



## MEMORANDUM: Phase II Technical Report

To:	Howard County Office of Transportation, Department of County Administration
From:	Sabra, Wang & Associates, Inc.
Subject:	Howard County Bus Rapid Transit Phase II Study Technical Report
Date:	April 5, 2016

This Technical Report documents the Howard County Bus Rapid Transit (BRT) Phase II Study effort, analysis, and results. The Phase II study is an extension of the previous conceptual Phase I effort performed to evaluate a Bus Rapid Transit network for the County, including linkages to other activity centers and transit systems in the Baltimore/Washington Region. The purpose of the Phase II study is to provide additional detail and rigor not part of the previous work, and filter/refine alternatives to a level that can be carried forward to the next stage of right of way design, environmental impact and preliminary engineering. The Phase II effort focuses on a Bus Rapid Transit (BRT) system within three primary corridors (US 29, Broken Land Parkway, and US 1), and examines specific route alignment and stations, ancillary feeder transit services, landside services such as park and rides and pedestrian accessibility, preliminary operating costs, and land use plans to support high quality transit service within and between them. The aim is to identify and evaluate the corridors and feasible alternatives that demonstrate the potential for attracting riders and receiving funding.

The Scope of Work provided initial alignments and station locations for each of the study corridors (US 29, Broken Land Parkway, and US 1). As part of the effort these were revised based upon alignment and station location feasibility analyses, potential intermodal and activity center connections, and ridership. Recommendations are detailed later in the report and include:

- Alignments: Inclusion of US 29 BRT branches to Clarksville and Broken Land Parkway Park and Ride Lots; Extension of the Broken Land Parkway BRT to Fort Meade and Odenton; Re-routing of the US 1 BRT to Arundel Mills and the Baltimore Washington International (BWI) Airport.
- Stations: Removal of the US 29 BRT US 40 and MD 32 stations due to land availability and connection issues; Addition of Broken Land Parkway stations to serve Fort Meade and Odenton; and addition of US 1 BRT stations to serve the BWI service area, and activity centers south of Laurel.
- Identification of stations with expected higher pedestrian and bicycle access markets (walkability).
- Revisions to the MTA commuter and local feeder /RTA bus services and new circulator/shuttle services to support the BRT system.

Based upon the recommended BRT system and feeder service, the study clearly documents a significant travel market and demand for high quality BRT From/To and within Howard County for each of the three corridors. New daily transit trips (linked) in 2035 from Howard County (production) over the No-Build are 9,080, and to Howard County (attractions) are 12,579. Forecast daily BRT boardings for trips to and from the BMC region in 2035 are 18,222 for US 29, 20,266 for US 1, and 18, 213 for Broken Land Parkway. Other findings are:

- There is significant demand from the Northern most stations (Mount Hebron and Long Gate) due to their proximity to I-70, and the new travel markets that this opens up.
- The network connections and the “system” connectivity offered by tying the 3 corridors together to major activity centers and regional fixed-rail transit networks expand connectivity and open up new travel markets (Arundel Mills, University of Maryland, BWI, etc.).
- Much of the demand is for the drive access/park and ride transit users which generates significant demand for park and ride lots.
- Recommended next steps include:
  - Coordination with Montgomery County (US 29), Prince George’s County (US 1), Anne Arundel County (US 1/ Broken Land/ 32)
  - Entry into Preliminary Engineering for determining: Dedicated ROW where needed to provide reliable transit speeds/ quality of service; Access/Egress to guideway at key locations; and Station costs/ parking supply/ ROW preservation
  - Consideration of interim commuter service enhancements (e.g. Bus on Shoulder)

The remainder of this Technical Memorandum is organized as follows:

- Project Background
- Proposed Bus Rapid Transit System
  - Corridors, and Alignments
  - Stations
  - MTA, Local, and Feeder Services
- Travel Forecasting
  - Model Run Scenarios
  - Land Use/Demographics
  - Service Policies
  - Ridership
  - Performance Measures
  - Costs (Rolling Stock and Operations and Maintenance)
  - Summary of Findings and Next Steps.

Each of the above is detailed in the sections that follow. Appendixes providing previous technical memorandum and details on the ridership model, route alignment analyses, and station area land use and access are also included.

