MONTGOMERY COUNTY PLANNING DEPARTMENT
THE MARYLAND-NATIONAL CAPITAL PARK AND PLANNING COMMISSION

Memorandum

To: Montgomery County Planning Board Commissioners

From: David Anspacher, Supervisor, Functional Planning and Policy DA

Date: July 24, 2019

Subject: Revisions to MD 355 Bus Rapid Transit Corridor Planning Study Phase 2 Staff Report

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Glenn Orlin, staff to the County Council, has brought to staff's attention two errors in the staff report for the MD 355 Bus Rapid Transit Corridor Planning Study Phase 2 item dated July 11, 2019 and has asked to have them corrected. These errors are redlined on pages 25 and 26 of the corrected staff report.

MONTGOMERY COUNTY PLANNING DEPARTMENT
THE MARYLAND-NATIONAL CAPITAL PARK AND PLANNING COMMISSION

Corrected Report, July 23, 2019

MCPB
Item No. 14
Date: 07-11-2019

MD 355 Bus Rapid Transit Corridor Planning Study Phase 2

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Completed: 07/03/2019

RECOMMENDATIONS

Transmit the following comments to the Montgomery County Transportation, Energy and Environment (T&E) Committee and the Montgomery County Department of Transportation:

1. Advance Alternative B, Median Transitway, as the preferred alternative and seek to increase the use of two-lane median transitways, especially south of Shady Grove Metrorail Station.
2. Construct the MD 355 BRT project in two phases:
    a. Phase 1: Clarksburg Outlets to Rockville Metrorail Station, including the spur to Germantown.
    b. Phase 2: Rockville Metrorail Station to Downtown Bethesda.
3. Advance preliminary engineering for both the Veirs Mill Road BRT project and the MD 355 BRT project concurrently. Prioritize construction of the entire Veirs Mill Road BRT project and Phase 1 of the MD 355 BRT project.
4. Proceed with the Snowden Farm Parkway alignment in Segment 7.
5. Concur with the recommended station location and phasing.
6. Conduct additional traffic evaluation and mitigation to determine whether it is feasible to convert general purpose traffic lanes to transit only lanes to reduce the cost and impacts of the project without creating excessive traffic delay.
7. Develop and implement interim improvements to Rockville Pike in White Flint to spur redevelopment and property dedication.

TABLE OF CONTENTS

1. SUMMARY

The *Draft MD 355 BRT Corridor Planning Study* report (Attachment A) evaluates enhanced transit service along MD 355, between Clarksburg and Downtown Bethesda, a distance of 22 miles. This study was funded by Montgomery County and conducted by the Montgomery County Department of Transportation (MCDOT).

The report is scheduled to be reviewed by the County Council T&E Committee on July 25, 2019 and by the full County Council on July 30, 2019, during which time the Council will consider which project alternative to advance and whether to provide funding for MCDOT to begin preliminary engineering on that alternative. Preliminary engineering would conduct the following tasks:

- Develop more detailed engineering on the Preferred Alternative
- Conduct surveys
- Evaluate right-of-way requirements
- Prepare detailed traffic studies
- Conduct environmental assessments
- Develop detailed project scope, schedule and cost estimate

Upon completion of preliminary engineering, the project will undergo final design and ultimately construction. Construction funding is typically not identified until after preliminary engineering is completed.

2. WHAT IS BUS RAPID TRANSIT?

Bus Rapid Transit, or BRT, is a high-quality and high-capacity bus-based transit system that delivers reliable, comfortable, convenient and branded transit service. Because BRT contains features similar to light rail or the Metrorail system, it is more reliable, comfortable and convenient than local bus services and can avoid the causes of delay that slow Metrobus and RideOn and the reliability issues that make these bus services often less desirable than Metrorail.

Internationally, BRT is a proven high-quality transit service that offers the benefits of light rail at far less cost. In the United States the record of BRT is mixed. This is because BRT is often compromised to reduce impacts to traffic and private property and to reduce costs. To achieve the full promise of BRT service, each of the four performance characteristics described below must be met:

1. **Reliability**. High-quality BRT service makes travel predictable. This is the main advantage of BRT service over travel by private vehicle and is critical to encouraging motorists to switch to transit. The main feature that achieves reliability is the dedicated transitway. Dedicated transitways are bus-only lanes that ensure that bus travel times are predictable from day to day by reducing the impacts of non-recurring congestion (congestion that cannot be anticipated because it is caused by irregular incidents such as road work, collisions and vehicle breakdowns). Median transit lanes are by far the most effective means to ensure reliable transit travel.

2. **Comfort**. High-quality BRT service includes amenities that reduce the stresses of travel and enables people to use their time more productively. Features that create a high-quality level of comfort include:

    - Premium transit vehicles
    - Enhanced stations
    - Real time information
    - Off-board fare collection
    - WiFi

3. **Convenience**: High-quality BRT service transports passengers to places quickly and provides Metrorail-like service frequency so that passengers do not have to consult a schedule; upon arrival at the station they can expect the BRT vehicle to arrive within a few minutes. Features that create a BRT level of convenience include:

    - Dedicated transitways
    - Transit signal priority
    - Queue jumps
    - Frequent / all-day transit service
    - Off-board fare collection
    - Level boarding

4. **Branded**: High-quality BRT creates a distinctive transit service – much like Metrorail – that is recognized and distinguished as reliable, comfortable and convenient. Distinctive features include:

    - Dedicated transitways
    - Premium transit vehicles
    - Enhanced stations
    - Frequent / all-day transit service

A glossary of various BRT components is provided on page 32 of this staff report.

3. STUDY DESCRIPTION

The purpose of the *Draft MD 355 BRT Corridor Planning Study* report is to provide a new transit service with higher speed and frequency along MD 355 between Clarksburg and Bethesda. The need of the study is described in the project's four goals:

- Goal 1: Provide an appealing, functional and high-quality transit service.
- Goal 2: Improve mobility opportunities, accessibility and transportation choices.
- Goal 3: Support planned development.
- Goal 4: Support sustainable and cost-effective transportation solutions.

3.1. Service Plan

The study identified four BRT routes that would operate along MD 355. These routes partially overlap to minimize the need to transfer between routes. The four routes are shown in Figure 1 and are listed below:

- 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
- FLASH 3: Montgomery College / College Campus to Bethesda Metrorail Station

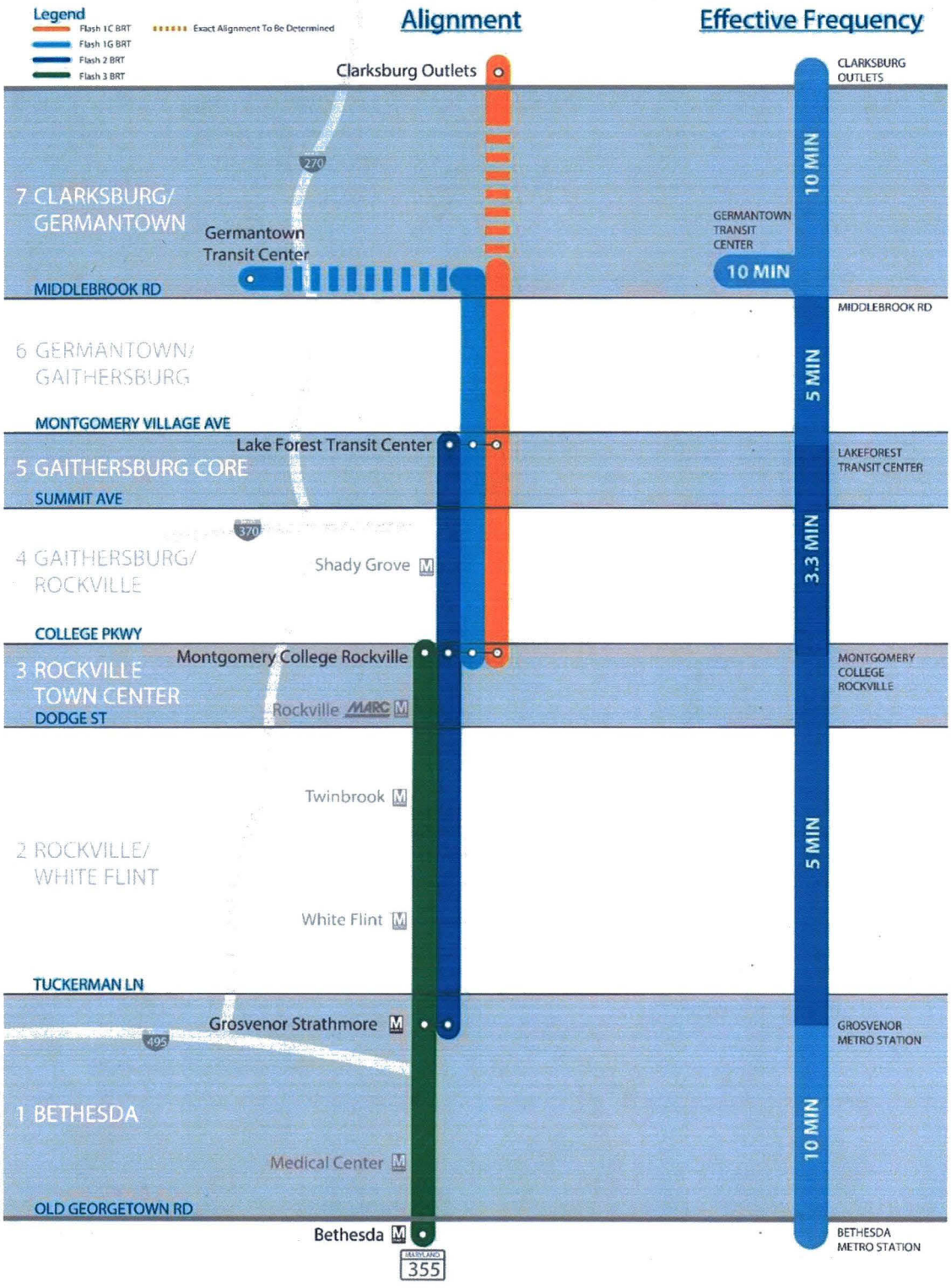
The service frequency and span of service for each route is shown in Table 1:

