook
ROCKVILLE PIKE
2 ROCKVILLE/ WHITE FLINT
White Flint
TWO MEDIAN BRT LANES
TUCKERMAN LN
Grosvenor-Strathmore
495
1 BETHESDA
MIXED TRAFFIC
OLD GEORGETOWN RD
Bethesda
BETHESDA
MARYLAND 355
KEY
= POTENTIAL STATION
= DEDICATED LANE
= VEHICLE
BRT = BRT


Alternative B Modified – One BRT Median Lane
• Dedicated median lanes, where feasible
• In Segments 4, 5, and 6, one-way peak period dedicated median lane
• Off-board fare collection
• Level boarding
• New BRT vehicles
• Upgraded stations
• FLASH branding
• Transit Signal priority
• Pedestrian and bike improvements
CLARKSBURG
OBSERVATION DRIVE
270
7 CLARKSBURG/ GERMANTOWN
MIDDLEBROOK RD
MIXED TRAFFIC
BRT
6 GERMANTOWN/ GAITHERSBURG
MONTGOMERY VILLAGE AVE
Passing Zone
5 GAITHERSBURG CORE
SUMMIT AVE
ONE MEDIAN BRT LANE (REVERSIBLE)
370
4 GAITHERSBURG/ ROCKVILLE
Shady Grove
COLLEGE PKWY
3 ROCKVILLE TOWN CENTER
Rockville
DODGE ST
ONE MEDIAN BRT LANE (FIXED)
Twinbrook
ROCKVILLE PIKE
2 ROCKVILLE/ WHITE FLINT
White Flint
TWO MEDIAN BRT LANES
TUCKERMAN LN
495
1 BETHESDA
MIXED TRAFFIC
KEY
= POTENTIAL STATION
= DEDICATED LANE
= VEHICLE
= BRT
OLD GEORGETOWN RD
Bethesda
BETHESDA
MARYLAND 355

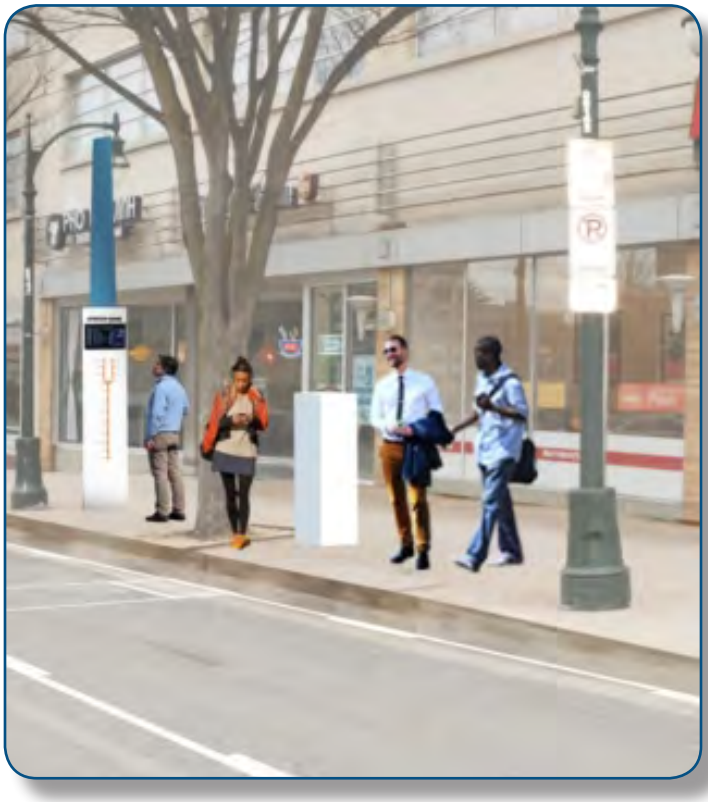

Alternative C - BRT in Curb
• Dedicated curb lanes, where feasible
• Off-board fare collection
• Level boarding
• New BRT vehicles
• Upgraded stations
• FLASH branding
• Transit Signal priority
• Pedestrian and bike improvements
• Queue jumps
CLARKSBURG
FREDERICK ROAD
270
7 CLARKSBURG/ GERMANTOWN
MIXED TRAFFIC
MIDDLEBROOK RD
6 GERMANTOWN/ GAITHERSBURG
TWO CURB BRT LANES
MONTGOMERY VILLAGE AVE
5 GAITHERSBURG CORE
MIXED TRAFFIC
SUMMIT AVE
370
4 GAITHERSBURG/ ROCKVILLE
Shady Grove
TWO CURB BRT LANES
COLLEGE PKWY
3 ROCKVILLE TOWN CENTER
Rockville
ONE CURB BRT LANE (SOUTHBOUND)
DODGE ST
Twinbrook
ROCKVILLE PIKE
2 ROCKVILLE/ WHITE FLINT
White Flint
AM PEAK
TWO CURB BRT LANES
TUCKERMAN LN
Grosvenor-Strathmore
495
ONE CURB BRT LANE (PEAK DIRECTION ONLY)
PM PEAK
1 BETHESDA
KEY
= POTENTIAL STATION
= DEDICATED LANE
= VEHICLE
BRT = BRT
OLD GEORGETOWN RD
Bethesda
BETHESDA
MARYLAND 355

How Will the BRT Operate?

There are four route patterns proposed for the proposed BRT service:

- FLASH 1C: Clarksburg to Montgomery College – Rockville
- FLASH 1G: Germantown to Montgomery College – Rockville
- FLASH 2: Lakeforest Transit Center to Grosvenor Metro
- FLASH 3: Montgomery College – Rockville to Bethesda

The BRT would operate from 4:15 AM - 1:45 AM daily, and each service pattern would operate every ten minutes during the peak period, which is defined as between 6:00 AM to 9:00 PM. Where the route patterns overlap, the effective headways (or time between buses) are shorter.



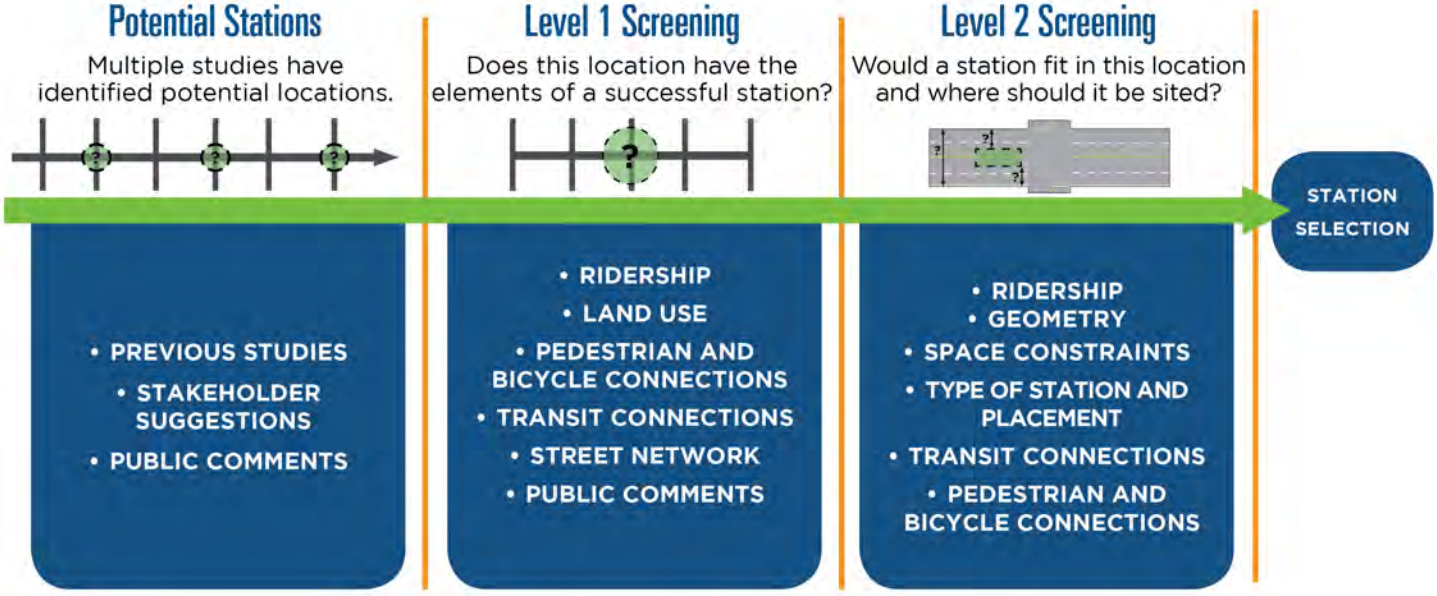
Where are the BRT Stations?

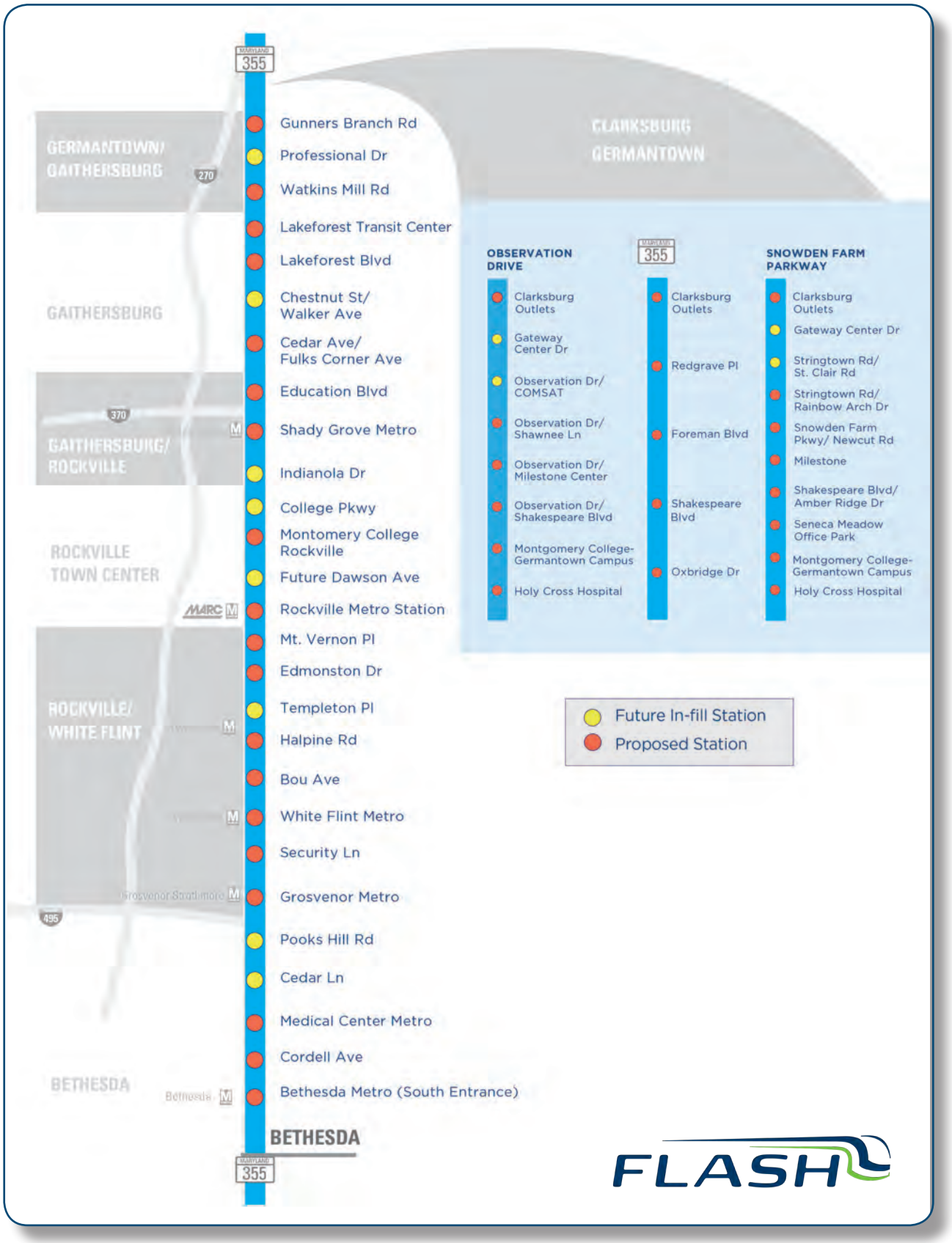
As part of Phase 2 of the MD 355 BRT Planning Study, a comprehensive assessment of potential station locations was performed that included two levels of station screening to evaluate the station options and ultimately determine a set of recommended stations to carry forward in the Alternatives.

A number of future "infill" stations were also identified that may become suitable after the initial launch of BRT service. A list of all of the station locations can be found in *Section 3.9* and more detail on the station selection process can be found in the *Station Screening Report*.

STATION SCREENING PROCESS

MCDOT has completed a two-level screening of potential station locations.




MARYLAND 355
GERMANTOWN/ GAITHERSBURG
270
GAITHERSBURG
370
GAITHERSBURG/ ROCKVILLE
ROCKVILLE TOWN CENTER
MARC
ROCKVILLE/ WHITE FLINT
495
BETHESDA
Gunners Branch Rd
Professional Dr
Watkins Mill Rd
Lakeforest Transit Center
Lakeforest Blvd
Chestnut St/ Walker Ave
Cedar Ave/ Fulks Corner Ave
Education Blvd
Shady Grove Metro
Indianola Dr
College Pkwy
Montomery College Rockville
Future Dawson Ave
Rockville Metro Station
Mt. Vernon Pl
Edmonston Dr
Templeton Pl
Halpine Rd
Bou Ave
White Flint Metro
Security Ln
Grosvenor Metro
Pooks Hill Rd
Cedar Ln
Medical Center Metro
Cordell Ave
Bethesda Metro (South Entrance)
BETHESDA
MARYLAND 355
CLARKSBURG
GERMANTOWN
OBSERVATION DRIVE
Clarksburg Outlets
Gateway Center Dr
Observation Dr/ COMSAT
Observation Dr/ Shawnee Ln
Observation Dr/ Milestone Center
Observation Dr/ Shakespeare Blvd
Montgomery College-Germantown Campus
Holy Cross Hospital
MARYLAND 355
Clarksburg Outlets
Redgrave Pl
Foreman Blvd
Shakespeare Blvd
Oxbridge Dr
SNOWDEN FARM PARKWAY
Clarksburg Outlets
Gateway Center Dr
Stringtown Rd/ St. Clair Rd
Stringtown Rd/ Rainbow Arch Dr
Snowden Farm Pkwy/ Newcut Rd
Milestone
Shakespeare Blvd/ Amber Ridge Dr
Seneca Meadow Office Park
Montgomery College-Germantown Campus
Holy Cross Hospital
Future In-fill Station
Proposed Station
FLASH

How do the MD 355 BRT Alternatives Compare?

The goals and objectives outlined above and in **Chapter 2** of this *Corridor Summary Report* were further developed into a set of criteria called Measures of Effectiveness (MOEs) to evaluate the alternatives. The team assessed MOEs for each alternative. These assessments will inform the selection of a Recommended Alternative and the ultimate development of a recommended phasing and implementation plan.

All the BRT alternatives would generate high ridership compared to the No-Build and TSM Alternatives. Alternatives B and B Modified display the highest ridership, approximately doubling the No-Build Alternative. It should be noted that approximately 50% of the ridership would occur in the off-peak period, showing there is a high-demand for frequent, all-day service.

Transit travel times between key origins and destinations would improve under the BRT alternatives when compared to the No-Build and TSM Alternatives. This will make it easier and more convenient for people to use transit after BRT is implemented.

Alternatives B and C would provide the greatest travel time savings, due to the addition of dedicated transit lanes. Alternatives B and C would also offer better overall reliability. Under variable traffic conditions such as construction, car breakdowns, and vehicle crashes, Alternative B should perform more reliably due to its physical separation from traffic.

Alternatives B and C would provide greater travel time savings than Alternative A, due to dedicated transit lanes

All the BRT Alternatives – Alternatives A, B, B Modified, and C – would improve access to and from housing, jobs, and activity centers for everyone, including key demographic groups.

Each of the BRT Alternatives would meet the project goal of providing improved access or increased transit options.

Traffic congestion is projected to get worse in 2040 regardless of which alternative is chosen and roadway congestion was found to be similar across all alternatives. Average delay per person would increase slightly (30 seconds or less) between the No-Build Alternative and the BRT Alternatives. Overall, the BRT Alternatives meet the project's objective of balancing the mobility needs of all users of the corridor.

More people from key demographic groups will have increased access to their destinations under the BRT Alternatives

SUPPORT MASTER PLAN DEVELOPMENT

The BRT Alternatives would support the growth of pedestrian-friendly places and advance the goals of the multiple jurisdictions and the Master and Sector Planned areas that span the corridor. Plans for areas along the MD 355 corridor propose enhanced transit to support their mobility, land use, and economic development goals.

BRT stations are proposed near existing or future land uses that are supportive of transit (including a mix of uses, high density, activity centers, or walkability) and would help accommodate redevelopment opportunities.

SUPPORT SUSTAINABLE AND COST-EFFECTIVE TRANSPORTATION SOLUTIONS

Environmental and Cultural Resources

Conceptual design of all alternatives sought to minimize impacts and right-of-way needs. Preliminary impacts to the natural environment and cultural or man-made resources were identified as minimal. There are no anticipated impacts to forests or streams in the area, and minimal potential impacts to wetlands, floodplains, and endangered species. For cultural impacts, sites were identified that will require a more detailed assessment as design advances to determine the site-specific impacts.

Right-of-Way Needs

Each of the Build Alternatives would require some degree of right-of-way in certain locations beyond what currently exists. Most of the right-of-way needs would be along the roadway frontage of properties along MD 355. As design advances, further avoidance and minimization strategies to reduce right-of-way needs will be investigated.

The conceptual design would fit within the right-of-way set aside in the various master plans. However, much of this right-of-way is not currently dedicated for transportation use. As properties come before the Planning Board and other jurisdictions for redevelopment, the County will work with applicants to address master planned right-of-way needs.

Cost

The Build Alternatives have a range of costs based on both the level of infrastructure investment and the location along the corridor.

TOTAL CAPITAL COSTS

ALTERNATIVE	TSM	A Mixed Traffic	B Median	B Mod. Median	C Curb
CAPITAL COSTS	$5M	$141M	$849M	$784M	$497M
BUSES	$10M	$43M	$37M	$37M	$37M
TOTAL COSTS	$15M	$184M	$886M	$820M	$534M

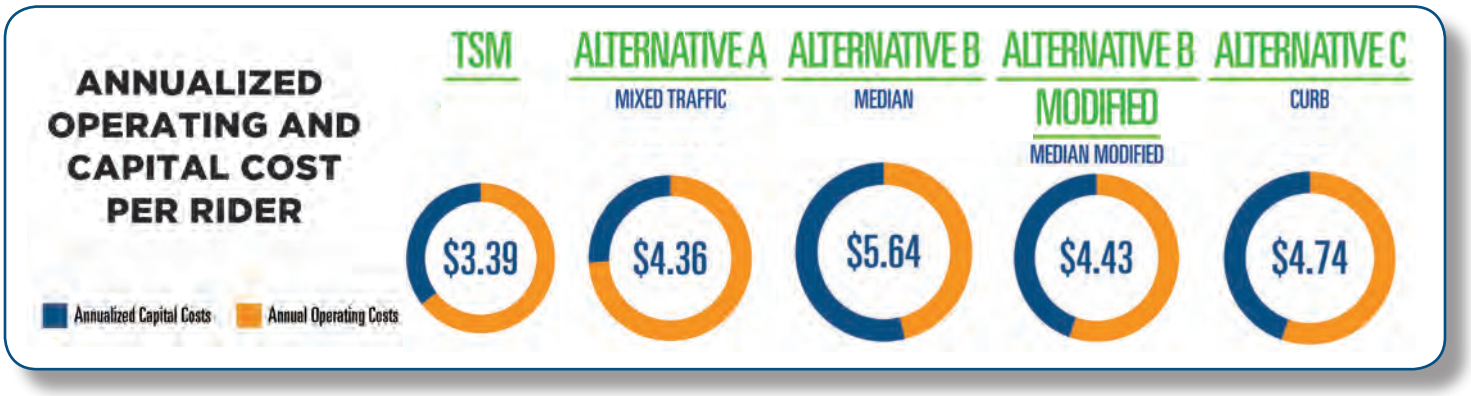
Alternative B would be the most expensive because it contains the most roadway widening, right-of-way needs, and impacts to existing utilities and infrastructure. Alternative B would also provide the greatest separation of the BRT from general purpose traffic and roadway congestion, which would result in increased reliability, travel times, and the highest ridership of any alternative.

When compared with Alternative B, Alternative B Modified would reduce the overall project cost by $65M. The single lane reversible guideway would provide separation from mixed traffic for BRT vehicles in the peak direction in Segments 4 through 6, thus providing similar reliability, travel times, and ridership as Alternative B in those Segments.

Alternative C would include roadway widening and costs to provide a dedicated curb-running transit guideway that could be shared by BRT and local bus service. The overall cost for Alternative C is lower than Alternative B, but it would not provide full separation for the BRT from traffic needing to use the curb lane to turn right at intersections or driveways. This lack of physical separation would likely not provide the same reliability as Alternative B.

Alternative A would be the least expensive BRT Alternative because it would operate in mixed traffic and only require roadway widening at queue jump locations. However, because the BRT would operate in mixed traffic, Alternative A would experience longer travel times and less reliability than Alternatives B, B Modified, and C.

Annualized capital and operating costs per annual rider were developed for each Build Alternative based on FTA guidelines that account for the typical life span of different project components. The annualization of capital and operating costs provides the best cost comparison for the alternatives because it combines operational costs, capital costs, and ridership. This comparison appears to support the selection of a BRT Alternative.



What are the Next Steps for the MD 355 BRT?

Following the selection of a Recommended Alternative, the MD 355 BRT project would move into Preliminary Engineering, which includes surveys; additional, more detailed traffic studies; final environmental documentation; development of final concepts; and a detailed scope, schedule, and cost estimate for construction. The project would then move into final design and ultimately construction. All of these steps are contingent on available funding. Given the length of the corridor and varying characteristics of the existing conditions, it is anticipated that the Recommended Alternative would be implemented in stages.

Public involvement has and will continue to play and important role in the planning and design of BRT on MD 355. Public involvement for the project in Phase 2 included a series of Community Updates, Public Open Houses, and Community Advisory Committee (CAC) meetings which was a continuation of the public outreach that began in Phase 1. In addition, www.RidetheFLASH.com is available to inform the public about BRT and keep them up-to-date on project information. As the project progresses through preliminary engineering and final design, public involvement and opportunities to provide input will continue.

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1 PROJECT OVERVIEW

1.1 Introduction

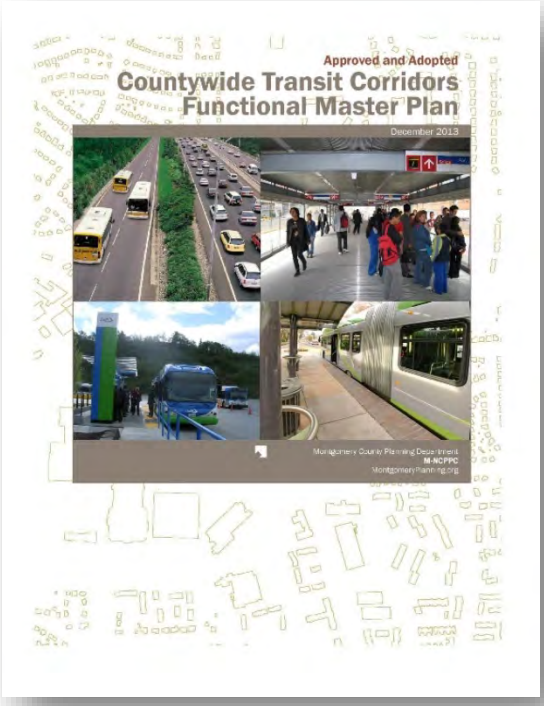
This *Corridor Study Report* documents Phase 2 of the MD 355 Bus Rapid Transit (BRT) Planning Study. The project is evaluating detailed alternatives for providing enhanced transit service along MD 355 from Bethesda to Clarksburg in Montgomery County, Maryland.

Phase 1 of this study was completed in April 2017 by Maryland Department of Transportation (MDOT) Maryland Transit Administration (MTA) as part of a larger countywide effort to establish a BRT network on major transportation corridors within Montgomery County. In Phase 1, preliminary alternatives were developed and qualitatively compared to determine a set of alternatives that would be carried forward and analyzed in further detail. Phase 2 builds upon the work completed in Phase 1 with the goal of identifying a Recommended Alternative to move forward into detailed design.

This study has been completed by the Montgomery County Department of Transportation (MCDOT) in cooperation with the MDOT State Highway Administration (SHA) and MDOT MTA, the Cities of Rockville and Gaithersburg, the Washington Metropolitan Area Transit Authority (WMATA), and the Maryland-National Capital Park and Planning Commission (M-NCPPC).

1.2 Project Background

Montgomery County first proposed BRT as the most appropriate mode for improving transit in the MD 355 corridor as part of the 1993 Strategic Transit Plan.

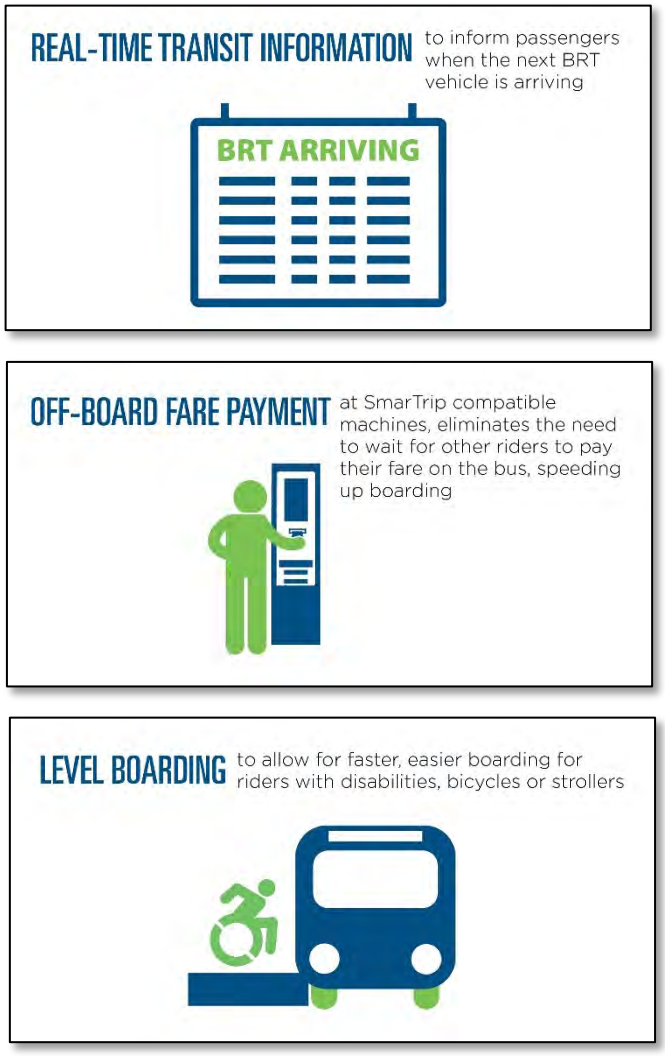


In 2011, MCDOT completed the Countywide BRT Study to identify key corridors within the County that could support premium BRT service. The study was a proactive effort to explore transit improvements that could address existing travel demand and anticipated growth in vehicle trips in Montgomery County. Out of the 23 initial BRT corridors evaluated for feasibility, 16 corridors were ultimately recommended including the MD 355 corridor from Clarksburg to Bethesda, with a future extension to Friendship Heights if and when the District of Columbia (DC) incorporates into its master plan (or equivalent) dedicated BRT lanes from Friendship Heights to the National Cathedral area and Georgetown.

Acting upon the findings from the 2011 Countywide BRT Study, M-NCPPC developed a Countywide Transit Corridors Functional Master Plan. This plan was approved and adopted by the Montgomery County Council in December 2013. The Functional Master Plan proposes the development of a BRT network throughout Montgomery County to support

mobility, land use, and economic development goals. To ensure network integrity and achieve the County's vision, it recommends and provides the basis for right-of-way reservations required to accommodate enhanced transit improvements in individual transit corridors along with the allocation of roadway space for vehicular traffic, transit, pedestrians, and bicycles. The Functional Master Plan contains recommendations for ten BRT corridors in the County, including along MD 355.

The Countywide BRT Study identifies BRT as the preferred mode of transit due to its ability to provide better service to existing transit passengers and attract potential new riders. BRT can provide a fast, convenient, and reliable alternative to automobile trips on congested roadways, and move more people in the same space as a general purpose lane. BRT typically combines rail-like stations with automated information systems and specialized buses with a unique brand identity. BRT stations are spaced further apart than local bus stops, and often include passenger shelters and level loading platforms; real-time passenger information systems; and off-board fare collection. BRT vehicles are typically specialized articulated buses with low-floors, multiple doors on the bus for efficient entry and exiting, higher capacity, bicycle provisions, and brand identity. Finally, BRT can be implemented in phases, integrating improvements in vehicles, stations, and guideways as operating and capital funds become available and as transit-supportive land use and densities materialize along segments of the corridors.

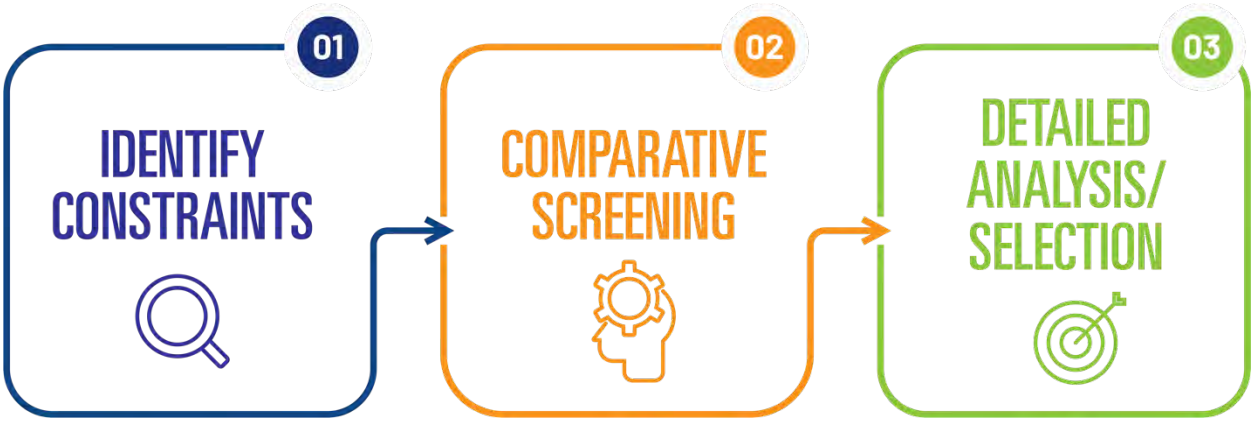


The first BRT corridor in the county is being implemented along US 29 and will be open in 2020. It will feature enhanced stations and BRT vehicles as described above and will serve as a prototype for the BRT infrastructure that will be developed for this corridor.

1.3 MD 355 BRT Corridor Planning Process

The MD 355 BRT Corridor Planning Study utilized the recommendations from the Countywide Transit Corridors Functional Master Plan as a starting point in the development of conceptual alternatives. The study is using a three-step process to recommend an alternative:

Figure 1-1: Corridor Planning Process



Step 1 - Identify Constraints: This process included data collection of existing transit operations, traffic volumes, crash statistics, environmental information, as-builts, and aerial mapping. This information was used to prepare a Draft Preliminary Purpose and Need document, which is discussed in more detail in **Chapter 2**. The information and document were presented to the Corridor Advisory Committees (CACs) and general public at Open Houses in Spring 2016. Input received from the public was used to identify constraints along the corridor.

Step 2 - Comparative Screening: Using the information developed in Step 1, a set of Conceptual Alternatives was developed for testing purposes. A set of screening criteria was identified to qualitatively compare the BRT Alternatives. The analysis performed during this step and the comparison of alternatives was used to screen out elements that showed the least benefit to improve the alternatives being tested and to develop a refined set of alternatives that would be analyzed in further detail during the next step. This work was completed by MDOT in Phase 1 of the MD 355 BRT Corridor Study.

Step 3 - Detailed Analysis / Selection: This is the current step in the corridor planning process, called Phase 2 of the MD 355 BRT Planning Study. It builds upon the Conceptual Alternatives developed in Phase 1, refining and analyzing alternatives in further detail.

This report represents the culmination of Step 3 and will present the results of that refinement and the findings of the analysis for each alternative. The recommendations of the study can be used in the future to guide the final design; environmental analysis and documentation; and implementation of the Recommended Alternative throughout the corridor.

1.4 Study Area

The MD 355 BRT Corridor Study extends approximately 22 miles from Clarksburg to the Bethesda Metrorail Station in Montgomery County, Maryland, crosses different municipal boundaries such as the

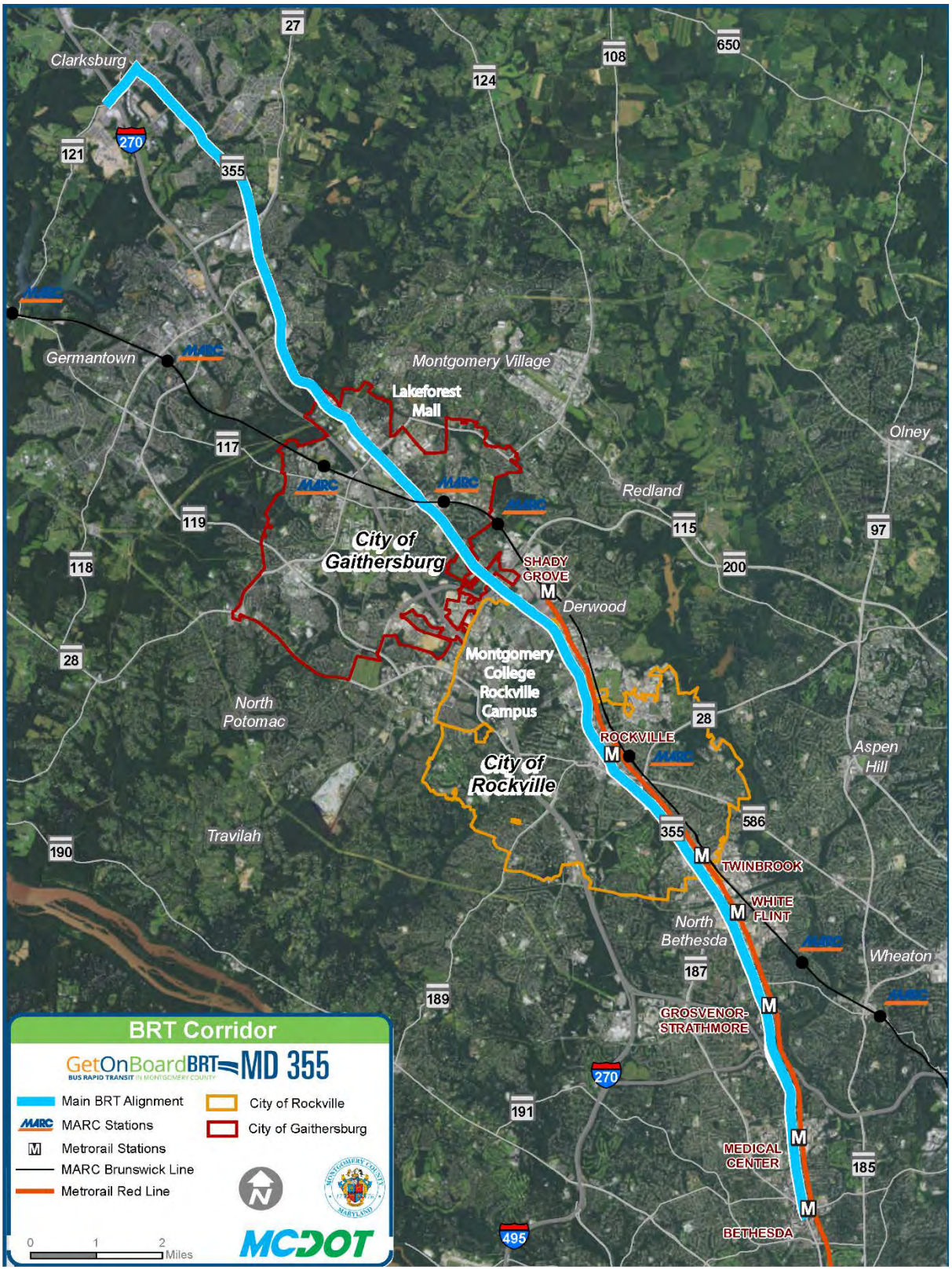
Cities of Rockville and Gaithersburg as shown **Figure 1-2**, and changes names multiple times (Wisconsin Avenue, Rockville Pike, Hungerford Drive, Frederick Pike, and Frederick Road) within the limits of the study area. The following sections describe the existing transit services, land use, and roadway conditions.