## **1 Project Background.**

*PlanHoward 2030*, the county’s general plan calls for the development of a feasibility study of a BRT system that provides connections to major origins and destinations and as an alternative to auto travel both within Howard County and neighboring counties. As an initial step in the feasibility assessment, a conceptual regional BRT system was defined and documented early 2012 in *Howard County BRT – Concept Plans and Preliminary Cost Estimates for the Envisioned System (April 20, 2012)*. However, this high level study did not include analyses of ridership, parking, operating costs, feeder service development, or the cost effectiveness of each corridor.

Consequently, the Phase I, Howard County BRT Sensitivity Analysis was initiated in the Summer of 2012 with an objective to “determine the most viable BRT corridor presented in the April 2012 report in terms of measures of effectiveness and cost per person trip” (Kick-Off Meeting Minutes, July 10, 2012 Meeting). The Howard County BRT Phase I study (Howard County Countywide Bus Rapid Transit System Travel Forecasting Study; Sabra, Wang and Associates Inc.; 2013), screened and analyzed a number of

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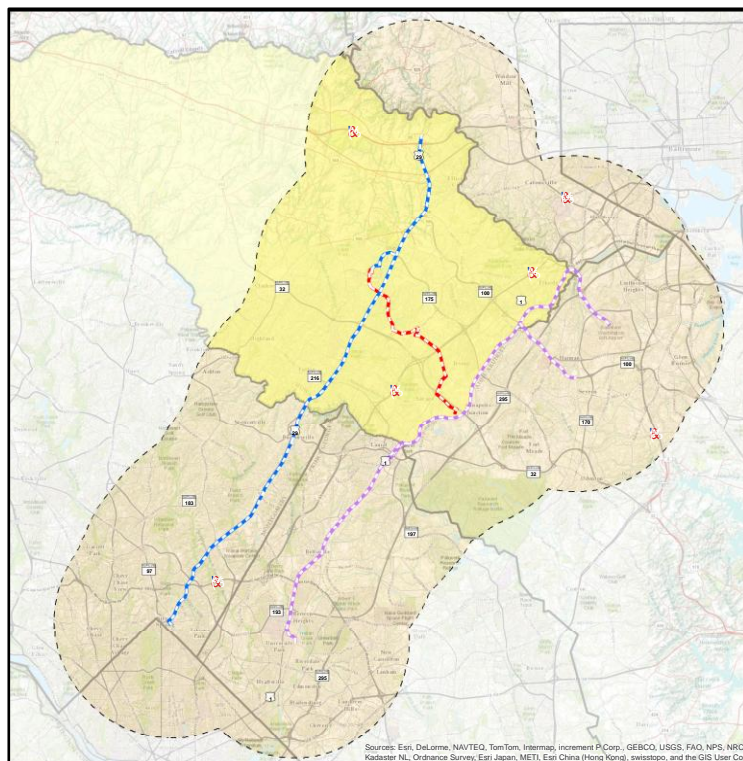
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BRT corridors within and to-from Howard County (US 29, Broken Land Parkway, MD 100, MD 216, and MD 32). It recommended US 29 and Broken Land Parkway as viable corridors that should be targeted for further study and implementation: “The characteristics along US 29 and on Broken Land Parkway would likely support a BRT system that would offer competitive travel options and attract significant ridership”. It also recommended in its next steps that the “possibility of BRT along the US 1 corridor should be explored, given the proximity to rail stations and redevelopment potential.” Another crucial recommendation from the Phase I report enhancing coordination with neighboring jurisdictions (particularly Montgomery County), the State Highway Administration, and the Maryland Transit Administration because any BRT implemented in Howard County is likely to cross boundaries and inter-jurisdictional travel.

The Phase I study did provide initial ridership and cost-effectiveness measures and identify potential corridors for further study. However, it was performed at a high level in order to screen the potential corridors and did not address the feasibility of specific alignments or station locations, parking demand and locations, walk and bicycle station access and amenities, feeder bus design, transit oriented development, and the system/network connectivity of the recommended BRT network.