Table 1: Preliminary Service Frequency and Span of Service

Route	Weekday		Weekend		
	Headway	Span of Service	Headway	Span of Service	
				Saturday	Sunday
FLASH 1C	10 min (peak) 15 min (off-peak)	4:15 AM – 12:00 AM	15 min	5:00 AM – 12:00 AM	5:00 AM – 12:00 AM
FLASH 1G		4:15 AM – 1:45 AM		5:00 AM – 1:45 AM	5:00 AM – 1:30 AM
FLASH 2		4:15 AM – 1:45 AM		5:00 AM – 1:45 AM	5:00 AM – 1:30 AM
FLASH 3		5:00 AM – 1:45 AM		5:00 AM – 1:00 AM	5:00 AM – 1:30 AM

All routes would deviate from MD 355 to stop at Montgomery College / Rockville Campus, Shady Grove Metrorail Station and the Lake Forest Transit Center. One route would deviate from MD 355 to stop at the Germantown Transit Center. Due to overlapping routes, the effective arrival frequency (or headway) varies from 3.3 minutes to 10 minutes. Figure 1 shows the effective arrival frequency during peak periods for each route.

Figure 1: BRT Routes and Effective Arrival Frequencies



3.2. Project Segmentation

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. The segments are primarily geographically based and each has its own set of characteristics, opportunities, challenges and constraints. The seven segments are shown in Table 2:

Table 2: Project Segments

Segment	Area	From	To
Segment 1	Bethesda Area	Bethesda Metrorail Station	Grosvenor Metrorail Station
Segment 2	White Flint and Twinbrook	Grosvenor Metrorail Station	Dodge Street
Segment 3	Rockville Town Center	Dodge Street	College Parkway
Segment 4	Shady Grove	College Parkway	Summit Ave
Segment 5	Gaithersburg Core	Summit Ave	MD 124 / Montgomery Village Ave
Segment 6	Gaithersburg & Germantown	MD 124 / Montgomery Village Ave	Middlebrook Rd
Segment 7	Clarksburg	Middlebrook Rd	Clarksburg Outlets

3.3. Description of Alternatives

Six alternatives were evaluated as part of this project. Five alternatives, including the No-Build Alternative, were fully evaluated as part of this study. An additional alternative, Alternative B Modified, was added near the conclusion of the process to minimize cost and impacts to private property of Alternative B. This alternative was not fully evaluated but was deemed feasible by the project team.

The six alternatives are described below. The four BRT alternatives are shown in Attachment B. An online map is available that shows the alignment, station locations and limit of disturbance for each of the BRT alternatives here: https://bit.ly/2ZVyNC8.

A note on terminology:

- Build Alternatives: includes Transportation System Management, Alternatives A, B, B Modified and C.
- BRT Alternatives: includes Alternatives A, B, B Modified and C.

3.3.1. No-Build Alternative

This alternative includes no additional infrastructure or operational improvements other than those already planned and programmed. This includes the existing 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 route. The No Build Alternative does not address the purpose and need of the project, but it serves as a baseline for comparing the improvements and impacts associated with the Build Alternatives.

3.3.2. Transportation System Management (TSM)

This alternative includes operational improvements to optimize bus service on MD 355 but does not include costly infrastructure improvements. It extends the existing Ride On extRa service, which currently exists between the Medical Center Metro Station and the Lakeforest Transit Center, south to the Bethesda Metrorail Station and north to Clarksburg. Additional transit signal priority is provided along the route.

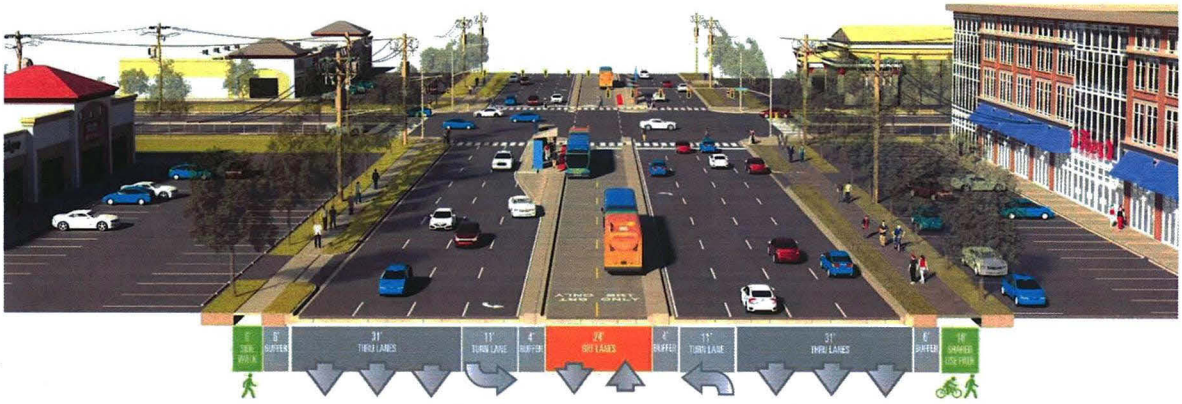
3.3.3. Alternative A: Mixed Traffic

This alternative operates in existing general purpose traffic lanes from the Bethesda Metrorail Station to Clarksburg along MD 355. It includes the following features to provide a comfortable, convenient and branded service: premium transit vehicles, enhanced stations, real time information, off-board fare collection, queue jumps, frequent / all-day transit service and level boarding.

3.3.4. Alternative B: Median Transitway

The main difference with Alternative A is that this alternative travels in a dedicated median transitway where feasible as shown in Attachment B and described below. All existing general purpose traffic lanes would be maintained but would be narrowed where a transitway is provided to minimize roadway widening. The transitway alignment for each segment is as follows:

- Two-Way Median Transitway: Segments 2, 4 and 6
- One-Way Median Transitway: Segments 3 and 5
- Mixed Traffic: Segments 1 and 7



An example of a two-way median transitway

This alternative includes the same features as Alternative A to provide a comfortable, convenient and branded service.

3.3.5. Alternative B Modified: Median Transitway

The main difference with Alternative B is that the median transitway in this alternative is largely one lane to reduce costs and impacts to private property as shown in Attachment B and described below. All existing general purpose traffic lanes would be maintained but would be narrowed where a transitway is provided to minimize roadway widening. The transitway alignment for each segment is as follows:

- Two-Way Median Transitway: Segment 2
- One-Way Median Transitway: Segments 3, 4, 5 and 6
- Mixed Traffic: Segments 1 and 7

This alternative includes the same features as Alternative A to provide a comfortable, convenient and branded service.

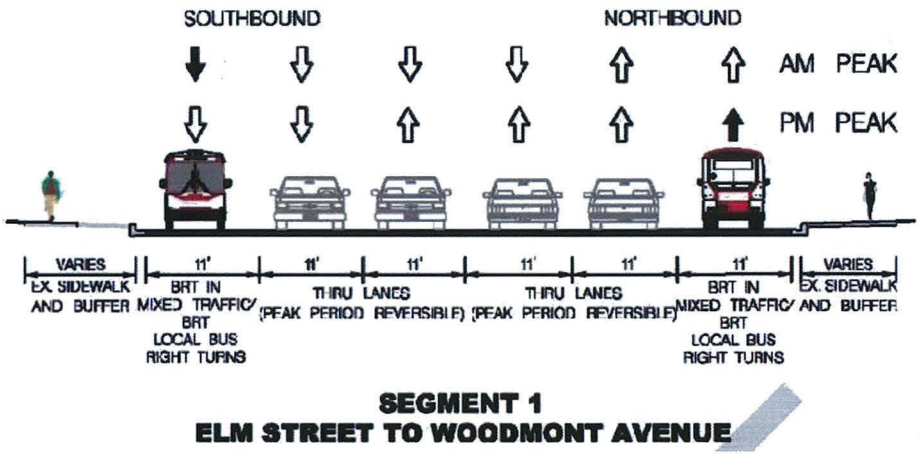
3.3.6. Alternative C: Curb Lane Transitway

The main difference with Alternative A is that this alternative largely travels in dedicated curb lanes shared with local transit service and right turning vehicles. All existing travel lanes would be maintained but would be narrowed where a transitway is provided to minimize roadway widening. The transitway alignment for each segment is as follows:

- Two Curb Lanes: Segments 2, 4 and 6

An example of a curb lane transitway

- One Curb Lane:
    - Segment 1: Space for the curb lane would be gained by replacing the existing landscaped median with a reversible traffic lane, much like is in operation on US 29 and MD 97 in Silver Spring. This would enable the southbound curb lane to operate as BRT in the morning and northbound curb lane to operate as BRT in in the evening (shown by the black arrows), while preserving six lanes for traffic (shown by the white arrows), which would also be used by the off-peak BRT vehicles. See image below.