1.4.1 Existing Transit Operations

Transit plays a major role in the Washington regional transportation system, and includes multiple bus operators, two commuter rail systems, and the regional Metrorail system. These transit systems provide connections to work sites and other economic opportunities throughout the DC Metropolitan region. The MD 355 corridor is served by fixed route transit service from two primary providers, the Washington Metropolitan Area Transit Authority's (WMATA) Metrorail and Metrobus and Montgomery County's Ride On. Within Montgomery County, current transit operations include:

- Metrorail Service: The Red Line parallels 11 miles of the 22-mile MD 355 corridor, from Bethesda Metrorail station to Shady Grove Metrorail Station. This portion of the Red Line has some of the highest ridership in the entire Metrorail system. There are seven Metrorail stations along the study corridor. Most of these stations are located either directly on MD 355 or are within close proximity. These stations are: Bethesda, Medical Center, Grosvenor-Strathmore, White Flint, Twinbrook, Rockville, and Shady Grove.
- Local Bus Service: Ride On and Metrobus provide local bus service throughout Montgomery County, with Metrobus providing connections into the neighboring jurisdictions of DC and Prince George's County. In total, 59 local routes operate within the MD 355 Study Corridor; 45 are operated by Ride On and 14 by Metrobus.
- Commuter Bus Service: MDOT MTA provides express services into and through Montgomery County (primarily during the peak periods) from Frederick County, Washington County, and Howard County. Most of MTA's commuter service operates primarily on Interstate highways, including I-270, but there are some stops on the study corridor, including Shady Grove Metrorail Station and the Gaithersburg Park and Ride facility.
- Commuter Rail Service: Maryland Area Regional Commuter (MARC) service is provided on the Brunswick Line from Frederick, Maryland and West Virginia, and Amtrak's Capitol Limited Line, both accessible at the Rockville Metrorail Station.

Figure 1-2: Study Area



A review of existing local transit conditions along the MD 355 corridor revealed the following:

- Most existing local bus routes are considered "feeder service": they connect riders in the surrounding neighborhoods with locations along the MD 355 corridor, typically at a Metrorail station;
- Many of the highest ridership study routes run east and west, connecting the Shady Grove side of the Red Line with the Glenmont side;
- Along the study corridor, both Metrobus and Ride On bus service suffers from service reliability issues: Metrobus on-time performance is 77.6 percent (goal of 79 percent) and Ride On on-time performance of 71 to 74 percent (goal of 90 percent).
- Study routes generally have high ridership relative to their level of service. Some of the highest ridership bus routes in the County operate on the corridor; and
- Stop-level ridership data reveal that the bulk of ridership on study routes occurs at Metrorail stations on the corridor. Other high-ridership locations include the Montgomery College – Rockville Campus, Lakeforest Transit Center, Germantown Transit Center, Kingsview Park and Ride, Montgomery Village, and the Veirs Mill Road corridor.

More information on existing transit operations can be found in the *Existing Conditions Report for Ride On and WMATA Metrobus Services* in **Appendix A**.

1.4.2 Existing Roadway Conditions

MD 355 is a busy economic corridor that extends the entire length of Montgomery County, from urban mixed-use centers in the south, through a range of suburban communities of varying densities before entering an exurban environment in the northernmost reaches of the County. The roadway changes in character as it crosses multiple local jurisdictions, spanning areas of high urban density that include features such as wide sidewalks and on-street parking; to more rural areas containing wide shoulders and open drainage systems.

1.4.2.1 MD 355

MD 355 is generally a six-lane roadway between Bethesda and Germantown, with wider roadway sections that incorporate multiple turning lanes at many signalized intersections. MD 355 is further characterized below. Within Bethesda, MD 355 is predominantly three lanes in each direction with turn lanes at key intersections. In the downtown urban core, the rightmost travel lanes serve as off-peak parking. The typical roadway section includes 11 to 12-foot wide travel lanes, a variable width raised concrete and landscaped median, and sidewalks located immediately adjacent to the roadway. See **Figure 1-3** for a photo of MD 355 in Bethesda.

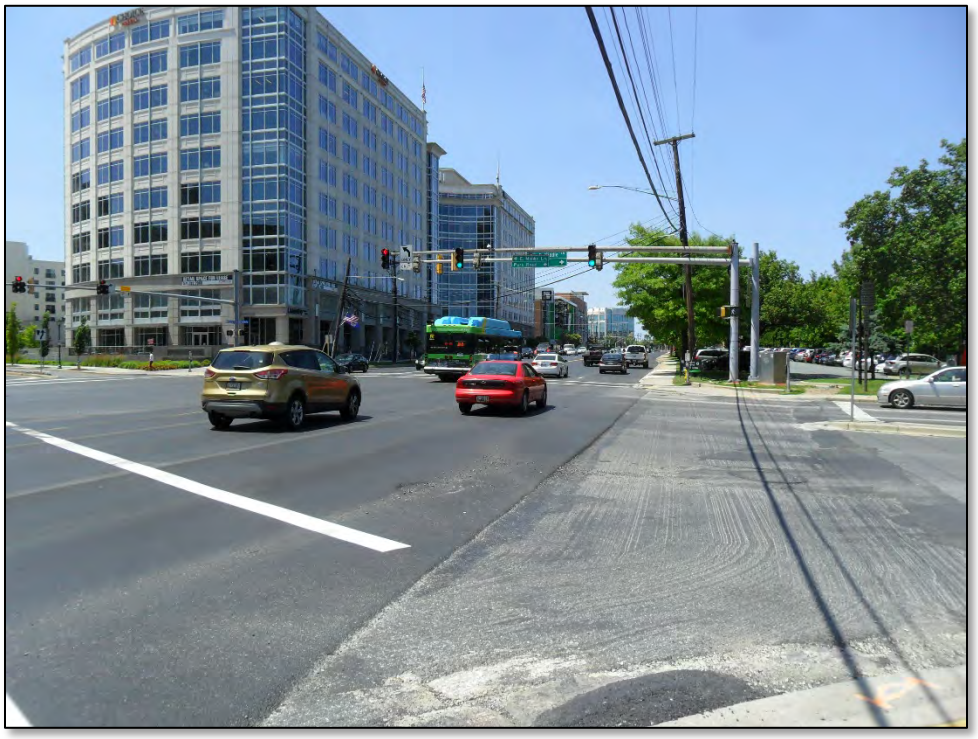
Figure 1-3: MD 355 in Bethesda

North of the MD 355 interchange with I-495, the MD 355 corridor is commonly called Rockville Pike and becomes more suburban and commercial and is dominated by commercial and mixed-use development, driveways spaced close together, and no access control. The roadway remains predominantly three lanes in each direction with turn lanes at key intersections. The typical roadway section includes 11 to 12-foot wide travel lanes, a varying width grass and concrete median, and sidewalks located on both sides of the roadway, both with and without landscape buffers. North of Montrose Parkway, the median becomes a continuous center left turn lane to provide access to businesses from both the north and southbound directions. The CSX railroad right-of-way, which is used by Metrorail's Red line, MARC's Brunswick Line, and Amtrak, is located behind a strip of commercial properties just to the east of and roughly parallel to MD 355 along this portion of the roadway corridor. See **Figure 1-4** for a photo of MD 355 along Rockville Pike.

Figure 1-4: MD 355 along Rockville Pike

As MD 355 passes through the Rockville Town Center, the roadway remains three lanes in each direction with turn lanes at key intersections. Due to right-of-way constraints in this area, the typical roadway section includes 11-foot wide travel lanes, a concrete median, and sidewalks on both sides of the roadway with no landscape buffers. North of Gude Drive, the MD 355 corridor returns to a more suburban character including commercial development and residential communities. The roadway typical roadway section widens to include 11 to 12-foot wide travel lanes, sidewalk buffers, and varying width grass and concrete medians. See **Figure 1-5** for a photo of MD 355 in Rockville Town Center.

Figure 1-5: MD 355 in Rockville Town Center



After crossing over Diamond Avenue and the CSX/MARC rail tracks in Gaithersburg, the corridor is mostly commercial. The roadway transitions to a five-lane typical roadway section, with a center left-turn lane to access businesses between the Father Cuddy Bridge and Odendhal Avenue. Many buildings along this section of the corridor are situated near the back of sidewalk, which is adjacent to the curb. North of the intersection with Odendhal Avenue, the roadway transitions back to three through lanes in each direction with raised medians providing separation and a boulevard streetscape. North of MD 124, the corridor maintains a largely commercial character, typified by several car dealerships and large-scale office campus parcels. See **Figure 1-6** for a photo of MD 355 in Bethesda.

Figure 1-6: MD 355 North of Gaithersburg

MD 355 transitions from a six-lane to a four-lane roadway at Middlebrook Road and the land use is mostly residential. North of MD 27 (Ridge Road), the roadway transitions from a four-lane divided roadway to a two-lane roadway and the character and land use along MD 355 changes from suburban to an exurban, low-density residential environment in this section of MD 355. See **Figure 1-7** for a photo of MD 355 in Bethesda.

Figure 1-7: MD 355 North of Middlebrook Road

1.4.2.2 Observation Drive

Observation Drive is an incomplete roadway that when completed will extend from Middlebrook Road to Stringtown Road, a distance of approximately 4.5 miles.

Currently, Observation Drive is a two-lane roadway between Middlebrook Road and Germantown Road that serves Holy Cross Germantown Hospital and transects the Montgomery College – Germantown Campus. North of Germantown Road, Observation Drive is a four-lane divided roadway, with wider roadway sections that incorporate turning lanes at median openings. This segment of roadway crosses over MD 27 (Ridge Road) and ends at Woodcutter Drive/Waters Discovery Lane. A gap of approximately two miles between Woodcutter Drive/Waters Discovery Lane and the northernmost section of Observation Drive at Roberts Tavern Drive is currently not constructed. MCDOT has performed preliminary engineering for the roadway extension from Woodcutter Drive/Waters Discovery Lane to Roberts Tavern Drive. A portion of the project (Phase 1) between Woodcutter Drive and Old Baltimore Road is funded for final design and construction under the County's current Capital Improvements Program (CIP) starting in fiscal year 2021. Phase 2 of the Observation Drive extension from Old Baltimore Road to Roberts Tavern Drive to finish extending the roadway is currently unfunded. See **Figure 1-8** for a photo of Observation Drive.

Figure 1-8: Observation Drive

1.4.2.3 Shakespeare Boulevard

Shakespeare Boulevard begins at Observation Drive and extends to Germantown Road. Within the BRT service area, Shakespeare Boulevard is a four-lane divided roadway with left turn lanes provided at median openings to major entrances and at signalized intersections. The land use along Shakespeare Boulevard within the project area is commercial to the north and residential to the south. There is a park and ride lot situated on the north side of the roadway, between Observation Drive and MD 355. See **Figure 1-9** for a photo of Shakespeare Boulevard.

Figure 1-9: Shakespeare Boulevard

1.4.2.4 Stringtown Road

Stringtown Road extends from Kings Valley Road in the east to Gateway Center Drive in the west, at which point it turns into Clarksburg Road. Within the study area, Stringtown Road is a two-lane to four-lane roadway with some median-divided segments. See **Figure 1-10** for a photo of Stringtown Road.

Figure 1-10: Stringtown Road

1.4.2.5 Snowden Farm Parkway

Snowden Farm Parkway, within the study area between Ridge Road and Stringtown Road, is generally a four-lane divided roadway. It starts at Ridge Road to the south and extends up to Clarksburg Road at the north. Along the corridor, median openings with turn lanes provide access to residential communities. There are two roundabouts along Snowden Farm Parkway. See **Figure 1-11** for a photo of Snowden Farm Parkway.

Figure 1-11: Snowden Farm Parkway

1.4.3 Corridor Development Characteristics

1.4.3.1 Land Use Patterns

Existing land use along the MD 355 corridor is diverse and includes residential, commercial, and institutional development, as well as a significant amount of open space (**Figure 1-12 and Table 1-1**). Agriculture and forest land cover are predominantly found in the northern portion of the study area, generally north of Germantown. Large forested areas are also associated with the Great Seneca Creek and Rock Creek stream valleys. South of Germantown, the corridor is more developed with mixed land use dominated by medium- and high-density residential use interspersed with commercial and institutional uses. The Lakeforest Mall and Montgomery Village Crossing retail centers anchor a large area of commercial land use in the central portion of the corridor in Gaithersburg. Large institutional uses in the southern portion of the corridor include the Shady Grove Metrorail Station and the National Institutes of Health in Bethesda.

Figure 1-12: 2010 Existing Land Use – MD 355 Corridor

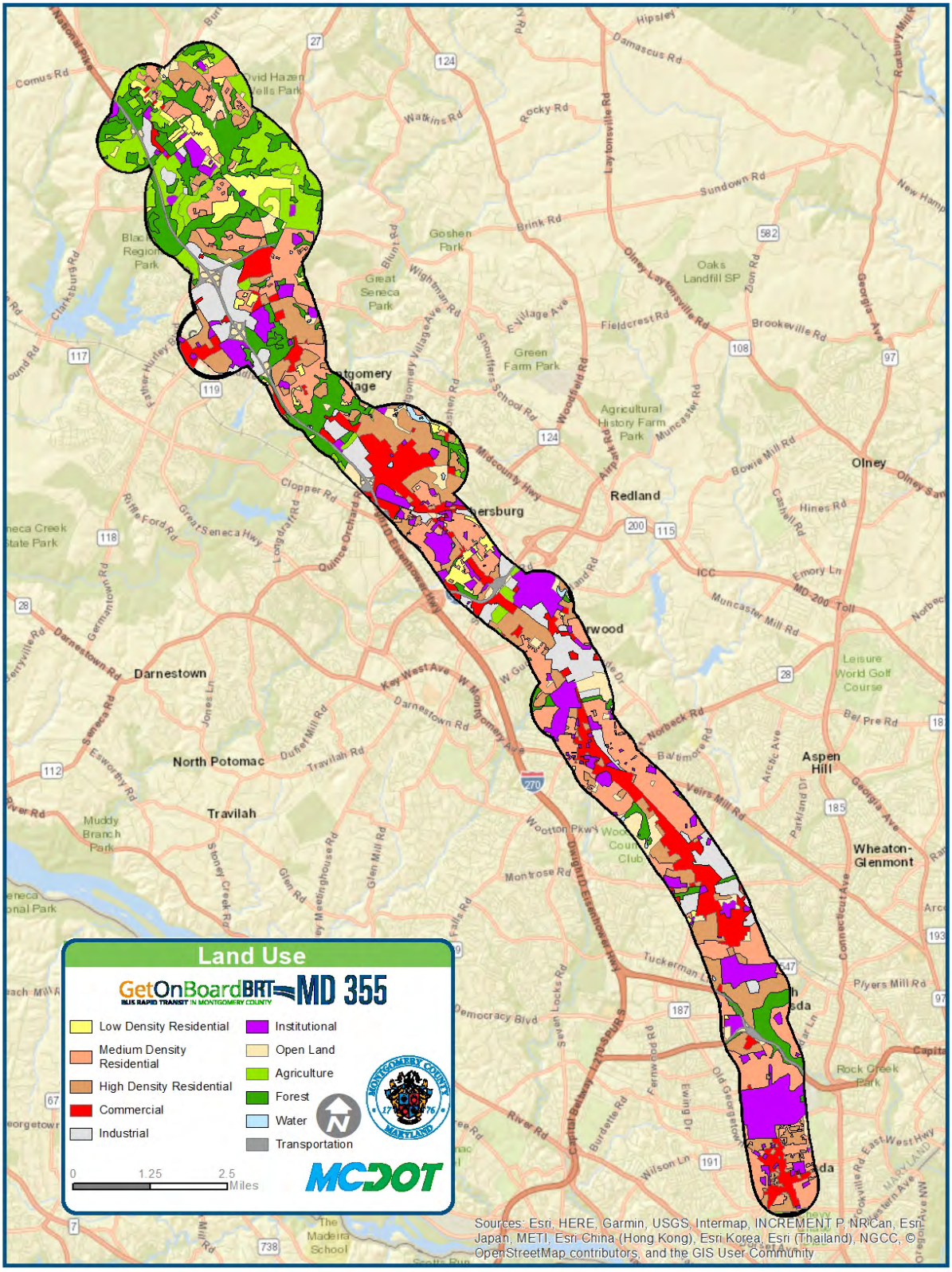


Table 1-1: 2010 Existing Land Use – MD 355 Corridor

Land Use Category	Acres	Percent
Low Density Residential	838.4	4.4%
Medium Density Residential	3,918.4	20.4%
High Density Residential	2,840.6	14.8%%
Commercial	2,293.5	12.0%
Industrial	1,584.5	8.2%
Institutional	2,234.3	11.6%
Open Land	704.6	3.6%
Agriculture	1,742.4	9.0%
Forest	2,646.5	13.7%
Water	60.5	0.3%
Transportation	382.9	2.0%
TOTAL	**19,246**	**100.0%**

Note: Land use calculated within 0.5-mile buffer from centerline of MD 355.
Source: Montgomery County 2010 Land Use Data

1.4.3.2 Community Planning

The MD 355 Corridor spans multiple jurisdictions and Master and Sector Plans. Each community within Montgomery County has a master plan that creates a comprehensive view of land use trends and future development. Plans provide a "blueprint" for land use, zoning, housing, transportation, schools, parks, libraries, and emergency service aspects of communities, and also address historic preservation, pedestrian and trail systems, utilities, and environmental issues. M-NCPPC creates new Master or Sector Plans for each community every 15 to 20 years. Most of the plans for areas along the MD 355 corridor propose enhanced transit to accommodate high density mixed-use development and redevelopment opportunities.

Bethesda Downtown Plan: The vision for redevelopment of the downtown area focuses on sustainability, with an emphasis on promoting alternative modes of transportation including pedestrian, bicycling, and BRT. From a design standpoint, the plan seeks to expand on the existing walkable, transit-oriented urban theme. There is a focus on energy conservation, availability of green spaces, and creating a vibrant mix of community-scale retail with economic and employment opportunities. The Plan also seeks to improve mobility for the existing transportation network and reduce dependency on automobiles. BRT options along MD 355 (Wisconsin Avenue) would support the land use and design objectives of the plan and would link to the future Purple Line light-rail transit to improve mass transit connections and improve pedestrian safety.

Bethesda/Chevy Chase Master Plan: The 1990 amendments called for increased public transit service and efforts to expedite transit traffic on the roadway system to achieve enhanced ridership levels. Moderate levels of development (housing and employment) were envisioned for the MD 355 (Wisconsin Avenue)

corridor, with the recognition that higher density development should be directed to major employment centers and near Metro stations.

Grosvenor/Strathmore Metro Area Minor Master Plan: This plan focuses on the redevelopment of the Grosvenor/Strathmore Metro site into a transit-oriented housing complex with supportive retail uses. BRT along MD 355 (Rockville Pike) is identified as a component of the Transportation Demand Management strategies in place to reduce single-occupancy vehicle use and to provide additional linkages with transit and pedestrian/bicycle infrastructure for connection with recreation and cultural amenities in the community.

North Bethesda/Garrett Park Master Plan: Increased transit use, increased housing opportunities, and development of affordable housing with an emphasis on transit-oriented design are the principal goals of the master plan. Bus transit improvements envisioned focus on increased service (shorter headways) and expansion of services to link Metrorail stations.

White Flint Sector Plan: The goal is to transform auto-oriented, suburban development pattern community surrounding the White Flint Metro station into an urban center of residences and employment. This plan envisions BRT and pedestrian/bicycle improvements along MD 355 (Rockville Pike) to support redevelopment of the corridor as an urban boulevard.

White Flint 2 Sector Plan: This plan addresses development along MD 355 (Rockville Pike) between White Flint Metro station and the city of Rockville. The vision is to transform the MD 355 corridor via implementation of BRT and mixed-use redevelopment of existing commercial properties, with a focus on additional housing opportunities while retaining employment and light industrial properties.

Twinbrook Sector Plan: This area is envisioned as a community of employment, residential, retail and technology use in an urban environment within the MD 355/I-270 corridor. Goals include recreating Twinbrook as a walkable place with safe and direct access to adjacent Metro stations and to surrounding parkland, new housing opportunities, and improved transportation connections, including to the proposed BRT system.

City of Rockville Plans: *The Rockville 2040 Plan* provides focused objectives regarding BRT, including locating stations to maximize ridership and economic development potential, and ensuring stations have adequate access for pedestrian and bicycle use,

The 2016 *Rockville Neighborhood Plan* establishes the vision transformation of the Rockville Pike corridor and adjoining areas “from an architecturally non-distinctive suburban retail strip into an attractive and vibrant neighborhood for shopping, living, and working”. Future community elements include redesign of MD 355 (Rockville Pike) into a multi-way boulevard, reducing building setbacks, widening sidewalks, promoting mixed-use development, improving architectural style and variety, and creation of additional public spaces.

Shady Grove Sector Plan: Along MD 355 (Frederick Pike), mixed-use development to promote housing opportunities is encouraged to the south of the Metrorail station. An urban village concept with

transit-oriented development surrounding the Shady Grove Metrorail Station is envisioned, with employment uses focused on industrial and technology sectors located along MD 355 to the north. BRT is envisioned as part of a suite of mobility connection improvements between Metrorail, MARC, and local pedestrian/bicycle network.

City of Gaithersburg Master Plan: Three general planning sections are centered along MD 355 (Frederick Pike) in the city which guide future land use and transportation considerations. The Southern Residential District is envisioned primarily as medium and low-density residential, with a mix of commercial, office, and research land uses from Shady Grove Road to Summit Avenue. The Fairgrounds Commercial District, which is predominantly commercial office, with some residential pockets from Summit Avenue to MD 124, is the most developed of the three sections and the most constrained in terms of available right-of-way for future roadway widening and improvements. The Northern Employment District is a mixture of commercial, research, and industrial land uses from MD 124 to Ridge Road.

Montgomery Village Master Plan: While the plan does not specifically include the MD 355 BRT as an anticipated improvement, the plan does call for increased service and bus connections with the Lakeforest Transit Center. Companion improvements to increase transit use include improved bicycle and pedestrian connections between the transit center, MARC stations, and future BRT stations. The plan also notes that improved transit service and connections would support redevelopment of the Lakeforest Mall and adjacent uses to reinvigorate this community area.

Great Seneca Science Corridor Master Plan: This plan generally covers lands west of the city of Gaithersburg (west of I-270) where a Life Sciences Center is planned which provides for a dynamic employment center incorporating health care, biotechnology, and academia. Medium to high density residential and mixed use development is also envisioned to supplement and support employment-based development. Enhanced transit service is an essential element of this plan and is the basis for its land use and zoning recommendations. This area is planned to be served by the Corridor Cities Transitway project, a BRT line that would connect with the MD 355 BRT near Shady Grove.

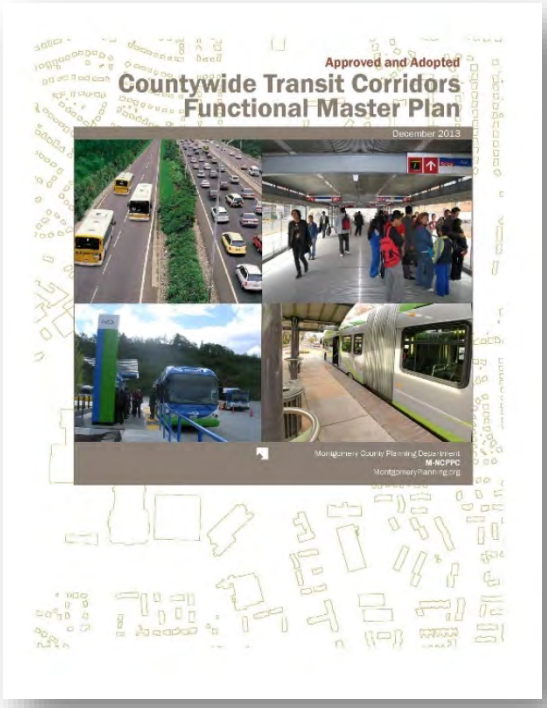
Germantown Master Plan/Employment Area Sector Plan: The *Germantown Master Plan* identifies two communities along the MD 355 (Frederick Road) corridor; Neelsville Village and Middlebrook Village. Each of these villages, mainly east of MD 355, are planned to be predominately residential communities with village centers (Milestone Center for Neelsville and Fox Chapel Center for Middlebrook) that provide a combination of retail, public, religious, service, recreation, and community uses. As development progresses, BRT service would provide increased connectivity to local and regional employment and cultural attractions.

The *Germantown Employment Area Sector Plan* covers the portion of the community to the west of MD 355 where three development areas abut MD 355: Seneca Meadows Milestone (an office/industrial development area); Montgomery College (center for education and technology which envisions an over one million square feet expansion of Montgomery College facilities), and Fox Chapel (a commercial hub at the intersection of MD 355 and Middlebrook Road). BRT service would support and serve all of these development interests.

Clarksburg Master Plan: Three planning areas along MD 355 (Frederick Road) are the Brink Road Transition Area, the Transit Corridor District, and the Town Center district. The Brink Road Transition Area in the southernmost section of the *Clarksburg Master Plan*, extends from Old Baltimore Road to Brink Road and capturing land use transition from Germantown to Clarksburg. Along MD 355, continuance of the existing residential character is encouraged, which is lower-density in comparison to planned development to the north. The Transit Corridor District extends from Stringtown Road to Old Baltimore Road and is predominantly residential, with single-family detached homes fronting on MD 355. Smaller mixed-use neighborhoods are envisioned at future transit stops. The Town Center is the northern terminus of the MD 355 BRT study and is located between Redgrave Place and Stringtown Road. The Master Plan envisions a mixed-use development core around a transit stop/center, surrounded by primarily residential use supported by community-scale commercial retail and office uses. Improved transit connections between Clarksburg and the Shady Grove Metro Station to the south is recognized as a vital improvement needed to realize the future vision of the plan.

1.5 Previous Studies

The alternatives development for Phase 2 of the MD 355 BRT Planning Study is informed by several studies including the *MD 355 Bus Rapid Transit Corridor Planning Study Conceptual Alternatives Report*; the *City of Rockville Bus Rapid Transit Town Center Integration Study*; the *City of Gaithersburg MD 355 Bus Rapid Transit Study*; and the *Countywide Transit Corridors Functional Master Plan*. In addition, BRT has been reinforced in multiple area plans and additional smaller proposals and studies. The key corridor plans are described briefly below.



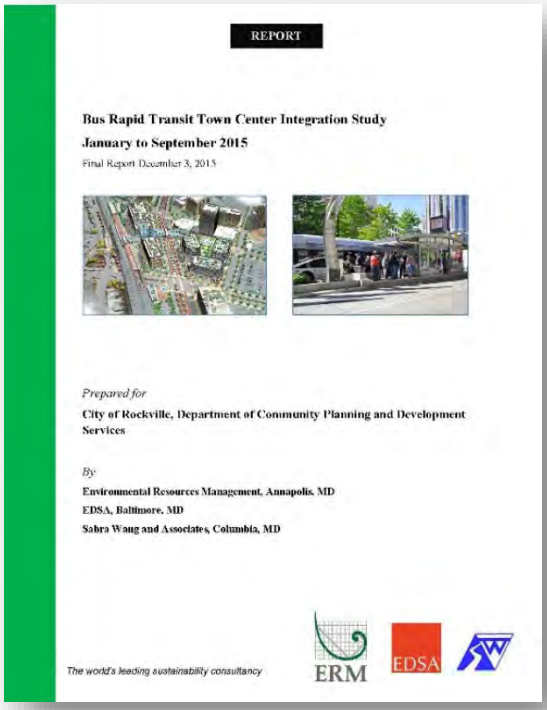
1.5.1 Countywide Transit Corridors Functional Master Plan (2013)

The Countywide Transit Corridors Functional Master Plan (CTCFMP) was approved by the Montgomery County Planning Board on July 25, 2013 and adopted by the County Council in December 2013. The Plan incorporated Bus Rapid Transit into the County's Master Plan of Highways along eleven corridors. MD 355 is divided into two segments in the plan: South, extending from Bethesda Metrorail Station[1] to Rockville Metrorail Station, and North, from Rockville Metrorail Station to Clarksburg Town Center. The Master Plan allowed for the extension of MD 355 South to Friendship Heights should the District of Columbia move forward with BRT service along Wisconsin Avenue. The Plan set right-of-way recommendations for corridors, assigned dedicated lane and mixed traffic treatments for different portions of the corridor, and proposed an initial set of station locations. The Plan

[1] The Bethesda Downtown Sector Plan, approved by the County Council in 2017, confirmed that the southern extent of the corridor is future southern Bethesda Metrorail Station entrance.

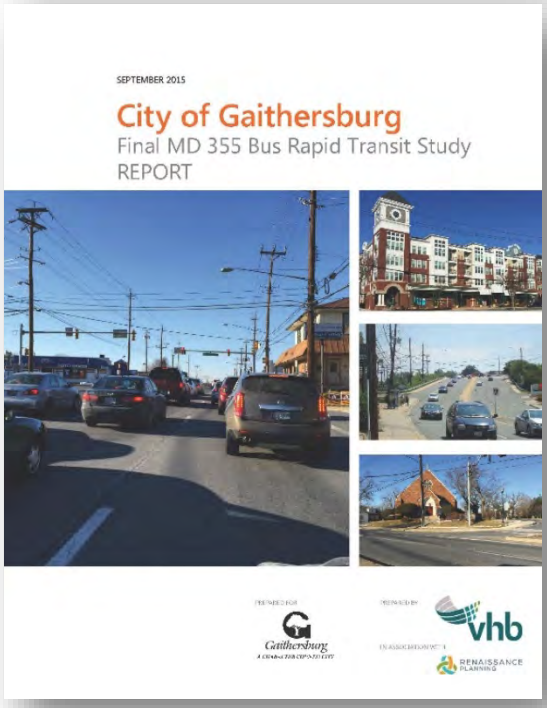
envisioned that later studies would set the precise location of stations along the corridors. The adoption of the CTCFMP required the creation of the Corridor Advisory Committees to advise the planning of BRT corridors like MD 355.

1.5.2 City of Rockville Bus Rapid Transit Town Center Integration Study (2015)



In response to the County and State's BRT planning work along MD 355, the City of Rockville moved forward with its own study evaluating possible approaches for incorporating the MD 355 BRT in the constrained area of Rockville Town Center. This study evaluated a possible reconfiguration of the Rockville Metrorail Station bus bays to facilitate mixed-use development and integration with BRT. It also proposed a tunnel through Rockville Town Center to accommodate vehicular through traffic. MCDOT has continued to coordinate with City of Rockville staff regarding potential alignments in the Town Center and station locations throughout the portions of the MD 355 corridor in Rockville.

1.5.3 City of Gaithersburg MD 355 Bus Rapid Transit Study (2015)



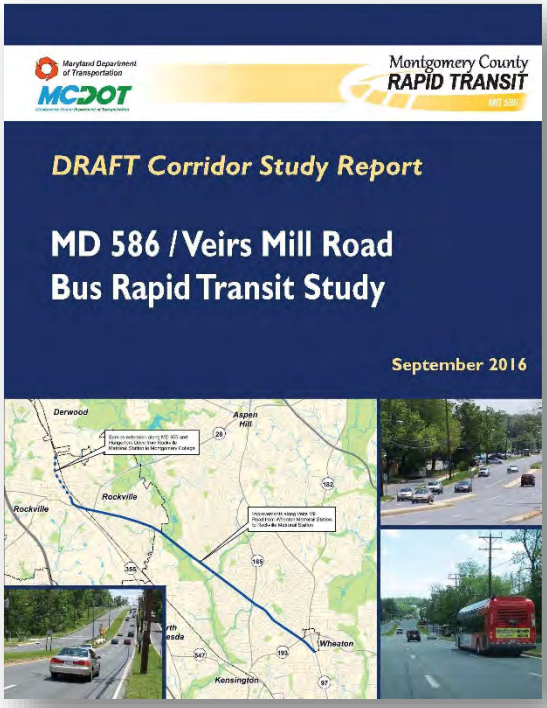
The City of Gaithersburg also performed a study to evaluate how the MD 355 BRT could be accommodated along the portions of MD 355 within the City. This plan considered potential right-of-way configurations to address the most constrained portions of the corridor and evaluated different station locations. The study recommended a mix of dual-lane and single-lane guideways throughout the portions of the corridor in the City. A hybrid alternative, involving construction of a single-lane reversible guideway between the Father Cuddy Bridge and Odendhal Avenue, emerged from a review of previously proposed guideway alternatives to achieve the greatest balance of BRT operations, traffic impacts, and property impacts throughout the corridor. It produced the lowest impact on traffic operations with minimal traffic diversions onto Perry Parkway and Russell Avenue, while maintaining acceptable levels of service at the signalized intersections. The proposed alternative does not require reconstruction of the Father Cuddy Bridge and reduces the number of impacted properties relative to other guideway options.

The study evaluated a set of potential station locations beyond those recommended in the Countywide Transit Corridors

Functional Master Plan. Based on this evaluation, stations were recommended at North Westland Drive, Education Boulevard, Cedar Avenue/Fulks Corner Avenue, Chestnut Street/Walker Avenue, Lakeforest Boulevard/Perry Parkway, Watkins Mill Road, and Professional Drive. The Gaithersburg City Council adopted the study's recommendations in September 2015. MCDOT has continued to engage with City of Gaithersburg staff regarding right-of-way, station, and other planning issues.

1.5.4 MD 586 / Veirs Mill Road Bus Rapid Transit Study (2016)

MDOT SHA conducted a planning study that evaluated BRT alternatives along MD 586 from the Wheaton Metrorail Station to the Rockville Metrorail Station and the extension of enhanced bus service from the Rockville Metrorail Station to Montgomery College – Rockville. BRT was identified as a solution for this transit-dependent and congested corridor because it would increase transit reliability and opportunities for low-income and minority populations, as well as access to a larger supply of affordable housing. Additionally, enhanced transit access could play an integral role in revitalizing the adjacent neighborhoods, relieving congestion, supporting land conservation, and improving safety for bicyclists and pedestrians. It is expected that BRT improvements would increase the mobility, safety, and sustainability of the study corridor.

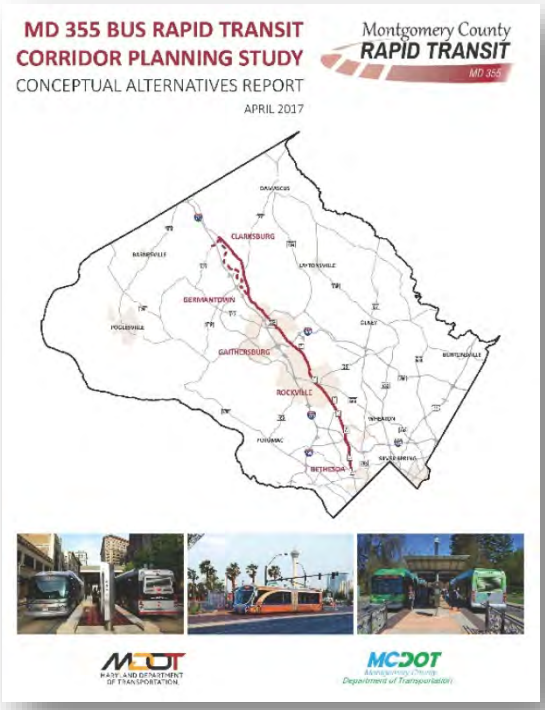


While the Veirs Mill Road BRT Study was not included in the Constrained Long Range Plan (CLRP) when traffic projections were developed for the MD 355 BRT project, it has been added to the 2045 CLRP and future planning for the MD 355 BRT would further consider it.

The Veirs Mill Road extension to Montgomery College – Rockville was considered when developing service patterns for the MD 355 BRT project.

1.5.5 MD 355 Bus Rapid Transit Corridor Planning Study Conceptual Alternatives Report (2017)

MDOT MTA managed the MD 355 Bus Rapid Transit Corridor Planning Study, referred to as the Phase 1 study in this report. This study developed a draft Purpose and Need and identified six Conceptual Alternatives, including four BRT Alternatives. The study conducted a preliminary screening to evaluate the four BRT Alternatives.



The No-Build Alternative and TSM Alternatives have been retained and refined in this round of study. Elements of the four BRT Alternatives are included in the five Build Alternatives evaluated in this study. These five Build Alternatives are further described in **Sections 3.1 and 7.1**.

The Phase 1 study also developed initial service planning options and proposed a set of station locations based on input from the Rockville and Gaithersburg studies and the County Functional Master Plan. The Phase 1 study was developed with substantial consultation and engagement with the two Corridor Advisory Committees (CAC), MD 355 North and MD 355 South.

1.5.5.1 Phase 1 Preliminary Purpose and Need Statement

A preliminary Purpose and Need Statement was developed in April 2016 in cooperation with the MDOT MTA as part of the Phase 1 study. The document included a corridor description, an overview of existing conditions, and identifies the transportation needs for the MD 355 corridor.

The purpose of the project is to provide a new, higher speed, high frequency, premium transit service along MD 355 between Bethesda and Clarksburg that would enhance transit connectivity and multimodal integration, address current and future ridership, attract new riders, and support approved residential and commercial growth along the corridor. It is also intended to improve safety for all modes of travel. Five goals were established: improve quality of service, improve mobility, develop transit services that enhance the quality of life, support master plan development, and support sustainable and cost-effective solutions.