Therefore, this Phase II effort was initiated to build upon the Phase I study and recommendation. The kick off meeting building took place on June 23, 2014. The purpose of the overall study is to provide additional detail and rigor not part of the previous work, and filter/refine alternatives to a level that can be carried forward to the next stage of right of way design, environmental assessment, and preliminary engineering. The Scope of Work for this Phase II Study provides for the inter-jurisdictional coordination and identification of the BRT system corridor alignment(s) and the BRT station locations within the US 29, US 1 and Broken Land Parkway corridors and identified initial alignments and station locations as:



**Figure 1 Initial Howard County Phase II BRT Corridors and Stations (SOW)**

- US 1: From the College Park Transportation Center (Metro Green Line, MARC Camden Line and future Purple Line) running north along US 1 with stations in south Laurel, downtown Laurel/ Laurel MARC, North Laurel, Savage, Jessup, Dorsey MARC Station, and Elkridge having a terminus of Baltimore/Washington/Thurgood Marshal Airport or Arundel Mills;
- US 29: From Silver Spring Transit Center running north along US 29 with stations in Four Corners, White Oak, Fairland, Burtonsville, Maple Lawn, Route 32, Town Center, Long Gate, US 40 West and Mount Hebron
- Broken Land Parkway: From the Columbia Town Center running east along Broken Land Parkway, the CSX rail right-of-way to US 1 and MD 32 with stations at Stevens Forest, Snowden River, Gateway, US 1, and Savage MARC station

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Figure 1 shows the initial corridor definitions and 5 mile catchment area.

The original scope of the model development effort was to build upon the travel forecasting model, demographic data, and base transportation networks used for the initial Howard County BRT Study (Phase I) study and to refine this model for suitability to forecast the US 1 corridor BRT which was not examined in the previous effort.

In initial discussions with Howard County, Baltimore Metropolitan Council (BMC), and others it became apparent that the travel forecasting model and demographic data used for the Howard County BRT Phase I effort were out of date and would be questioned by the BMC and other regional partners if used for the study. This necessitated obtaining the most recent BMC Model 4.3 and Round 8 Cooperative Forecasts and updating networks, TAZ refinements, and model scripts for the for the Phase II study. This unanticipated effort caused the study to be divided into two phases. Phase IIa (Tasks 1 – 5 of the original scope) consists of the scope of work carried out in 2014 and early 2015 including:

- Regional Coordination
- Model Development, Enhancements and Validation
- Station Area Planning, BRT system alignments
- Service parameters and stations to be tested
- Feeder services

Phase IIb consisting of Tasks 6 – 9 of the original scope of work including the future (2035) No build and BRT I build alternative forecasts, system performance and cost analysis, a technical report was carried out during 2015 (after a hiatus to obtain for additional funding and notice to proceed with the remaining tasks). After reviewing the potential of focusing transit oriented development around stations beyond what is already approved with County zoning and/or site development proposals, it was determined that the analysis of an additional transit supporting land use scenario was not warranted and was therefore not carried out.

## 2 Proposed Bus Rapid Transit (BRT) System

### 2.1 Corridors and Alignments

The initial corridors, alignments and station locations were revised based upon parallel project and study review and significant stakeholder coordination with neighboring jurisdictions, the State Highway Administration concerning the US 29 Montgomery County BRT study, and the Howard County Planning staff. These are described in SWAI Memorandum *Howard County Phase II BRT System Alignments and Station Locations to Test, June 16, 2015* also provided as an Appendix. An additional coordination meeting with Howard County Planning staff took place on August 5, 2015 to integrate the from the station area planning, route, and more recent feedback on potential option recommendations and developments in neighboring jurisdictions (Montgomery County, Anne Arundel, and Prince George's). Highlights include:

- Additional station(s) along US 1 between College Park Metro and South Laurel to serve emerging activity centers along the corridor.
- Explore the extension of the Broken Land Parkway BRT service in mixed flow South to Fort Meade and the Odenton MARC Station, and coordinate with Anne Arundel County.
- Arundel Mills and the Maryland Live Casino are greatly underserved by transit and an alternative that connects these to the US 1 corridor BRT should be explored. Anne Arundel County asked about serving BWI and Arundel Mills along a common ROW.