- Segment 3: The curb lane would be fixed in the southbound direction. Northbound BRT vehicles would operate in the general traffic lanes.

- Mixed Traffic: Segments 5 and 7

This alternative includes the same features as Alternative A to provide a comfortable, convenient and branded service.

3.4. Segment 7 Alignments

One complication to the study is that the build alternatives (Alternative A, Alternative B, and Alternative C) are assigned a different alignment in Segment 7, making comparisons among alternatives somewhat more difficult. The Segment 7 alignments are shown in Attachment C and include:

- MD 355
- Observation Drive
- Snowden Farm Parkway

4. PREVIOUS STUDIES

Several plans and studies have been conducted in support of bus rapid transit on MD 355:

- *The Countywide Transit Corridors Functional Master Plan* (2013) is the guiding policy document for BRT in Montgomery County. This plan identifies 10 bus rapid transit corridors and includes recommendations for master-planned rights of way, station locations, recommendations for dedicated transit lanes and the number of additional lanes that can be added to the road to provide dedicated bus lanes.
- *The City of Rockville Bus Rapid Transit Town Center Integration Study (2015)* evaluated approaches for incorporating BRT in the constrained area of Rockville Town Center.
- *The City of Gaithersburg MD 355 Bus Rapid Transit Study* (2015) recommended a mix of two lane and one lane transitways through portions of the City.
- *The MD 355 Bus Rapid Transit Corridor Planning Study Conceptual Alternatives Report* (2017) contained six conceptual alternatives, including four BRT alternatives. This study was prepared by the Maryland State Highway Administration with the Montgomery County Department of Transportation and was a precursor to the *Draft MD 355 BRT Corridor Planning Study* report.

5. MASTER PLAN CONSISTENCY

The *Countywide Transit Corridors Functional Master Plan* (2013), as modified by the *Bethesda Downtown Plan* (2017), divides MD 355 into two segments: MD 355 South, extending from the planned Bethesda Metrorail Station entrance at Elm St to Rockville Metrorail Station, and MD 355 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. Table 3 indicates whether each segment in each alternative is consistent with the master plan. Where they are not consistent, the reason is noted. As the alignments for Segment 7 vary for each alternative, it is not possible to determine master plan consistency at the stage.

Table 3: Master Plan Consistency for Transitway Segment

Segment	Alternative B: Median Transitway	Alternative B Modified: Median Transitway	Alternative C: Curb Lane Transitway
1. Bethesda	Lacks dedicated transitway.	Lacks dedicated transitway.	Yes
2. White Flint & Twinbrook	Yes	Yes	Yes
3. Rockville Town Center	Yes	Yes	Yes
4. Shady Grove	# of lanes exceeds recommendation.	Yes	Yes
5. Gaithersburg Core	Yes	Yes	Lacks dedicated transitway.
6. Gaithersburg & Germantown	# of lanes exceeds recommendation.	Yes	# of lanes exceeds recommendation.

A complete analysis of master plan consistency for transitways is provided in Attachment D.

The *Countywide Transit Corridors Functional Master Plan* also provides recommendations on station locations. These station locations were included largely to allow the Planning Board to require additional property dedication for transit stations as part of development approvals, if needed. The plan recognizes that the master-planned station locations may need to be modified during the facility planning process. Page 22 states: "...station locations are subject to modification during these more detailed planning and engineering phases of project development and implementation..." Page 35 states: "...the specific location of the station...should be determined during facility planning. The number of stations may also be increased or decreased during facility planning." A complete analysis of master plan consistency for stations is provided in Attachment E.

Most stations that are recommended in the *Countywide Transit Corridors Functional Master Plan* are recommended to be constructed as part of the MD 355 BRT project with a few exceptions:

- MD 355 & Shady Grove Road: This station was relocated to Westland Drive.
- MD 355 & Gude Drive: This station was relocated to College Parkway.
- MD 355 & Pooks Hill Road: This station is proposed as a future station location.
- MD 355 & Cedar Lane: This station is proposed as a future station location.

Additionally, as the alignments for Segment 7 vary for each alternative, it is not possible to determine master plan consistency at this stage.

6. STUDY SHORTCOMINGS

There are two significant shortcomings with this study that influence the analysis and staff recommendations:

First, the recommendations in the *Countywide Transit Corridors Functional Master Plan* were developed based on ridership forecasts for a network of bus rapid transit corridors. In conformance with standard procedures, the transit ridership forecasts in the *Draft MD 355 BRT Corridor Planning Study* report did not evaluate how ridership would change if additional BRT corridors were in existence because at the time the analysis was conducted, these BRT corridors were not included in the region's Constrained Long-Range Plan (CLRP). As several BRT corridors are now included in the CLRP, including the Veirs Mill Road BRT, this will likely increase BRT ridership on MD 355, especially to the north of Veirs Mill Road.

Second, travel demand models are developed to make comparisons among alternatives during "normal" conditions. They are unable to capture the differences between alternatives due to non-recurring congestion (congestion that cannot be anticipated because it is caused by irregular incidents such as road work, collisions and vehicle breakdowns). This is a major shortcoming of the study as travel time reliability is the major benefit that median transitways offer over travel by private vehicle. Therefore, the difference between the ridership forecasts for Alternative B and Alternative B Modified compared with the Transportation System Management, Alternative A and Alternative C is likely to be greater than the analysis shows.

7. COMPARISON OF ALTERNATIVES

While numerous metrics were evaluated as part of the *Draft MD 355 BRT Corridor Planning Study* report for each of the alternatives, the following provides only those metrics that show a meaningful differentiation among the Build Alternatives:

- Project Benefits
  - Ridership
  - Travel Time
  - Travel Time Reliability
- Project Impacts
  - Potential Private Property Impacts
  - Public Park Impacts
  - Wetland Impacts
- Projects Costs
  - Capital Costs
  - Annualized Costs per Rider

These metrics are discussed in the sections below.

Please note: staff believes that the analysis in the *Draft MD 355 BRT Corridor Planning Study report* conveys a higher level of precision than the tools that generate them are able to provide. Staff would encourage the Planning Board not to wrestle too much with the intricacies of the ridership, travel time and traffic analyses, but rather to draw general conclusions from the analysis. In staff's opinion, these general conclusions are that:

- Median transitways and curb lanes provide faster average travel times for BRT than travel in mixed traffic.
- Median transitways offer substantially greater travel time reliability than curb lane transitways and mixed traffic.
- Therefore, median transitways will attract greater ridership than curb lanes, which will generate greater ridership that mixed traffic.

Nevertheless, the analysis as presented in the report is described below.

7.1. Project Benefits

As noted at the beginning of the staff report, four performance characteristics must be met to achieve the full promise of BRT service:

- Reliability: High-quality BRT service makes travel predictable. This is the main advantage of BRT service over travel by private vehicle and is critical to encouraging motorists to switch to transit.
- Comfort: High-quality BRT service includes amenities that reduce the stresses of travel and enables people to use their time more productively.

- Convenience: High-quality BRT service transports passengers to places quickly and provides Metrorail-like service frequency so that passengers do not have to consult a schedule; upon arrival at the station they can expect the BRT vehicle to arrive within a few minutes.
- Branded: High-quality BRT creates a distinctive transit service – much like Metrorail – that is recognized as reliable, comfortable and convenient.

Staff's evaluation of each of these performance characteristics is shown in Figure 2. Overall, Alternative B provides the high-quality BRT service, followed by Alternative B Modified. Alternative C provides mediocre BRT service.

Figure 2: Evaluation of Alternatives

Performance Characteristics	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative B Modified: Median Transitway	Alternative C: Curb Lane Transitway
Reliability	○	○	●	◑	○
Comfort	◔	●	●	●	●
Convenience	○	◔	●	◕	◔
Branding	○	○	●	◕	◔
Overall	○	◔	●	◕	◑

● = Best
○ = Worst

7.1.1. Ridership

Figure 3 shows projected average daily boardings in 2040 for weekdays, Saturdays and Sundays. The key finding is that Alternative B would have the highest bus ridership of all the alternatives. This generally reflects the higher travel speeds associated with the median guideway, which makes the service more attractive to potential riders.