1.5.5.2 Phase 1 Alternatives Development

Four conceptual BRT alternatives were identified and analyzed in Phase 1 based on the criteria below.

- Increase in total Daily Transit Ridership
- Increase in Total Daily Bus Ridership
- Total Daily BRT Ridership

- Boarding by Station –for the North, Central, and South Sections
- BRT Travel Times for AM and PM peaks for northbound and southbound
- BRT Travel Times vs Local Bus Travel Times for north and southbound
- BRT Travel Time vs. Auto for north and southbound
- Increase in AM and PM Peak Total Person Throughput
- Increase in Daily Total Person Throughput
- Increase in Accessibility to jobs within 45 and 60 minutes along the corridor
- Increase in Household Accessibility to Corridor Regional Activity Centers within 45 and 60 minutes along the corridor
- Property Impacts
- Construction and Operating costs

The No-Build Alternative (Alternative 1) and the Transportation System Management (TSM) Alternative (Alternative 2) were automatically moved forward to Phase 2. The remaining four BRT Alternatives – 3A, 3B, 4A, and 4B were assessed. Differences between the retained alternatives included whether the service would be mostly in dedicated median lanes (Alternatives 3A and 3B) or in dedicated curb lanes (Alternatives 4A and 4B); whether the southern service terminus would be Grosvenor Metrorail Station (3A and 4A) or Bethesda Metrorail Station (3B and 4B); and whether the northern part of the alignment would operate along MD 355 and terminate at Redgrave Place (3B, 4A, and 4B) or along Observation Drive and terminate at the Clarksburg Outlets (3A). As part of the alternatives development, the team also assessed preliminary station locations and service plans for the corridor.

1.5.5.3 Alternatives Considered in Phase 1

Alternative 3A – Median Option

Alternative 3A in Phase 1 included new BRT service from the Clarksburg Outlets to the Grosvenor Metrorail Station. The service would be in mixed traffic from the Clarksburg Outlets to Middlebrook Road along Observation Drive and in dedicated median lanes from Middlebrook Road to the Grosvenor Metrorail Station along MD 355.

Alternative 3B – Median Option

Alternative 3B in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Bethesda Metrorail Station. The service would be mostly in dedicated median lanes from Redgrave Place to the Bethesda Metrorail Station, running its full length along MD 355.

Alternative 4A – Curb Option

Alternative 4A in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Grosvenor Metrorail Station. The service would be mostly in dedicated curb lanes from Redgrave Place to the Grosvenor Metrorail Station, running its full length along MD 355.

Alternative 4B – Curb Option

Alternative 4B in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Bethesda Metrorail Station. The service would be mostly in dedicated curb lanes from Redgrave Place to the Bethesda Metrorail Station, running its full length along MD 355.

1.5.5.4 Alternatives Recommended For Further Study

Four Alternatives were identified to advance to Phase 2 of the study. These alternatives were the No-Build Alternative, the TSM Alternative, Alternative 3C, and Alternative 4C. Alternatives 3C and 4C were hybrid alternatives, which were refined from the original Conceptual BRT Alternatives based on the analysis conducted, input received from the CACs and public, and coordination with project stakeholders. These were the basis of the alternatives development for Phase 2 of the study.

Alternative 3C – Median Option

Alternative 3C in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Bethesda Metrorail Station, primarily in median lanes. The service would be mostly in dedicated median lanes from the Grosvenor Metrorail Station to Middlebrook Road, and in mixed traffic along Observation Drive between Middlebrook Road and Clarksburg.

Alternative 4C – Curb Option

Alternative 4C in Phase 1 included new BRT service from Redgrave Place in Clarksburg to the Bethesda Metrorail Station, primarily in curb lanes. The service would be mostly in dedicated curb lanes from the Grosvenor Metrorail Station to Middlebrook Road, and in mixed traffic along MD 355 between Summit Avenue and MD 124 and along Observation Drive between Middlebrook Road and Clarksburg.

2 PURPOSE AND NEED

This section provides a summary of the documented existing and future transportation needs from the *MD 355 BRT Draft Preliminary Purpose and Need Document* from Phase 1. These needs formed the basis for the development of the project purpose statement.

Additionally, objectives for the implementation of BRT in the MD 355 corridor are presented. These have been refined with public and stakeholder input during the current project development phase. These objectives provide a framework for project-specific Measures of Effectiveness (MOEs), which will be used to assess how potential transit concepts address the identified purpose and needs for the MD 355 corridor.

2.1 Purpose

The purpose of the project is to provide a new transit service with greater travel speed and frequency along MD 355 between Bethesda and Clarksburg that will help accomplish the following:

- Enhance transit connectivity and multimodal integration along the corridor as part of a coordinated regional transit network;
- Improve the ability for buses to move along the corridor (bus mobility) with increased operational efficiency, on-time performance/reliability, and travel times;
- Address current and future bus ridership demands;
- Attract new riders and provide improved service options for existing riders as an alternative to congested automobile travel through the corridor;
- Support approved Master Planned residential and commercial growth along the corridor;
- Improve transit access to major employment and activity centers;
- Achieve Master Planned non-auto driver modal share;
- Provide a sustainable and cost-effective transit service; and
- Improve the safety of travel for all modes along the corridor.

2.2 Need

The identified transportation needs (those conditions which increase travel demand or hinder optimum transportation operations) along the MD 355 corridor provide the foundation for the statement of the project's purpose. Three categories of needs have been identified for the MD 355 BRT study:

2.2.1 Growth in Study Area

By 2040, the Washington D.C. metropolitan regional population is expected to increase by more than 1.8 million people to a total of 8.8 million people (a 26 percent increase). Similarly, regional employment is projected to increase by nearly 1.5 million jobs to a total of 5.5 million jobs (a 36 percent increase). According to the Metropolitan Washington Council of Government (MWCOG) growth and land use

projections as shown in **Table 2-1**, Montgomery County will be a significant contributor to this regional growth trend:

Table 2-1: Montgomery County Demographic Growth Forecast

	2014	2040	Growth	Percent Growth
Households	374,000	464,000	90,000	24%
Population	1,011,000	1,213,000	202,000	20%
Employment	528,000	738,000	210,000	40%

Source: MWCOG Round 8.3 Cooperative Land Use Forecast

The MD 355 study corridor's population and employment are forecasted to increase similarly to that of the region **(Table 2-2)**. Population and employment are forecast to increase 33 percent and 28 percent, respectively, between 2014 and 2040. The largest growth projected within the corridor is concentrated in the segment north of I-495 (Capital Beltway) through Rockville to Gaithersburg.

Table 2-2: MD 355 Corridor Demographic Growth

	2014	2040	Growth	Percent Growth
Population	308,100	409,300	101,200	33%
Employment	282,800	369,200	86,300	28%

Source: MWCOG Round 8.3 Cooperative Land Use Forecast

See **Section 1.4.3** for more information on Master and Sector Plans.

2.2.2 Roadway Congestion

Future growth and employment in the region (and along the MD 355 corridor) will generate an increased level of demand on the existing transportation network. Increased population and employment will exacerbate existing capacity and network performance along MD 355 and intersecting roadways. Average daily traffic volumes along MD 355 are expected to increase substantially between 2015 and 2040 **(Table 2-3)**.

Table 2-3: MD 355 2040 Forecast ADT Volumes and Growth

MD 355 Roadway Segments	Range of 2015 Average Daily Volumes (counted)	Range of 2040 Average Daily Volumes (forecast)	Total Average Traffic Growth 2015 to 2040
I-495 to MD 410 (East-West Highway)	28,800-67,800	33,800-80,200	18%
MD 28 (Veirs Mill Road) to I-495	40,800-60,800	51,200-73,325	23%
I-370 to MD 28 (Veirs Mill Road)	41,400-50,600	50,100-61,000	21%
MD 124 (Montgomery Village Avenue) to I-370	26,500-43,900	33,000-53,700	23%
MD 27 (Ridge Road) to MD 124 (Montgomery Village Avenue)	21,200-39,800	23,500-45,900	13%
MD 121 (Clarksburg Road) to MD 27 (Ridge Road)	7,700-22,200	8,600-23,500	13%

Despite signal timing optimization and planned improvements at key intersections along the corridor, overall travel times and vehicle speeds are forecast to be adversely affected **(Table 2-4)**.

Table 2-4: MD 355 2040 Peak Hour/Peak Direction Travel Speeds and Travel Times

MD 355 Roadway Segments	2015 Avg Speed (mph) AM/PM	2040 Avg Speed (mph) AM/PM	2015 Avg Travel Time (min) AM/PM	2040 Avg Travel Time (min) AM/PM
Pooks Hill Road to MD 410 (East-West Highway)	14/11	12/18	9/12	10/7
MD 547 (Strathmore Avenue) to Pooks Hill Road	21/22	14/23	4/4	6/4
Twinbrook Pkwy to MD 547 (Strathmore Avenue)	22/15	18/11	5/7	6/10
Edmonston Drive to Twinbrook Parkway	26/21	22/19	3/4	3/4
I-370 to Edmonston Drive	17/19	14/16	16/14	19/17
Professional Drive to I-370	19/21	10/20	12/11	22/11
MD 27 (Ridge Road) to Professional Drive	27/28	17/28	7/7	11/7
MD 121 (Clarksburg Rd) to MD 27 (Ridge Rd)	16/34	15/29	12/6	12/7

In summary:

- Work related trips and other non-work trips are forecasted to increase 40 percent and 25 percent, respectively, between 2014 and 2040 according to MWCOG.
- Congested conditions are forecast to worsen, with traffic increasing 13 to 23 percent by 2040 which would contribute to unpredictable and slow travel times for automobiles and buses in the corridor.
- Peak-hour average travel speeds are projected to decrease between two to five miles per hour by 2040 in comparison with 2015 conditions.

With the combination of increased travel demand and longer travel times forecast between 2015 and 2040, there will be greater variations in network performance along MD 355 associated with congestion. Slower average speeds and more unpredictable performance will impact not only private vehicles but also bus transit along the corridor. Increased travel times and reduced reliability could have a negative effect on transit use without transit service improvements.

2.2.3 Lack of Competitive Travel Options

Currently, Metrorail and local bus services (Metrobus and Ride On) are the only existing transit options along MD 355, none of which span the entire length of the corridor.

Metrorail service on the Red Line terminates at Shady Grove and thereby only directly serves the southern half of the MD 355 corridor between Bethesda and Rockville; therefore, populations in the Gaithersburg, Germantown, and Clarksburg areas are not directly served by high quality transit such as Metrorail. Additionally, Metrorail station spacing does not support the types of short trips associated with the majority of non-work trips or future redevelopment and infill.

Along the MD 355 corridor, Metrobus and Ride On bus both suffer from service reliability, with Metrobus operating on-time performance of 77.6 percent (goal of 79 percent)[2] and Ride On operating on-time performance of 71-74 percent (goal of 90 percent)[3].

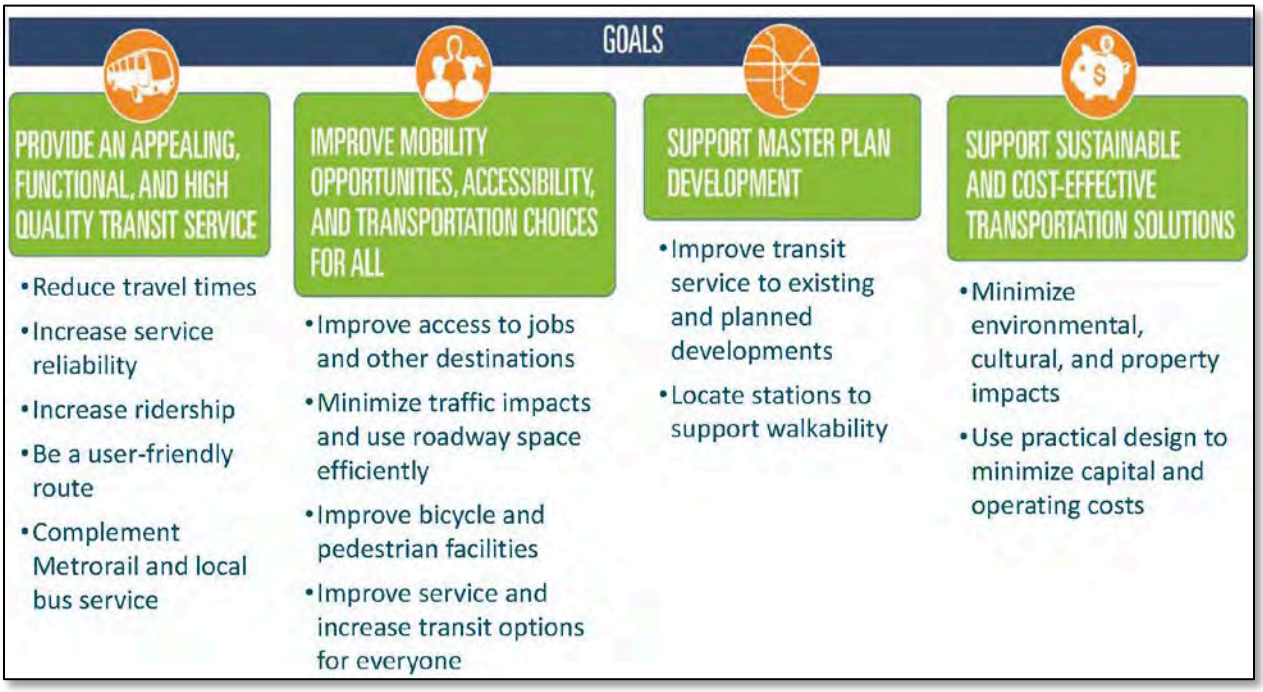
Projected growth in the corridor and changing demographics are also expected to increase demand for transit service. An aging and more ethnically diverse future population will likely increase the transit service market for citizens who are transit-dependent for the majority of their mobility needs due to physical impairments, economic challenges, and/or lack of access to an automobile or a licensed driver. Additionally, a growing segment of the population is becoming transit-dependent by choice, electing to utilize public transit, vehicle-sharing services, or some other transit option rather than owning and operating a personal vehicle. This lifestyle characteristic is likely to increase as the corridor, based on master plan objectives, redevelops with a focus on transit-oriented development.

2.3 MD 355 BRT Goals and Objectives

The purpose statement included in **Section 2.1** described four distinct goals to assess the ability of each alternative to meet the Purpose and Need of the MD 355 BRT Planning Study.

[2] For Metrobus, on-time performance is calculated as the number of bus vehicles arriving at a stop at or close to the scheduled arrival time, divided by the total number of vehicles arriving at stop, over an analysis period (e.g. day, week, month, year). Performance is reported at a system-wide level.

[3] For Ride-On service, a bus trip is considered on time if it arrives at the time point no more than two minutes early or no more than seven minutes late comparing the actual arrival to the scheduled arrival. Performance is reported for each individual route.



2.3.1 Provide an Appealing, Functional, and High-Quality Transit Service

Measures to be evaluated under this goal focus on improving overall transit performance along the corridor. A successful BRT system will provide recognizable advantages for the rider in comparison to other travel modes. Consequently, a higher-quality transit service is needed to increase transit ridership and attract new riders that would otherwise opt to use an automobile.

2.3.2 Improve Mobility Opportunities, Accessibility, and Transportation Choice

Measures to be evaluated under this goal focus on providing a more accessible transit service that improves mobility within the corridor and offers a high quality alternative transportation choice. A well-used transit service has the potential for higher person-throughput than a general-purpose lane for automobile users and traditional bus service. This means that a BRT vehicle operating in a dedicated lane may move more people than a stream of single occupant vehicles utilizing that same space. Utilization of BRT components along MD 355 provides for the opportunity to maximize the capacity of the existing transportation infrastructure and move more people through the corridor. Improving transit travel time increases accessibility and a better transit service provides an alternative for those seeking one.

This optimization of roadway usage facilitates the inclusion of other roadway users, such as pedestrians and cyclists, further improving the access to multimodal facilities. The improved connectivity between automobiles, transit, pedestrian, and cyclist increases choices and the overall efficiency of a regional transportation network.

2.3.3 Support Planned Development

Measures to be evaluated under this goal focus on providing transit service improvements along MD 355 that would provide conditions to allow value-capture from public and private investments. Transit Oriented Developments (TODs) are defined as compact, mixed-use developments near transit facilities and high-quality walking environments. The goal of TOD is to embrace the transit element and create sustainable communities where people of all ages and incomes have greater transportation and housing choices, increasing location efficiency where people can walk, bike, and take transit. In addition, TOD projects have demonstrated an increase in local transit ridership and a reduction in automobile congestion, providing value for both the public and private sector. Current master plans and sector plans propose TODs at the Bethesda, White Flint, Twinbrook, Rockville, and Shady Grove Metrorail stations, as well as in proposed TODs along MD 355 near White Flint, Halpine Road in Rockville, and other locations.

Value-capture benefits of TODs may include increased ridership, joint development opportunities, increases in the supply of affordable housing, and returns on investment to those who own land and businesses near transit stops. Furthermore, strategic selection of some station locations for a high-quality transit service may support infill and redevelopment, which serve as catalysts for revitalizing neighborhoods.

2.3.4 Support Sustainable and Cost-Effective Transportation Solutions

Measures to be evaluated under this goal focus on preservation of natural and cultural activity centers as well as physical constraints such as private property. A successful transit service along MD 355 must carefully consider these natural and cultural activity centers and minimize their impacts to control the overall capital investment cost. The commitment to environmental stewardship also requires stringent mitigation measures for impacts to environmental resources.

Financial constraints to be considered include factors such as operational costs, capital costs, and third-party investment interests. The *Countywide Transit Corridor Functional Master Plan* prioritizes transit investment along MD 355 to reduce physical impacts and financial constraints, leveraging transportation innovation to support economic development in the County, prioritizing transit usage to increase the overall connectivity and mobility along the corridor.

2.4 Measures of Effectiveness

The goals described above were further developed into a set of criteria called Measures of Effectiveness (MOEs) to evaluate the alternatives. The MOEs are used to assess how the system performs its functions within its environment. The team identified and assessed the MOEs for each alternative based on the Goals and Objectives established in the Purpose and Need statement which are included in **Table 2-5**. **Chapter 8** includes the results and MOE evaluation of the alternatives.

Table 2-5: Measures of Effectiveness

	Goals	Objectives	Measure of Effectiveness
1	Provide an appealing, functional, and high quality transit service	Make bus trips faster and more competitive with automobile travel times	Transit travel time between key origin destination pairs
			BRT travel time versus local bus travel time between segment mid-points
			BRT travel time versus auto travel time between segment mid-points
		Improve transit quality and level of service in the corridor	Transit travel time reliability along the corridor
		Increase transit ridership and mode share within and along the corridor	Total daily, Saturday, and Sunday transit ridership within and along the corridor
			New transit riders along the corridor
			Transit mode share along the corridor
2	Improve mobility opportunities, accessibility, and transportation choices	Make the most productive use of the roadway capacity	Daily person throughput
		Provide improved accessibility to jobs and activity centers for corridor residents, and those coming to the corridor	Number of jobs accessible by transit within 30, 45, and 60 minutes for households in the corridor
			Number of activity centers accessible by transit within 30, 45, and 60 minutes for households in the corridor
			Number of households that can reach jobs in the corridor by transit within 30, 45, and 60 minutes
			Number of households that can reach activity centers in the corridor by transit within 30, 45 or 60 minutes
			Number of households that have access to BRT stations within ½ mile network distance
		Balance the mobility needs of automobiles, trucks, and transit users	Number of miles of LOS E or F along the corridor
			Person hours of delay along the corridor
			Intersection performance along the corridor
		Enhance pedestrian and bicycle connections and options in the corridor	Miles of sidewalks within ½ mile of the corridor
			Miles of low-stress bicycle facilities within ½ mile of the corridor
		Improve transit services for underserved populations	Number of low-income persons within ½ mile of a BRT station
			Number of minority persons within ½ mile of a BRT station
			Number of limited English proficiency persons within ½ mile of a BRT station
			Number of seniors (65+) within ½ mile of a BRT station
			Number of persons with disabilities within ½ mile of a BRT station

3	Support planned development	Increase trips by transit to master planned developments	Transit ridership to planned developments
		Select station locations that support infill and redevelopment	Rating of physical and allowable development possibility: immediate and longer term available or re-developable land within ½ mile of the station and whether approved plans and zoning support it
			Projected Population and employment with ½ mile walk of the BRT stations
4	Support sustainable and cost-effective transportation solutions	Minimize environmental impacts	Acres of public park property affected within Limit of Disturbance (LOD)
			Number of archaeological sites within the LOD
			Number of historic properties within the LOD
			Number of historic properties indirectly impacted
			Linear feet of streams within the LOD
			Acres of 100-year floodplains within the LOD
			Acres of wetlands within the LOD
			Acres of forests impacted within the LOD
			Number of properties with hazardous materials present affected
			Number of Rare, Threatened, and Endangered (RTE) species
			Air quality impacts
		Minimize impacts to private and public property	Number of acres of property impacted within the LOD
			Number of partial property acquisitions and potential displacements
			Number of indirect property effects
			Acres of surface parking affected
		Minimize cost of building and operating transportation services	Total capital cost
			Capital cost per mile
			Total annual operating and maintenance costs
			Annualized capital costs and operating costs (yielding a total annual cost) per rider
			Eligibility for and likelihood of receiving federal funding or other funding sources

3 ALTERNATIVES

This chapter describes the alternatives development for Phase 2 of the MD 355 BRT Planning Study, including the identification of alternatives previously considered, the range of alternatives retained for detailed analysis during Phase 2, and the Recommended Alternative. The alternatives analysis was prepared as part of a comprehensive process that incorporated input from the public and stakeholders as well as local and state agencies.

Five alternatives, including the No-Build Alternative, were initially evaluated as part of Phase 2 of the MD 355 BRT Planning Study. Based on the process for retaining alternatives discussed later in this chapter, the No-Build Alternative and four Build Alternatives have been evaluated and a Recommended Alternative will be identified. These retained Build Alternatives are identified as the TSM Alternative, Alternative A, Alternative B, and Alternative C. Additional details on alternatives development are provided in the *Alternatives Technical Report* In **Appendix B**.

For Alternatives A, B, and C, proposed pedestrian and bicycle amenities would conform to *The Montgomery County Bicycle Master Plan* (2018), the *City of Rockville Bikeway Master Plan* (2017), and other master planned pedestrian and bicycle improvement recommendations where feasible. In locations where incorporating master planned recommendations as part of the BRT improvements would be prohibitively impactive to existing parcels, a less impactive pedestrian solution has been proposed. However, design of the BRT would not preclude master planned recommendations as those parcels redevelop.

3.1 Design Criteria

The Build Alternatives were based upon MDOT SHA and/or local agency standards, and American Association of State Highway and Transportation Officials (AASHTO) standards, including *AASHTO Policy on the Geometric Design of Highways and Streets (2011)*, *MDOT SHA Book of Standards for Highway and Incidental Structures (2017)*, and *MCDOT Road Code (2008)*. MD 355 BRT design and all other roadway design in public right-of-way used in the development of alternatives are presented in the *Alternatives Technical Report.*

The limit of disturbance (LOD) was developed for the Build Alternatives using the proposed pavement width, any necessary proposed pedestrian improvements, proposed stormwater management facilities, and grading behind the curb or pedestrian improvements. This LOD is used to quantify environmental impacts and serve as the proposed right-of-way line where it is located outside the existing right-of-way line.

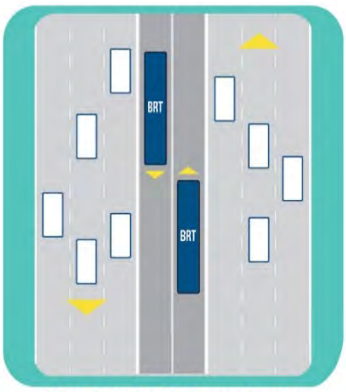
In order to more accurately establish the LOD and develop construction cost estimates, preliminary stormwater management facilities were designed for the Build Alternatives. The stormwater facilities were designed to meet Montgomery County stormwater management requirements.

3.2 BRT Alternative Components

BRT combines elements such as dedicated guideways, specialized buses, specialized signal operations, and bus stations with level boarding and off-board fare collection. Some of the elements that may be incorporated into the MD 355 BRT alternatives are defined in more detail in the following sections.

3.2.1 Guideway

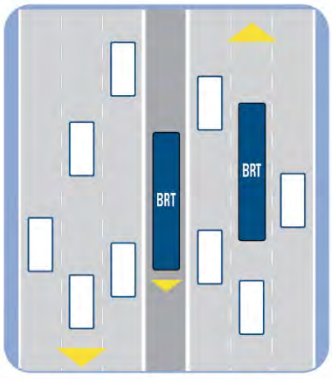
Transit service can be provided via a variety of guideway treatments: a dedicated two-lane median guideway, a dedicated one-lane median guideway (to accommodate transit service in one direction or in both directions), dedicated curb lanes, or running in mixed traffic. The guideways can be mixed and matched along the corridor to provide the best solution within the existing constraints and needs of the area. These treatments are described in more detail below.



Dedicated Two-Lane Median Running Way

3.2.1.1 Dedicated Two-Lane Median Guideway

Two lanes located in the center of the roadway would be dedicated for use by the BRT and may be physically separated from traffic by a raised curb or median. Median BRT lanes would minimize conflicts with general traffic and allow the BRT to operate faster and more reliably. The BRT would still need to interact with other traffic at intersecting cross streets. To avoid conflicts, general traffic could only make left turns at signalized intersections.

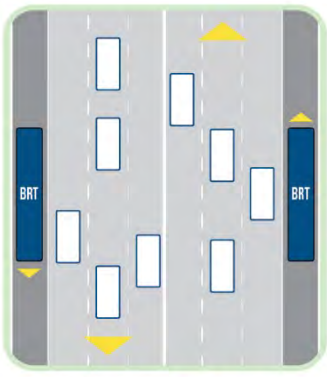


Dedicated One-Lane Median Running Way

3.2.1.2 Dedicated One-Lane Median Guideway

Multiple types of BRT operations are being considered utilizing a single BRT lane in these locations: bi-directional, fixed direction, and reversible operations. In bi-directional operations, BRT vehicles traveling in both directions would share a single dedicated lane in the center of the roadway. Since the BRT travels within this one lane in both directions, passing zones would be created, generally at station locations, so BRT vehicles moving in opposite directions would not conflict with each other.

In fixed-direction operations, a single median BRT lane would be used solely by the southbound BRT. The northbound BRT would travel in mixed traffic. In reversible-direction operations, the direction of the BRT in the one median lane would vary depending on the time of day. BRT vehicles traveling in the peak direction would use the median BRT lane and BRT vehicles traveling in the non-peak direction would be in mixed traffic.



Dedicated Curb Lanes

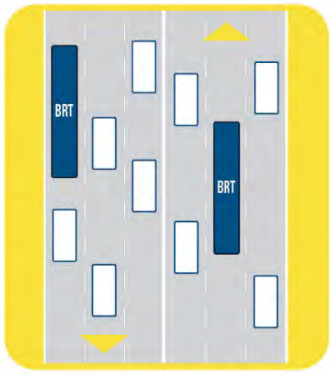
3.2.1.3 Dedicated Curb Lanes

The lanes adjacent to the curb would be used exclusively by the BRT, local buses, and right-turning vehicles. The roadway surface may be painted or otherwise

marked to reinforce the lane designation. Similar to the median guideways, multiple types of dedicated curb lane operations are being considered including two lanes (one on each side of the roadway), and one curb BRT lane in locations where existing constraints make additional widening impactive and where off-peak BRT vehicles can efficiently operate in mixed traffic.

3.2.1.4 Mixed Traffic

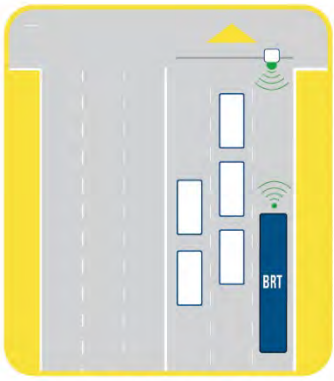
The BRT would travel with general traffic. It would not have lanes dedicated for its use.



Mixed Traffic

3.2.2 Transit Signal Priority

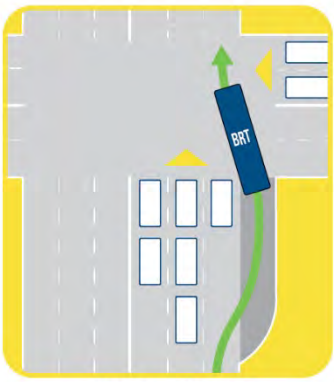
Transit Signal Priority (TSP) would give priority to BRT vehicles when certain conditions are met by either extending a green light or shortening a red light by a few seconds to allow an approaching BRT to pass through the intersection. TSP was implemented on the MD 355 corridor between Medical Center and the Lakeforest Transit Center as part of Ride On extRa service.



Transit Signal Priority

3.2.3 Queue Jumps

Queue jumps are a short section of widened roadway or an existing right turn lane to allow BRT vehicles to bypass congestion or delays at intersections. In most applications, queue jumps are used in conjunction with TSP to provide a lane and dedicated BRT signal that allows BRT vehicles to enter an intersection and "jump" ahead of the other vehicles stopped at the light. In some locations where constraints allow, the roadway is widened to provide a receiving lane that allows the BRT vehicle to merge into traffic beyond the signal. This is beneficial if there is no "BRT Only" signal phase.



Queue Jumps

3.2.4 Station Components

The Metropolitan Washington Council of Governments (MWCOG) commissioned the *Montgomery County Bus Rapid Transit Station Prototype Design Project* to develop customizable station prototypes for the proposed BRT corridors throughout Montgomery County. The station prototypes include canopy/wind screen weather protection, seating, lighting, off-board fare collection, dynamic and static information displays, landscaping/hardscaping, and bike accommodations as shown in the rendering in **Figure 3-1**.

Figure 3-1: BRT Station Prototype Rendering

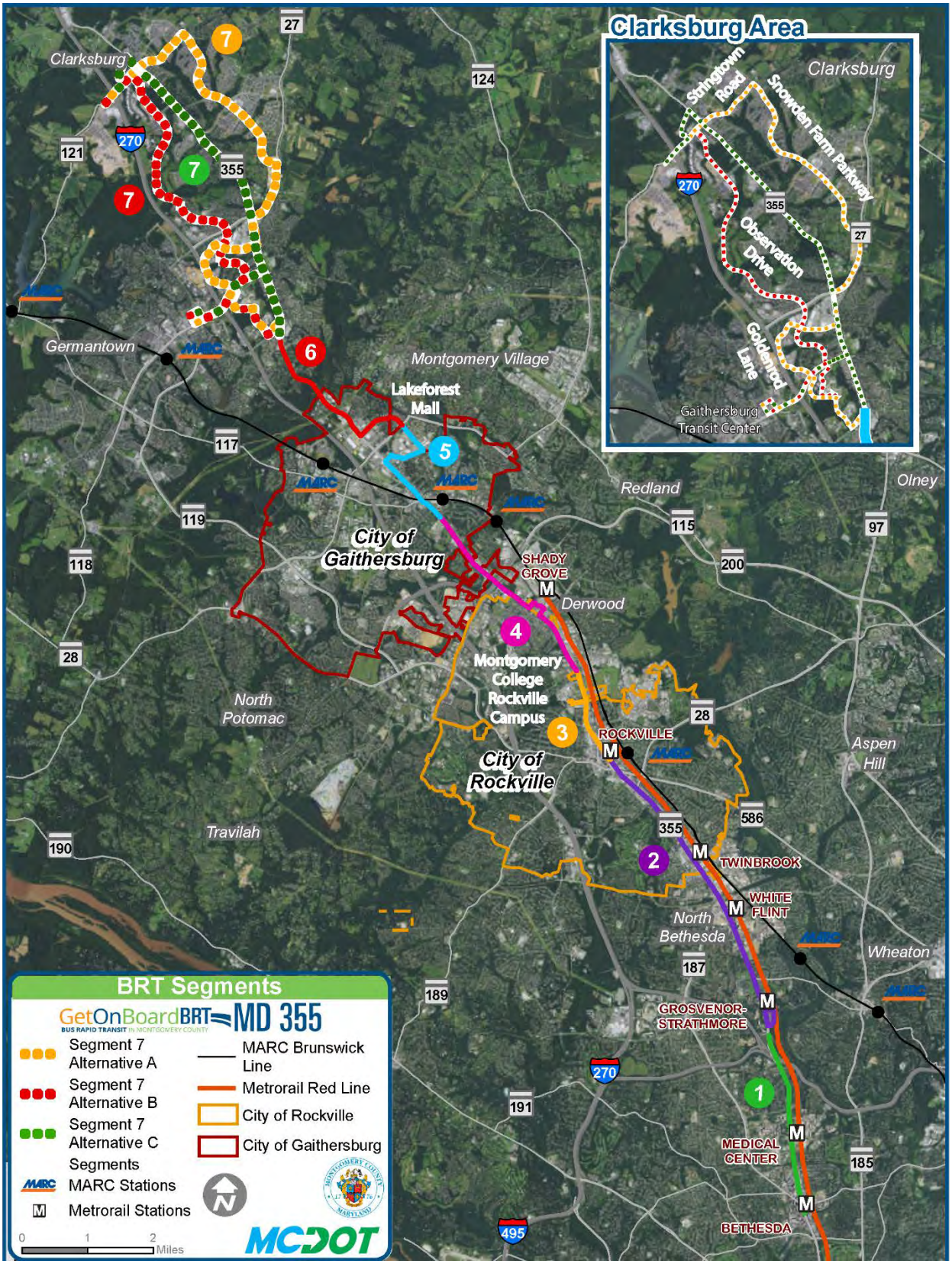
3.3 Alignment Segments

Due to the existing conditions that vary along MD 355 as the roadway transitions from an urban environment in downtown Bethesda to an exurban setting in Clarksburg, the corridor was divided into seven segments during Phase 1 of this study and carried forward into Phase 2. The segments are primarily geographically based with each having its own set of characteristics, opportunities, challenges, and constraints. The seven segment methodologies were retained for Phase 2 and are used to describe the alternatives in detail below. They are listed in **Table 3-1** and shown in **Figure 3-2**.

Table 3-1: Alternative Alignment Segments

Segment	Geographic Description
1	Bethesda Metrorail Station to Grosvenor Metrorail Station
2	Grosvenor Metrorail Station to Dodge Street
3	Dodge Street to College Parkway
4	College Parkway to Summit Avenue
5	Summit Avenue to MD 124
6	MD 124 to Middlebrook Road
7	Middlebrook Road to Clarksburg

Figure 3-2: Alternative Alignment Segments



In Segment 7, each Build Alternative includes a different alignment from Middlebrook Road to Clarksburg; along MD 355, along Observation Drive, and along Snowden Farm Parkway. The alignments along MD 355 and Observation Drive were carried forward from Phase 1 of the study and would both require improvements by others before BRT could be implemented. MD 355 narrows to a two-lane roadway north of Ridge Road and would require future widening by MDOT SHA. Observation Drive has not been completed between Waters Discovery Lane and Stringtown Road and would require future construction by MCDOT.

Consequently, an additional alignment was added during Phase 2 along Snowden Farm Parkway. This is the only alignment that would not require extension or widening. It is also the current center of the development in Clarksburg, with mixed use and low to medium-density residential development along the corridor.

3.4 No-Build Alternative

The No-Build Alternative would include no additional transit infrastructure or operational improvements other than those already planned and programmed in the Metropolitan Washington Council of Governments (MWCOG) Constrained Long-Range Transportation Plan (CLRP), including the Ride On extRa service launched in October 2017 from the Medical Center Metro Station to Lakeforest Transit Center. This service includes Transit Signal Priority (TSP) at key locations along the corridor. The No-Build Alternative would not address the purpose and need for the project; however, it serves as a baseline for comparing the impacts and improvements associated with the Build Alternatives.