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- Evaluate the park and ride sheds at all stations and incorporate more detailed station area bike and pedestrian planning in the study than was done in the Phase I effort.
- To capture the system connectivity, the BRT corridors would be modeled as a single transit system and not as individual model scenarios for each line.
- Removal of the US 29 BRT US 40 and MD 32 stations due to available real estate and access issues. How to serve the Johns Hopkins Applied Physics Laboratory should be explored (feeder service or diversion).
- Explore providing a peripheral (not at the Transit Center but possibly within walking distance) park and ride lot for Columbia Town Center connected by an mixed traffic extension of the Broken Land Parkway BRT service.

The resultant recommended BRT System is summarized in Table 1 includes the following alignments and stations:

- US 29 Corridor from Mount Hebron to the Silver Spring Transit Center with stations at Mount Hebron, Long Gate, Columbia Town Center, Maple Lawn, Burtonsville, Fairland, US 29 & Tech Road, White Oak Transit Center, Four Corners, and Silver Spring Transit Center. Due to the inability to locate a station and park and ride at US 29 and MD 32, BRT Service will run from the Broken Land Parkway and Clarksville Park and Ride Lots and enter the BRT ROW at MD 32 and US 29.
- Broken Land Parkway from a Park and Ride location near Columbia Town Center, through Columbia Town Center, to the Odenton MARC Station with stations at a Columbia Park and Ride, Columbia Town Center, Stevens Forest, Snowden River Parkway, Columbia Gateway, Jessup South, Savage and US 1 Savage MARC, Fort Meade, and Odenton MARC. Shuttle/circulators at Columbia Gateway and Fort Meade will also be assumed. The BRT would run in mixed flow or on the shoulder along MD 32 South of the Savage MARC station.
- US 1 from BWI to the College Park Transit Center. Stations include: BWI, BWI Business Park, Northrup Grumman, Consolidated Rental Car facility, Arundel Mills, Dorsey MARC Station, Jessup North, Jessup South, Savage, North Laurel, Downtown Laurel, South Laurel, Konterra, College Park North (IKEA), North University of Maryland, University of Maryland US 1 and College Park Transit Center. A branch to the Elkridge station will also be included in the initial runs.

Note, that where ever considered feasible a dedicated/ exclusive guideway was assumed in order to test the full potential of BRT to, from, and within Howard County. The proposed system and the right of way treatments assumed is shown in Figure 2. While exclusive premium service was assumed for Montgomery County and the other jurisdictions for planning purposes in this effort it is recognized that they will ultimately make their own regarding the service and type of guideway to implement within their borders.

Diagrams illustrating the schematic route network and intermodal connections along each corridor are also provided in an Appendix. Each of the corridors and its options are described below.