Figure 3: Projected Average Daily Boardings (2040)

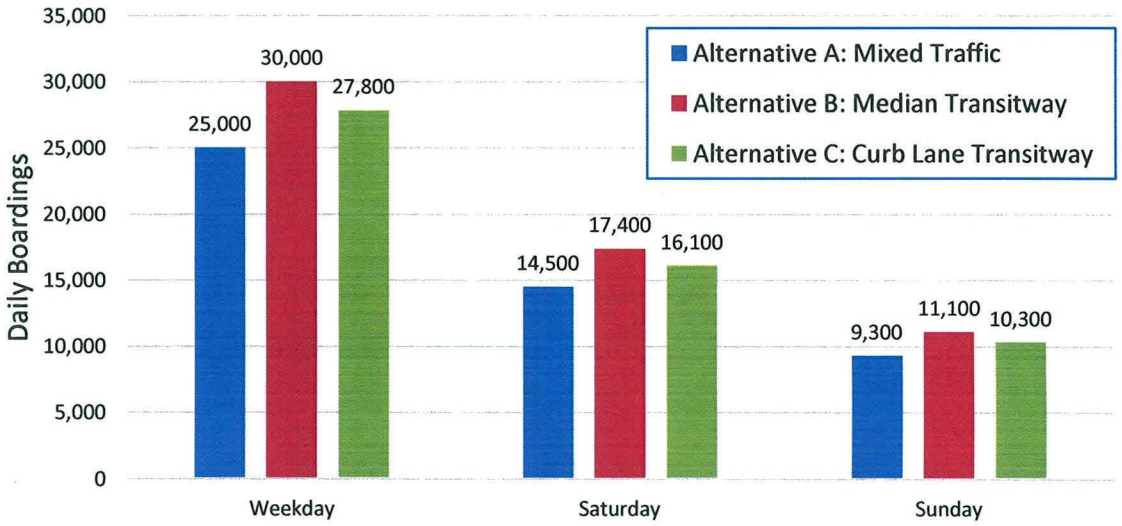
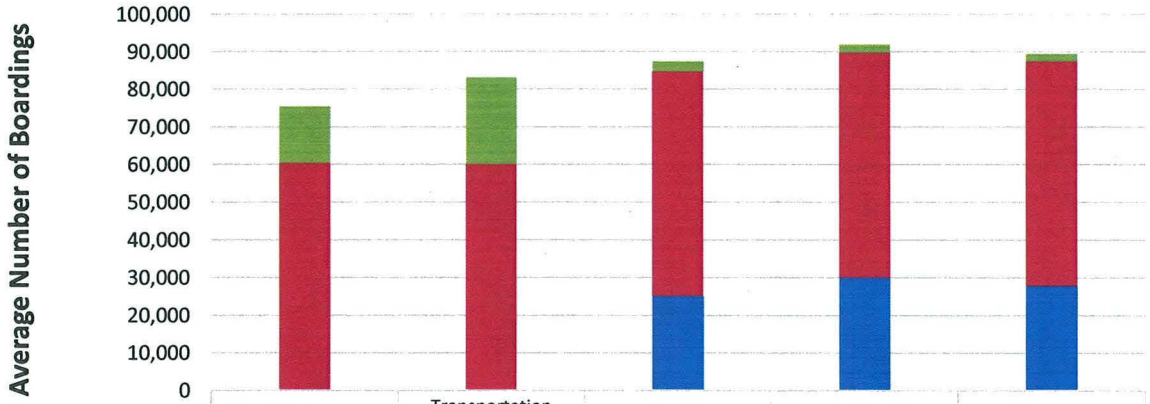


Figure 4 shows projected average weekday boardings in 2040 for local bus, Metrorail and BRT. The key findings are that:

- 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 about 95 percent of local bus passengers shifting to the new BRT service. This would occur under each of the BRT Alternatives.
- BRT service on MD 355 would have little impact on Metrorail ridership, indicating that BRT addresses the needs of a different travel market than Metrorail.

Figure 4: Projected Average Weekday Boardings for the MD 355 Corridor (2040)

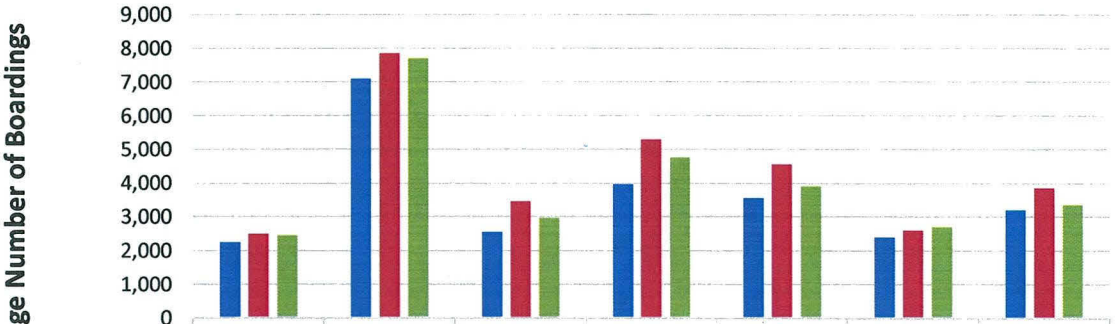


	No Build	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative C: Curb Lane Transitway
Local Bus	14,900	23,000	2,700	2,200	1,900
Metrorail	60,400	60,100	59,700	59,700	59,700
Bus Rapid Transit	0	0	25,000	30,000	27,800

Figure 5 shows projected average weekday boardings in 2040 for each segment. The key findings are that:

- The segment with the most boardings for all three BRT Alternatives is 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 segment with the second highest boardings is Segment 4, which runs between College Parkway at the north end of Rockville Town Center and Summit Avenue in City of Gaithersburg. This segment includes the Shady Grove Metrorail Station and the southern end of the City of Gaithersburg.
- The segment with the third highest boardings is 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.

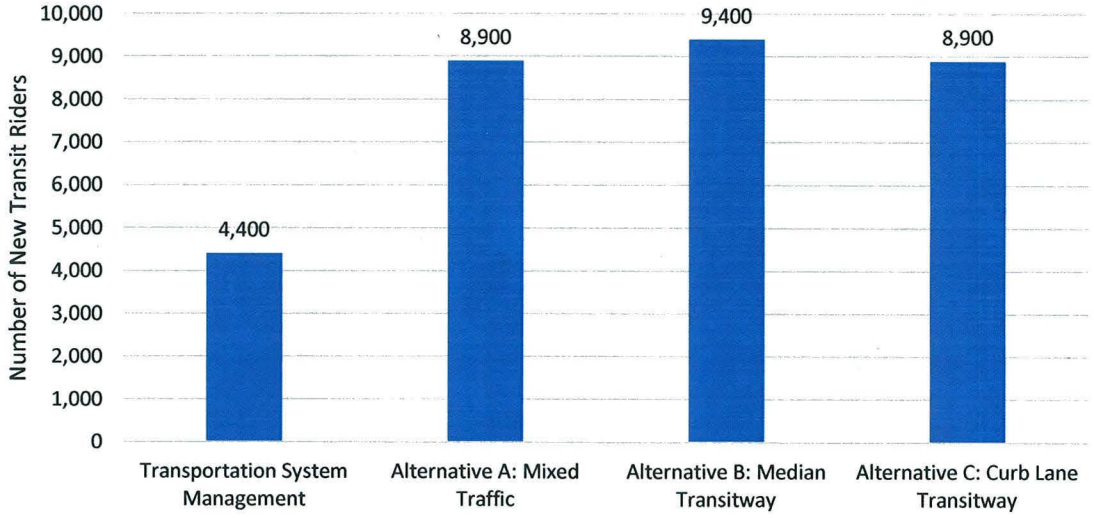
Figure 5: Projected Average Daily Boardings by Segment (2040)



	1. Bethesda	2. White Flint & Twinbrook	3. Rockville Town Center	4. Shady Grove	5. Gaithersburg Core	6. Gaithersburg & Germantown	7. Clarksburg
Alt A: Mixed Traffic	2,250	7,100	2,550	3,950	3,550	2,400	3,200
Alt B: Median	2,500	7,850	3,450	5,300	4,550	2,600	3,850
Alt C: Curb Lane	2,450	7,700	2,950	4,750	3,900	2,700	3,350

BRT service provides benefits for both existing and new transit riders. Figure 6 compares the projected number of new transit riders that would result due to implementation of transit improvements, representing the number of cars that would be removed from the road. 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 Alternatives A and C, at 8,900. New riders on all three BRT Alternatives would exceed the new riders generated by the TSM Alternative.

Figure 6: Projected Number of New Transit Riders



7.1.2. Travel Time

Table 4 shows the transit travel time between key origin-destination pairs within the corridor during peak periods. 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.

Table 4: Peak Period Transit Travel Time (in Minutes) by Alternative for Select Origin-Destination Pairs in 2040

Origin	Destination	No Build	TSM	Alt A: Mixed Traffic	Alt B: Median Transitway	Alt C: Curb Lane Transitway	Notes
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 Metro
White Flint	Bethesda	30	26	23	21	23	Bus Only
Rockville	Bethesda	57	42	40	36	39	Bus Only

* Note: Origin-destination pairs originating in Clarksburg have been removed from this analysis. This is because the build alternatives reflect different alignments in Clarksburg, making comparisons difficult.

Table 5 compares BRT travel time to auto travel time to determine the extent to which BRT travel time is competitive with the auto. In general, Alternative B and Alternative C provide the greatest time-competitiveness.

Table 5: BRT Travel Times Compared to Auto Travel Times in 2040 (Minutes)

Origin/ Destination	No Build	TSM Alternative		Alternative A (Mixed Traffic)		Alternative B (Median)		Alternative C (Curb Lanes)	
	Auto	Auto	Ride On extRa	Auto	BRT	Auto	BRT	Auto	BRT
AM Peak Southbound									
Gaithersburg to Bethesda	47	51	73	46	71	54	61	46	58
AM Peak Northbound									
Bethesda to Gaithersburg	45	41	69	40	63	41	65	43	67
PM Peak Southbound									
Gaithersburg to Bethesda	46	45	67	46	70	49	62	51	61
PM Peak Northbound									
Bethesda to Gaithersburg	67	65	86	60	82	73	77	70	79

7.1.3. Travel Time Reliability

As noted previously, travel demand models are developed to make comparisons among alternatives during "normal" conditions. They are unable to capture the differences between alternatives due to non-recurring congestion (congestion that cannot be anticipated because it is caused by irregular incidents such as road work, collisions and vehicle breakdowns). But anecdotally we know the importance of reliability. WMATA's Metrorail service became somewhat less reliable over the years and people began to abandon it.