3.5 Transportation System Management (TSM)

The TSM Alternative would extend the Ride On extRa service south from the Medical Center Metro Station to Bethesda and north from Lakeforest Transit Center to Clarksburg and would include additional TSP and stops along the corridor. The TSM Alternative alignment is shown in **Figure 3-3.**

3.5.1 Segments 1 through 6

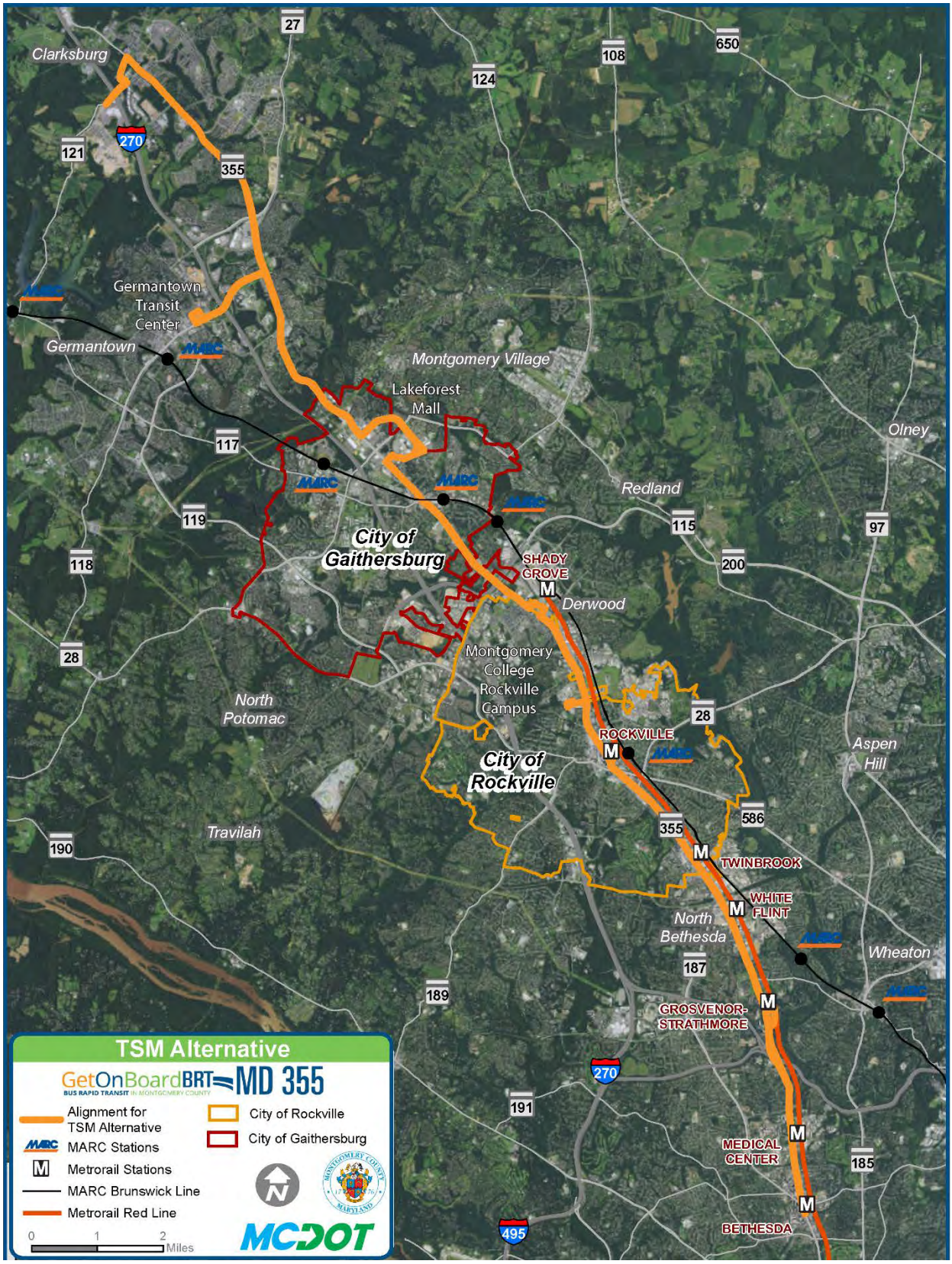
In Segments 1 through 6, the Ride On extRa would operate in mixed traffic along MD 355. There would be no widening of the roadway.

In Segment 5, the Ride On extRa currently terminates at the Lakeforest Transit Center. The service would be extended from Lost Knife Road onto Christopher Avenue before returning the MD 355. The alignment would remain on MD 355 before reaching the end of Segment 6 at Middlebrook Road.

3.5.2 Segment 7

In Segment 7, the Ride On extRa would operate in mixed traffic along on MD 355 from Middlebrook Road to the BRT terminus at Clarksburg, via Clarksburg Road, Gateway Center Drive and Stringtown Road.

Figure 3-3: TSM Alternative



3.6 Alternative A

Alternative A would enhance elements of the TSM Alternative by including additional elements such as TSP and queue jumps to create a BRT service with limited infrastructure improvements. Alternative A would consist of BRT service, operating in mixed traffic using existing lanes from the Bethesda Metrorail Station near Elm Street to Clarksburg along MD 355. It would also include BRT stations with off-board fare collection and level boarding, articulated buses, and FLASH branding.

There would be no widening of the roadway, with the exception of queue jumps at select intersections. The Alternative A alignment is shown in **Figure 3-4** and a breakdown by segment is described below and shown in **Figure 3-5**. Detailed Plan Sheets are included in **Appendix D** and detailed typical roadway sections are included in the *Alternatives Technical Report* in **Appendix B.**

Queue jumps are proposed in two of the Build Alternatives, Alternative A and Alternative C, which is described in more detail in **Section 3.8**. The locations are listed in **Table 3-2.** The locations were selected based on projected intersection delay, average queue lengths, geometric feasibility, and right-of-way requirements.

Table 3-2: Proposed Queue Jump Locations

Segment	Location	Northbound	Receiving Lane	Southbound	Receiving Lane
2	Tuckerman Lane	✓	No		
2	Strathmore Avenue	✓	No	✓	No
2	Nicholson Lane	✓	Yes		
2	Marinelli Road	✓	Yes		
2	Edmonston Drive	✓	No		
2	Wootton Parkway	✓	No	✓	No
2	Monroe Place	✓	No		
3	East Middle Lane	✓	No	✓	No
4	Redland Boulevard	✓	No		
4	Watkins Pond Boulevard			✓	Yes
4	Rockville Corporate Center			✓	Yes
4	Gude Drive			✓	No
6	Germantown Road	✓	Yes		
6	Middlebrook Road	✓	Yes		
7	Foreman Boulevard	✓	Yes	✓	Yes
7	Little Seneca Parkway	✓		✓	Yes

Figure 3-4: Alternative A

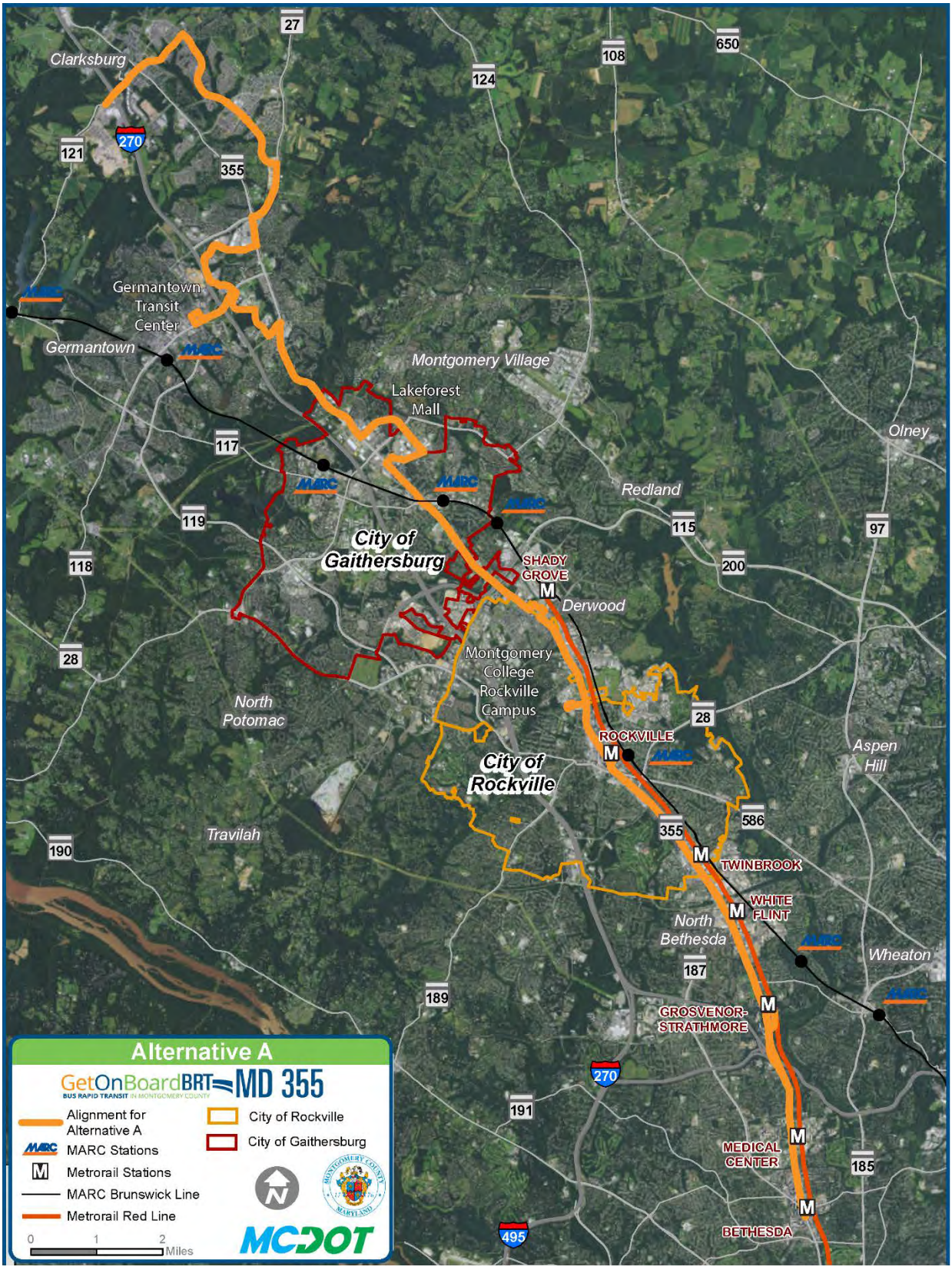
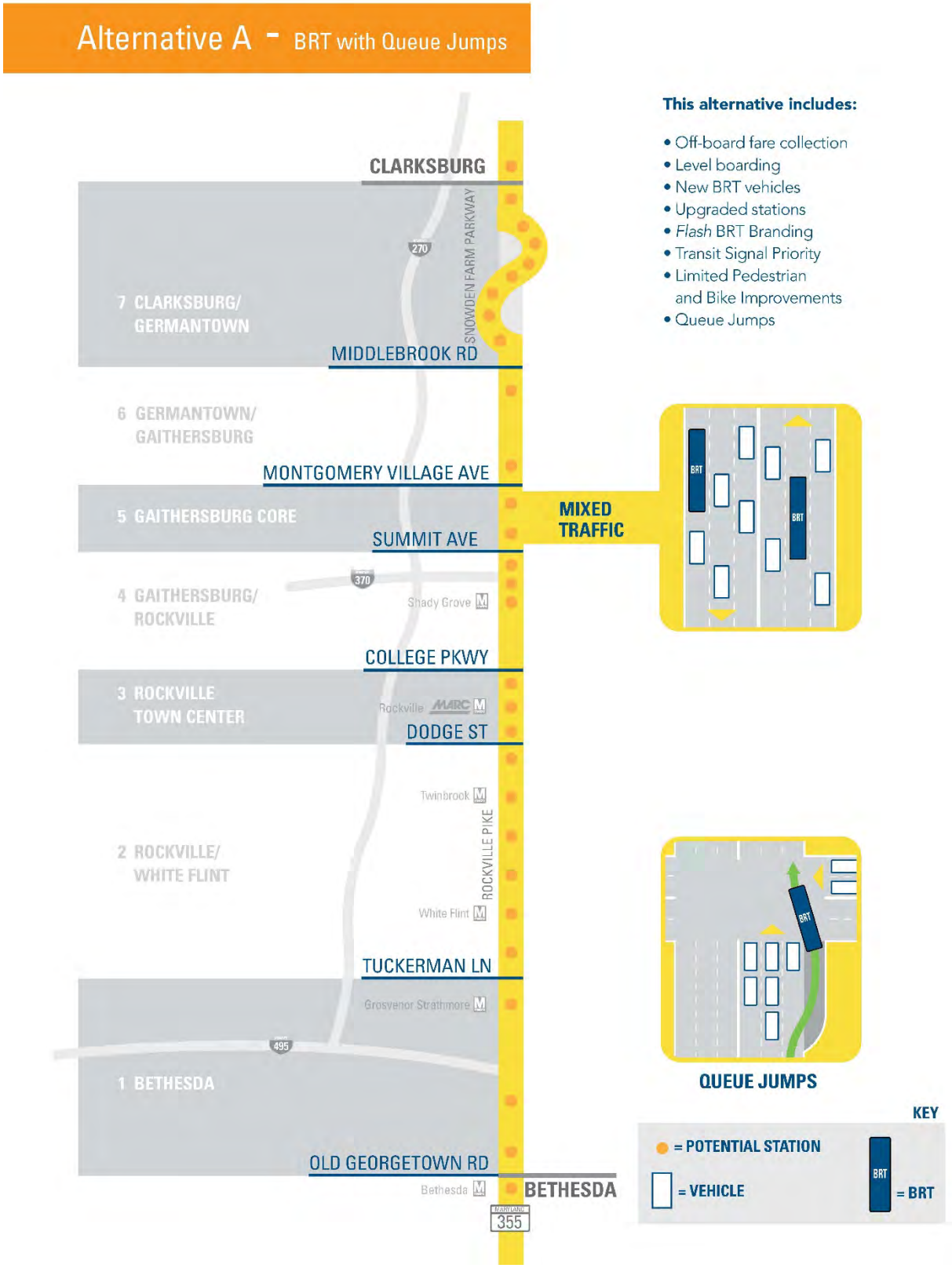


Figure 3-5: Alternative A Segment Features



3.6.1 Segments 1 through 6

In Segments 1 through 6, the BRT would operate in mixed traffic along MD 355. There would be no widening of the roadway except at queue jump locations.

In Segment 3, BRT service would be provided to Montgomery College - Rockville via Mannakee Street. A station would be located on the college campus near the intersection of Mannakee Street and South Campus Drive.

In Segment 4, BRT service would be provided to the Shady Grove Metrorail Station via Redland Road, Somerville Drive, and Metro Station Drive in mixed traffic. A station would be located at the intersection of Somerville Drive and the Metro Access Loop Road.

In Segment 5, BRT service would divert from MD 355 at Lakeforest Boulevard to travel in mixed traffic on Lakeforest Boulevard, Russell Avenue, Odendhal Avenue, and Lost Knife Road to the Lakeforest Transit Center on the east side of the Lakeforest Mall. From the Lakeforest Transit Center, the BRT would travel in mixed traffic on Lost Knife Road and cross MD 124 (Montgomery Village Avenue) to continue onto Christopher Avenue in Segment 6. See **Figure 3-6** for the service route to Lakeforest Transit Center.

Figure 3-6: Service Route to Lakeforest Transit Center

In Segment 6, BRT service would continue from Lost Knife Road onto Christopher Avenue before returning the MD 355. The alignment would remain on MD 355 before reaching the end of Segment 6 at Middlebrook Road.

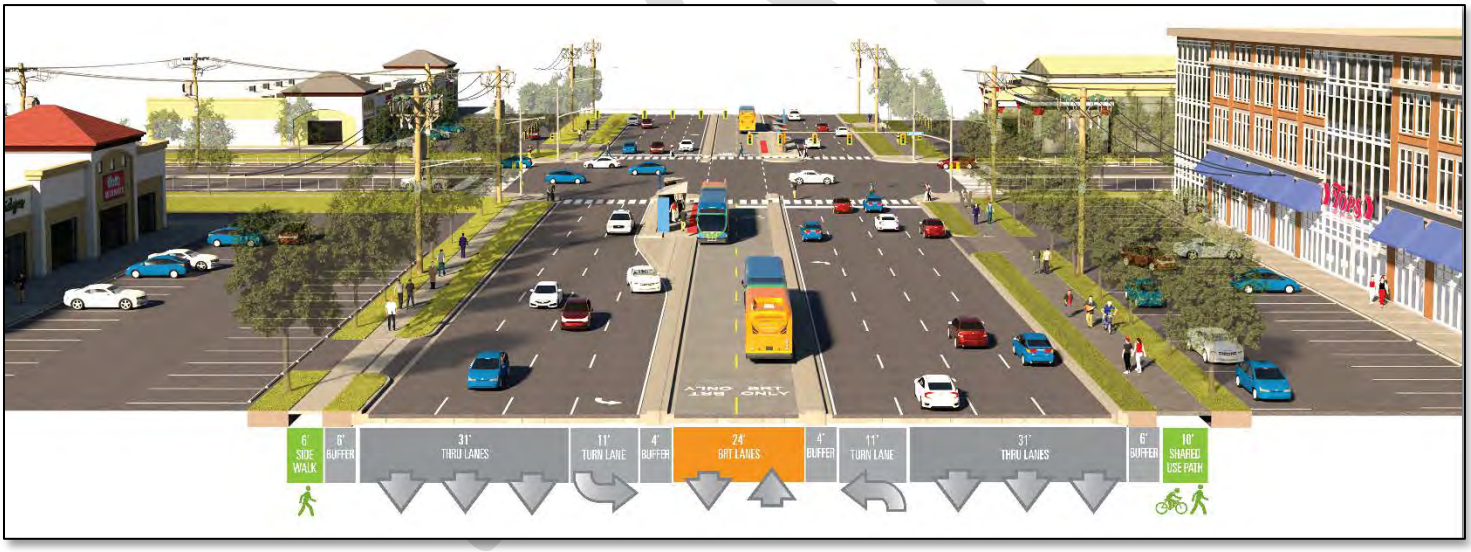
3.6.2 Segment 7

In Segment 7, the BRT would travel in mixed traffic along Middlebrook Road to Observation Drive, Goldenrod Lane, Seneca Meadows Parkway, Shakespeare Boulevard, then up MD 355 to Ridge Road, Snowden Farm Parkway to Stringtown Road to the BRT terminus at Clarksburg. Some of the service route patterns serve the Germantown Transit Center, so the BRT service would turn on Germantown Road to access the Germantown Transit Center and not continue north to Clarksburg.

3.7 Alternative B

Alternative B would generally operate in dedicated median lanes where feasible or in mixed traffic. The median guideway would be physically separated from the general purpose travel lanes by varying width concrete, grass, or landscaped medians. Because the dedicated BRT lanes would be located in the median, left turns would be restricted to signalized intersections. See **Figure 3-7** for a typical section of Alternative B.

Figure 3-7: Alternative B Typical Section



Alternative B would also include additional TSP at key locations along the corridor, BRT stations with off-board fare collection and level boarding, articulated buses, and FLASH branding. The Alternative B alignment is shown in **Figure 3-8** and a breakdown by segment is described below and shown in **Figure 3-9.** Detailed Plan Sheets are included in **Appendix D** and detailed typical roadway sections are included in the *Alternatives Technical Report* in **Appendix B.**

Figure 3-8: Alternative B

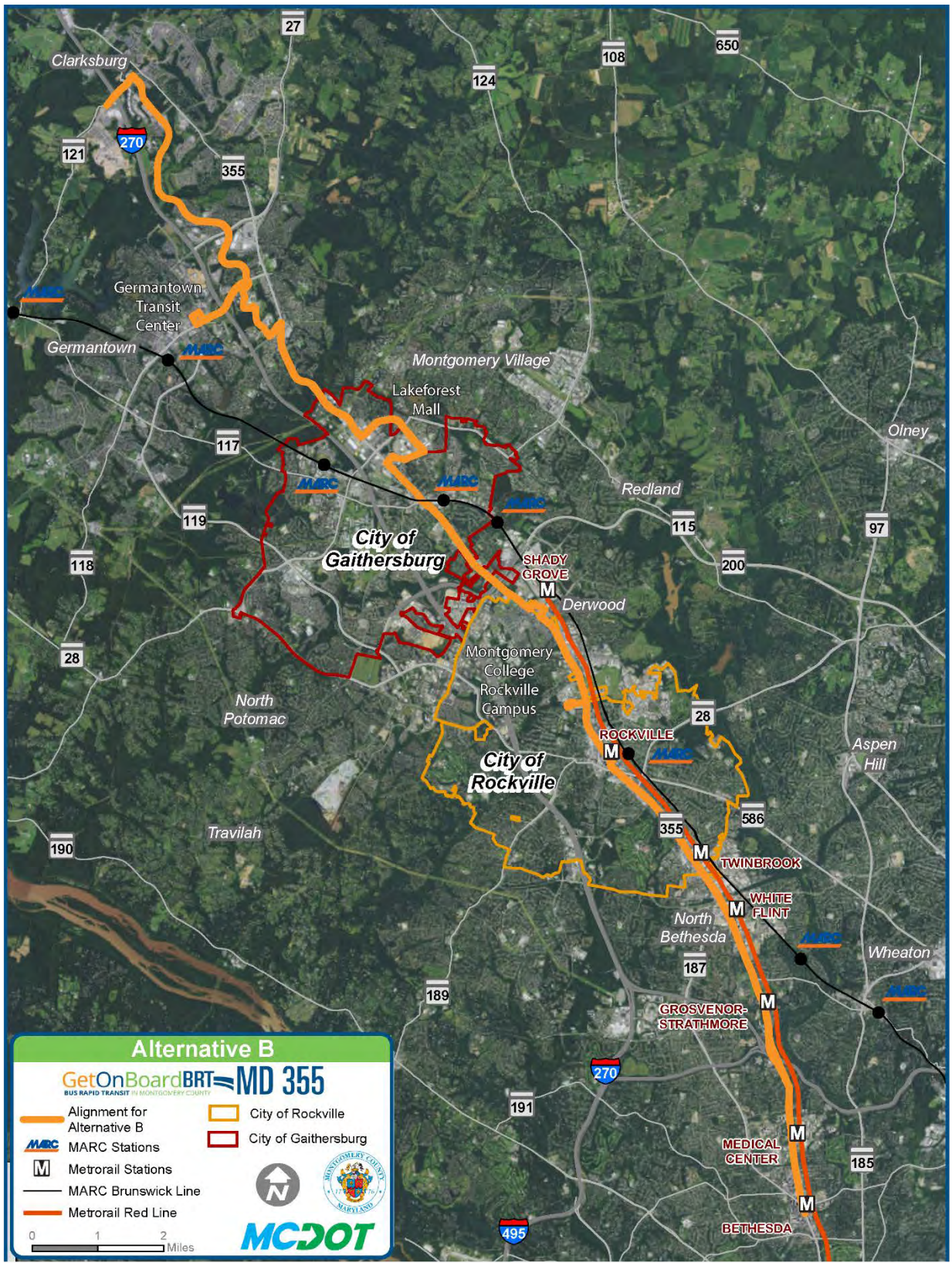
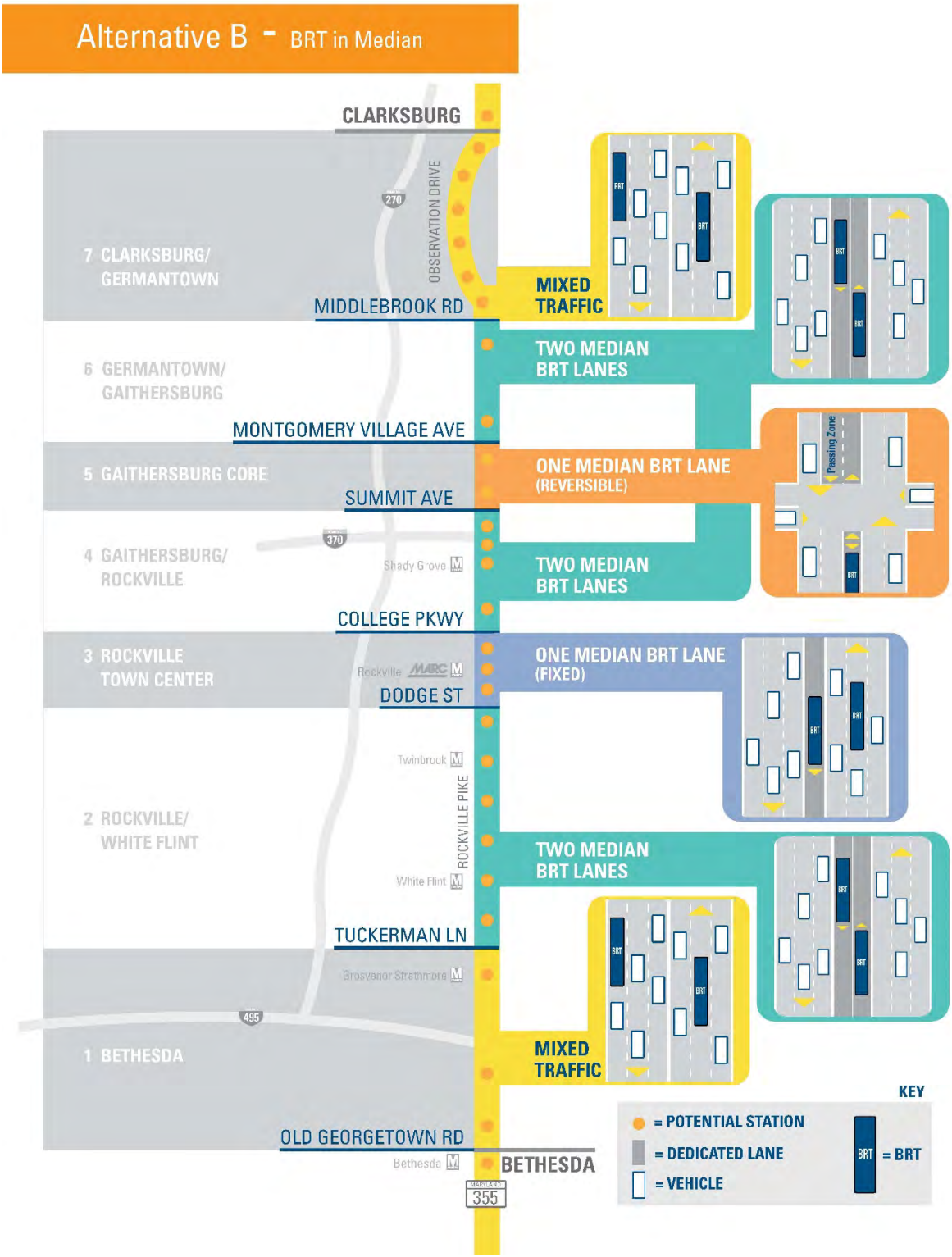


Figure 3-9: Alternative B Segment Features



3.7.1 Segment 1

In Segment 1, Alternative B would be the same as Alternative A. It would operate in mixed traffic and there would be no widening of the roadway.

3.7.2 Segments 2, 4, and 6

Alternative B would include 11-foot wide dedicated BRT lanes in each direction in the median of MD 355 from Tuckerman Lane to Dodge Street in Segment 2; from College Parkway to Redland Road, from Metro Station Drive to Shady Grove Road, and from South Westland Drive to Summit Avenue in Segment 4; and from Christopher Avenue to Middlebrook Road in Segment 6.

In Segment 4, as MD 355 crosses under I-370, a single 11-foot wide bidirectional dedicated median BRT lane would run between Shady Grove Road and South Westland Drive, in order to avoid impacts to the existing structure. North of South Westland Drive the alignment would transition back to two 11-foot wide median dedicated lanes in each direction to the end of Segment 4 at Summit Avenue. All existing travel lanes would be maintained but would be narrowed to ten-feet wide to minimize roadway widening.

Also in Segment 4, BRT service would be provided to the Shady Grove Metrorail Station via Redland Road, Somerville Drive, and Metro Station Drive in mixed traffic.

In Segment 6, the BRT would operate in mixed traffic on Christopher Avenue from MD 124 to the MD 355 corridor. It would then operate in 11-foot wide dedicated median lanes in each direction to Middlebrook Road.

3.7.3 Segment 3

Due to existing constraints, Alternative B would include a single 11-foot wide southbound dedicated BRT lane in the median from Dodge Street to North Campus Drive. In the northbound direction, the BRT would operate in mixed traffic. At North Campus Drive, the northbound BRT vehicle would transition from mixed traffic to a dedicated transit lane. All existing travel lanes would be maintained but would be narrowed to ten-feet wide to minimize roadway widening.

BRT service would be provided to Montgomery College - Rockville via Mannakee Street.

3.7.4 Segment 5

The BRT would operate in 11-foot wide dedicated lanes in each direction from Summit Avenue to the BRT station at Fulks Corner Avenue and Cedar Avenue. The guideway would transition to a single 11-foot lane on the north side of the intersection at Fulks Avenue and Cedar Avenue and maintain that configuration to the next station at Lakeforest Boulevard. A single-lane guideway would be necessary in this segment to minimize impacts associated with widening MD 355 on the Father Cuddy Bridge and at numerous properties with minimal building setbacks along MD 355 north of the Father Cuddy Bridge. The single-lane guideway would utilize a reversible operation, which would allow for peak direction BRT service in the guideway and would require off-peak BRT service to use the mixed traffic lanes, depending on the time

of day. All existing through travel lanes would be maintained but would be narrowed to ten feet wide to minimize roadway widening. The BRT guideway would replace the existing two-way left turn lane, which will eliminate left-turn access at unsignalized intersections and driveways. Dedicated left turn lanes will be provided at signalized intersections where left turns are permitted.

BRT service would divert from MD 355 at Lakeforest Boulevard to travel in mixed traffic on Lakeforest Boulevard, Russell Avenue, Odendhal Avenue, and Lost Knife Road to the Lakeforest Transit Center on the east side of the Lakeforest Mall. From the Lakeforest Transit Center, the BRT would travel in mixed traffic on Lost Knife Road and cross MD 124 (Montgomery Village Avenue) to continue onto Christopher Avenue in Segment 6 as shown in **Figure 3-6**.

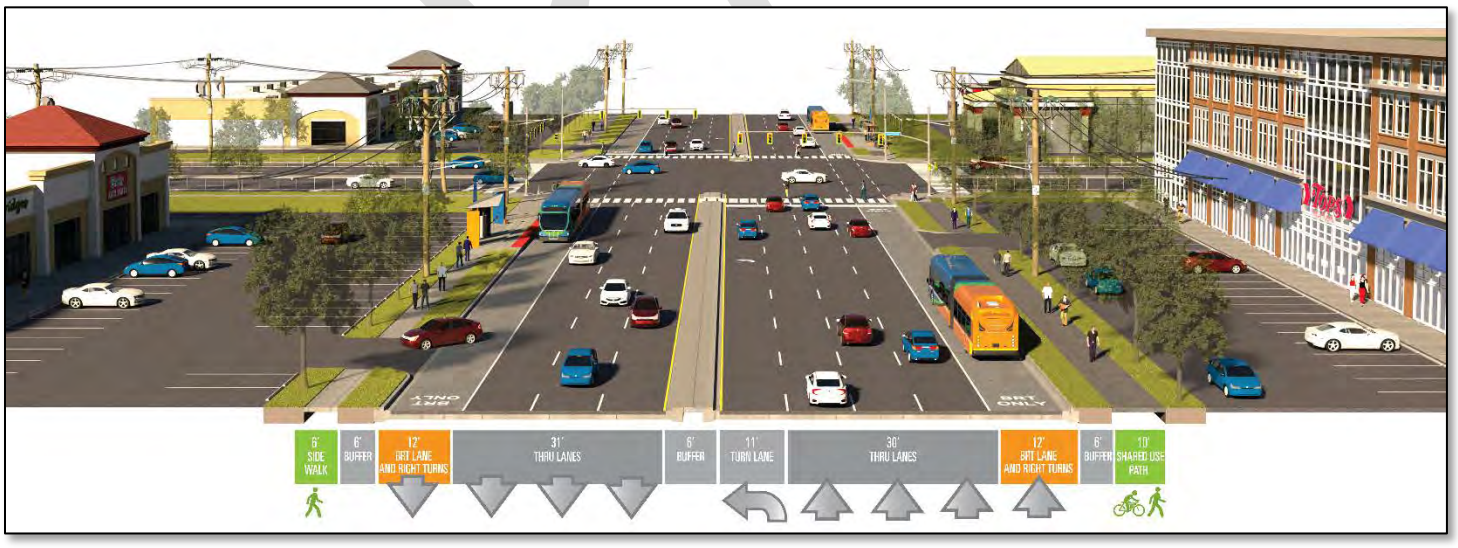
3.7.5 Segment 7

In Segment 7, the BRT would operate in mixed traffic. It would travel along Middlebrook Road to Observation Drive, including service on the as yet unbuilt portion of Observation Drive between Waters Discovery Lane and Stringtown Road, and then turn on Stringtown Road to the BRT Terminus at Clarksburg. The capital and maintenance costs associated with the Observation Drive extension project are being funded as a separate County CIP project and are not included in cost estimates for this project.

3.8 Alternative C

Alternative C would generally operate in dedicated curb lanes along MD 355 where feasible. See **Figure 3-10** for a typical section of Alternative C.

Figure 3-10: Alternative C Typical Section



Alternative C would include additional TSP and queue jumps at key locations along the corridor. The same queue jump locations would be included in Alternative C that are proposed for Alternative A in **Table 3-2**. It would also include BRT stations with off-board fare collection and level boarding, articulated buses, and

FLASH branding. The Alternative C alignment is shown in **Figure 3-11** and a breakdown by segment is described below and shown in **Figure 3-12**. Detailed Plan Sheets are included in **Appendix D** and detailed typical roadway sections are included in the *Alternatives Technical Report* in **Appendix B.**

3.8.1 Segment 1

Segment 1 would include a dedicated curb lane in the peak direction between the Bethesda Metrorail Station at Elm Street and Alta Vista Road (southbound in the AM peak and northbound in the PM peak). In order to minimize property impacts in this very constrained area, an off-peak direction lane would be repurposed to create a reversible roadway with different AM and PM lane configurations.

The middle general traffic lanes would be reversible requiring removal of the raised concrete median, allowing changes in direction throughout the day to accommodate BRT peak direction dedication, which would be managed by dynamic signals and signage. In the AM peak period, the typical section would include a southbound dedicated BRT lane; three southbound through lanes; and two northbound through lanes, which would accommodate the off-peak northbound BRT in mixed traffic. In the PM peak period, the roadway configuration would change to include two southbound through lanes, which would accommodate the off-peak southbound BRT in mixed traffic; three northbound through lanes; and a northbound dedicated BRT lane.

3.8.2 Segments 2, 4, and 6

Segments 2, 4, and 6 would include 11-foot wide dedicated curb lanes in each direction which would be shared with local transit service and right turning vehicles. All existing travel lanes would be maintained but would be narrowed to ten-feet wide to minimize roadway widening.

In Segment 4, BRT service would be provided to the Shady Grove Metrorail Station via Redland Road, Sommerville Drive, and Metro Station Drive in mixed traffic. As MD 355 crosses under I-370, the BRT would transition to mixed traffic operations in order to avoid impacts to the structure. North of South Westland Drive alignment transitions back to 11-foot wide dedicated curb lanes in each direction to the end of Segment 4 at Summit Avenue.

In Segment 6, the BRT would operate in mixed traffic on Christopher Avenue from MD 124 to the MD 355 corridor. It would then operate in 11-foot wide dedicated curb lanes in each direction to Middlebrook Road.

Figure 3-11: Alternative C

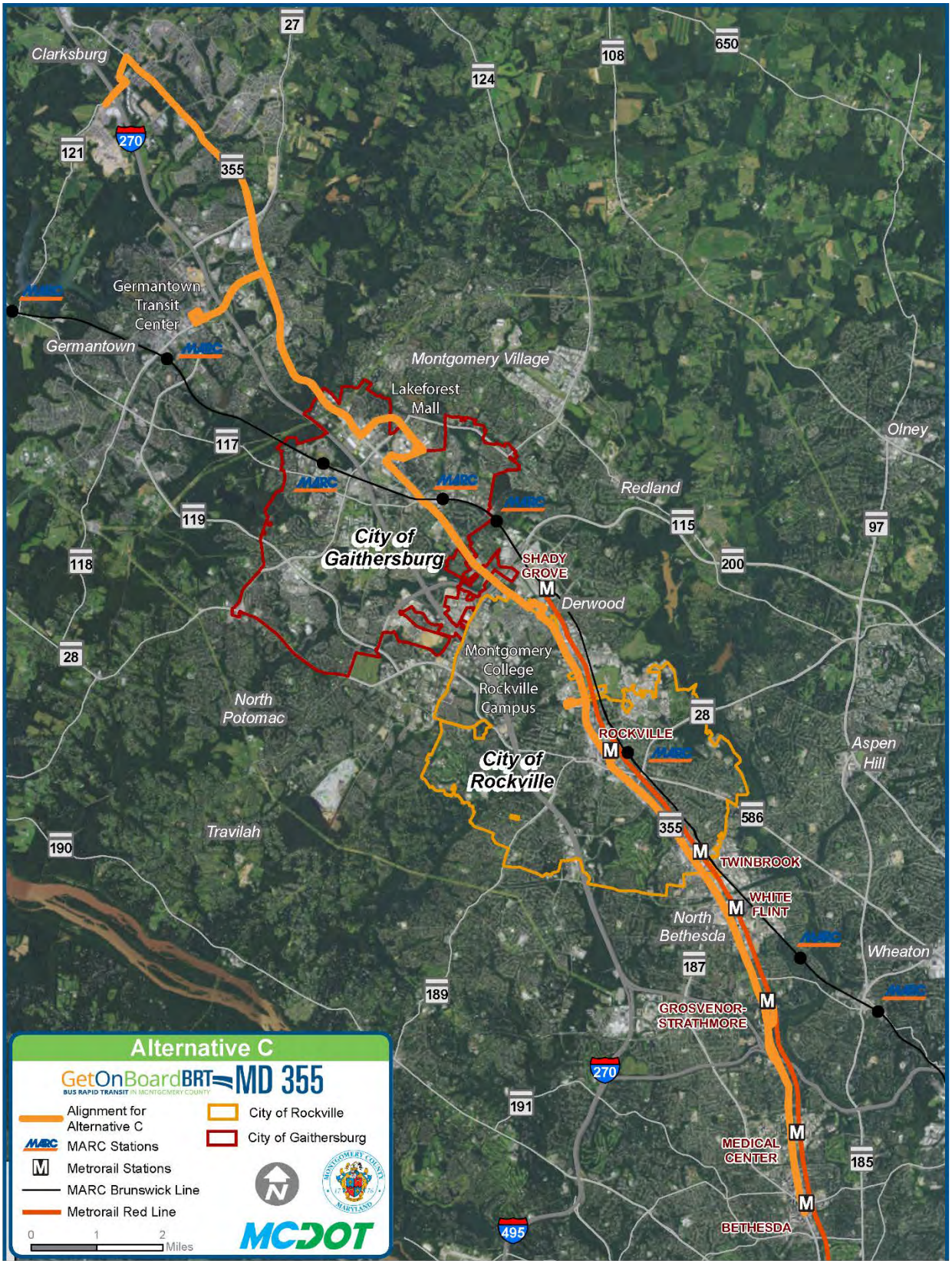
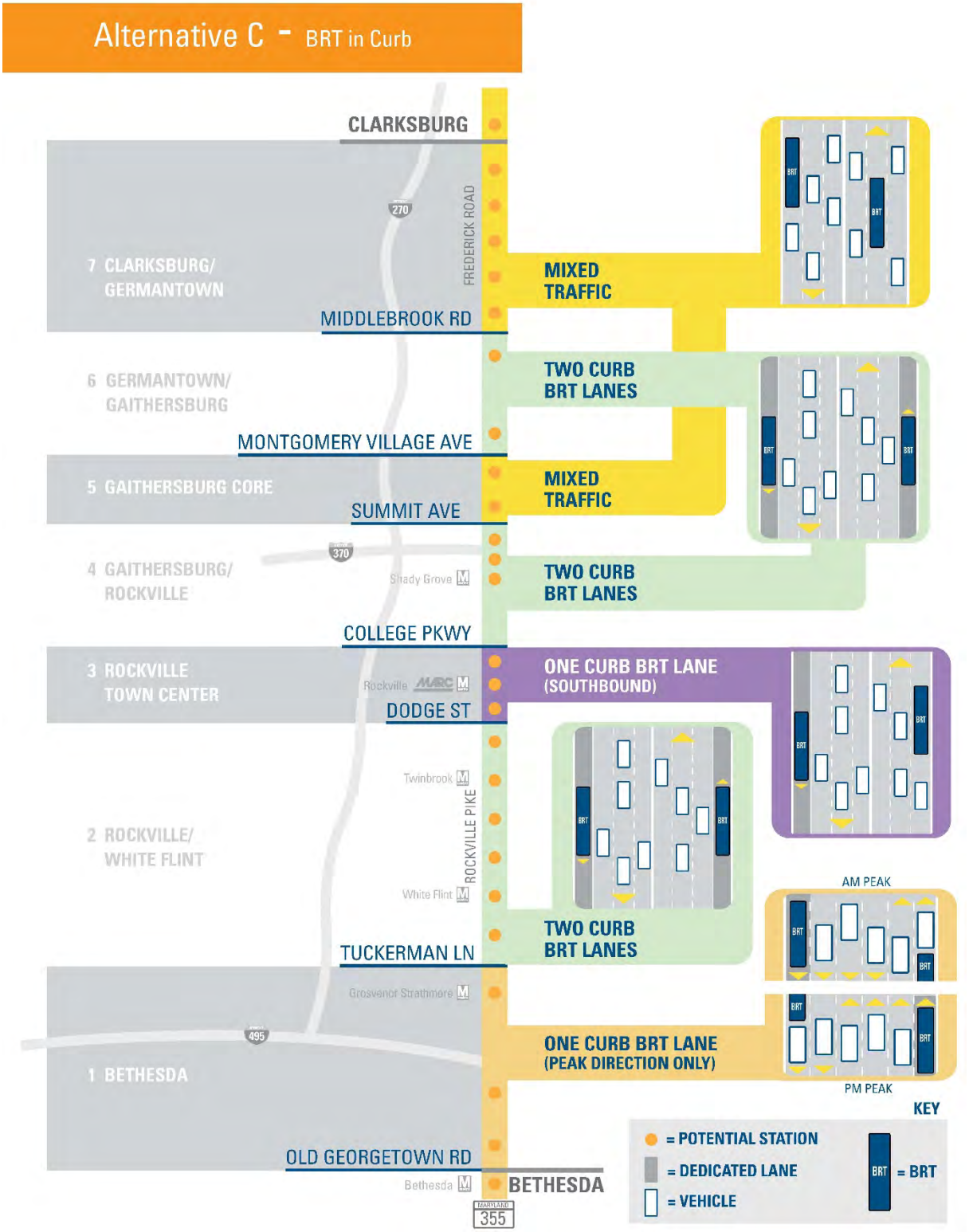


Figure 3-12: Alternative C Segment Features

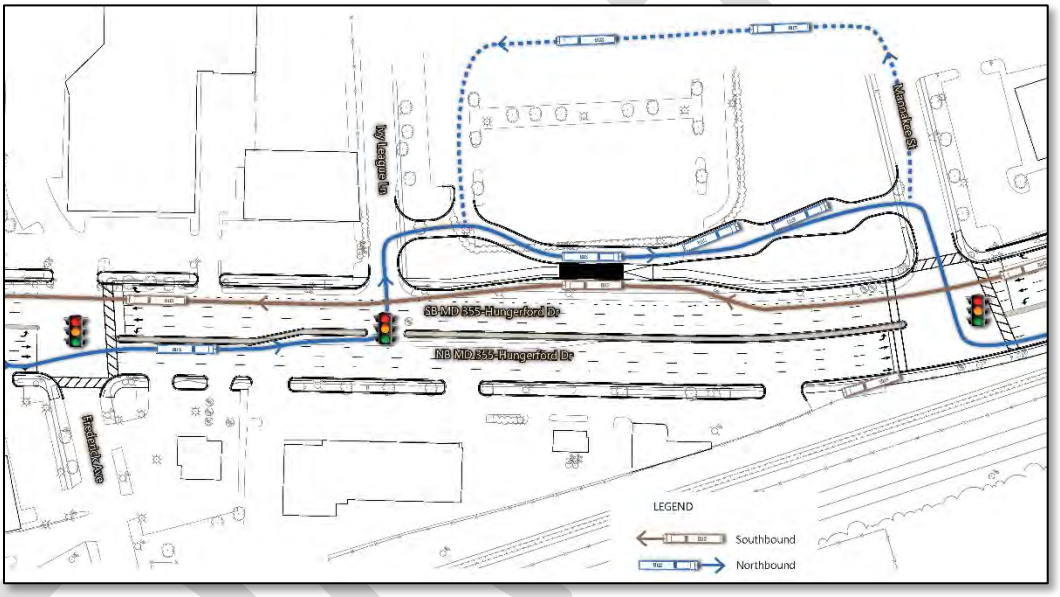


3.8.3 Segment 3

The BRT would run in mixed traffic in both directions of MD 355 from Dodge Street to Beall Avenue to minimize impacts. From Beall Avenue to College Parkway a 11-foot wide southbound dedicated curb lane would be added, and the northbound BRT would continue to operate in mixed traffic.

Access to Montgomery College - Rockville would be provided by constructing a BRT station, loop, and layover area between Ivy League Lane and Mannakee Street. Both southbound and northbound buses would enter on Ivy League lane and exit on Mannakee Street. **Figure 3-13** shows the BRT station, loop, and layover area.

Figure 3-13: BRT Station and Loop at Montgomery College – Rockville



3.8.4 Segment 5

BRT service would operate in mixed traffic in both directions along MD 355 from Summit Avenue to Lakeforest Boulevard. BRT service would divert from MD 355 and follow the same route as Alternatives A and B along Lakeforest Boulevard, Russell Avenue, Odendhal Avenue, and Lost Knife Road to the Lakeforest Transit Center on the east side of the Lakeforest Mall. From the Lakeforest Transit Center, the BRT would travel in mixed traffic on Lost Knife Road and cross MD 124 (Montgomery Village Avenue) to continue onto Christopher Avenue in Segment 6 as shown in **Figure 3-6**.

3.8.5 Segment 7

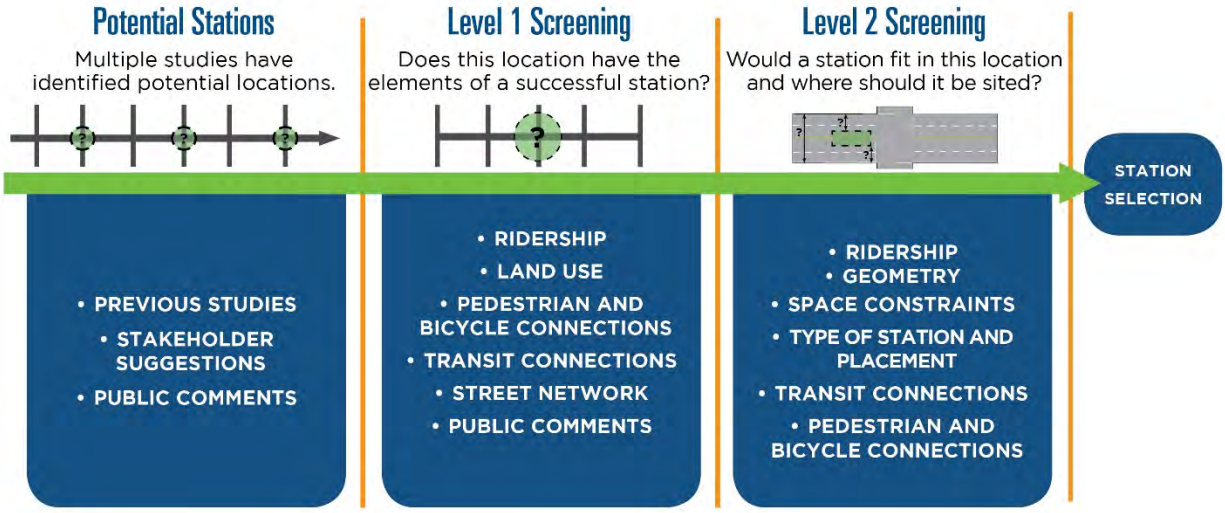
In Segment 7, the BRT would operate in mixed traffic along on MD 355 from Middlebrook Road to the BRT terminus at Clarksburg, via Clarksburg Road, Gateway Center Drive and Stringtown Road. MD 355 would be widened to six general travel lanes north of Middlebrook Road and four lanes north of MD 27 (Ridge Road) as part of a separate MDOT SHA project prior to the construction of stations and operation of the

BRT on MD 355 north of Middlebrook Road. The capital and maintenance costs associated with the MDOT SHA widening project will be borne by other agencies or projects and are not included in cost estimates for this project.

3.9 BRT Station Locations

As part of Phase 2, MCDOT performed a comprehensive assessment of potential station locations. As part of this assessment, two levels of station screening were conducted to evaluate the station options as shown in **Figure 3-14**. In the first level of screening, intersections/activity centers were identified at a planning level to determine if they appeared to be suitable for BRT service. The Level 2 Screening assessed the station locations identified in Level 1. On the basis of engineering considerations, service planning, and ridership analysis, the station locations were refined or eliminated. At the conclusion of the Level 2 analysis, a set of recommended stations were identified to carry forward in the Alternatives.

Figure 3-14: Station Screening Process



Based on those recommendations, each Alternative has a common set of 22 station locations in Segments 1 through 6. In Segment 7, each Alternative has a different number and set of locations based on the specific alignment in that segment. In Alternative A, Segment 7 includes eight stations along Observation Drive, Seneca Meadows Parkway, Shakespeare Boulevard, MD 355, Snowden Farm Parkway, Stringtown Road, and at the Clarksburg Outlets. In Alternative B, Segment 7 includes six stations along Observation Drive and at the Clarksburg Outlets. In Alternative C, Segment 7 includes five stations along MD 355 and at the Clarksburg Outlets. The screening process also identified a number of future "infill" stations that may become more suitable for BRT service after the initial launch of the service. These stations are identified in the *Station Screening Report* in **Appendix C**.

The station locations for the TSM Alternative and Alternatives A, B, and C are shown in **Table 3-3**.

Table 3-3: TSM Alternative and Alternatives A, B, and C Station Locations

Segment	Location	TSM Alternative[4]	Alternative A	Alternative B	Alternative C
1	Bethesda Metrorail Station (Future second entrance)	✓	✓	✓	✓
1	MD 355 and Cordell Avenue	✓	✓	✓	✓
1	Medical Center Metrorail Station	✓	✓	✓	✓
2	Grosvenor-Strathmore Metrorail Station	✓	✓	✓	✓
2	MD 355 and Security Lane	✓	✓	✓	✓
2	White Flint Metrorail Station	✓	✓	✓	✓
2	MD 355 and Bou Avenue	✓	✓	✓	✓
2	MD 355 and Halpine Road	✓	✓	✓	✓
2	MD 355 and Edmonston Drive	✓	✓	✓	✓
2	MD 355 and Mount Vernon Place	✓	✓	✓	✓
3	MD 355 and East Middle Lane (Rockville Metrorail Station)	✓	✓	✓	✓
3	MD 355 and Mannakee Street	✓	✓	✓	✓
3	Montgomery College - Rockville[5]	✓	✓	✓	
4	Shady Grove Metrorail Station	✓	✓	✓	✓
4	MD 355 and South Westland Drive	✓	✓	✓	✓
4	MD 355 and Education Boulevard	✓	✓	✓	✓
5	MD 355 and Cedar/Fulks Corner Avenue	✓	✓	✓	✓
5	MD 355 and Lakeforest Boulevard	✓	✓	✓	✓
5	Lakeforest Transit Center	✓	✓	✓	✓
6	MD 355 and Watkins Mill Boulevard	✓	✓	✓	✓
6	MD 355 and Gunner's Branch Road	✓	✓	✓	✓
7	Holy Cross Hospital		✓	✓	
7	Montgomery College Germantown		✓	✓	
7	MD 355 and Oxbridge Drive	✓			✓
7	Germantown Transit Center	✓	✓	✓	✓
7	Seneca Meadows Office Park		✓		
7	Shakespeare Boulevard and Amber Ridge Drive		✓		
7	Observation Drive and Shakespeare Boulevard			✓	
7	MD 355 and Shakespeare Boulevard	✓			✓
7	MD 355 and Milestone Center Entrance		✓		

[4] Stations that are already served by the Ride On extRa Route 101 are noted with a blue checkmark.
[5] Depending on the service pattern, Alternatives would serve the Montgomery College - Rockville area via MD 355 and Mannakee Street or a station at Montgomery College - Rockville's existing transit center. No service pattern would stop at both locations.

Segment	Location	TSM Alternative[4]	Alternative A	Alternative B	Alternative C
7	Snowden Farm Parkway and Newcut Road		✓		
7	Stringtown Road and Rainbow Arch Drive		✓		
7	Observation Drive and Milestone Center Drive			✓	
7	Observation Drive and Shawnee Lane			✓	
7	MD 355 and Foreman Boulevard	✓			✓
7	MD 355 and Redgrave Place	✓			✓
7	Clarksburg Outlets	✓	✓	✓	✓

3.10 Service and Operations Planning

A preliminary service plan was developed for the BRT and for local service in order to help inform the ridership forecasting. This preliminary service plan will continue to be refined as the project progresses.

3.10.1 BRT Service Plan

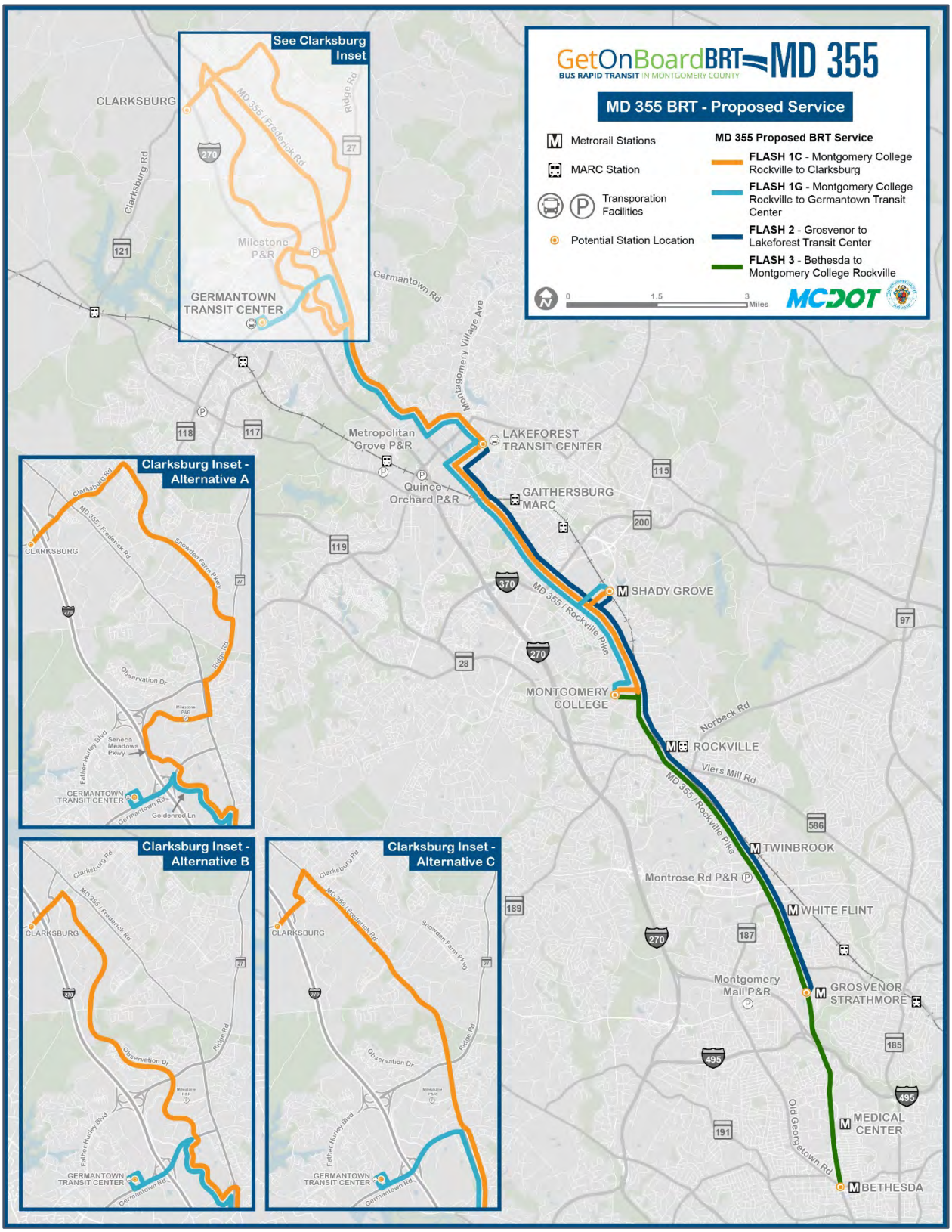
After assessing the existing conditions and analyzing the market demand for transit, service plans were developed for the proposed MD 355 BRT, which included hours of operation, alignment recommendations, and frequency of service. A variety of data sources were used to inform this service plan: U.S. Census demographic and employment data, regional travel demand models, projected development and growth patterns, existing transit ridership data, and community input.

Four partially overlapping BRT routes were developed, all of which operate primarily on MD 355, as shown in **Figure 3-15**:

- FLASH 1C: Clarksburg to Montgomery College - Rockville Campus;
- FLASH 1G: Germantown Transit Center to Montgomery College - Rockville Campus;
- FLASH 2: Lakeforest Transit Center to Grosvenor Metrorail Station; and
- FLASH 3: Montgomery College - Rockville Campus to Bethesda Metrorail Station.

FLASH 3 would travel from Bethesda Metro Station to Montgomery College Rockville via MD 355. FLASH 2 would travel from Grosvenor Metro Station to Lakeforest Transit Center via MD 355 and Shady Grove Metro Station. FLASH 1 would contain two branches, or sub-routes, one that would terminate at the Germantown Transit Center (FLASH 1G) and one that would terminate at Clarksburg (FLASH 1C). FLASH 1G would travel from Montgomery College Rockville to the Germantown Transit Center. This route would travel along MD 355 for most of its service, leaving the road to make stops at the Shady Grove Metro Station, the Lakeforest Transit Center, and the Germantown Transit Center. FLASH 1C would travel from

Figure 3-15: MD 355 BRT FLASH Map



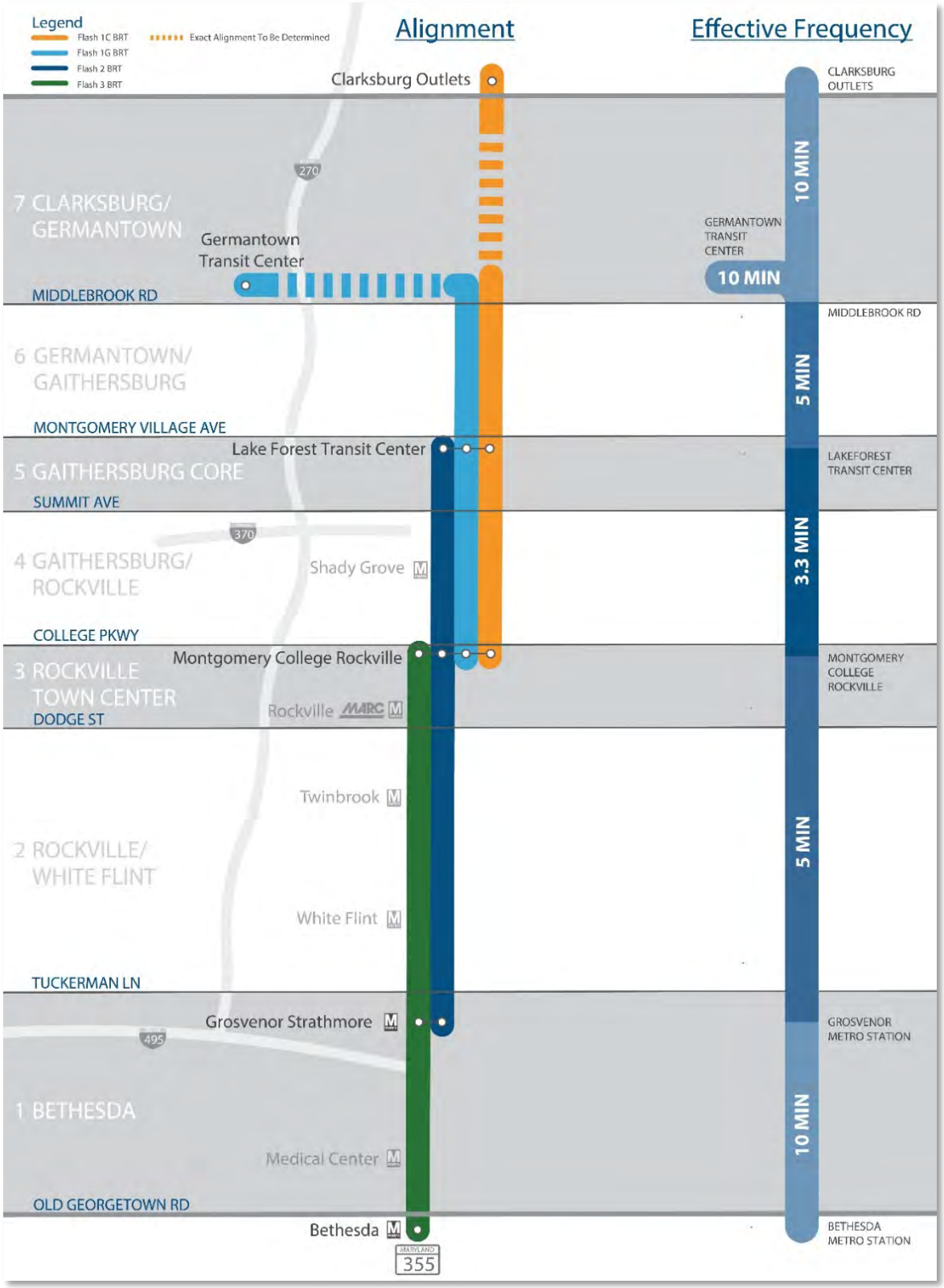
Montgomery College Rockville to Clarksburg Premium Outlets. Like FLASH 1G, this route would serve stations at Shady Grove Metro Station and Lakeforest Transit Center. The alignment between Middlebrook Road and the Clarksburg Premium Outlets, however, would vary depending upon the alternative ultimately chosen. The headway, or number of minutes between bus arrivals, and span of service for each BRT route is listed in **Table 3-4**. For FLASH service, the peak period is defined as between 6:00 AM to 9:00 PM. Off-peak is considered anytime outside of these hours.

Table 3-4: BRT FLASH Route Span of Service

Route	Weekday Headway	Weekday Span	Weekend Headway	Saturday Span	Sunday Span
FLASH 1C	10 mins peak 15 mins off-peak	4:15 AM - 12:00 AM	15 mins	5:00 AM - 12:00 AM	5:00 AM - 12:00 AM
FLASH 1G	10 mins peak 15 mins off-peak	4:15 AM - 1:45 AM	15 mins	5:00 AM - 1:45 AM	5:00 AM - 1:30 AM
FLASH 2	10 mins peak 15 mins off-peak	4:15 AM - 1:45 AM	15 mins	5:00 AM - 1:45 AM	5:00 AM - 1:30 AM
FLASH 3	10 mins peak 15 mins off-peak	5:00 AM - 1:45 AM	15 mins	5:00 AM - 1:00 AM	5:00 AM - 1:00 AM

Figure 3-16 shows a schematic map of BRT service showing origins, destinations, and major destinations served. The effective headway of the combined BRT routes during peak periods is also shown to give a better sense of how BRT service overlaps to provide high quality, frequent, and reliable transit service on the MD 355 corridor.

Figure 3-16: FLASH Route Levels of Service



4 TRAFFIC MODELING AND RIDERSHIP FORECASTING

This chapter provides an overview of traffic modeling and ridership forecasting. More detailed information can be found in the *Traffic and Ridership Forecasting Analysis Summaries* in **Appendix E**.

4.1 Introduction

There are a wide range of results from the traffic and ridership modeling analysis completed as part of the project. As discussed in **Section 2.4**, these results are structured as MOEs, each of which is associated with a project Goal and Objective. The MOEs were developed as a means of measuring how well each alternative performed relative to the Goal and Objective with which the MOE is associated.

The remainder of this section is structured by each ridership and/or traffic-related Goal and Objective, describing how the MOE results provide insight on how well the project performs relative to each goal and objective.

4.2 Goal: Provide an Appealing, Functional, and High-Quality Transit Service

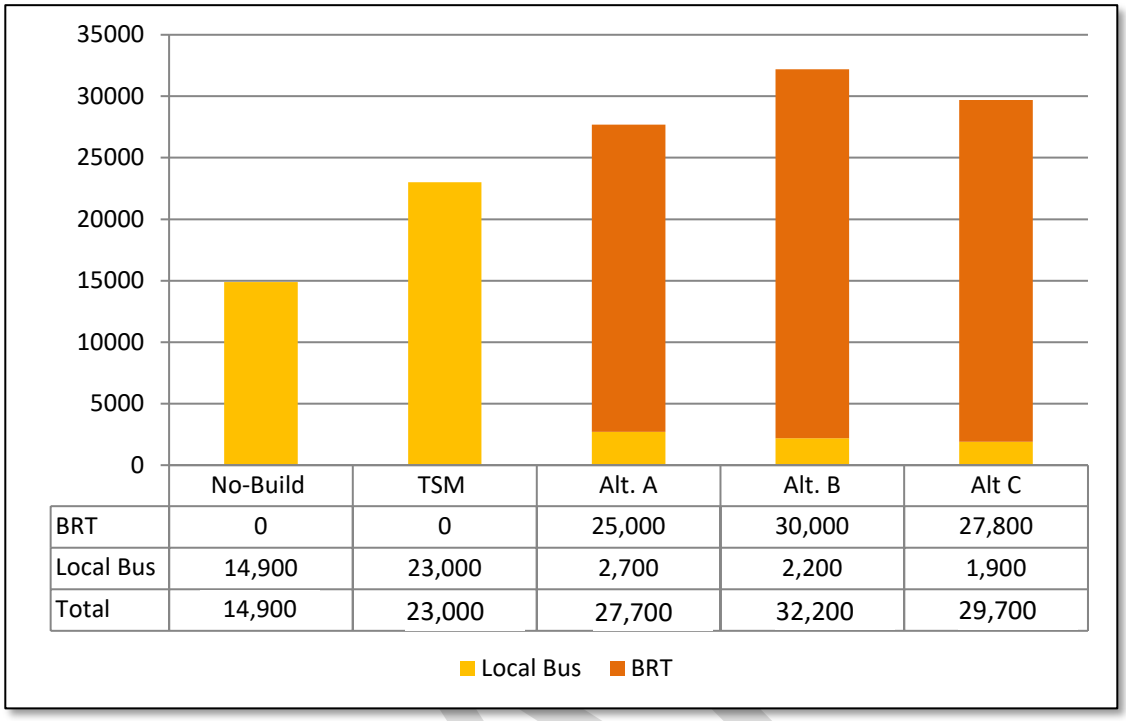
Objective: Increase Transit Ridership and Mode Share Within and Along the Corridor

4.2.1 BRT Boardings and Daily Transit Ridership

This section presents ridership data in several different formats in order to provide different insights into overall ridership performance and the ridership differences between alternatives. The first ridership metric, as shown in **Figure 4-1**, outlines bus ridership in the corridor in the year 2040 for all alternatives. The key findings from the figure are as follows:

- Alternative B would have the highest bus ridership of all of the alternatives. This generally reflects the higher travel speeds associated with the median guideway, which makes the service more attractive to potential riders.
- All three BRT Alternatives (Alternatives A, B, and C) would have higher total bus ridership than the TSM Alternative. The different priority treatments (dedicated lanes, signal priority, queue jumps) provided under the BRT Alternatives would result in faster travel times, which support higher ridership.
- The improved attractiveness of BRT compared to local bus would result in transit riders shifting from local bus to the new BRT service. This would occur under each of the BRT Alternatives.
- Approximately 50 percent of the ridership would occur in the off-peak period.

Figure 4-1: Weekday Bus Ridership (2040)

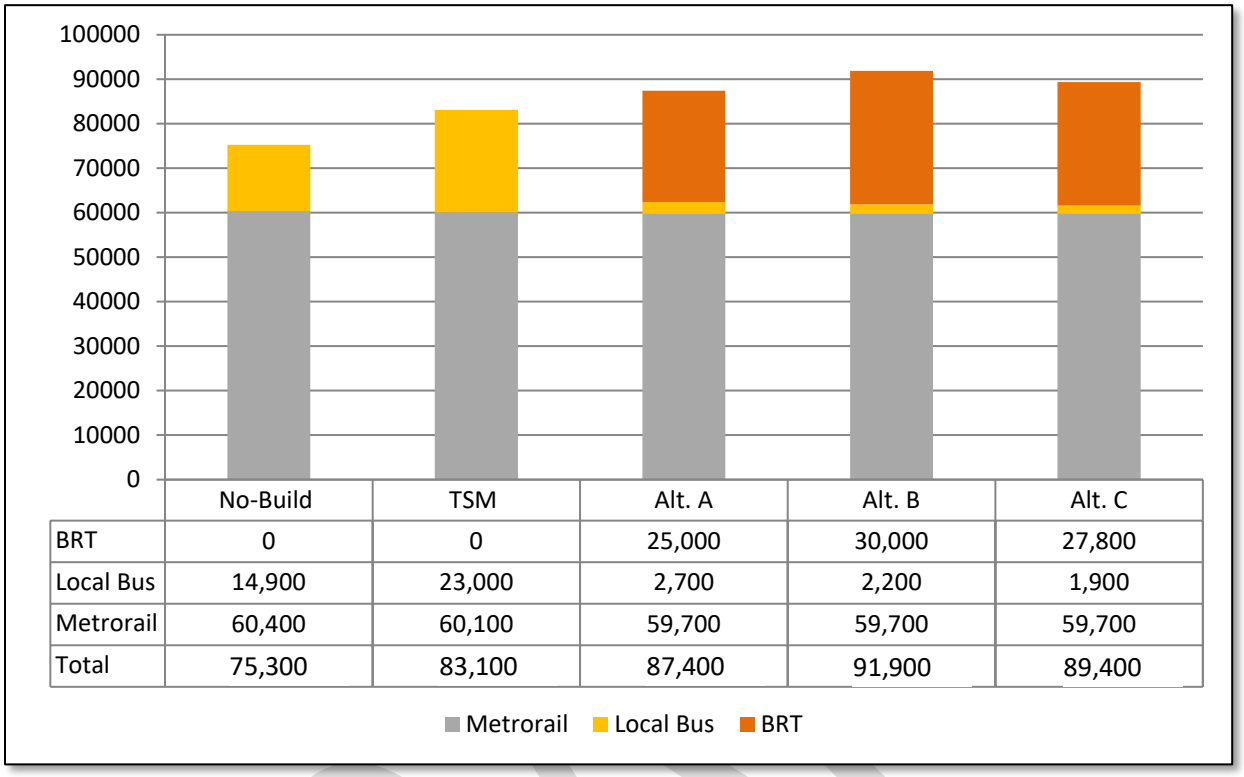


	No-Build	TSM	Alt. A	Alt. B	Alt C
BRT	0	0	25,000	30,000	27,800
Local Bus	14,900	23,000	2,700	2,200	1,900
Total	14,900	23,000	27,700	32,200	29,700

The second set of ridership data, as outlined in **Figure 4-2**, shows total daily transit boardings in the corridor in the year 2040 and includes daily boardings on all transit modes: BRT, local bus, and Metrorail. The key findings from the figure are as follows:

- The highest transit boardings in the corridor would occur on Alternative B, followed by Alternative C and then Alternative A.
- All three BRT Alternatives would result in higher total transit boardings in the corridor than the TSM Alternative.
- Metrorail ridership in the corridor would decline minimally under the three BRT Alternatives when compared to the No-Build Alternative, meaning BRT service would complement Metrorail service, not hurt ridership.
- Implementation of BRT would result in **meeting the project objective of increasing transit ridership**.

Figure 4-2: Total Daily Transit Boardings by Alternative, By Mode (2040)

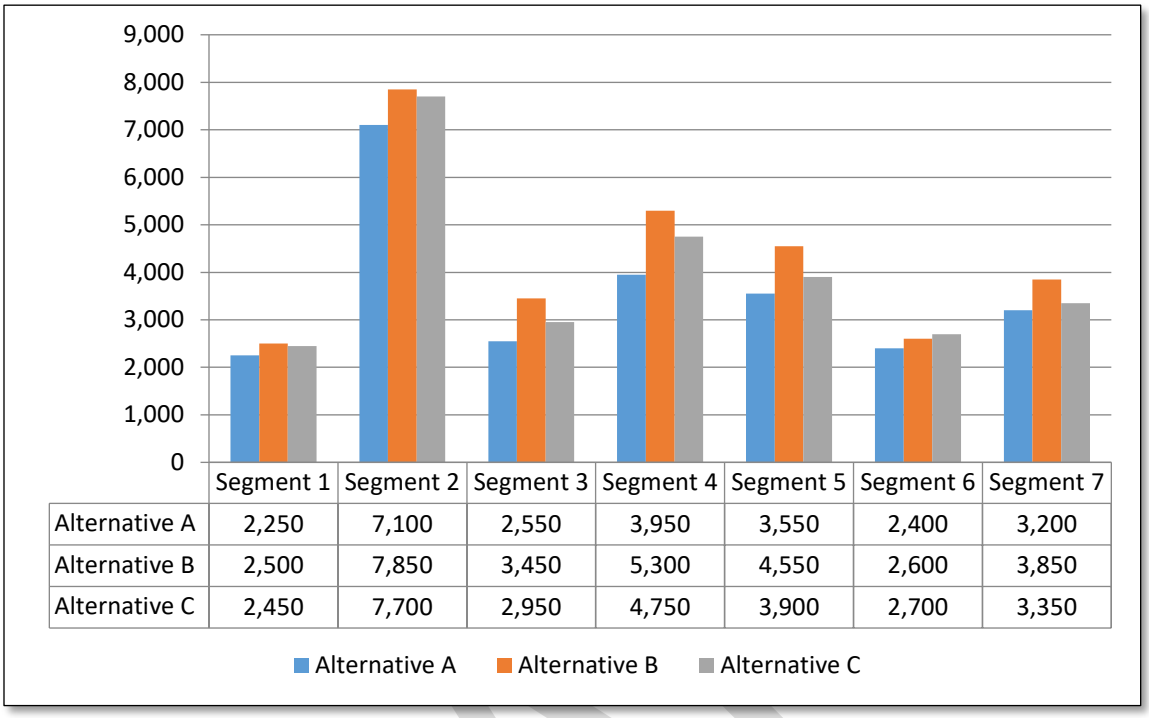


	No-Build	TSM	Alt. A	Alt. B	Alt. C
BRT	0	0	25,000	30,000	27,800
Local Bus	14,900	23,000	2,700	2,200	1,900
Metrorail	60,400	60,100	59,700	59,700	59,700
Total	75,300	83,100	87,400	91,900	89,400

Figure 4-3 provides data on 2040 BRT boardings by segment and helps provide an understanding of which segments generate the highest BRT ridership. The data shows the following:

- The highest boarding segment in all three BRT Alternatives would occur in Segment 2, which runs between the Grosvenor Metrorail station and Dodge Street, and includes the White Flint area. This finding is not surprising given the future land use changes resulting in a more highly developed segment.
- The next highest boarding segment would occur in Segment 4, which runs between College Parkway at the north end of Rockville Town Center and Summit Avenue in Gaithersburg. This segment includes the Shady Grove Metrorail Station and the southern end of Gaithersburg.
- The third highest boarding segment would occur in Segment 5, which runs from Summit Avenue to Christopher Avenue. This segment is completely within the City of Gaithersburg.
- Segment 7, which starts at Middlebrook Road at its southern end, has different alignments under each BRT Alternative. Boardings under each alternative, regardless of alignment, would be generally comparable across each alternative.