To draw conclusions about how non-recurring congestion will affect future transit travel times and therefore ridership projections, staff evaluated average travel times in 2018 using INRIX data for all vehicles[1]. While this analysis serves as a proxy for transit travel time reliability in 2040, it is reasonable to assume that if non-recurring congestion is affecting vehicles today, it is only going to get worse in the future.

As an example of the non-recurring congestion issue on MD 355, Figure 7 and Figure 8 show the extent to which travel time is unreliable between Clarksburg and Rockville. In these figures, the dark line represents average travel times between Clarksburg and Rockville in the southbound direction (Figure 7) and the northbound direction (Figure 8). The dashed line at the top of the figures shows how much additional travel time one has to plan for to be on time 95 percent of the time. For example, Figure 7 shows that at 8:00 am the average travel time in the southbound direction is about 31 minutes, but to ensure an on-time arrival 95 percent of the time, one needs to give themselves 52 minutes to make the trip. Similarly, Figure 8 shows that at 5:00 pm the average travel time in the northbound direction is 34 minutes, but to ensure an on-time arrival 95 percent of the time, one needs to give themselves 55 minutes to make the trip. In short, in both directions rush-hour travelers need to give themselves an extra 21 minutes to arrive on time.

Alternative B (median transitway) and to a somewhat lesser extent Alternative B Modified will largely be shielded from the effects of non-recurring congestion, since these alternatives are separated from the roadway by a concrete median. Alternative A (mixed traffic) and to a slightly lesser extent Alternative C (curb lane transitway), will be greatly impacted by non-recurring congestion, because private vehicles are likely to encroach into the transit lanes during heavily congestion conditions.

[1] INRIX collects anonymized data on actual congestion from millions of trips everyday.

Figure 7: Average Southbound Travel Times between Clarksburg and Rockville (2018)

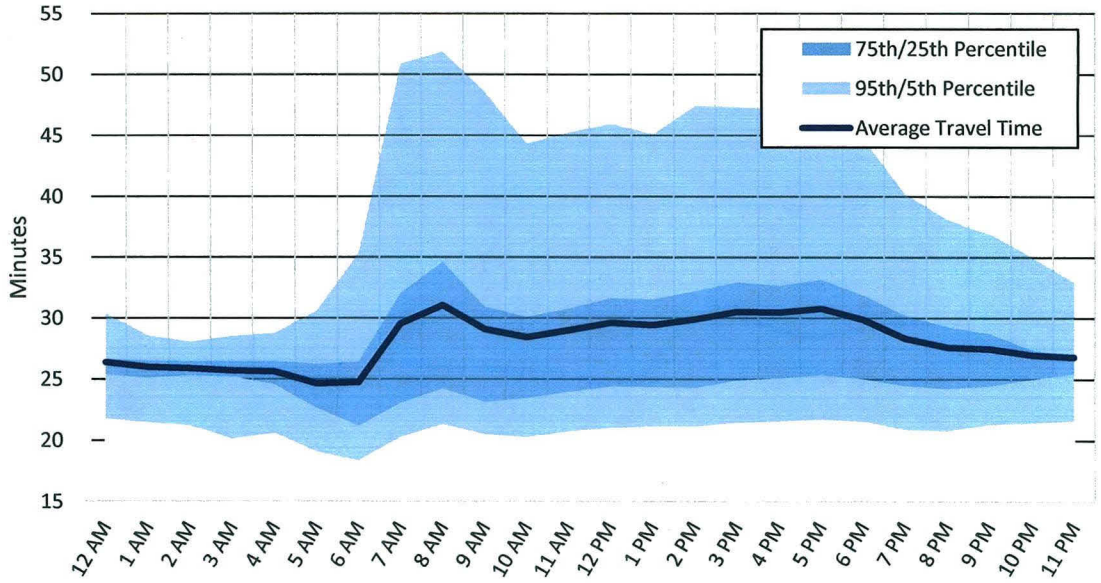
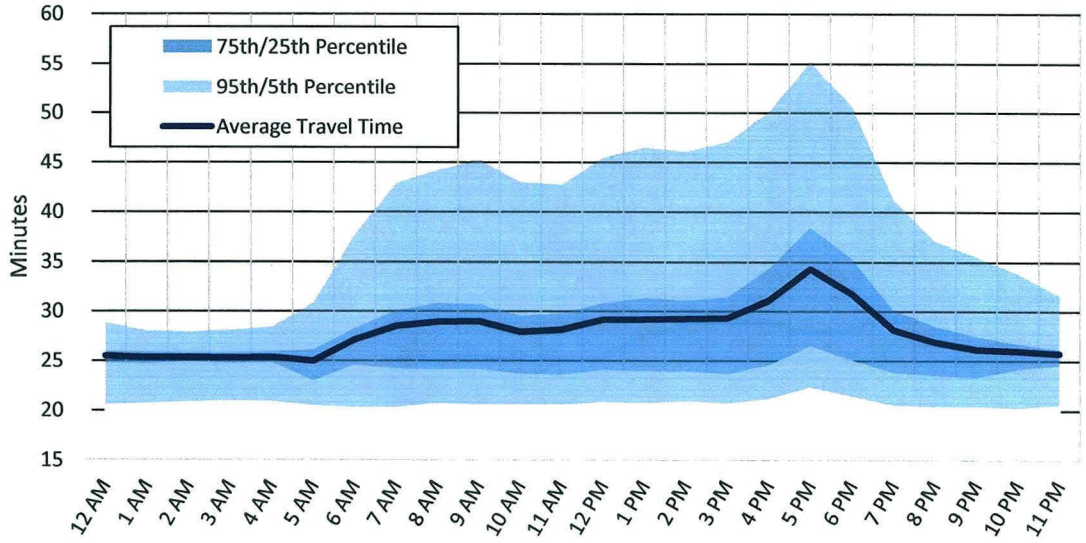


Figure 8: Average Northbound Travel Times between Rockville and Clarksburg (2018)



7.2. Project Impacts

Project impacts that provide meaningful differentiation among alternatives include traffic impacts, private property impacts, public park impacts and wetland impacts. At this phase in the MD 355 BRT Planning Study, project impacts are still preliminary. As the project progresses, further avoidance and minimization efforts will be investigated to reduce impacts.

7.2.1. Traffic Impacts

Table 6 compares the traffic impacts of each alternative. Overall, the four Build Alternatives would increase delay for people traveling in private vehicle compared to the No-Build Alternative. This is offset by the travel time improvements for transit passengers such that the average person delay only increases slightly for the Build Alternatives. There are a number of reasons for reduction in automobile travel times, including:

- Signal timing adjustments to accommodate exclusive transit phases.
- Signal timing adjustments to accommodate a longer pedestrian crossing to accommodate dedicated transit lanes.
- Transit-only phases to accommodate vehicles entering and exiting the median guideway.

Table 6: Traffic Impacts in 2040

Metric	No Build	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative C: Curb Lane Transitway
Miles of LOS E or F in AM (Northbound)	2.6	2.7	2.7	3.0	3.2
Miles of LOS E or F in AM (Southbound)	7.6	9.4	8.1	8.4	5.9
Miles of LOS E or F in PM (Northbound)	8.4	8.1	7.2	9.4	8.8
Miles of LOS E or F in PM (Southbound)	5.0	5.5	6.4	5.5	5.7
# of Intersections with LOS E or F (AM/PM)*	16/14	17/14	13/14	20/24	15/23
Average Minutes of Person Travel Delay (AM/PM)	3.0/3.0	3.0/3.0	3.0/3.6	3.6/3.6	3.6/3.6

* Excludes Segment 7

7.2.2. Private Property Impacts

In most locations, the Build Alternatives would fit within the right-of-way recommended in the Master Plan of Highways and Transitways. However, much of this right-of-way is not currently dedicated for transportation use. As properties are approved by the Planning Board and other jurisdictions for development or redevelopment, the expectation is that they will dedicate to the master planned right-of-way, reducing impacts to private property.

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 residential and commercial properties for implementation of Alternative B and Alternative C.

Right-of-way requirements that would result from the project alternatives are summarized in Table 7. The total number of potential displacements that would result from the alternatives is included in Table 8 ~~Table 8~~.

Table 7: Potential Right-of-Way Requirements (Acres)

Right-of-Way Requirements	No Build	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative C: Curb Lane Transitway
Residential	0.0	0.2	3.9	17.1	11.8
Commercial	0.0	0.2	8.5	43.8	26.8
Total Impact	0.0	0.4	12.4	60.8	38.6

Table 8: Potential Displacements

Impacts	No Build	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative C: Curb Lane Transitway
Residential Displacements	0	0	0	4	1
Commercial Displacements	0	0	0	24	11
Total Displacements	0	0	0	28	12

7.2.3. Public Park Impacts

Table 9 shows the acres of public parkland within the project limit of disturbance. 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 9: Acres of Public Parkland within the Project Limit of Disturbance

Impact	No Build	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative C: Curb Lane Transitway
Potential Park Impacts	0	0	0.08	1.08	0.94

7.2.4. Wetland Impacts

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, wetlands may be permanently impacted through encroachment of construction and temporarily from construction activities in the vicinity of wetland resources, as shown in Table 10. Table 10 also summarizes the Build Alternative impacts to floodplain resources.

Table 10: Wetland Impacts

Impact	No Build	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative C: Curb Lane Transitway
DNR Wetland Impacts (Acres)	0	0	0	0.15	0.08
Floodplain Impacts (Acres)	0	0	0	0.73	0.57

7.2.5. Historic Impacts

For the Build Alternatives, direct and indirect impacts to cultural resources would include partial right-of-way impacts affecting historic resource properties and/or structures and potential access or visual effects (direct effects) for architectural properties (see Table 11 and Table 12). This number is subject to revisions based on additional pending archaeological investigations and architectural survey work that the next draft report should address. The area of potential effect may also be subject to revision given recent federal guidance and this may result in additional survey work and an expanded list of affected resources.

Table 11: Potential Number of Historic Architectural Properties Directly Impacted by Each Alternative

	No Build	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative C: Curb Lane Transitway
# of Property Impacts	0	0	24	24	28
# of NRHP Eligible Property Impacts	0	0	0	0	0

Table 12: Potential Number of Historic Architectural Properties Indirectly Impacted by Each Alternative

	No Build	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative C: Curb Lane Transitway
# of Property Impacts	0	0	27	26	30
# of NRHP Eligible Property Impacts	0	0	0	0	0

7.3. Project Costs

7.3.1. Capital Costs

Table 13 shows the capital cost per segment and the total cost for each alternative. Costs in Segment 2 (White Flint and Twinbrook) represent roughly 40 percent of the costs of the BRT alternatives (Alternatives A, B, B Modified and C), largely due to the high cost of property acquisition in this area. Right-of-way acquisition represents roughly 20 percent of the total cost of the BRT alternatives (Alternatives A, B, B Modified and C).

Table 13: Capital Cost per Segment (millions $)

Segment	Transportation System Management ~~No Build~~	Alternative A: Mixed Traffic ~~Transportation System Management~~	Alternative B: Median Transitway ~~Alternative A: Mixed Traffic~~	Alternative B Modified: Median Transitway	Alternative C: Curb Lane Transitway
1. Bethesda	$0.7	$18.0	$19.0	$19.0	$37.0
2. White Flint & Twinbrook	$0.9	$50.0	$346.0	$346.0	$190.0
3. Rockville Town Center	$0.2	$11.0	$92.0	$92.0	$65.0
4. Shady Grove	$0.3	$26.0	$170.0	$141.0	$123.0
5. Gaithersburg Core	$0.5	$9.0	$86.0	$80.0	$10.0
6. Gaithersburg & Germantown	$1.0	$9.0	$121.0	$91.0	$59.0
7. Clarksburg	$2.0	$19.0	$15.0	$15.0	$13.0
Vehicles	$10.0	$43.0	$37.0	$37.0	$37.0
Total	**$15.6**	**$185.0**	**$886.0**	**$821.0**	**$534.0**

7.3.2. Annualized Costs per Rider

Annualized cost per rider is a measure of cost-effectiveness that divides annualized capital and operating costs by the number of riders per year. Annualized costs per rider were developed for each Build Alternative based on FTA guidelines for the typical lifespan of different project components and are shown in Table 14. While capital and operating costs are high for the BRT alternatives overall, the annualized costs per rider for Alternatives B Modified and C are comparable to each other, though Alternative B is higher.

Table 14: Annualized Capital and Operating Costs per Annual Rider

	Transportation System Management	Alternative A: Mixed Traffic	Alternative B: Median Transitway	Alternative B Modified: Median Transitway	Alternative C: Curb Lane Transitway
Annual Capital & Operating Costs	$12,900,000	$33,800,000	$52,300,000	$41,100,000	$40,900,000
Annual BRT Riders	3,820,000	7,700,000	9,280,000	9,280,000	8,630,000
Total Annualized Cost per Rider	$~~3.38~~3.52	$~~4.39~~4.54	$~~5.64~~5.77	$~~4.43~~4.57	$~~4.74~~4.88

8. THE WHITE FLINT DILEMMA

The cost of right-of-way acquisition in Segment 2 (White Flint and Twinbrook) is estimated to be about $184 million for Alternative B and Alternative B Modified and $99 million for Alternative C, or over 20 percent of the total cost of each alternative. This presents Montgomery County with a dilemma. Due to these high costs, there is an incentive for Montgomery County to delay implementation of BRT in Segment 2 in the hope that redevelopment and the resulting right-of-way dedication will reduce the cost and impacts of property acquisition. However, due to current market conditions, property owns have indicated that they are unlikely to move forward with redevelopment until MD 355 is transformed from the unenticing auto-centric highway that it is today into an appealing multimodal boulevard as envisioned in the White Flint Sector Plan.

A View of MD 355 in White Flint

9. STAFF RECOMMENDATIONS

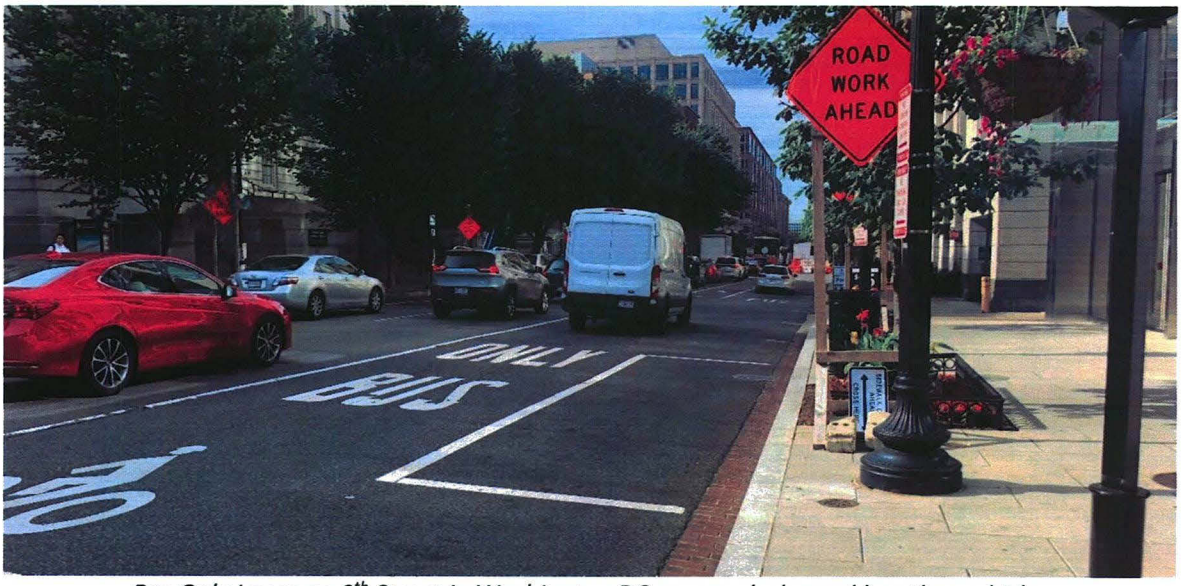
1. Advance Alternative B, Median Transitway, as the preferred alternative and seek to increase the use of two-lane median transitways, especially south of Shady Grove Metrorail Station.

Staff recommends implementing BRT on MD 355 with a dedicated median transitway. Median transitways provide the highest ridership of all the Build Alternatives and offer travel times that are a substantial improvement over the TSM Alternative. Perhaps most importantly median transitways are the only alternative that provides a high level of travel time reliability. Since reliability is the main advantage of BRT service over travel by private vehicle, it is critical to encouraging motorists to switch to transit. While this alternative will have the greatest impacts to private property, historic resources, environmental resources and park land, at this stage the amount of impacts is rough and as the project progresses, further avoidance and minimization efforts will be investigated to reduce impacts.

Furthermore, staff recommends seeking opportunities to increase the amount of two-lane median transitways, especially to the south of the Shady Grove Metrorail Station, where the directional split of travel on MD 355 tends to have a greater balance due to the commercial nature of the corridor.

Staff strongly recommends against Alternative C. While curb lane transitways can be an appealing option because they take up less space and therefore cost less and have fewer impacts to adjacent properties than median transitways, travel times are slower and they will suffer from poor travel time reliability. This is because:

- Much of the MD 355 corridor is lined with commercial properties, so the number of right turning vehicles using the curb lanes could severely limit the functionality of the curb lane transitway.
- When heavy congestion occurs, other vehicles are more likely to encroach onto the curb lane transitway.



Bus Only Lanes on 9th Street in Washington DC are regularly used by other vehicles

Contrary to the findings of the *Draft MD 355 BRT Corridor Planning Study* report, it is staff's opinion that the actual ridership for this alternative would be substantially less than Alternative B because it will be impacted by non-recurring congestion. People who have the ability to choose to drive tend to avoid unreliable transit services. While Alternative C would improve travel time by local bus, this benefit is greatly outweighed by the unreliability of the service, as 95 percent of local bus patrons would choose to switch to BRT.

2. **Construct the MD 355 BRT project in two phases:**

    a. **Phase 1: Clarksburg Outlets to Rockville Metrorail Station, including the spur to Germantown.**
    b. **Phase 2: Rockville Metrorail Station to Downtown Bethesda.**

As the cost of the MD 355 BRT project is high, staff recommends dividing it into two phases. Phase 1 would connect the Clarksburg Outlets to the Rockville Metrorail Station and should be prioritized because high-quality transit does not exist north of Shady Grove and because this is the lowest cost section of the corridor. It would also connect to the planned Veirs Mill Road BRT, which is likely to increase the ridership of both routes.