Figure 4-3: Daily Weekday BRT Boardings by Alignment Segment (2040)

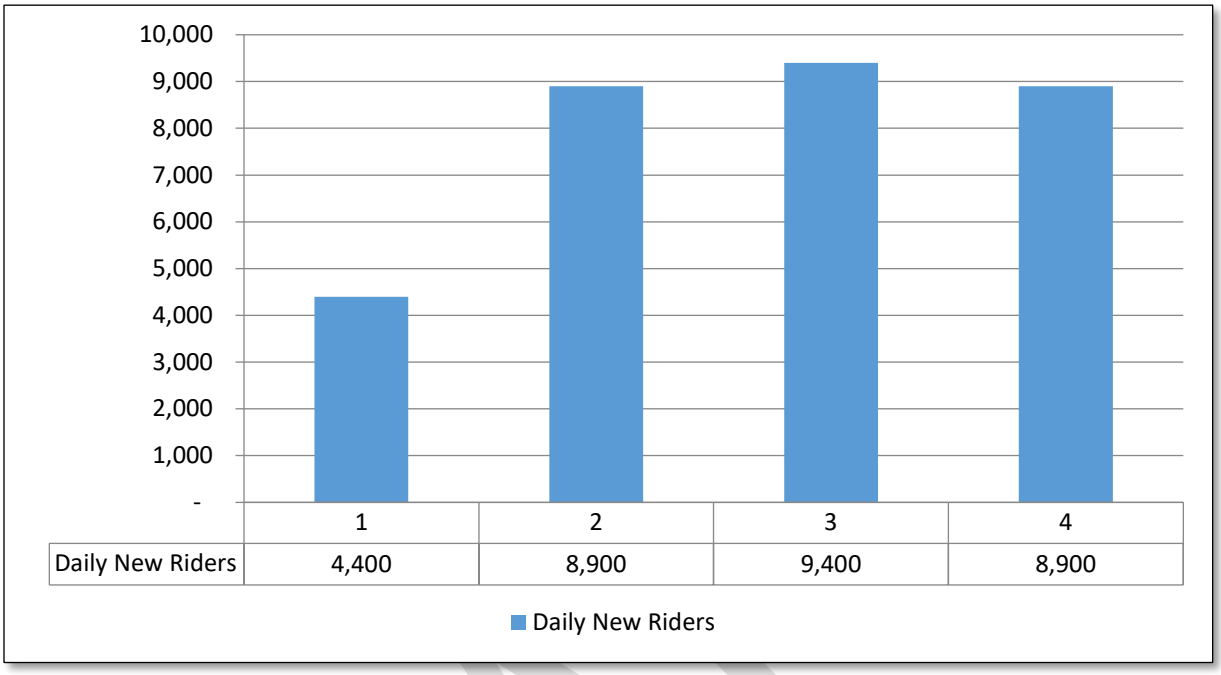


	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
Alternative A	2,250	7,100	2,550	3,950	3,550	2,400	3,200
Alternative B	2,500	7,850	3,450	5,300	4,550	2,600	3,850
Alternative C	2,450	7,700	2,950	4,750	3,900	2,700	3,350

Figure 4-4 compares new transit riders that would result due to implementation of transit improvements under the TSM Alternative or one of the BRT Alternatives. New transit riders are riders who utilized a non-transit mode in the No-Build Alternative who would now utilize transit to make their trip. Alternative B would result in the highest number of new transit riders at 9,400, followed by both Alternative A and C, at 8,900. New riders on all three BRT Alternatives would exceed the new riders generated by the TSM Alternative.

This new rider data is another indication that the BRT alternatives would help meet the objective of increasing transit ridership.

Figure 4-4: Daily New Riders by Alternative (2040)



The final ridership-related data is year 2040 transit mode share, which is presented in **Table 4-5**. Mode share is the percentage of total daily trips made in a geographic area by each travel mode, the largest of which are auto and transit. In this instance the geographic areas of interest are the MD 355 corridor as well as Montgomery County. The data in **Table 4-1** show the following changes in mode share:

- Transit mode share for trips originating in the corridor would improve to 9 percent for each of the three BRT Alternatives, when compared to the No-Build Alternative mode share of 8.3 percent. This data reflects the new rider data discussed above, and means more trips made in the corridor would be made by transit when compared to the No-Build Alternative because the BRT Alternatives make transit more attractive to people deciding how to compete their trip.
- Transit mode share for trips destined to the corridor would improve to 7.2 percent and 7.3 percent (depending on alternative) when compared to the No-Build Alternative mode share of 6.6 percent. Again, each of the BRT Alternatives would make transit more attractive and convenient, thus attracting additional riders to transit for trips to the corridor.
- The final mode share metric is for trips originating in all of Montgomery County. In this instance, mode share for trips originating within the County would increase to 8.6 percent and 8.8 percent (depending on alternative) when compared to the No-Build Alternative mode share of 8.3 percent. This change, while small in terms of the percentage change, is especially notable due to the large number of trips generated each day in the County. To be able to shift mode share across the large base of trips originating in the County shows the impact of the BRT Alternative in making transit more attractive.
- Mode share improvements relative to the No-Build Alternative are higher under all three BRT Alternatives than under the TSM Alternative.

Table 4-1: Mode Share Changes for Trips Originating in Corridor, Trips Destined for Corridor and Trips Originating in All of Montgomery County (2040)

Geographic Area	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative C
From Study Area	8.3%	8.7%	9.0%	9.0%	9.0%
To Study Area	6.6%	6.9%	7.3%	7.2%	7.2%
From Montgomery County	8.3%	8.5%	8.8%	8.7%	8.6%

The second objective of this goal is to *Make bus trips faster and more competitive with automobile travel time*. Three MOEs related to this objective are presented.

4.2.2 Transit Travel Time between Key Origin-Destination Pairs

This MOE evaluated the transit travel time between key origin-destination pairs within the corridor. In nearly all instances across all BRT Alternatives, transit travel times would be improved based on the combination of improved BRT frequencies and improved trip travel times. Of note is the faster No-Build Alternative transit travel time in the Clarksburg to Shady Grove Origin-Destination pair when compared to Alternatives A and B. This better performance under the No-Build Alternative when compared to these two alternatives is the result of the existing direct express service running between Clarksburg and Shady Grove via I-270, which would run faster than the two BRT alternatives that would make a less direct trip between Clarksburg and Shady Grove in order to serve important trip generators in the Clarksburg area north of Middlebrook Road (Alternative A runs via Observation Drive, Ridge Road and Snowden Farm Parkway and Alternative B runs via Observation Drive). Alternative C, which would run straight down MD 355, would have a shorter travel time than the No-Build Alternative.

Transit travel time between key origins and destinations within the corridor would improve under each of the BRT Alternatives when compared to the No-Build and TSM Alternatives. **This will make it easier and more convenient for people to use transit after BRT is implemented.**

When comparing BRT alternatives, Alternatives B and C generally provide greater travel time benefits than Alternative A, reflecting the added travel time premium provided by the dedicated transit lanes under Alternatives B and C. Also of note is that BRT travel times vary by segment for Alternatives B and C. This more detailed data is provided in Sections 4.1.1.3 and 4.1.1.4.

The data for this MOE is presented in **Table 4-2**.

Table 4-2: Transit Travel Time (in Minutes) By Alternative for Select Origin-Destination Pairs

Origin	Destination	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative C	Notes
Clarksburg	Shady Grove	50	56	62	50	46	Bus Only
Clarksburg	White Flint	90	90	77	79	61	Bus-to-Metrorail
Germantown	Shady Grove	44	42	40	33	35	Bus Only
Lakeforest	Rockville	43	43	38	29	31	Bus Only
Lakeforest	Bethesda	53	53	46	42	43	Bus-to-Metrorail
White Flint	Bethesda	30	26	23	21	23	Bus Only
Rockville	Bethesda	57	42	40	36	39	Bus Only

4.2.3 BRT Travel Time Compared to Local Bus Travel Time

This MOE compares BRT travel time to local bus travel time in order to provide an understanding of the type of travel time premium provided by the BRT improvements. The comparison results are shown in **Table 4-3**, which provides a summary of local bus and BRT travel times between Chestnut Street in Gaithersburg and East-West Highway in Bethesda. This portion of the corridor was selected for analysis because it is one of the most heavily traveled portions of the corridor for all modes, and thus most accurately reflects the type of traffic conditions in which the BRT would be operating.

Table 4-3: BRT Travel Times Compared to Local Bus Travel Times (Minutes)

Origin	Destination	No-Build Alternative	TSM Alternative		Alternative A		Alternative B		Alternative C	
		Local Bus	Local Bus	Ride On extRa	Local Bus	BRT	Local Bus	BRT	Local Bus	BRT
AM Peak Southbound										
Chestnut Street	East-West Highway	72.8	74.5	66.3	83.3	63.1	88.6	53.0	70.2	51.8
AM Peak Northbound										
East-West Highway	Chestnut Street	70.5	62.7	56.3	72.5	48.9	75.6	49.9	75.2	53.7
PM Peak Southbound										
Chestnut Street	East-West Highway	66.3	66.9	55.1	79.7	56.5	90.1	49.5	71.1	47.9
PM Peak Northbound										
East-West Highway	Chestnut Street	83.9	79.5	69.4	84.9	63.1	96.4	53.0	79.6	51.8

The data in **Table 4-3** show the following key findings:

- BRT would have a travel time premium relative to local bus for each of the BRT Alternatives for each period of the day and for each direction of travel. These premiums are also present when comparing BRT travel time to local bus travel times under the No-Build and TSM Alternatives.
- BRT would also have a travel time premium relative to the Ride On extRa travel times under the TSM Alternative, except when compared to Alternative A in the PM Peak southbound direction (the difference between Alternative A and the TSM Ride On Extra would be approximately one minute).
- Local bus travel times would improve under Alternative C when compared to the No-Build Alternative in the AM and PM peak directions (AM peak southbound and PM peak northbound). This reflects the benefits provided to local bus from the improvements associated with Alternative C, including the dedicated curb lane, queue jumps and TSP.
- Local bus travel times would deteriorate under the other BRT alternatives compared to the No-Build Alternative. This deterioration is related to different elements of the BRT improvements that impact general traffic operations overall and local bus specifically.
- The data in **Table 4-3** shows that the improvements associated with a BRT Alternative would provide a more attractive and convenient transit service than local bus service.

4.2.4 BRT Travel Times Compared to Auto Travel Times

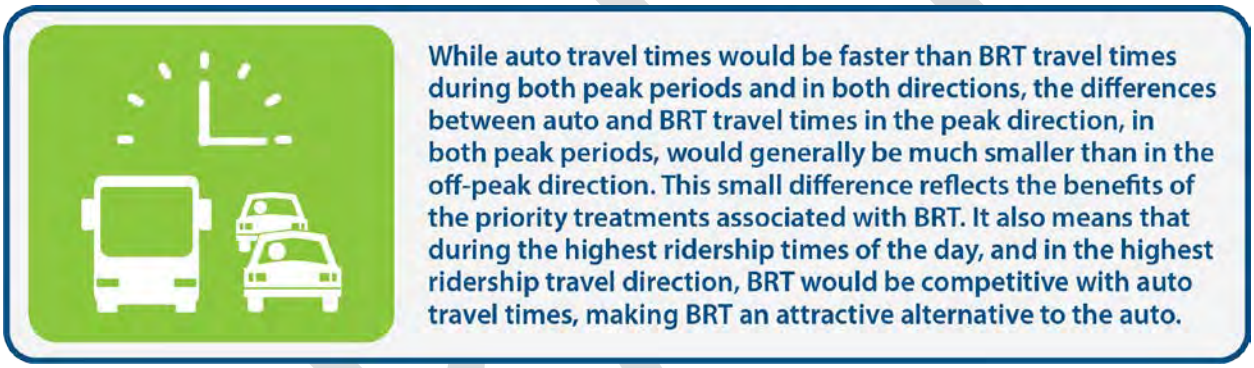
This MOE compares BRT travel time to auto travel time in order to provide an understanding of the differences between BRT and auto travel time and whether BRT travel time is competitive with the auto. The comparison results are shown in **Table 4-4**, which provides a summary of auto and BRT travel time in the portion of the corridor between Watkins Mill Road in Gaithersburg and East-West Highway in Bethesda.

Table 4-4: BRT Travel Times Compared to Auto Travel Times (Minutes)

Origin	Destination	No-Build Alternative	TSM Alternative		Alternative A (Mixed Traffic)		Alternative B (Median)		Alternative C (Curb)	
		Auto	Auto	Ride On extRa	Auto	BRT	Auto	BRT	Auto	BRT
AM Peak Southbound										
Chestnut Street	East-West Highway	47.1	50.9	72.6	45.5	71.2	54.1	61.0	45.8	58.4
AM Peak Northbound										
East-West Highway	Chestnut Street	44.7	40.5	69.4	40.1	62.7	40.7	64.8	43.3	66.9
PM Peak Southbound										
Chestnut Street	East-West Highway	46.1	44.9	67.3	46.4	69.5	48.5	61.9	50.9	60.5
PM Peak Northbound										
East-West Highway	Chestnut Street	66.8	64.7	86.1	59.7	82.4	72.5	76.9	70.1	78.5

The data in **Table 4-4** show the following key findings:

- Auto travel times would be less than BRT travel times during both peak periods and in both directions, for all BRT alternatives. The greatest differences would occur in the off-peak directions.
- A closer examination of peak direction travel times shows that the differences between auto and BRT travel times would generally be much smaller than during the off-peak direction for Alternatives B and C. Examples where the time difference between auto and BRT would be less than 20 percent include:
    - Alternative B in the AM southbound direction: The difference in travel time between BRT and auto would be 6.9 minutes, a 12.7 percent difference.
    - Alternative B in the PM Northbound direction: The difference in travel time between BRT and auto would be 4.4 minutes, a 6.1 percent difference.
    - Alternative C in the PM Northbound direction: The difference in travel time between BRT and auto would be 8.4 minutes, an 11.9 percent difference.



The third objective of this goal is to *Improve transit quality and level of service in the corridor*. There is one MOE related to transit reliability outlined below.

4.2.5 Transit Reliability along Corridor

This transit reliability MOE is measured based on how well the forecasted separation of BRT vehicles arriving at the intersection of MD 355 and Cedar Avenue in Gaithersburg would correspond to the scheduled separation of buses. This analysis was completed for each of the three northern BRT routes (FLASH 1C, 1G, and 2) for both the AM and PM peak hours.

Service is more reliable when the actual separation is closer to scheduled separation. Strong reliability means waiting passengers can be confident a bus will arrive within a reasonable amount of time and will have a reasonable passenger load. In situations where separation is poor and buses “bunch” or arrive too close together relative to the scheduled headway, there will be a large gap behind the trailing bus in the bunch. This results in a longer wait time for passengers arriving at the stop after the trailing bus has left. This gap also means that the first bus to arrive after the bunch will likely have passenger crowding because it is forced to carry passengers who would have been more evenly distributed across multiple buses if the buses had been correctly separated.

To evaluate bus separation, outputs from the project VISSIM traffic simulation model were used to identify when vehicles arrived at Cedar Avenue in Gaithersburg during the AM peak hour and the PM peak hour, by BRT route, as well as their separation from the vehicle in front of them. In addition, ten VISSIM model runs were completed for each route to reflect variable operating conditions from day to day. All three routes evaluated would operate every ten minutes, so ideal separation would also be ten minutes for each route.

The data in **Table 4-5** shows the percentage of BRT vehicles whose separation from the vehicle in front of them falls within a range of seven minutes to 13 minutes (three minutes on each side of the scheduled headway of ten minutes). This range reflects the difficulty in maintaining exact scheduled separation under real-world conditions but also incorporates an acceptable range of separation that would not impose an undue burden on passengers.

The data in **Table 4-5** shows that in the AM peak all Build Alternative/route pattern combinations would have more than 80 percent of their vehicle arrivals at the intersection of MD 355 and Cedar Avenue fall within the range of seven to 13 minutes. Alternatives B and C would each perform generally comparably to each other, while Alternative A would have a lower performance relative to Alternatives B and C. This likely reflects the fact that Alternative A would run in mixed traffic and therefore is subject to more traffic disruptions than the two dedicated lane alternatives.

The same separation percentage patterns generally hold true in the PM peak, except in one instance. Under Alternative A, on the FLASH 1C Route, only 64 percent of vehicle arrivals would fall into the range of seven to 13 minutes. In the PM peak, Alternative B generally performs the best of the three alternatives, followed by Alternative C, and then by Alternative A. As with AM peak, this likely reflects the level of transit dedication under each alternative, with Alternative B providing the highest level of separation from traffic disruptions.

Table 4-5: Percent of Bus Separations that Fall Between 7 and 13 Minutes – 3 Minutes Above or Below 10 Minute Scheduled Headways (Peak Direction)

AM Peak Southbound			
Route Pattern	Alternative		
	A	B	C
FLASH 2 - Lakeforest to Grosvenor	100%	100%	100%
FLASH 1G - Germantown to Montgomery College	83%	96%	81%
FLASH 1C - Clarksburg to Montgomery College	84%	82%	95%
PM Peak Northbound			
Route Pattern	Alternative		
	A	B	C
FLASH 2 - Lakeforest to Grosvenor	92%	87%	93%
FLASH 1G - Germantown to Montgomery College	82%	94%	88%
FLASH 1C - Clarksburg to Montgomery College	64%	96%	83%

One additional factor that may have an impact on BRT reliability is a phenomenon known as non-recurring congestion. Non-recurring congestion is congestion that occurs because of incidents such as traffic accidents, vehicle breakdowns, or road work that occurs on a variable basis and thus cannot be planned for. The data provided in **Table 4-5** reflect modeling of "normal" conditions and therefore do not consider the impacts of potential incidents.

To understand the impact non-recurring congestion has on the MD 355 corridor and the approximate magnitude of the variability it creates in travel time, INRIX traffic data was analyzed. Travel time data for the MD 355 corridor was reviewed for 2018 over a 24-hour period for two segments: Clarksburg to Rockville and Rockville to Bethesda. The data evaluated shows how travel time for cars can vary along the corridor by time of day. During the peak commuting periods (AM and PM), the travel time can vary by as much as 20 minutes, or 64 percent longer than average for travel between Clarksburg and Rockville. Drivers need to factor this additional time into their commute in order to arrive on time every time. This variability in travel time manifests itself as unreliable corridor conditions that frustrate travelers.

Non-recurring congestion events would have a greater impact on BRT reliability under Alternatives A and C because they are more impacted by general traffic conditions. The impacts would be greatest for Alternative A, which runs in mixed traffic. The dedicated transit lanes completely separated from general traffic under Alternative B would be the most effective in mitigating the impacts of non-recurring congestion on BRT reliability.

4.3 Goal: Improve Mobility Opportunities, Accessibility, and Transportation Choices

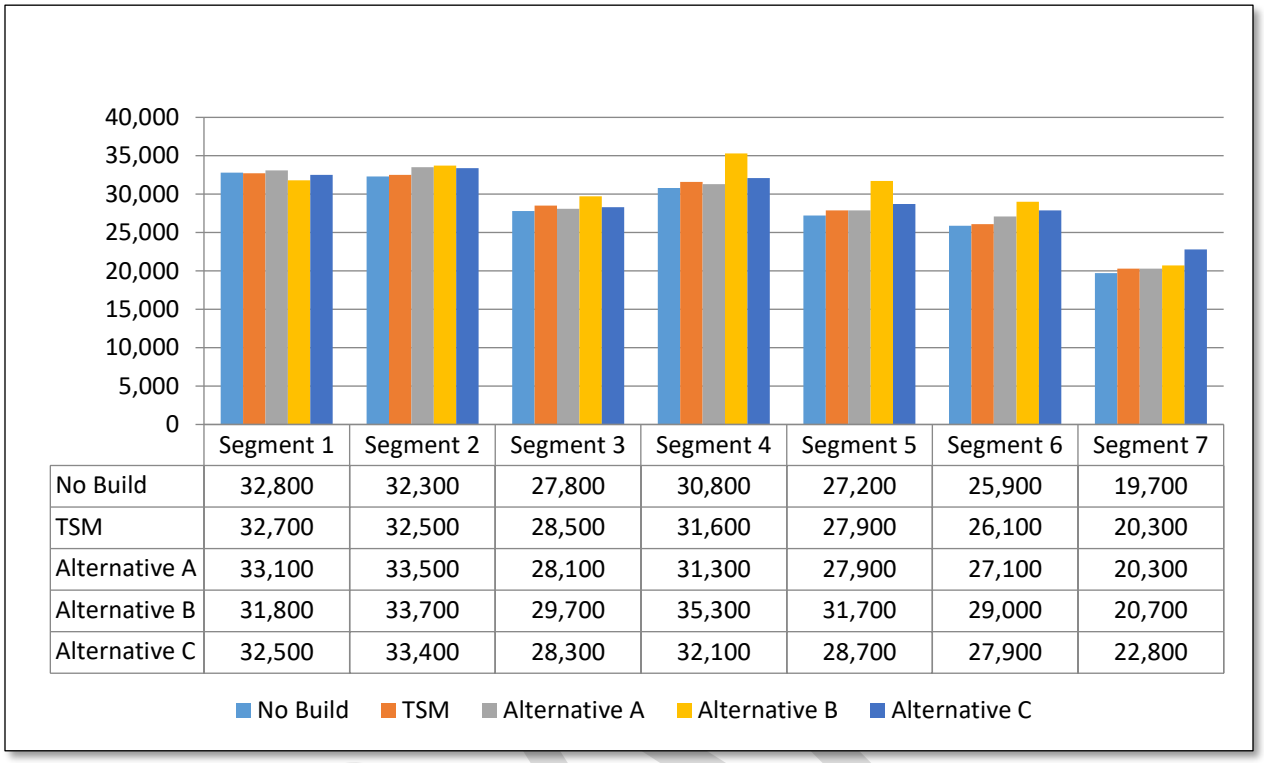
Objective: Make the Most Productive Use of Roadway Capacity

Person throughput is a measure of how many people, not vehicles, cross over an imaginary line drawn across a roadway (also known as a screen line) at key points within the roadway corridor. The concept of person throughput as it relates to the proposed BRT improvements along the MD 355 corridor is that these improvements would result in a shift of people from low occupancy cars to high occupancy transit vehicles, thus resulting in the same (or greater) number of people moving over the screen line, but in fewer vehicles. This desired outcome would result in a more productive use of the MD 355 corridor as more people are moved without expanding roadway capacity or creating more congestion.

In the case of MD 355, a screen line was selected at the approximate mid-point of each of the seven alignment segments and daily person throughput under the No-Build Alternative, TSM Alternative, and Alternatives A, B, and C were calculated for each of these points along the corridor. The results are outlined in **Figure 4-5**.

The data in **Figure 4-5** shows that throughput would generally increase under each of the BRT Alternatives when compared to the No-Build Alternative, meaning BRT improvements would result in a more productive use of MD 355. This result is a benefit for all users of the roadway.

Figure 4-5: Person Throughput by Alternative, by Segment



	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
No Build	32,800	32,300	27,800	30,800	27,200	25,900	19,700
TSM	32,700	32,500	28,500	31,600	27,900	26,100	20,300
Alternative A	33,100	33,500	28,100	31,300	27,900	27,100	20,300
Alternative B	31,800	33,700	29,700	35,300	31,700	29,000	20,700
Alternative C	32,500	33,400	28,300	32,100	28,700	27,900	22,800

4.4 Goal: Improve Mobility Opportunities, Accessibility, and Transportation Choices

Objective: Provide Improved Accessibility to Jobs and Activity Centers for Corridor Residents, and those Coming to the Corridor

This set of MOEs measures the change in accessibility to jobs between the No-Build Alternative and the three BRT Alternatives under certain travel times: 30 minutes, 45 minutes, and 60 minutes. Improved service frequencies and travel times under the BRT Alternatives would increase the number of jobs or activity centers that can be reached within a reasonable amount of time, therefore expanding the transit market. Outlined below in **Tables 4-6 and 4-7** is corridor-wide data on accessibility to jobs by transit. The first, **Table 4-6**, outlines the number of jobs that can be accessed by households located within the corridor during a range of travel times (30 minutes, 45 minutes, and 60 minutes) by transit under each alternative. The data shows an increase in accessibility for each of the BRT Alternatives, under each of the travel time evaluated, when compared to the No-Build Alternative.

Table 4-6: Number of Jobs Accessible by Transit for Households in the Corridor

Alternative	Travel Time Scenario		
	30 Minutes	45 Minutes	60 Minutes
No-Build Alternative	130,900	395,500	832,300
TSM Alternative	131,100	397,100	836,100
Alternative A	139,400	414,100	864,900
Alternative B	140,300	414,400	860,600
Alternative C	139,700	414,700	863,000

The data presented in **Table 4-7** shows the number of households that can access jobs within the corridor by transit, by travel time scenario. The households displayed in the table represent households both within and outside the corridor. The data shows that access to jobs within the corridor would increase with each of the BRT Alternatives when compared to the No-Build Alternative.

Table 4-7: Number of Households with Access to Jobs within the Corridor

Alternative	Travel Time Scenario		
	30 Minutes	45 Minutes	60 Minutes
No-Build Alternative	98,400	260,800	547,800
TSM Alternative	94,400	261,100	549,400
Alternative A	98,400	268,900	562,000
Alternative B	99,900	269,300	560,100
Alternative C	98,900	267,700	559,700

The accessibility analysis shows that each of the BRT Alternatives would result in improved accessibility to jobs for corridor residents as well as to jobs within the corridor for residents who live outside the corridor.

Each of the BRT Alternatives meets the project objective of "providing improved accessibility to jobs for corridor residents and those coming to the corridor".

4.5 Goal: Improve Mobility Opportunities, Accessibility, and Transportation Choices

Objective: Balance the Mobility Needs of Automobiles, Trucks, and Transit Users

Several MOEs related to the objective of balancing the needs of the different users of MD 355 were developed and evaluated to measure the impact of the provision of transit priority on general traffic operations. These include the Change in Number of Miles of Level of Service (LOS) E or F by Alternative;

Change in Average Person Travel Time Delay by Alternative; and Change in Intersection Level of Service by Alternative.

The first MOE evaluated, Miles of LOS E and F, by Alternative for the AM Peak is displayed below in **Table 4-8** and comparable data for the PM peak is shown in **Table 4-9**. The AM peak data displayed in **Table 4-8** shows that miles of LOS E or F would increase slightly under the BRT Alternatives when compared to the No-Build Alternative, except under Alternative C in the southbound direction, where miles of LOS E or F would actually decline. This means that the provision of priority to BRT would have only marginal impacts on MD 355 general traffic operations in the AM peak.

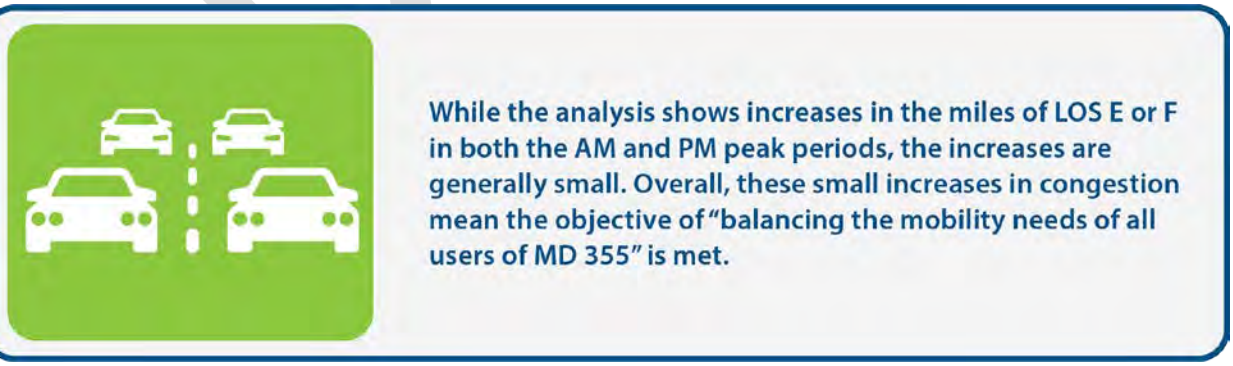
Table 4-8: Number of Miles of LOS E or F during the AM Peak Period

Alternative	Northbound	Southbound
No-Build Alternative	2.6	7.6
TSM Alternative	2.7	9.4
Alternative A	2.7	8.1
Alternative B	3.0	8.4
Alternative C	3.2	5.9

The data in **Table 4-9**, outlining PM peak miles of LOS E or F, shows the same general patterns as those occurring in the AM peak, with small increases in miles of LOS E or F under each of the Build Alternatives when compared to No-Build Alternative.

Table 4-9: Number of Miles of LOS E or F during the PM Peak Period

Alternative	Northbound	Southbound
No-Build Alternative	8.4	5.0
TSM Alternative	8.1	5.5
Alternative A	7.2	6.4
Alternative B	9.4	5.5
Alternative C	8.8	5.7



The second MOE evaluated is Change in Average Person Travel Time Delay by Alternative. This MOE is a measure of the average delay, in minutes, for each person who travels through the MD 355 BRT corridor and includes delay on side streets.

The data in **Table 4-10** shows that average delay per person would change only slightly between the No-Build Alternative and the three BRT Alternatives, meaning, on average, that the implementation of BRT would not result in a major increase in delay for a person moving through the MD 355 corridor network. This reflects the findings shown in **Tables 4-8 and 4-9**.

Table 4-10: Average Person Travel Delay (in minutes)

Alternative	AM	PM
No-Build Alternative	3.0	3.0
TSM Alternative	3.0	3.0
Alternative A	3.0	3.6
Alternative B	3.6	3.6
Alternative C	3.6	3.6

The final MOE related to this objective is Intersection Performance along the Corridor. The *Traffic and Ridership Forecasting Analysis Summaries* included in **Appendix E** contain detailed data on intersection performance for each signalized intersection along the entire MD 355 alignment. A summary of the results is summarized here.

- AM Peak intersection LOS would remain relatively unchanged compared to the No-Build Alternative, with the greatest impacts occurring in the Alternative B. Less than five percent of the intersections evaluated would deteriorate to a failing LOS (LOS E or F).
- In the PM peak, LOS would degrade for the Alternatives B and C. The Increase in delay is between four and six minutes across 77 intersections within the corridor.
- Additionally, there would be some localized reduction in delay in each of the BRT alternatives due to intersection improvements.

5 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter presents the existing socioeconomic, cultural, and environmental conditions of the resources in the study area and the potential impacts of the No-Build and Build Alternatives. Additional detail, data, and information may be found in the following technical reports and memoranda:

- *Greenhouse Gas Emissions Technical Memorandum,* **Appendix F**
- *Noise Technical Memorandum,* **Appendix F**
- *Community Effects Technical Report,* **Appendix H**
- *Cultural Resources Technical Report,* **Appendix I**
- *Hazardous Materials Technical Report,* **Appendix J**
- *Indirect & Cumulative Effects Technical Report,* **Appendix K**
- *Natural Resources Technical Report,* **Appendix L**

5.1 Introduction

There are a wide range of results from the socioeconomic, cultural, and environmental analysis completed as part of the project. As discussed in **Section 2.4**, these results are structured as MOEs, each of which is associated with a project Goal and Objective. The MOEs were developed as a means of measuring how well each alternative performed relative to the Goal and Objective with which the MOE is associated.

The remainder of this section is structured by each socioeconomic, cultural, and environmental-related Goal and Objective, describing how the MOE results provide insight on how well each alternative performs relative to each goal and objective.

5.2 Methodology

Data was primarily compiled from published sources, most significantly Maryland Department of Natural Resources and Maryland Department of Environment data and resource reports. Environmental and cultural resource geographic data sets were acquired from the Maryland Open Data portal, Montgomery County GIS Open Data, and other federal and state resource agencies. Natural and cultural resources were confirmed via a windshield survey; however, no field work was conducted during this project phase.

Potential impacts have been calculated using the LOD for the proposed alternatives. The LOD was developed for the Build Alternatives using the proposed pavement width, any necessary proposed pedestrian improvements, and grading behind the curb or pedestrian improvements. This LOD is used to quantify environmental impacts and serve as the proposed right-of-way line where it is located outside the existing right-of-way line.

In most locations, the LOD was offset ten feet behind the cut/fill line or retaining wall in order to accommodate drainage and construction easements. In some constrained locations, the offset was reduced to five feet to avoid or minimize impacts to adjacent properties.

More detailed information on the LOD and the roadside design options are included in the *Alternatives Technical Report* in **Appendix B**. Potential impacts were calculated using the LOD and are provided by alternative in this chapter.

As the study progresses, further avoidance and minimization efforts to reduce impacts will be investigated. MCDOT will work with environmental resource and regulatory agencies on refining the MD 355 BRT Recommended Alternative in a continuing effort to avoid and minimize project impacts, where practicable, in order to obtain necessary permits and approvals.

5.3 Goal: Support Sustainable and Cost-Effective Transportation Solutions

Objective: Minimize Impacts to Private and Public Property

5.3.1 Existing Land Use Affected Environment

Existing land use from a corridor perspective largely reflects historic urban and suburban patterns which were designed primarily in reaction to the post-war expansion of automobile transport and highway infrastructure. Within the southern segments of the corridor (generally between Bethesda and Shady Grove), medium to high density urban scale residential and commercial uses interspersed with large institutional uses are the dominant land uses. The density and scale of development becomes more suburban from Shady Grove north through Gaithersburg and Clarksburg, with some large protected natural areas along the Great Seneca Creek stream valley. Land use development and community growth has continued to place further demand on the highway network to support mobility While local and regional transit services have developed over the years, none of these efficiently serve the full extent of the MD 355 corridor. Transit improvements are vital to achieving transformative land use and community changes along the corridor.

5.3.2 Existing Land Use Effects

The No-Build Alternative would have no direct impact on existing land use beyond what is already programmed and planned along the study corridor. No parcels would be impacted, and no right-of-way would be required as a result of the No-Build Alternative. In addition, the No-Build Alternative would not impact any existing parking or result in any indirect impacts such as changes to property access.

However, the No-Build Alternative is not consistent with master plan land use goals and objectives for the MD 355 corridor. The No-Build Alternative would not support planned future development patterns which envision higher-density mixed use transit-oriented development throughout the majority of the MD 355 corridor.

In most locations, the conceptual design would fit within the right-of-way set aside in the various master plans described in **Section 1.4.3**; however, much of this right-of-way is not currently dedicated for transportation use. As properties come before the Planning Board and other jurisdictions for development or redevelopment, the County will work with applicants to address master planned right-of-way needs and investigate design and acquisition strategies to accommodate the BRT system.

Construction of the Build Alternatives would have a range of impacts on corridor properties, with varying impacts on corridor parcels, parking areas, and access. Right-of-way requirements would also likely involve displacement of existing land uses for implementation of Alternative B and Alternative C.

Right of way needs that would result from the alternatives are summarized in **Table 5-1**. The total number of potential displacements that would result from the alternatives is included in **Table 5-2**. At this phase in the MD 355 BRT Planning Study, right-of-way needs are still preliminary. As the study progresses, further avoidance and minimization to reduce property impacts will be investigated.

Table 5-1: Potential Right-of-Way Needs (Acres)

	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative C
Residential Impacts (acres)	0.0	0.16	3.88	17.05	11.77
Commercial Impacts (acres)	0.0	0.19	8.51	43.78	26.78
Total Impacts (acres)	**0.0**	**0.35**	**12.39**	**60.83**	**38.55**

Table 5-2: Potential Displacements

	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative C
Residential displacements	0	0	0	4	1
Commercial displacements	0	0	0	24	11
Total displacements	**0**	**0**	**0**	**28**	**12**

Right-of-way needs would typically involve small sliver areas of property and would not substantially alter existing community character or future land use objectives throughout the corridor. Property displacements would predominantly affect commercial properties.

Existing parking would also be impacted by the right-of-way needs of the Build Alternatives. **Table 5-3** summarizes the acres of parking impacts impacted by the alternatives.

Table 5-3: Surface Parking Impacts (Acres)

	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative C
Acres of Surface Parking Impacted	0	0.02	0.26	8.21	4.98

Similar to the overall property impacts, effects on parking would generally involve small areas from numerous locations in predominantly commercial properties and car dealerships. Many of the affected commercial complexes currently have excess parking available within their properties, so that loss of parking due to roadway widening to accommodate the BRT would not be anticipated to present a substantive impact.