Phase 2 would connect the Rockville Metrorail Station to the Bethesda Metrorail Station. This phase should be constructed last because it has the highest cost, of which right-of-way acquisition in Segment 2 (White Flint / Twinbrook) accounts for about 20 percent of the total cost of the MD 355 BRT. Leaving this section of the MD 355 BRT until last has the benefits of potentially reducing the costs of property acquisition, should redevelopment and property dedication occur on Segment 2. This could also have the benefit of providing property owners with greater certainty that the BRT project will be forward in the White Flint area.

3. **Advance preliminary engineering for both the Veirs Mill Road BRT project and the MD 355 BRT project concurrently. Prioritize construction of the entire Veirs Mill Road BRT project and Phase 1 of the MD 355 BRT project.**

Both the Veirs Mill Road corridor and Phase 1 of the MD 355 corridor have high existing transit demand but lack high-quality transit.

4. **Proceed with the Snowden Farm Parkway alignment in Segment 7.**

Staff recommends initially implementing the MD 355 BRT project along the Snowden Farm Parkway alignment instead of the MD 355 alignment or the Observation Drive alignment. While this is inconsistent with the *2013 Countywide Transit Corridors Functional Master Plan*, which recommends that the BRT project travel along MD 355 to Redgrave Place, there are several reasons why MCDOT should move forward with the BRT project on Snowden Farm Parkway:

- Much of the existing Clarksburg development is focused on Snowden Farm Parkway, so the Snowden Farm Parkway alignment would better serve existing land use.

- Snowden Farm Parkway has been largely completed since the *Countywide Transit Corridors Functional Master Plan* was approved.
- The BRT project on MD 355 would impact the Clarksburg Master Plan Historic District and National Register District. (Note that any alterations to the roadway or adjacent properties required by lane widening or station construction within the historic district boundaries would require an Historic Area Work Permit (HAWP) and approval by the Historic Preservation Commission (HPC)).
- Constructing the transitway along Snowden Farm Parkway does not preclude the other alignments in the future.
- Observation Drive remains incomplete between Waters Discovery Lane and Stringtown Road.

5. **Concur with the recommended station location and phasing.**

While MCDOT recommends delaying two stations (Pooks Hill Road, Cedar Lane) and relocating two stations (Gude Drive, Shady Grove Road), their rationale is sound.

6. **Conduct additional traffic evaluation and mitigation to determine whether it is feasible to convert general purpose traffic lanes to transit only lanes to reduce the cost and impacts of the project without creating excessive traffic delay.**

Converting general purpose traffic lanes to transit only lanes can reduce the cost and property impacts of implementing BRT. As an example, the Purple Line project originally proposed adding a two-lane median transitway on University Boulevard between Piney Branch Road and Adelphi Road in Prince George's County while preserving six general traffic lanes. After detailed traffic analysis, the project team and the Maryland State Highway Administration determined that they could reduce the cost and impacts of the Purple line project to private property on University Boulevard by converting two existing general purpose traffic lanes to a two-lane median transitway and by making additional traffic improvements on other nearby roads, including New Hampshire Avenue.

7. **Develop and implement interim improvements to Rockville Pike in White Flint to spur redevelopment and property dedication.**

Due to the high cost of right-of-way acquisition in Segment 2 (White Flint and Twinbrook), staff believes it would be unwise to implement BRT in this area until additional property dedication occurs. Understanding that current market conditions make redevelopment (and therefore property dedication) unlikely without transforming MD 355 from an auto-centric highway to a multimodal boulevard, staff recommends developing an innovative and exciting program of improvements to spur redevelopment by improving multimodal connections and implementing placemaking activities that create a buzz for Rockville Pike, including:

- White Flint Circulator Bus
- Streetscape Enhancements
- Off-Peak Parking

- Additional Protected Pedestrian Crossings
- Sidewalk Improvements along MD 355
- Bikeway Improvements on Side Streets

These improvements will be further considered as part of the White Flint Sector Plan's Metrorail Station Area study, which the Planning Department is scheduled to begin in the current fiscal year.

10. GLOSSARY OF BRT COMPONENTS

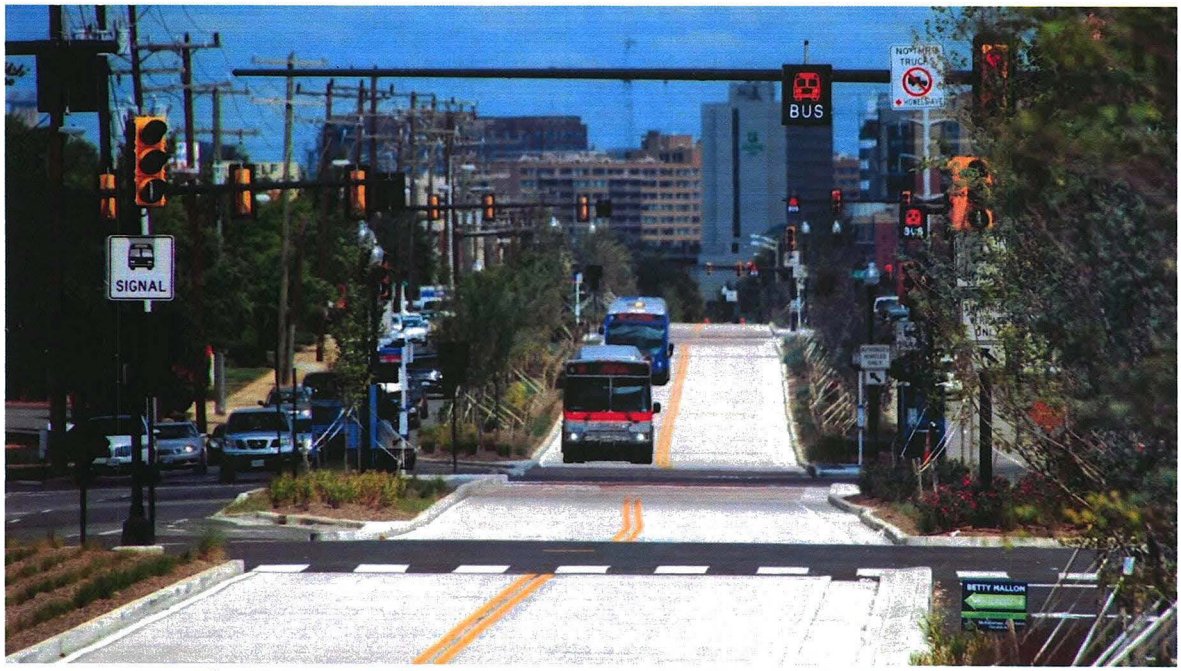
This section of the staff report provides a description of several BRT components, including transitway types, operational improvements and station enhancements.

10.1. Transitway Types

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

10.1.1. Dedicated Two-Lane Median Transitway

Two lanes located in the center of the roadway that are dedicated for use by the BRT vehicle and may be physically separated from traffic by a raised curb or median. Median BRT lanes minimize conflicts with general purpose traffic lanes and allow the BRT vehicle to travel with faster speeds and greater travel time reliability. To avoid conflicts with BRT vehicles, general traffic is only permitted to make left turns at signalized intersections. Two-lane median transitways require the most space and are therefore the most costly and impactful to implement. An example of a two-lane median transitway is the Metroway on US 1 in Alexandria.



The Metroway BRT Service Operates in a Two-Lane Median Transitway

10.1.2. Dedicated One-Lane Median Transitway

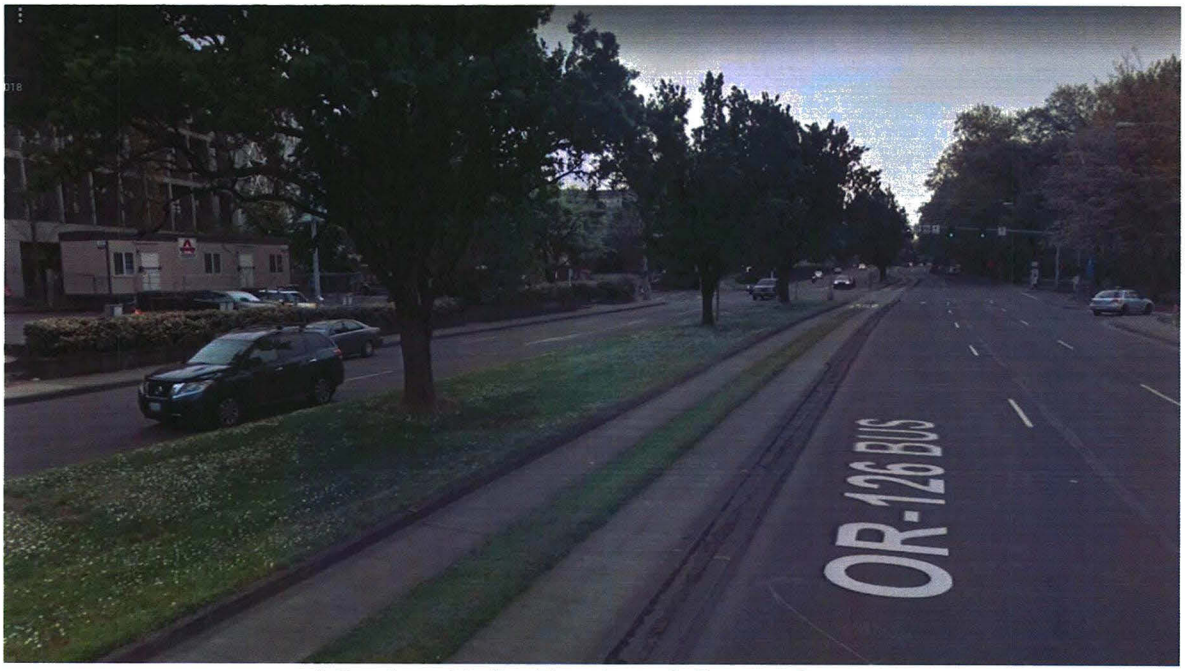
Multiple types of BRT operations are being considered utilizing a single BRT lane, including: bi-directional, fixed direction, and reversible transit operations.

In bi-directional operations, BRT vehicles traveling in both directions share a single dedicated lane in the center of the roadway. Since the BRT vehicles travel within this one lane in both directions, passing zones are created, generally at station locations, so BRT vehicles moving in opposite directions do not conflict with each other.

In fixed-direction operations, a single median BRT lane is used solely by the BRT vehicles in one direction. The BRT vehicles travel in general purpose traffic lanes in the other direction.

In reversible-direction operations, the direction of the BRT vehicle in the one-lane median varies depending on the time of day. BRT vehicles traveling in the peak direction use the median BRT lane and BRT vehicles traveling in the non-peak direction use the general traffic lanes. An example of a one-lane median transitway is the Emerald Express in Eugene, Oregon.

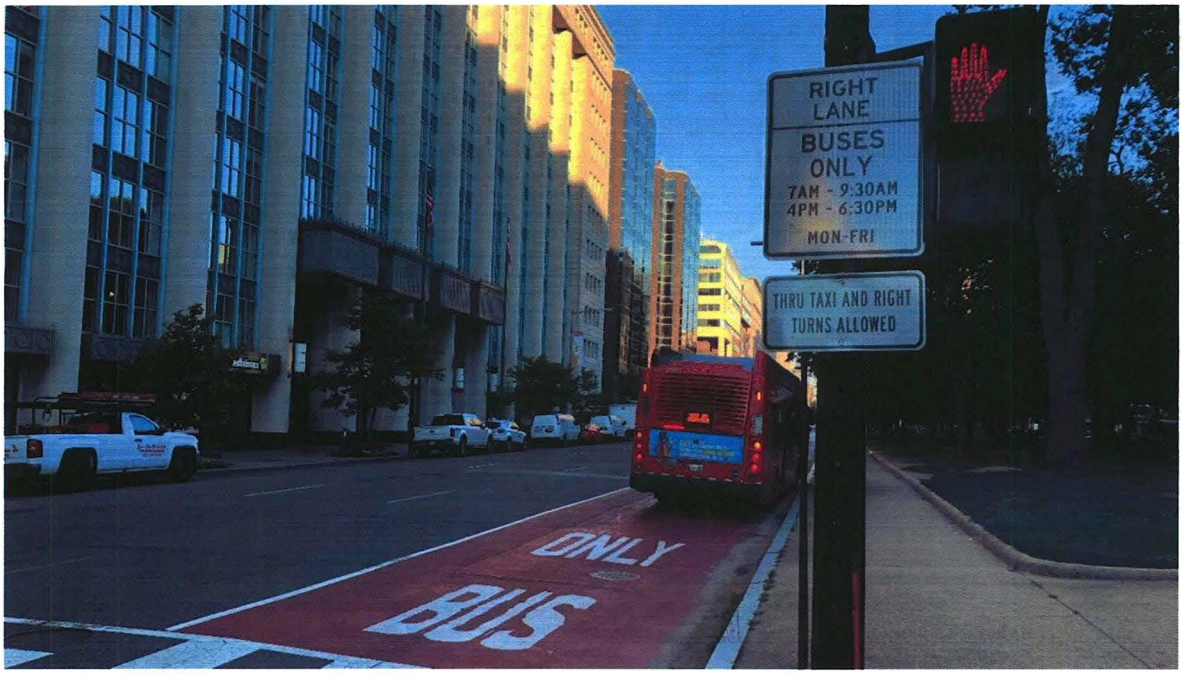
One-lane median transitways are most appropriate on roadways where the directional split of travel varies by the time of day. In the peak direction it provides fast speeds and reliability but is less costly and impactful than two-lane median transitways. On roads where the directional split of travel is balanced, one-lane median transitway result in slower speeds and less travel time reliability for the direction of travel that uses general traffic lanes.



A One-Lane Median Transitway in Eugene, Oregon

10.1.3. Dedicated Curb Lanes Transitway

The lanes adjacent to the curb are used exclusively by the BRT vehicle, 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. This transitway is less costly and impactful than the two-lane and one-lane median transitways, but speed and travel time reliability will suffer due to right turning vehicles and non-recurring congestion. An example of a curb lane transitway is in Washington, DC.



Curb Lane Transitway in Washington, DC

10.1.4. Mixed Traffic

The BRT vehicle travels in the same lanes as traffic. It would not have lanes dedicated for its use.

10.2. Operational Improvements

10.2.1. Transit Signal Priority

Transit Signal Priority (TSP) gives 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 vehicle 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.

10.2.2. 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.

10.3. Transit Vehicles

10.3.1. Premium Transit Vehicles

BRT vehicles offer a higher quality of service than typical transit vehicles.

The BRT Vehicle for the Metroway in Northern Virginia

10.3.2. Level Boarding

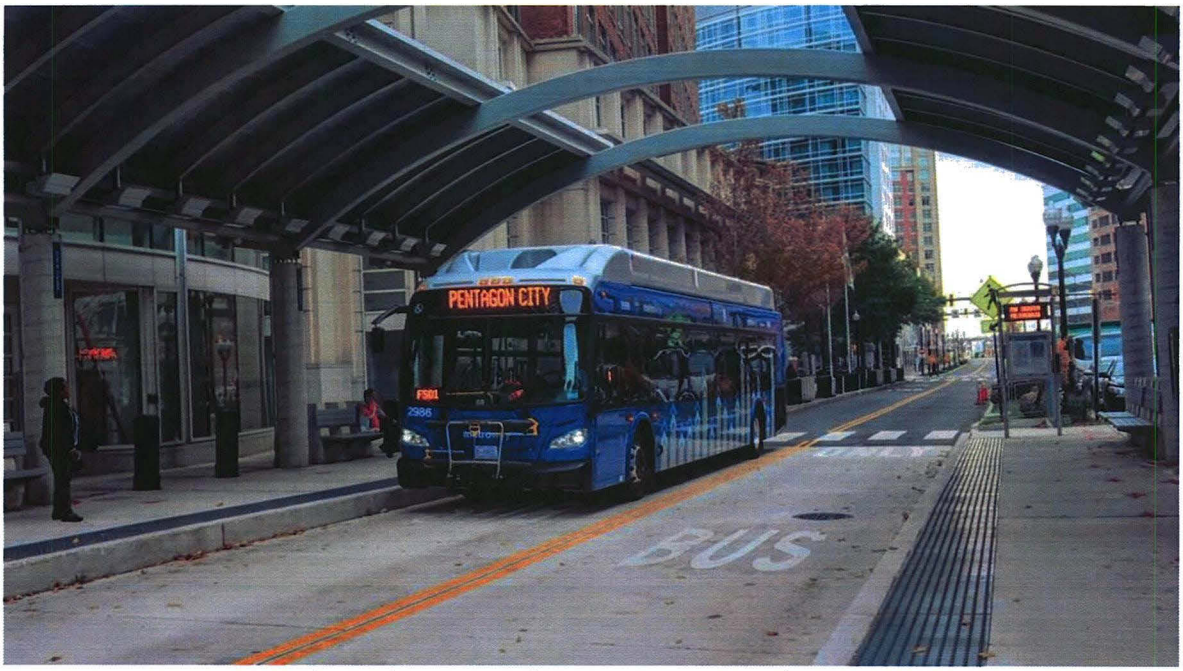
Like Metrorail, BRT services provides level boardings, which allows persons with mobility challenges to board the BRT vehicle more easily.

Level Boardings on the Emerald Express in Eugene, Oregon

10.4. Station Enhancements

10.4.1. Enhanced Stations

BRT services include enhanced stations with weather protection, seating, lighting, off-board fare collection, real time information displays, landscaping/hardscaping and bicycle accommodations.



An Enhanced Station on the Metroway in Crystal City, Virginia

10.4.2. Off-Board Fare Collection

Like Metrorail, BRT services collect fares from passengers before they board the vehicle, to reduce travel time delay.

Off-Board Fare Collection in Toronto, Canada

11. PUBLIC OUTREACH

Public involvement for this project included a series of Community Updates, Public Open Houses (winter 2018 and summer 2019), and Community Advisory Committee (CAC) meetings. These efforts were a continuation of the public outreach that were conducted as part of an earlier phase, 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.

In addition, the City of Rockville Mayor and Council and the City of Gaithersburg Mayor and City Council received briefings on the study on June 19, 2019 and June 10, 2019, respectively.

12. ATTACHMENTS

Attachment A: Draft MD 355 BRT Corridor Planning Study Phase 2 Report

Attachment B: BRT Alternative Descriptions

Attachment C: Segment 7 Alignments

Attachment D: Master Plan Consistency for Transitways

Attachment E: Master Plan Consistency for Station Locations

Attachment F: Additional Comments Transmitted by the M-NCPPC