Indirect property impacts include changes to a property such as closure of an access point. **Table 5-4** summarizes the indirect property impacts for the alternatives.

Table 5-4: Indirect Property Impacts

	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative C
Closure of Access Point	0	0	0	4	10

Where existing access may be impacted, future design would determine alternatives for access replacement to minimize impacts. Alternative access strategies may involve reorientation of existing access points, use of shared driveways, enhanced signage, and turning lane or signalization measures.

5.4 Goal: Support Planned Development

Objective: Increase Trips by Transit to Master Planned Developments

The MOEs related to this goal focus on providing transit service improvements along MD 355 that would provide conditions to allow value-capture from public and private investments such as TODs. Benefits of TODs may include increased ridership, joint development opportunities, increases in the supply of affordable housing, and returns on investment to those who own land and businesses near transit stops.

5.4.1 Future Land Use Affected Environment

Development density and character throughout the corridor is generally planned to increase based on master plan goals, which considers implementation of the MD 355 BRT system as a key community improvement to accomplish broad TOD objectives. To the south, redevelopment and refocus of development design on mixed-use, transit-oriented use is consistently identified as encouraging renewal of older, established urban/suburban communities. Northern portions of the corridor have been more recently established and are seeing new developments that embody transit-oriented design principles in recognition of future enhanced transit service.

5.4.2 Future Land Use Effects

5.4.2.1 Transit Ridership to Planned Developments

Enhanced transit would be a benefit both for residents as well as the businesses and communities along the MD 355 Corridor. The number of people projected to use transit to access planned developments

along the corridor was calculated for each alternative and is shown in **Table 5-5**. Planned developments were identified based on each of the Area Sector plans developed for locations along the corridor. The number of people going to planned developments was projected through the travel demand forecasting process.

Table 5-5: Transit Trips to Planned Developments

	No-Build Alternative	TSM Alternative	Alternative A: Mixed Traffic	Alternative B: Median	Alternative C: Curb
Germantown	5,500	6,200	7,100	7,100	6,900
Great Seneca	11,000	11,200	11,600	11,500	11,500
Shady Grove	2,100	2,100	2,200	2,200	2,200
Twin-brook	2,800	2,800	3,000	3,000	3,000
White Flint	4,500	4,700	5,100	5,100	5,000
Total	**25,900**	**27,000**	**29,000**	**28,900**	**28,600**

A second objective under this goal is to *Select station locations that support infill and redevelopment*. There are two MOEs that support this objective.

5.4.2.2 Projected Commercial Development Increase in the Study Area Due to BRT

Statistical modeling using inputs from previous property transactions and developments to project the likely impact on the pace and extent of growth in the MD 355 BRT Corridor was conducted to anticipate commercial development impacts as a result of the proposed MD 355 BRT.

The analysis found that over the next 20 years, the "natural" amount of growth, or the growth that would happen absent any significant investment in BRT, that would occur within the study area is 28 million square feet of additional commercial space. This equals 1.4 percent growth in the amount of commercial space per year. If the BRT were to be constructed, the model projected that it would lead to an additional 1.2 million square feet of commercial development over 20 years, which is an additional 0.05 percent of development in the study area each year.

This analysis suggests that the MD 355 Corridor is likely to undergo significant commercial development over the next 20 years regardless of whether the BRT is constructed or not. While 1.2 million square feet of commercial development is significant, it is a relatively small amount compared to the total amount of commercial development expected. This indicates that BRT would play a more integral role in accommodating commercial growth along the corridor that is likely to happen anyway, by providing ways for people to access new jobs and commercial spaces that would contribute fewer *additional* cars to the roadways and would require construction of fewer parking facilities, and that its direct impact in terms of causing additional commercial growth is relatively low.

5.4.2.3 Projected (2040) Population and Employment Within a Half-Mile Walking Distance of BRT Stations or High Frequency Bus Stops

Current and planned development along the MD 355 Corridor will impact the future success of BRT or high frequency bus, and vice versa. The projected population and employment in 2040 within a half-mile walkshed of BRT stations or high frequency bus stops was calculated for each alternative and is shown in **Table 5-6**. The population and employees within walking distance of BRT or high-frequency bus service in 2040 would increase under all of the Build Alternatives. Alternative B would experience the largest increase of about 36,100 compared to the No-Build Alternative.

Table 5-6: 2040 Population and Employment within Half-Mile Walksheds of all BRT Stations or High Frequency Bus Stops

	No-Build Alternative	TSM Alternative	Alternative A: Mixed Traffic	Alternative B: Median	Alternative C: Curb
2040 population projection	20,100	26,400	26,900	27,000	26,200
2040 employment projection	57,700	79,300	80,400	81,100	78,800
Total 2040 population + employment	**77,800**	**105,700**	**107,300**	**108,100**	**105,000**

5.5 Goal: Support Sustainable and Cost-Effective Transportation Solutions

Objective: Minimize Environmental Impacts

5.5.1 Cultural Resources

Cultural resources, defined as properties that are listed or eligible for listing on the National Register of Historic Places (NRHP), are evaluated pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended. Resources on or eligible for the NRHP are those that are associated with events, activities, or persons of historic significance; embody distinctive characteristics of an architectural, engineering, or construction type, period, or method that represent the work of a master or possess high artistic values; or those that have or may be likely to yield important information on history or prehistory.

Cultural resource studies including an architectural survey and a Phase IA archaeological reconnaissance were conducted to identify cultural resources on or potentially eligible for listing in the NRHP. More detailed information on the cultural resource analysis can be found in the *Cultural Resource Study Technical Report*.

5.5.1.1 Architectural Survey

The architectural study consisted of a windshield survey of architectural resources 48 years in age and older within an area of potential effects (APE), defined as 250 feet on both sides of the road centerline. Resources were only documented that could be observed from the public right-of-way. A total of 202 above-ground resources 48 years in age and older within the architectural APE were recorded during this study. As a result of the survey, six resources are recommended to be eligible for listing in the National Register of Historic Places (NRHP) and are shown in **Figures 5-1 through 5-6**:

- Neelsville Presbyterian Church (M: 19-5)
- Cider Barrel (M: 19-33)
- Clarksburg Heights (M: 13-61)
- Grace United Methodist Church (M: 21-164)
- Phillips Service Station (M: 26-68)
- Little Tavern (M: 35-14-3)

Resources considered eligible for listing in the NRHP are afforded consideration and protection when federal actions may impact those resources. Future development of the MD 355 BRT project is anticipated to seek funding through the Federal Transit Administration (FTA) and therefore consideration of effects on resources eligible for the NRHP must be considered in the applicable federal decision making regarding the potential award of funding.

Figure 5-1: Neelsville Presbyterian Church (M: 19-5)

Figure 5-2: Cider Barrel (M: 19-33)

Figure 5-3: Clarksburg Heights (M: 13-61)

Figure 5-4: Grace United Methodist Church (M: 21-164)

Figure 5-5: Phillips Service Station (M: 26-68)

Figure 5-6: Little Tavern (M: 35-14-3)

5.5.1.2 Archaeological Survey

A Phase IA archaeological reconnaissance of the project alternatives was completed within a focused archaeological APE extending 25 feet from the edge of the pavement on both sides of the existing roads. The survey involved visual inspection and photographic documentation of the archaeological APE, which revealed disturbance throughout much of the archaeological APE.

5.5.1.3 Cultural Resource Effects

The No-Build Alternative and TSM Alternative would have no effects on cultural resources as these alternatives would have no direct impacts that would physically affect structures or properties or the visual/historic setting of historic resources.

Impacts to historic architectural resources considered all of the 202 structures identified, which may have importance to local or county history. Six corridor resources have been designated, through coordination with the Maryland Historic Trust (MHT) as having national importance and eligible for inclusion in the NRHP.

For the Build Alternatives, direct and indirect impacts to cultural resources would include partial right-of-way impacts (direct impacts) affecting the historic resource property and/or structure and potential access or visual effects (indirect impacts) for architectural properties **(Table 5-7 and Table 5-8)**.

Table 5-7: Potential Number of Historic Architectural Properties Directly Impacted by Each Alternative

Alternative	Number of Architectural Property Impacts	Number of NRHP Eligible Property Impacts
No-Build	0	0
TSM	0	0
A	24	0
B	24	0
C	28	0

Table 5-8: Potential Number of Historic Architectural Properties Indirectly Impacted by Each Alternative

Alternative	Number of Architectural Property Impacts	Number of NRHP Eligible Property Impacts
No-Build	0	0
TSM	0	0
A	27	0
B	26	0
C	30	0

As design advances, more detailed assessment will be necessary to determine the specific impacts to each site. As previously noted, final design activities will include efforts to avoid and minimize direct and indirect impacts to historic properties along the corridor. Depending upon the timing of the final design phase, additional historic architectural resource evaluations may be necessary as more structures would meet the 48-year old threshold for National Register of Historic Places (NRHP) consideration.

Areas of potentially intact soils were inventoried along the APE as indicative of locations where undisturbed archaeological features could be present. Along Segments 1 through 6, where the alternatives share the same alignment, 8.5 acres of potentially intact soil were identified. In Segment 7, Alternative A would include approximately 8.8 acres of intact soil, Alternative B would include approximately 29.0 acres, and Alternative C would include approximately 16.2 acres of intact soils.

Depending on final design of study alternatives, potentially impact soils areas in Segment 7 may require Phase IB archaeological survey pending consultation with the MHT. The probability of discovering archaeological sites within the study area appears greatest along the proposed route of Observation Drive in Segment 7. The MD 355 BRT project would ultimately use Observation Drive as part of its travel path under Alternative B; however, completion of this currently unconstructed roadway connection is not a part of this proposed action and would be completed by others.

5.5.2 Natural Resources

The following information is summarized from the *Natural Resources Technical Report* in **Appendix L**. Potential environmental resource impacts have been calculated using the LOD for the proposed alternatives. The No-Build Alterative is not expected to result in any impacts to natural environmental resources; therefore, impacts resulting from the No-Build Alternative are not detailed in the summary that follows.

5.5.2.1 Topography and Geology

Affected Environment

The study area is located within the Piedmont Plateau physiographic region characterized by gently rolling terrain of low relief. Within the study area, elevations generally range from approximately 240 to 640 feet above mean sea level. Topography is generally level to moderately rolling, with lower elevations typically found in the southern extent and surface elevations generally rising to the highest elevations in the study area near Clarksburg. Areas of steep slope are generally limited to stream valley areas.

Topography and Geology Effects

The proposed alternatives would entail only limited excavation in certain segments for roadway widening or conversion of median areas. Therefore, no impacts to geology are projected and study area geology would not pose constraints on proposed construction activities and uses.

5.5.2.2 Soils

Affected Environment

Prime farmland and soils of statewide importance support the production of food and similar crops in Maryland. Conversion of these soils to non-agricultural use as part of a major federal action must consider compliance with the federal Farmland Protection Policy Act (7 U.S.C. 4201 et seq).

Soils Effects

Table 5-9 summarizes the impacts to prime or statewide important farmland soil.

Table 5-9: Prime or Statewide Important Farmland Soil Impacts

	TSM Alternative	Alternative A	Alternative B	Alternative C
Prime Farmland Soil (acres)	0	216.3	196.4	200.1
Statewide Important Soil (acres)	0	95.5	81.1	81.0
TOTAL (acres)	**0**	**311.8**	**277.5**	**281.1**

Impacts of the Build Alternatives would need to consider compliance with the federal Farmland Protection Policy Act and coordination with the NRCS if farmland soils are proposed to be converted to non-agricultural use in areas where those soils are not already committed to urban use. However, the vast

majority of the LOD is already converted or planned and zoned for urban development. The entire study area is also part of the Census-designated Washington, DC-VA-MD Urbanized Area. Those lands identified as "urbanized area" are not considered as farmland under the statute and therefore the FPPA would not apply to the proposed improvements.

5.5.2.3 Surface Water Resources and Water Quality

Communities depend on clean and reliable water for domestic use, agriculture, industry, and other economic benefits. Additionally, streams and adjacent land corridors offer aesthetic and recreational value for residents and provide habitat for fish and wildlife.

Protection of surface waters and water quality in urban and developing areas such as the MD 355 BRT Corridor is strongly correlated to the management of runoff from impervious surfaces (parking lots, rooftops, roadways, and other infrastructure). The design of transit improvements must consider both the flow or volume of runoff from urban areas and the potential pollutants which may ultimately be transported into streams or lakes.

Affected Environment

The MD 355 BRT Corridor lies within portions of four watersheds: Cabin John Creek, Rock Creek, Seneca Creek, and the Potomac River. Water quality issues in these watersheds include elevated levels of suspended solids, phosphorus, and bacteria.

Surface Water and Water Quality Effects

The No-Build Alternative and TSM Alternative would not adversely affect water quality.

Effects of the Build Alternatives on water resources would be predominately within the Seneca Creek watershed where the majority of roadway widening is proposed. The primary water quality issue within this watershed is total suspended solids.

Construction stage impacts on water resources would be primarily related to protection of water quality through implementation of best management controls to minimize erosion and sedimentation potential and construction vehicle and fuels management.

Operations of the Build Alternatives would include stormwater management facilities which would manage runoff from the additional impervious surface coverage and would use environmental site design principles to prevent soil erosion and suspended sediment loadings in receiving streams within the watershed.

5.5.2.4 Hydrogeology and Groundwater

Affected Environment

The study area is generally underlain by unconfined/water-table aquifers and locally-occurring limestone aquifers, fed from rain/snowfall. Groundwater wells in this region are drilled to a few hundred feet deep. However, unconfined aquifers in the piedmont region are more susceptible to drought. Well yields are

low and can flow typically only a few gallons per minute. At the northern end of the proposed BRT corridor, a sole source aquifer — the "Piedmont (Maryland Piedmont) Aquifer Montgomery, Howard, Carroll Counties SSA 30" — is designated by the U.S. EPA. Sole source aquifers area defined as an aquifer that supplies at least 50 percent of the drinking water for its service area and there are no reasonably available alternative drinking water sources should the aquifer become contaminated. The SSA-30 aquifer is located north of the MD 355 intersection with MD-118/Germantown Road in the northern extent of the study area.

Hydrogeology and Groundwater Effects

The No-Build and TSM Alternatives would not involve any construction or changes to the natural environment. As a result, environmental effects to hydrogeology or groundwater resources are not anticipated.

Under the Build Alternatives, there would be no permanent effects on hydrogeology and geology. Potential temporary effects from construction activities, including excavation grading, would be addressed through erosion and sediment controls to protect groundwater aquifers. Compliance with the requirements of the federal Safe Water Drinking Act through Sole Source Aquifer review would need to be completed with EPA Region 3 during future project development phases. This review would ensure that the proposed transportation project does not pose a substantial quality or quantity threat to the aquifer and drinking water supplies.

5.5.2.5 Wetlands

Wetlands are highly productive and biologically diverse natural habitats that enhance water quality, help to control erosion, filter stormwater runoff, and provide important wildlife habitat. Maryland Department of Natural Resources non-tidal wetland mapping resources were used to identify existing wetlands within the study area.

Affected Environment

Wetlands and waterways in the study area corridor, outside of protected stream valley areas, have generally been influenced to some extent by development and are not considered to be high quality resources. Approximately 1.2 to 1.3 acres of palustrine wetlands are located along the study alternatives and each of the alternatives cross approximately 0.35 acres of riverine wetlands.

Wetland Effects

No impacts to wetland resources are anticipated with implementation of the No-Build and TSM Alternatives as no physical changes or improvements would be constructed.

Under the Build Alternatives, palustrine wetlands may be permanently impacted through encroachment of construction and temporarily from construction activities in the vicinity of wetland resources, as shown in **Table 5-10**.

Table 5-10: DNR Wetland Impacts

Resource	TSM Alternative	Alternative A	Alternative B	Alternative C
Wetlands (acres)	0	0	0.15	0.08

Based on DNR mapping, the wetland potentially impacted under Alternative B and Alternative C is located in Segment 4 and is a palustrine wetland near Bohrer Park in Gaithersburg; however, based on aerial photography it appears there may be adequate space to avoid impact to this resource in later stages of design through alignment shifts or treatments such as retaining walls.

During future project development, wetland resources would be required to be field delineated in accordance with applicable USACE delineation guidance. Detailed impact assessment using refined design would then be used to avoid and minimize impacts to wetland resources.

If impacts to wetlands are unavoidable, applicable state and federal permits will be required. A federal Clean Water Act, Section 404 permit from the USACE would be required for the discharge of dredged or fill material into wetlands. State permits likely required would include a Nontidal Wetlands Permit, a Section 401 Water Quality Certificate, a Waterway Construction Permit. No impacts to the Germantown Bog are anticipated from the Build Alternatives, including Alternative B which would use Observation Drive.

5.5.2.6 Floodplains

Floodplains are areas adjacent to a stream that become inundated with water when the normal channel capacity of the water course is exceeded, and overtopping occurs, primarily during and after storm events. Floodplains provide an area to temporarily store flood water, reducing flood peaks and erosion potential for nearby developed areas. These same areas provide benefits for water quality by filtering stormwater runoff and soil erosion before entering surface and ground water sources. Wildlife are also drawn to the fertile soils and variety of habitats found in floodplains.

Affected Environment

100-year floodplains were identified using Flood Insurance Rate Maps (FIRM) and the corresponding GIS layer produced by the Federal Emergency Management Agency (FEMA). Nontidal floodplains are regulated at the state level by MDE. Should there be any disturbance to wetlands or waterways, including modifications to existing drainage structures, or disturbance within the FEMA designated floodplain, permits would be required from the MDE and the USACE.

Portions of the environmental study area either cross or border several floodplain areas, including Great Seneca Creek, Muddy Branch, and Rock Creek. These stream areas fall within the 100-year floodplain. None of these floodplains have regulated floodways in the portions that intersect the environmental study area.

Floodplain Effects

As no physical changes are proposed, the No-Build Alternative would not affect floodplain resources.

Potential floodplain impacts of the Build Alternatives are generally limited to the crossing of Great Seneca Creek in Segment 6.

Compliance with Executive Order 11998, Floodplain Management would be required if the Build Alternatives encroach on existing 100-year floodplains through fill activities. To comply with EO 11998, future design phases would need to consider methods to avoid and minimize floodplain impacts. Coordination with MDE would be necessary and an MDE Waterways Construction Permit would be required if physical impacts to floodplains are proposed. Impacts to the existing floodplains may be minimized by modifying the project design such as minimizing slope impacts, bridge, culvert, and crossing structures to maintain the current flow regime. **Table 5-11** summarizes the Build Alternative impacts to floodplain resources.

Table 5-11: Floodplain Impacts

	TSM Alternative	Alternative A	Alternative B	Alternative C
Floodplain Impact (acres)	0	0	0.73	0.57

5.5.2.7 Special Protection Areas

Montgomery County has identified Special Protection Areas (SPAs) within which the county requires additional consideration of resource protection measures to protect water quality, aquatic life, and wildlife habitat. Additionally, the state has implemented the Maryland Biodiversity Conservation Network (BIONET), which identifies and prioritizes areas of potential ecological importance.

Affected Environment

Two Montgomery County SPAs, the Ten Mile Creek SPA and the Clarksburg SPA, are located in the northern reaches of the study area located north of the MD 355 intersection with MD 27 (Ridge Road). The county's SPAs require protections beyond standard environmental laws, regulations, and guidelines for land development and certain uses.

The only highly significant BIONET area identified by the state is located in the northern part of the study area, generally analogous in location with the county SPAs.

Special Protection Area Effects

No impacts to SPAs or Maryland BIONET areas would be associated with the No-Build and TSM Alternatives

Activities and construction within Montgomery County SPAs are subject to stringent water resource protection measures, potentially including pre and post construction monitoring. Avoidance of SPAs,

including any regulatory buffers, must be considered in the future design of Build Alternatives. Where avoidance would not be possible, coordination with MDNR and Montgomery County Department of Environmental Protection would be required to evaluate minimization, and potentially, mitigation options. Impact consideration in these areas must also carefully consider temporary, construction-stage effects to protect sensitive habitats and natural conditions. While no special regulations are associated with the BIONET resources, consultation with MDNR should continue through future design activities to further characterize potential resource concerns and evaluate options for minimization.

5.5.2.8 Vegetation and Wildlife

Terrestrial habitats in the study area include large unfragmented forest tracts along stream valleys, with small, fragmented patches of forest cover and generally ornamental land cover (e.g. grasses, shrubs, specimen trees) found throughout the more developed portions of the corridor. Wildlife species in the study area are generally those considered common and adaptable to urban development within Maryland.

Affected Environment

Natural vegetation within the study corridor is generally found predominately along protect stream corridors, especially the Great Seneca and Little Seneca stream valleys. Large forest habitats are most often found in the northern portion of the study area, north of MD 124/Quince Orchard Road. These large forest areas are identified by the MDNR as potential forest interior dwelling species (FIDS) habitat, generally contiguous forest lands at least 50 acres in size. FIDS habitat is identified as a conservation concern throughout the state as development expands and fragments once large forest patches, adversely affecting wildlife species especially birds.

Vegetation and Wildlife Effects

No impacts to vegetation or wildlife would be associated with the No-Build and TSM Alternatives

No impacts to FIDS forest lands or important habitat areas are anticipated from construction of the Build Alternatives, although individual trees may be impacted along existing roadways to accommodate widening or station placement.

Future design phases will require forest stand delineations to provide detailed consideration of impacts in accordance with the Maryland Forest Conservation Act, the Montgomery County Forest Conservation Law, and the Maryland Roadside Tree Law.

5.5.2.9 Rare, Threatened, and Endangered Species (RTE)

Protection of rare, threatened, and endangered species and their habitats is a shared concern among federal, state, and county resource agencies. Federally listed species under the Endangered Species Act (16 U.S.C. 1531) are protected under both federal and state regulations, while state-listed species are only protected under state regulations.

Affected Environment

One threatened species, the Northern Long-eared bat was identified by the U.S. Fish and Wildlife Service as potentially affected by the proposed action. However, as the Build Alternatives would not involve 15 acres or greater of tree clearing and no known hibernacula or maternity roosts are documented in Montgomery County, the proposed action may affect, but is not likely to adversely affect northern long-eared bat.

Maryland DNR Sensitive Species Project Review Areas (SSPRA) represents the general location of documented rare, threatened and endangered species. These areas incorporate various types of regulated areas under the Critical Area Criteria and other areas of concern statewide, including: Natural Heritage Areas, Listed Species Sites, Other or Locally Significant Habitat Areas, Colonial Waterbird Sites, Nontidal Wetlands of Special State Concern, and Geographic Areas of Particular Concern.

Along Alternative A and Alternative B, a SSPRA is located between MD 355 and I-270 and their intersections of Ridge Road and Germantown Road/MD-118, comprised of a resource known as the Germantown Bog. The Germantown Bog is considered a Nontidal Wetland of Special State Concern and may contain threatened plant species such as the Buxbaum's Sedge, Canada Burnet, and Swamp Oats.

Table 5-12: Number of Rare, Threatened, and Endangered Species

	TSM Alternative	Alternative A	Alternative B	Alternative C
Number of Rare, Threatened, and Endangered Species (federal/state)	0/0	0/1	0/1	0/0

Rare, Threatened and Endangered Species Effects

No effects on rare, threatened or endangered species would be generated by implementation of the No-Build and TSM Alternative.

No impacts to rare, threatened and endangered species are anticipated from construction and operation of the Build Alternatives. While the proposed BRT system under Alternative A and Alternative B would use Observation Drive, no physical improvements associated with the MD 355 BRT project are proposed in the area adjacent to the Germantown Bog.

Potential effects on rare, threatened, and endangered species would need to be further evaluated through coordination with the U.S. Fish and Wildlife Service and the MDNR during subsequent project development stages. Effects on these species of concern would be closely tied to identified impacts on surface waters, wetlands, terrestrial vegetation, forests, or other special resource lands which may provide suitable habitat. Potential permanent impacts to species or habitats would require additional survey and study to fully characterize impacts and potential mitigation measures. Temporary impacts

related to construction activities can typically be managed through use of BMPs, proper erosion and sediment controls, and time-of-year or other activity restrictions.

5.5.2.10 Land and Forest Conservation and Green Infrastructure

Forest conservation easements provide protection of forest lands on private property, typically put in place as required mitigation for development projects under the Maryland Forest Conservation Act of 1991.

Maryland Green Infrastructure is a planning tool designed to further consideration of natural area and identify potential mitigation locations for promoting ecological conservation at a regional scale. Green infrastructure lands include hubs (large, unfragmented habitat areas), corridors (linear remnants of natural land that connect hubs), and gaps (developed areas). While hubs provide important habitat to native plants and animals, corridors allow movement of animals, seeds, and pollen to support long-term survival and diversity. Many of these hubs, and especially corridors, follow stream valleys

Affected Environment

Maryland forest conservation easements are located within the study area adjacent to or abutting the MD 355 corridor. Most of the conservation easements are located north of the intersection with MD 118/Germantown Road. The conservation easements are generally co-located with residential and commercial development areas and lay along existing riparian corridors.

Within the study area, both green infrastructure hub and corridor areas are found near Little Seneca Creek, Great Seneca Creek, Muddy Branch, and Rock Creek. The major gap location is identified in the northern part of the study area involving the North Germantown Greenway Stream Valley Park and Little Seneca Creek.

Forest Conservation and Green Infrastructure Effects

The No-Build and TSM Alternatives would have no impact on Maryland Green Infrastructure resources or forest conservation easements.

The Build Alternatives would avoid impacts to forest conservation easements. Each of the Build Alternatives may have an impact on identified Maryland Green Infrastructure components but are not anticipated to have a substantial adverse effect. Green infrastructure components highly correspond with natural resource areas of concern which typically have a regulatory or other specific legal consideration. Consideration of Green Infrastructure is non-regulatory but provides an additional basis for developing potentially multi-value mitigation strategies.

5.5.3 Publicly Owned Public Parks and Recreational Facilities

Public parks and recreational facilities are important community resources and are afforded protection under Section 4(f) of the federal Department of Transportation Act of 1966. Under this Act, federal transportation actions which “use” publicly-owned parks and recreation areas (in addition to other protected lands) cannot be approved unless there is no prudent and feasible alternative to using that land

and the project includes "all possible planning to minimize harm to the park or recreation area resulting from the use.

Additionally, public parks and recreation areas which were acquired or developed by State or local agencies using federal Land and Water Conservation Fund (LWCF) are protected under Section 6(f) of the Land and Water Conservation Fund Act of 1965. The Act prohibits the conversion of LWCF-funded property to a non-recreational use (e.g. transportation use) without the approval of the National Park Service and mitigation through replacement lands of equal value, location, and usefulness.

5.5.3.1 Affected Environment

Within the study area M-NCPPC manages ten parks, two are owned by the City of Gaithersburg, four by Rockville, and one, Seneca Creek State Park, is owned by the State of Maryland. Eight Recreation centers within the study area provide a variety of services for youth through elderly citizens.

5.5.3.2 Environmental Consequences

As shown in **Table 5-13**, Alternative A would have a minor impact to parks, and Alternatives B and C would have modest impacts to local parks, affecting about one acre each. These impacts would need to be further assessed during the next phase of design to determine the actual impact and identify potential mitigation.

Table 5-13: Acres of Public Park Land within the LOD

	TSM Alternative	Alternative A	Alternative B	Alternative C
Potential Park Impacts (acres)	0	0.08	1.08	0.94

5.5.4 Air Quality

Potential air quality benefits of the proposed MD 355 BRT system, in terms of reduced single-occupancy vehicle use and vehicle miles traveled (VMT), would be complemented by TOD patterns envisioned throughout the corridor for which the BRT system would serve as a development catalyst.

5.5.4.1 Affected Environment

Smart transit-oriented growth provides a host of environmental and social benefits, including helping to reduce VMT, fuel use, and emission of greenhouse gases (GHG). GHG primarily consist of carbon dioxide (CO_2) released into the atmosphere from the burning of fossil fuels.

While transit improvements provide direct benefits related to the use of BRT and other transit modes in lieu of driving private vehicles, the land use effects of enhanced transit service and resulting TOD land use changes help to reduce VMT, fuel use, and GHG emissions of even non-transit users by reducing typical

trip distances between homes, jobs, and shopping destinations and improving the appeal and efficiency of walking or bicycling.

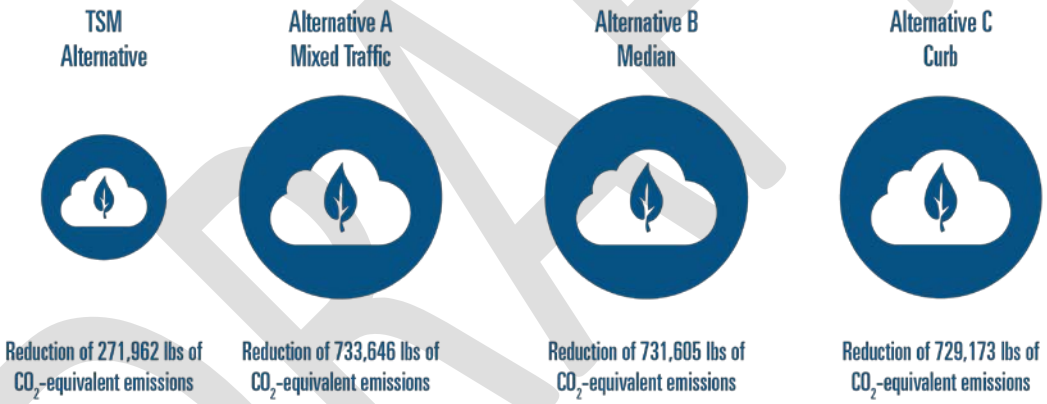
Within the Washington DC-VA-MD metropolitan urbanized area, existing transit services have been estimated to provide an overall 20 percent benefit, or reduction, in regional VMT with approximately 8.7 percent attributed directly to transit ridership and approximately 11.7 percent attributed to transit-oriented land use patterns.

5.5.4.2 Air Quality Effects

The No-Build Alternative would have no beneficial impact on air quality and would continue to promote conditions which increase vehicles miles traveled, congested conditions, and result GHG emissions.

Figure 5-7 summarizes the potential benefits of the TSM Alternative and Build Alternatives on regional GHG emissions, accounting for combined BRT ridership benefits and associated land use pattern benefits.

Figure 5-7: Air Quality Impacts



5.5.5 Noise

While the proposed BRT system would not be anticipated to significantly contribute to noise as much of the system would operate within existing transportation corridors, a screening level assessment of potential noise concerns was completed using the Federal Transit Administration (FTA) Noise Impact Assessment Spreadsheet tool.

5.5.5.1 Affected Environment

Assessment was focused on Alternative B and C where roadway widening would bring BRT operations or existing roadway traffic closer to receptors than existing conditions along portions of the alternative alignment. Existing noise levels (dBA) were conservatively estimated based on existing land use conditions. BRT activity was assumed to involve five peak hourly trips (day) and four hourly trips (night) traveling at 45 mph.

5.5.5.2 Noise Effects

The No-Build Alternative and TSM Alternative would have no impacts on ambient noise levels in the study area.

Each of the Build Alternatives may have minor noise impacts, especially in areas of higher density commercial development; however, commercial enterprises are not considered to be noise sensitive uses; these areas generally already experience elevated noise levels; and the contribution of the proposed BRT system would not be substantive. In areas where the BRT is proposed to operate in mixed travel conditions, no discernable noise effects are anticipated.

Under Alternative B, a moderate impact along the commercial corridor between Gude Drive and Shady Grove Road, especially on the northbound side where existing facilities are located less than 50 feet from the roadway, may be realized. However, as previously noted, commercial facilities are generally not considered to be noise-sensitive land uses and a moderate impact using the assessment does not indicate a noise impact above FTA threshold criteria.

While not specifically identified through the general assessment, the following locations have sensitive receptors and the noise environment at these locations is anticipated to be affected by roadway widening. Future detailed analysis is therefore warranted for:

- Segment 4 West Deer Park to Education Boulevard: Bohrer Park (Gaithersburg) and Caring Matters (a hospice center) are adjacent to southbound MD 355. Careful consideration of noise effects at this this location should carefully consider the appropriate land use category (either 1 or 3) to accurately address noise impacts.
- Segment 4 Ridgemont Road to Shady Grove Road: The King Farm Homestead and Community Garden is located along the southbound lanes of MD 355. Potential effects on the setting of this historic resource should be evaluated in future project phases.
- Segment 5 Summit Avenue to Fulks Corner Avenue: The St. Martin of Tours Church is located at 201 South Frederick Avenue in Gaithersburg and this community resource is approximately 25 from the edge of MD 355.

Further assessment must be completed during subsequent project development phases to provide detailed analysis of potential noise impacts. From a conceptual perspective, it appears that design flexibility may be available to reduce potential noise effects.

5.5.6 Hazardous Materials

Information on properties with hazardous materials was obtained through an Environmental Data Resources, Inc. (EDR) DataMap™ Environmental Atlas™ report and a desktop review of locations. The EDR Report provided results from over 100 federal, state, and tribal hazardous material databases, and historical topographic mapping.

5.5.6.1 Affected Environment

An examination of current and historical activities and conditions, and a review of local, state, and federal regulatory database records was made to complete a qualitative review and to evaluate certain locations along the MD 355 BRT Corridor that have a history of chemical usage and the potential that such usage may have impacted the soil and/or groundwater which may be encountered during the construction and operation of the project. No sampling or chemical analysis of soils, surface water, or groundwater was performed and no interviews with property owners or facility managers were completed. Generally, the screening encompassed the area within one-quarter mile from the centerline of the study alternatives. Additional distances were screened for certain types of potential hazards that may have a larger influence area (up to one mile) from the study alternatives.

5.5.6.2 Hazardous Materials Effects

Based on the findings of the EDR report and supplemental database and mapping information review, properties with potential hazardous materials concerns were ranked on their potential *to affect* or *be affected by* (i.e. influence) the proposed alternatives. The results are shown in **Table 5-12**. The number of potentially affected properties is nearly identical across all the alternatives. More detailed information can be found in the *Hazardous Materials Technical Report*.

Table 5-14: Potential Hazardous Materials (Potential for Influence)

Potential Issues (by Type)	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative C
Automobile Repair Facility	N/A	41	40	40	41
Drycleaner (Active)	N/A	7	7	7	7
Drycleaner (Inactive/ Historic)	N/A	23	24	22	23
MD SWCY	N/A	1	1	1	1
SWF/LF	N/A	1	1	1	1
UST Rank 1	N/A	39	36	35	39
Total potential hazardous materials locations	**N/A**	**112**	**109**	**106**	**112**

5.6 Goal: Improve Mobility Opportunities, Accessibility, and Transportation Choices

Objective: Improve Transit Services for Underserved Populations

5.6.1 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, calls on federal agencies to identify and address disproportionately high and adverse human health or environmental effects of federal programs, policies, and activities on minority and low-income populations. Federal actions associated with the proposed MD 355 BRT project may include future funding and permit decisions related to final design, construction, and operation. While

those decisions are specifically addressed in this *Corridor Summary Report*, environmental justice populations and potential effects have been considered during Phase 2 project development and design activities.

Under EO 12898, "populations" are an identifiable group or groups of persons living in geographic proximity who share racial/ethnic and/or low-income characteristics. Minorities include those who identify racially or ethnically as American Indian and Alaska Native, Asian, Black or African American, Hispanic or Latino, or Native Hawaiian and other Pacific Islander. Low-income populations exhibit household incomes at or below federally-defined poverty levels.

5.6.1.1 Environmental Justice Populations

Within the MD 355 BRT Corridor, populations within 0.5 mile of each alternative were analyzed to identify environmental justice populations using American Community Survey (ACS) data from the U.S. Census Bureau at the block group level, which is the smallest geographic unit for which Census data is reported. Within the 0.5-mile buffer of the Build Alternatives, there are 142 block groups. Minority and low-income findings for the MD 355 BRT Corridor were also compared to data for Montgomery County, the Washington D.C. metropolitan area, and the State of Maryland to provide a broader, regional baseline of environmental justice characteristics.

Block groups which exhibited a minority population of greater than 47.5 percent and/or block groups for which greater than 7.7 percent of the population was determined to be living below the U.S. Census poverty threshold were considered as potential environmental justice populations within the MD 355 BRT Corridor **(Figure 5-8)**. Within the corridor, 79 block groups were identified as meeting the minority population criteria and 43 block groups met the low-income criteria. Of those block groups, 31 met both minority and low-income criteria.

5.6.1.2 Environmental Justice Effects

At this stage of project development, environmental justice considerations were most applicable to the identification of BRT station locations to ensure equitable access along the corridor. The location of environmental justice populations was documented and influenced planning for the placement of BRT stations to ensure fair and equitable access. From a corridor perspective, the MD 355 BRT project is envisioned to provide beneficial transit service for environmental justice and all corridor residents, with improved access to employment opportunities and community services and facilities.

Tables 5-15 through 5-19 lists the number of low-income persons, minority persons, limited English proficiency persons, seniors (65+), and persons with disabilities within one half-mile of a BRT station for each alternative, respectively. This information will help inform future design efforts and focus environmental justice considerations while also showing that these key demographic groups also realize benefits through greater access to high frequency bus service.

Figure 5-8: Environmental Justice Characteristics

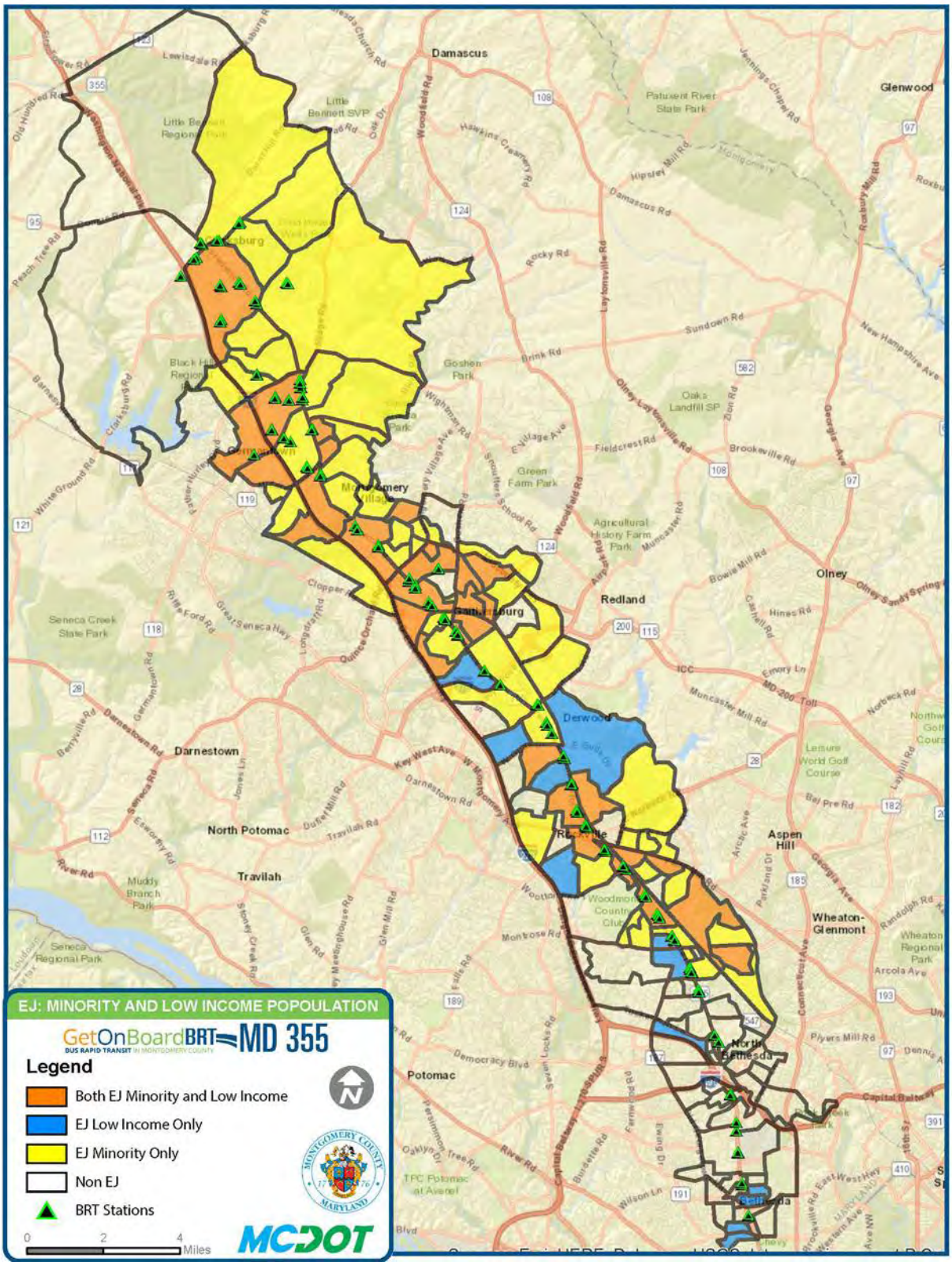


Table 5-15: Number of Low-Income Households within Half-Mile Walksheds of all BRT Stations or High Frequency Bus Stops

	No-Build Alternative	TSM Alternative	Alternative A: Mixed Traffic	Alternative B: Median	Alternative C: Curb
Number of low-income households	3,784	5,047	4,981	5,164	5,047

Table 5-16: Number of Minority People within Half-Mile Walksheds of all BRT Stations or High Frequency Bus Stops

	No-Build Alternative	TSM Alternative	Alternative A: Mixed Traffic	Alternative B: Median	Alternative C: Curb
Number of minority people	28,433	33,911	33,351	33,185	33,911

Table 5-17: Number of LEP Household within Half-Mile Walksheds of all BRT Stations or High Frequency Bus Stops

	No-Build Alternative	TSM Alternative	Alternative A: Mixed Traffic	Alternative B: Median	Alternative C: Curb
Number LEP people	2,376	2,862	2,855	2,888	2,862

Table 5-18: Number of Seniors within Half-Mile Walksheds of all BRT Stations or High Frequency Bus Stops

	No-Build Alternative	TSM Alternative	Alternative A: Mixed Traffic	Alternative B: Median	Alternative C: Curb
Number of Seniors (65+)	6,819	9,045	9,096	9,178	9,045

Table 5-19: Number of People with Disabilities within Half-Mile Walksheds of all BRT Stations or High Frequency Bus Stops

	No-Build Alternative	TSM Alternative	Alternative A: Mixed Traffic	Alternative B: Median	Alternative C: Curb
Number of people with disabilities	1,820	2,023	1,984	2,043	2,023

Environmental justice populations will continue to be considered in future project phases including design, construction, and operation. Final design activities will identify potential direct impacts on environmental justice communities related to project design and construction staging. Targeted outreach may be necessary to better understand potential effects to environmental justice populations and to identify ways to avoid or minimize so that effects to these communities are not disproportionate.

5.7 Goal: Improve Mobility Opportunities, Accessibility, and Transportation Choices

Objective: Enhance Pedestrian and Bicycle Connections and Options in the Corridor

5.7.1 Miles of Sidewalks Within One-Half Mile of the Corridor

Increased sidewalk accessibility within a half-mile has a positive impact on people's ability to access multimodal transportation options. The number of miles of existing sidewalk was quantified within a half-mile walkshed of BRT stations or high frequency bus stops for each alternative and is summarized in **Table 5-20**.

Table 5-20: Miles of Sidewalk within Half-Mile Walksheds of all BRT Stations or High Frequency Bus Stops

	No-Build Alternative	TSM Alternative	Alternative A: Mixed Traffic	Alternative B: Median	Alternative C: Curb
Miles of Sidewalk	137	239	236	233	237

5.7.2 Miles of Low-Stress Bicycle Facilities Within One-Half Mile of the Corridor

Low-stress bicycle infrastructure is defined by Montgomery County as infrastructure suitable for most skill levels of bicycle riders. An alternative with more miles of low-stress bicycle infrastructure provides greater accessibility for bicycle riders and more multimodal transportation options. The number of miles of low-stress bicycle facilities was quantified within a half-mile walkshed of BRT stations or high frequency bus stops, including proposed new low-stress bicycle infrastructure under each alternative. for each alternative and is summarized in **Table 5-21**.

Table 5-21: Miles of Low-Stress Bicycle Infrastructure within Half-Mile Walksheds of all BRT Stations or High Frequency Bus Stops

	No-Build Alternative	TSM Alternative	Alternative A: Mixed Traffic	Alternative B: Median	Alternative C: Curb
Miles of Bicycle Infrastructure	12.6	19.8	19.7	27.4	27.0

6 PUBLIC INVOLVEMENT

Public involvement for the project in Phase 2 included a series of Community Updates, Public Open Houses, and Community Advisory Committee (CAC) meetings. These efforts are a continuation of the public outreach that began in Phase 1, which included ten CAC meetings and two rounds of Open Houses. In addition, a new user-friendly website, www.RidetheFLASH.com, was created to educate the public about BRT and keep them up-to-date on project information. Additional details on public outreach events can be found in the *Public Outreach Summary* in **Appendix M**.

6.1 January - February 2018 Open Houses

The MD 355 project team held three public open house events on January 22, January 24, and February 1, 2018 to inform the public about the MD 355 Bus Rapid Transit (BRT) project and gather input and feedback on the alternatives presented as well as the study approach. Approximately 170 people attended the open houses. The following major themes and common topics emerged from the comments provided by open house participants:

- A desire for the project to be implemented quickly and/or strong support for the project
- Support for an alternative that includes dedicated lanes, and preference for Alternative B
- Timing of the project, costs, and the power source for the vehicles

6.2 June 2019 Open Houses

The MD 355 project team held two public open house events on June 26 and 27, 2019 to present the results of the engineering, travel forecasting, ridership analysis, and service planning to the public, and to gather their input on a Recommended Alternative and phasing and implementation. All materials were available online in a virtual open house to reach a broader audience. Members of the public were invited to provide responses to a web-based survey, which asked for opinions regarding respondents':

- Preferred alternative, by segment
- Priorities for phased implementation of the project (i.e., where they would like to see BRT implemented first)
- Preferred route (if any) the BRT should take in the Clarksburg area
- Priorities for BRT with respect to meeting broad goals such as reducing travel time and minimizing impacts; opinion (if any) on station locations identified in the Phase 2 Study
- Opinion regarding the potential for BRT to have a positive impact on their community

MCDOT received a total of 246 survey responses. The responses indicated that the majority of respondents would prefer a Recommended Alternative that includes dedicated lanes, with no clear favored option between median lanes (Alternatives B and B Modified) and curb lanes (Alternative C). The top priorities for BRT implementation amongst respondents were providing a fast and reliable trip as well as supporting the development of more livable and walkable communities.

6.3 Corridor Advisory Committees (CAC)

Upon the Montgomery County Council's approval of the Countywide Transit Corridors Functional Master Plan (2013), the Council called for the formation of a CAC for the MD 355 BRT Corridor Planning Study. CACs were established in Phase 1 to coordinate and monitor the progress of the project. Two CACs were initiated, split geographically, comprised of stakeholders representing the MD 355 study corridor. In Phase 2, the MD 355 South CAC was split into two due to the large number of stakeholders in the group, creating three CAC groups for this phase of the project.

The meetings covered a range of topics and provided residents, business owners, and interested stakeholders the opportunity to provide input, discuss study assumptions and methodologies, and to share information from the meetings with the community groups they represent. Presentations and other documents for each CAC Meeting can be found in **Appendix M.**

- CAC Meeting #11 – October 2017: Included an overview of the Strategic Plan for Phase 2, the public engagement process, project alternatives, and Goals, Objectives, and Measures of Effectiveness
- CAC Meeting #12 – February 2018: Included engineering of typical sections, service planning recommendations, and evaluation of station locations
- CAC #13 – June 2019: Included a presentation and discussion of results of the engineering, travel forecasting, and ridership analysis with respect to key MOEs

6.4 Community Updates and Industry Events

To help the public learn more about BRT in the County and the MD 355 BRT project, MCDOT and its project team and partners held 17 community events and attended five industry events in the larger Washington, DC region. The *Ride the FLASH* website listed the venues and times where MCDOT representatives would be present, and many of the events were advertised through the event organizers. These community events ranged from having a table at regular local events and a variety of community festivals, to setting up an information tent at transit stations during peak commute hours. The purpose of these events was to bring public attention to MCDOT's BRT projects and to reduce the burden on members of the public to attend project-specific events to receive information from MCDOT staff and provide feedback. Additionally, these events allowed MCDOT to record feedback from members of the public who are not typically well represented in public engagement processes. A total of 2,300 individuals participated in BRT outreach at community events.

6.5 Coordinating Partner Agency Meetings

The Project Team met regularly with government and agency partners affected by the project and who, in some cases, may have a role in the implementation of BRT service along MD 355. These meetings were considered a critical component of stakeholder engagement throughout the study. These coordinating partner agencies included: the Cities of Gaithersburg and Rockville, M-NCPPC, WMATA, and MDOT SHA and MTA.

7 ADDITIONAL ALTERNATIVE DEVELOPMENT AND ALTERNATIVES COMPARISON

7.1 Additional Alternative Development (Alternative B Modified)

Following the completion of the Alternatives Development, design modifications were developed for Alternative B (mostly median-running) in Segments 4 through 6 in an attempt to reduce costs and property impacts. This Alternative, called Alternative B Modified, would include a one-way peak direction guideway in the median of MD 355. The BRT service would operate in the single-lane guideway in the peak direction, and off-peak direction service would operate in mixed traffic. The off-peak BRT service would enter into short segments of dual-lane guideway to access the station platforms via a "bus box" (i.e., a short opening in the guideway separator) next to the left turn lane, shown in **Figure 7-1**. The off-peak BRT service would exit from the station area into mixed traffic via a short exit lane operating under coordinated signal control with the traffic signal at the station intersection. See **Figure 7-2** for a typical section of Alternative B Modified at a BRT station. A breakdown by segment is shown in **Figure 7-3** and detailed Plan Sheets for Alternative B Modified are included in **Appendix D**.

Figure 7-1: Alternative B Modified Bus Box

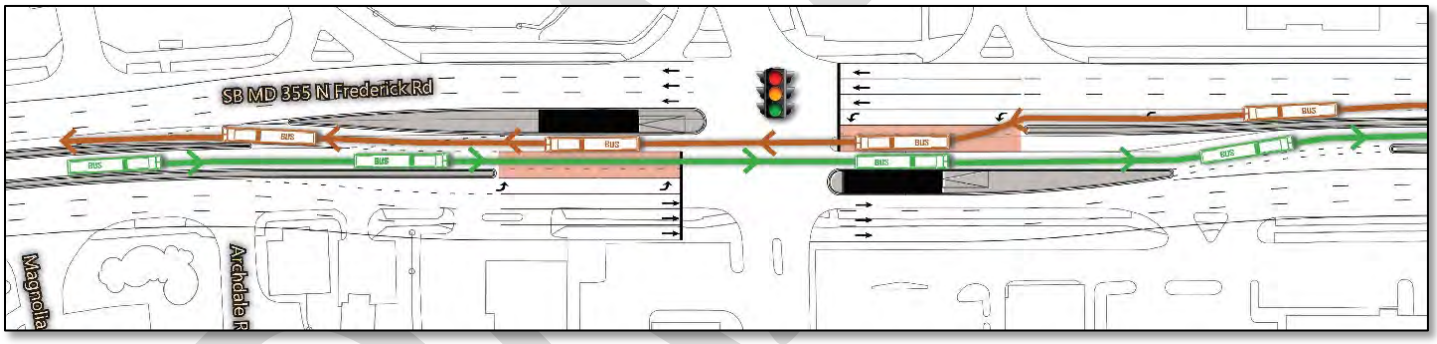


Figure 7-2: Alternative B Modified Typical Section

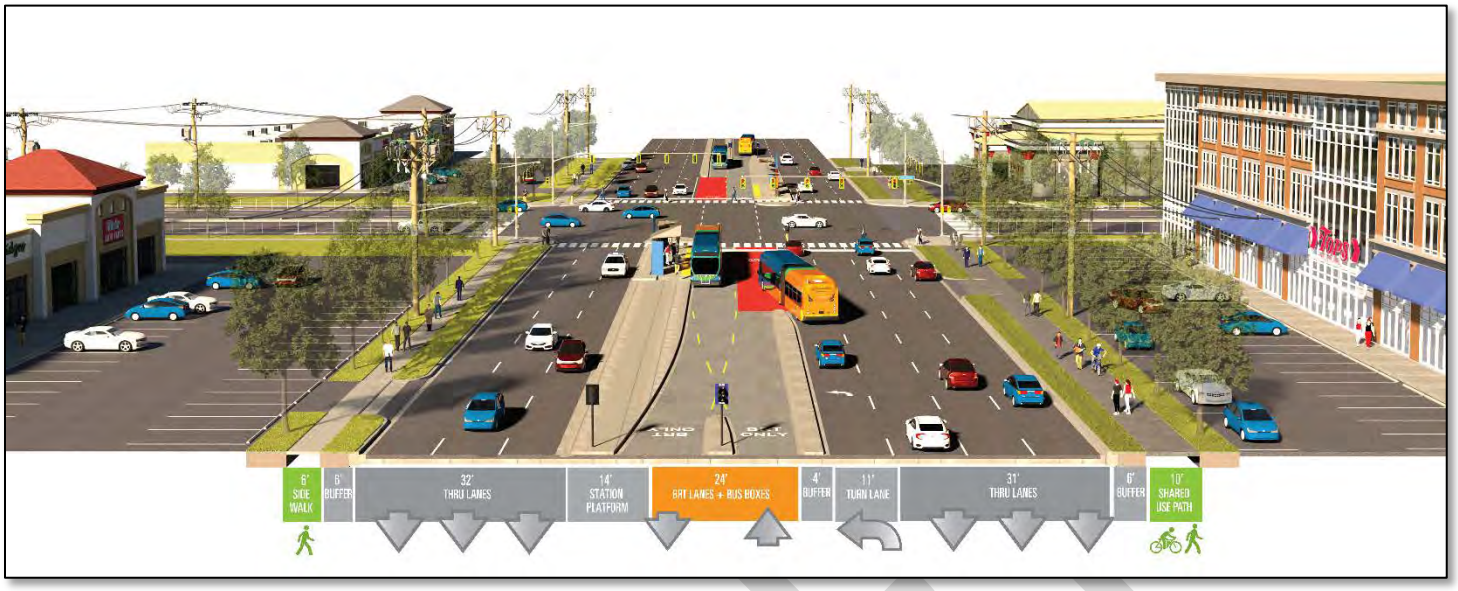
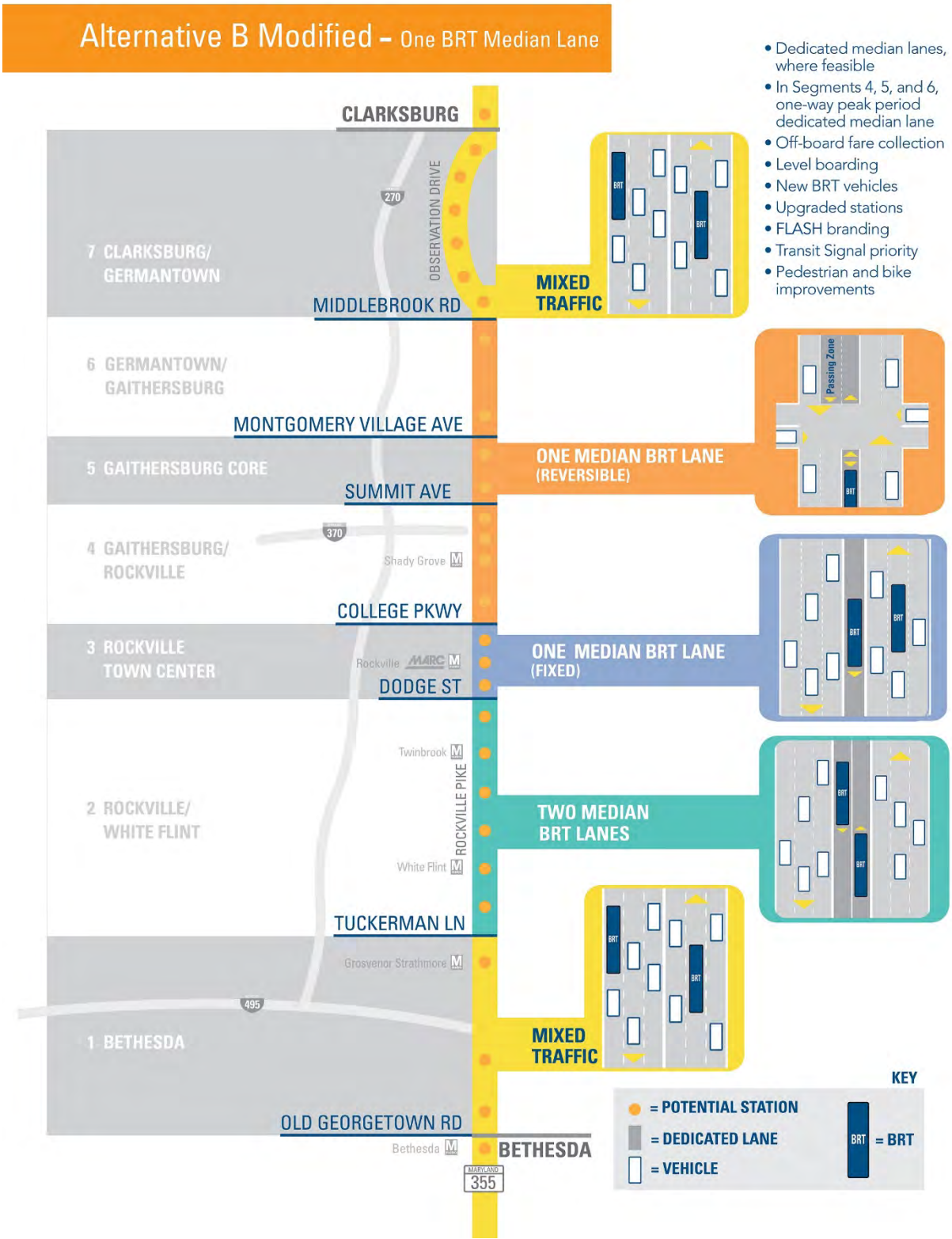


Figure 7-3: Alternative B Modified Segment Features



7.1.1 Traffic Modeling and Ridership Forecasting

In order to evaluate the effectiveness of Alternative B Modified, an assessment was conducted to determine whether running BRT service in mixed traffic in the off-peak direction would have a significant impact on BRT travel times such that there would be a potential impact on ridership relative to Alternative B. This assessment to evaluate potential impacts to travel time and ridership compared Alternative B off-peak direction travel times to off-peak direction travel times for Alternative A (mixed traffic) and Alternative C (mostly curb-running).

While the Alternative B off-peak direction travel times are not directly comparable to off-peak direction BRT travel times for Alternatives A and C, they are sufficiently close such that the Project Team determined that new model runs for Alternative B Modified were not required. Alternative B travel time and ridership numbers were used for Alternative B Modified when comparing the alternatives.

8 Summary of Results

Detailed MOEs that aligned with the goals outlined in **Chapter 2** were examined for the overall corridor for each of the alternatives. MOEs such as ridership and travel time, land use, environmental effects, and cost were used to compare the alternatives in each segment. These comparisons will inform the selection of a Recommended Alternative and the ultimate development of a recommended phasing and implementation plan.

8.1 Traffic Modeling and Ridership Forecasting

As discussed in **Chapter 4**, all of the BRT Alternatives – Alternatives A (mixed traffic), B and B Modified (mostly median-running), and C (mostly curb-running) – would improve accessibility for key demographic groups between housing, job, and activity centers. The BRT would not significantly impact existing traffic and would generate high ridership, with Alternative B experiencing the highest ridership, at approximately two times the No-Build Alternative. In addition, approximately 50 percent of the ridership would occur in the off-peak period.

Alternatives B, B Modified, and C would provide travel time savings over local bus, the TSM Alternative, and Alternative A. Alternatives B and B Modified would also offer an additional travel time advantage during more congested corridor conditions by providing a dedicated transit lane separate from general purpose traffic within portions of the corridor.

Alternatives B and B Modified are likely to have the greatest impact on traffic operations for the MD 355 corridor, because they would largely restrict left turns to signalized intersections and require the most significant modifications to traffic signal timings. However, the modeling indicates the overall impact of any of the Build Alternatives on traffic operations would be limited to a total of four to six minutes of additional traffic delay across the entire corridor (77 intersections combined). Most trips on MD 355 do not involve traveling the entire 22-mile corridor and the average increase in delay per person on MD 355 is forecasted to be less than one half minute.

A quantitative comparison of the transit and traffic operations of the alternatives retained for detailed study is summarized in **Table 8-1**. The 2040 transit and traffic operations projections were derived from the travel demand and ridership modeling and VISSIM analysis that were completed for each retained alternative, as explained in **Chapter 4**.

Table 8-1: Alternatives Comparison – 2040 Ridership and Traffic

Comparison Factors	No-Build Alternative	TSM Alternative	Alternative A	Alternative B and B Modified	Alternative C
Total Daily Transit Boardings by Alternative	75,300	83,100	87,400	91,900	89,400
New transit riders along the corridor	0	4,400	8,900	9,400	8,900
Transit mode share along the corridor					
From Study Area	8.3%	8.4%	9.0%	9.0%	9.0%
To Study Area	6.6%	6.7%	7.3%	7.2%	7.2%
From Montgomery County	8.3%	8.3%	8.8%	8.7%	8.6%
Transit travel time between key origin-destination pairs					
Clarksburg to Shady Grove	50	56	62	50	46
Clarksburg to White Flint	90	90	77	79	61
Germantown to Shady Grove	44	42	40	33	35
Lakeforest to Rockville	43	43	38	29	31
Lakeforest to Bethesda	53	53	46	42	43
White Flint to Bethesda	30	26	23	21	23
Rockville to Bethesda	57	42	40	36	39
Transit travel time reliability along the corridor (Percent of BRT Vehicles Separated from Vehicle in Front of It by Between 7 and 13 Minutes at Cedar Avenue) – AM Peak Period					
FLASH 2: Lakeforest to Grosvenor Metrorail Station	N/A	N/A	100%	100%	100%
FLASH 1G: Germantown Transit Center to Montgomery College - Rockville Campus	N/A	N/A	83%	96%	81%
FLASH 1C: Clarksburg to Montgomery College - Rockville Campus	N/A	N/A	84%	82%	95%
Transit travel time reliability along the corridor (Percent of BRT Vehicles Separated from Vehicle in Front of It by Between 7 and 13 Minutes at Cedar Avenue) – PM Peak Period					
FLASH 2: Lakeforest to Grosvenor Metrorail Station	N/A	N/A	92%	87%	93%
FLASH 1G: Germantown Transit Center to Montgomery College - Rockville Campus	N/A	N/A	82%	94%	88%
FLASH 1C: Clarksburg to Montgomery College - Rockville Campus	N/A	N/A	64%	96%	83%
Peak Period (AM & PM) Weekday Person Throughput					
1 – Cedar Lane	32,800	32,700	33,100	31,800	32,500
2 – Twinbrook Parkway	32,300	32,500	33,500	33,700	33,400
3 - N. Washington Street	27,800	28,500	28,100	29,700	28,300
4 – Shady Grove Road	30,800	31,600	31,300	35,300	32,100
5 – Chestnut Street	27,200	27,900	27,900	31,700	28,700

Comparison Factors		No-Build Alternative	TSM Alternative	Alternative A	Alternative B and B Modified	Alternative C
6 – Watkins Mill Road		25,900	26,100	27,100	29,000	27,900
7 – Ridge Road		19,700	20,400	20,300	20,700	22,800
Number of jobs accessible by transit within 30, 45, and 60 minutes for households in the corridor	30 45 60	130,900 395,500 832,300	131,100 397,100 836,100	139,400 414,100 864,900	140,300 414,400 860,600	139,700 414,700 863,000
Number of activity centers accessible by transit within 30, 45, and 60 minutes for households in the corridor	30 45 60	5.7 17.4 38.5	5.7 17.4 38.7	6.4 18.1 38.6	6.5 18.2 38.3	6.4 18.2 38.6
Number of households that can reach jobs in the corridor by transit within 30, 45, and 60 minutes	30 45 60	98,400 260,800 547,800	94,400 261,100 549,400	98,400 268,900 562,000	99,900 269,300 560,100	98,900 267,700 559,700
Number of households that can reach activity centers in the corridor by transit within 30, 45 or 60 minutes	30 45 60	387,500 789,700 1,383,900	385,100 789,100 1,382,400	385,100 793,300 1,391,000	385,100 793,700 1,381,300	385,100 793,300 1,383,900
Number of households that have access to BRT stations within ½ mile network distance		20,100	26,600	27,000	27,100	26,600
Number of miles of LOS E or F along the corridor						
Northbound		2.6	2.7	2.7	3	3.2
Southbound		7.6	9.4	8.1	8.4	5.9
Average Person Travel Delay (in minutes) (AM/PM)		3.0/3.0	3.0/3.0	3.0/3.6	3.6/3.6	3.6/3.6
Number of Intersections Operating at LOS E or F in Segments 1 through 6 (AM/PM)		16/14	17/14	13/14	20/24	15/23

8.2 Alignment Considerations

In Segments 1 through 6 all of the Build Alternative would operate primarily along MD 355. However, the alternatives would divert to serve major transit hubs such as Montgomery College – Rockville, Shady Grove Metrorail Station, and Lakeforest Transit Center. In Segment 7, all three alternative alignments serve the Germantown Transit Center. While these diversions would add travel time to the BRT routes, boardings at these stations were some of the highest on the corridor.

At the Shady Grove Metrorail Station, the BRT stations would be located at the intersection of Somerville Drive and the Metro Access Loop Road, which would require BRT riders transferring to and from Metrorail to walk approximately 900 feet to and from the Metro station entrance. Should WMATA reconfigure the existing parking and loop road in the future, MCDOT would work with WMATA to site the BRT station closer to the Metro station entrance.

The existing Lakeforest Transit Center is located to the east of Lakeforest Mall, approximately three-quarters of a mile from MD 355. Lakeforest Mall is largely vacant, and redevelopment of the site has been mentioned. Future plans to redevelop the Lakeforest Mall should include examination and strong consideration for shifting the transit center to the west, creating a shorter diversion for the BRT and placing the transit center closer to the activity along MD 355.

Potential park and ride lots were included in the ridership models at three locations: Lakeforest Transit Center, Milestone, and Clarksburg. The results showed that park and rides would support 900 to 1,800 daily BRT riders. 50 percent of boardings at Lakeforest Transit Center were park and ride users; 20 percent of boardings at Milestone were park and ride users; and 20 percent of boardings at Clarksburg were park and ride users. These results show that there is a need for park and ride services in these locations and more detailed park and ride design will be included in the next phase of design.

In Segment 7, there is no clear difference in the ridership numbers. Snowden Farm Parkway is the alternative alignment option that best serves existing and future development with the least contingencies. It is the current center of activity in Clarksburg and the only alignment that can be implemented in the near term, since MD 355 would require widening of the roadway north of Ridge Road (MD 27) by MDOT SHA, and Observation Drive has not yet been constructed between Waters Discovery Lane and Stringtown Road. However, selecting Snowden Farm Parkway does preclude the other alignments in the future.

8.3 Affected Environment

8.3.1.1 Right-of-Way Needs

Development of the alternatives has sought to reduce right-of-way needs as much as possible at this early stage of design by reducing buffers where necessary, reducing lane widths, and including retaining walls. However, each of the Build Alternatives require some degree of additional transportation right-of-way that results in a need for property acquisition in certain locations. The right-of-way requirements to construct each alternative are summarized in **Table 8-2**. Most of the property impacts involve partial parcel acquisition typically involving roadway frontage along MD 355.

Table 8-2: Potential Right-of-Way Needs

	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative B Modified	Alternative C
Property Impacts (Acres)	0	0.4	12.4	60.8	53.6	38.6
Relocations (number)	0	0	0	28	26	12

At this phase in the MD 355 BRT Planning Study, right-of-way needs are preliminary. As the study progresses through more detailed engineering stages, further avoidance and minimization strategies to reduce the necessary right-of-way will be investigated. It should be noted that in most locations, the

conceptual design would fit within the right-of-way set aside in the various master plans described in **Section 1.4.3**; however, much of this right-of-way is not currently dedicated for transportation use. As properties come before the Planning Board and other jurisdictions for development or redevelopment, the County will work with applicants to address master planned right-of-way needs and investigate design and acquisition strategies to accommodate the BRT system.

8.3.1.2 Environmental and Cultural Impacts

All of the Build Alternatives would result in minimal environmental and cultural impacts as discussed in **Chapter 5**. A comparison of the environmental impacts of the alternatives retained for detailed study are summarized in **Table 8-3**.

Table 8-3: Alternatives Comparison – Environmental Impacts

Comparison Factors	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative C
Cultural Resources					
Architectural Sites (number)	0	0	24	24	28
Indirect Impacts to Historic Sites (number)	0	0	27	26	30
Area of Potentially Intact Soil (archaeology) (acres)	0	0	17.3	37.5	24.7
Public Park Property Required (acres)	0	0	0.08	1.08	0.94
Natural Resources					
Prime or Statewide Important Farmland Soil Impacts	0	0	311.8	277.5	281.1
Stream Impact (linear feet)	0	0	0	0	0
100-Year Floodplain (acres)	0	0	0	0.73	0.57
Wetlands (acres)	0	0	0	0.15	0.08
Forests (acres)	0	0	0	0	0
Properties with hazardous materials present (number)	0	174	173	170	174
RTE Species (number)	0	0	1	1	0
Air Quality Benefits	0 lbs CO_2 reduction	271,962 lbs CO_2 reduction	733,646 lbs CO_2 reduction	731,605 lbs CO_2 reduction	729,173 lbs CO_2 reduction
Total potential hazardous materials locations	N/A	112	109	106	112

8.4 Alternative Cost Estimates

The Build Alternatives have a range of costs based on both the level of infrastructure investment and on the location along the corridor. The engineering and construction costs were developed from a major quantities estimate for each alternative, using the methodology outlined in the *MD 355 BRT Alternatives Technical Report* in **Appendix B**. The right-of-way cost estimates were developed based on land use and

zoning of corridor municipal jurisdictions and are based on the area of right-of-way required on each property. For property displacements, the right-of-way cost included the cost of purchasing the entire property and relocation costs.

A summary of the conceptual construction cost estimates is shown in **Table 8-4**. A breakdown of construction cost by segment can be found in the *Alternatives Technical Report* in **Appendix B**.

Table 8-4: Conceptual Construction Cost Estimates

	No-Build Alternative	TSM Alternative	Alternative A	Alternative B	Alternative B Modified	Alternative C
Construction	N/A	$4M	$113M	$517M	$475M	$290M
Right-of-Way	N/A	$1M	$29M	$332M	$309M	$207M
Vehicles	N/A	$10M	$43M	$37M	$37M	$37M
Total	**N/A**	**$15M**	**$185M**	**$886M**	**$821M**	**$534M**

Operating costs were developed based on the proposed BRT service plan and local bus service assumptions, shown in **Table 8-5**. They will continue to be refined as the project progress.

Table 8-5: BRT Operating Costs

Alternative	Number of Vehicles	Annual Revenue Hours	Annual Revenue Miles	Annual Estimated Operating Cost (2018 USD)
TSM Alternative*	18	100,800	1,241,500	$11M
Alternative A	49	284,300	3,902,800	$32M
Alternative B and B Modified	42	249,900	3,758,300	$28M
Alternative C	42	249,400	3,687,800	$28M

*This cost is in addition to existing Ride On extRa buses and operation costs

Annualized capital and operating costs per annual rider were developed for each Build Alternative based on FTA guidelines for the typical life for different project components. This is summarized in **Table 8-6**.

Table 8-6: Annualized Capital and Operating Costs per Annual Rider

	TSM Alternative	Alternative A	Alternative B	Alternative B Modified	Alternative C
Total Annual Capital and Net Operating Costs	$13M	$34M	$52M	$41M	$41M
Annual BRT Riders	3,816,800	7,737,600	9,282,000	9,282,000	8,626,800
Total Annualized Cost per Rider	$3.52	$4.54	$5.77	$4.57	$4.88

* Annual BRT Riders are Ride On extRa riders in the TSM alternative

The annualization of capital and operating costs provides the best cost comparison for the alternatives because it combines operational costs, capital costs, and ridership. Based on the comparison of annualized cost, a Build Alternative is justified.

8.5 Alternative Summary

Alternative B is the most expensive because it would involve the most roadway widening, right-of-way needs, and impacts to existing utilities and infrastructure. Alternative B would also provide the greatest separation of the BRT from general purpose traffic and roadway congestion, which would result in increased reliability, shorter travel times, and the highest ridership of any alternative. When compared with Alternative B, Alternative B Modified would reduce the overall project cost by $65M. It would also reduce the right-of-way needs by approximately 7.1 acres. The single-lane reversible guideway would provide separation from mixed traffic for BRT vehicles in the peak direction in Segments 4 through 6, thus providing similar reliability, travel times, and ridership as Alternative B in those Segments.

Alternative C includes roadway widening and costs to provide a dedicated transit guideway that could be shared by BRT and local bus service. The overall cost for Alternative C is significantly lower than Alternative B, but it would not provide full separation for the BRT from traffic using the curbside lane to turn at unsignalized intersections or driveways, therefore not providing the same reliability at Alternative B.

Alternative A is the least expensive BRT alternative because it would operate in mixed traffic and only require roadway widening at queue jump locations. However, because the BRT would operate in mixed traffic, Alternative A would experience the longest travel times and the least reliability when compared to Alternatives B, B Modified, and C.

9 RECOMMENDED ALTERNATIVE AND PHASING STRATEGY

9.1 Recommended Alternative

A review of the alternatives comparison on the segment level included in **Chapter 7** shows that, as anticipated, due to the varying characteristics of the existing conditions of each segment, none of the Build Alternatives achieves the project Goals and Objectives while minimizing costs and impacts for the full length of the corridor.

Following a presentation of the Phase 2 Study results to the Montgomery County Council Transportation and Environment Committee, the Montgomery County Council voiced a preference for BRT that provides the performance of Alternative B or B Modified while also further mitigating project impacts and costs. As the project advances in design, the project team will seek to minimize some of the costs and impacts associated with Alternative B or B Modified in order to increase the economic viability of this alternative.