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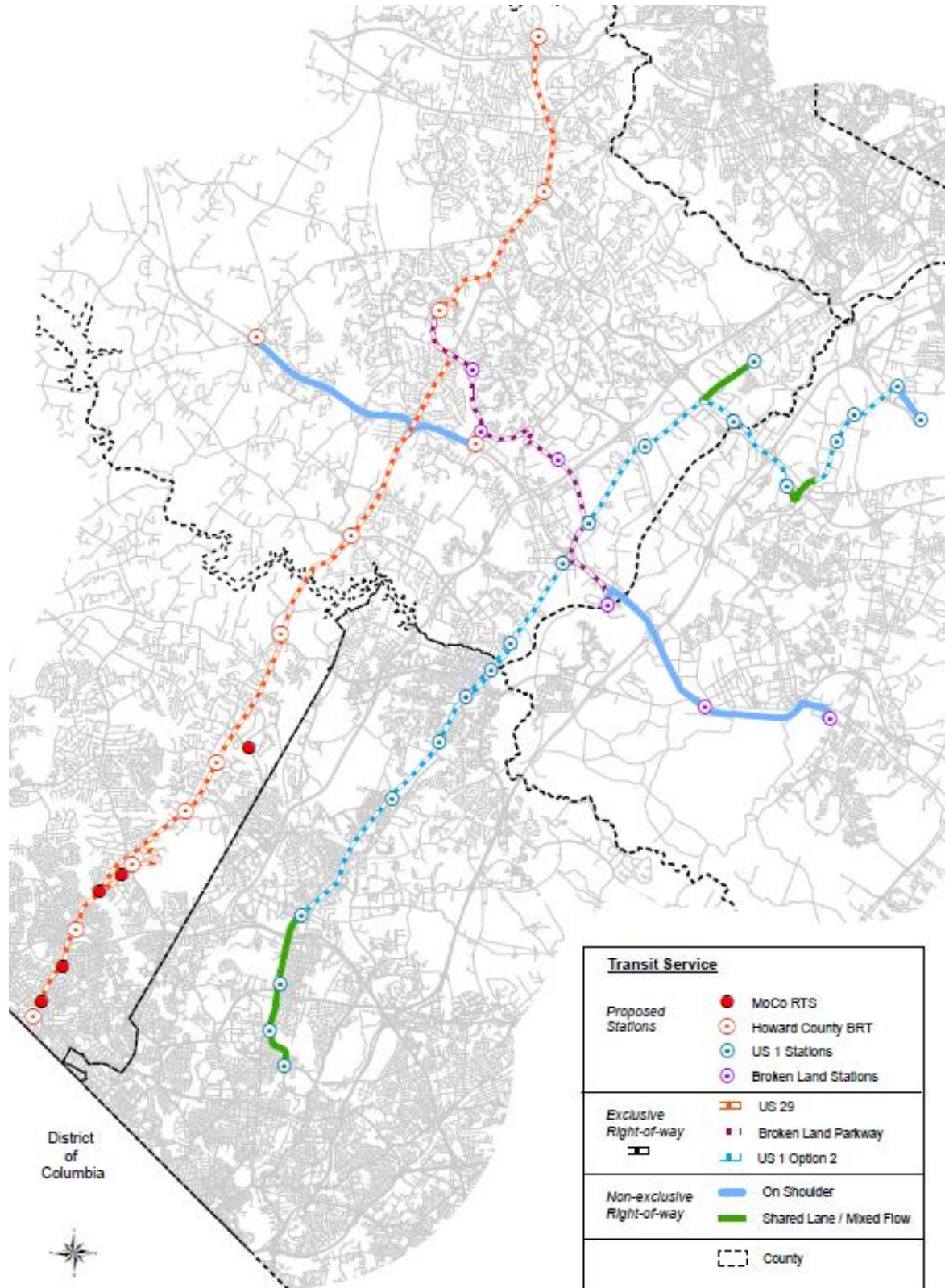
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**Table 1 BRT 1 Corridors, Stations, and Alignment Summary**

				Recommended Alignment					
Corridor	Alignment	North Terminus	South Terminus	Stations & ROW Treatment			Key Destinations	Intermodal Connections	
US 29	Primarily follows US 29	Mount Hebron	Silver Spring Transit Center	1	Mount Hebron	New w parking	Exclusive	Downtown Silver Spring, White Oak, Maple Lawn, Columbia Town Center, Long Reach/ Ellicott City	Long Gate P&R, Clarksville P&R, Broken Land Parkway P&R, Maple Lawn P&R, Burtonsville P&R, White Oak Transit Center  MTA, RTA, Ride On, Metrobus, Metrorail Red Line, Purple Line, MARC
				2	Long Gate	New w parking	Exclusive		
				3	Columbia Town Center	New w remote parking	Exclusive		
				4	Maple Lawn	New w parking	Exclusive		
				5	Burtonsville	Montgomery County BRT	Montgomery County BRT		
				6	Fairland	Montgomery County BRT	Montgomery County BRT		
				7	US 29 & Tech Road	Montgomery County BRT	Montgomery County BRT		
				8	White Oak Transit Center	Montgomery County BRT	Montgomery County BRT		
				9	Four Corners	Montgomery County BRT	Montgomery County BRT		
				10	Silver Spring Transit Center	Montgomery County BRT	Montgomery County BRT		
				11	MD 32 Clarksville P&R	Enhanced	On Shoulder		
				12	MD 32 Broken Land Pkwy P&R	Enhanced	On Shoulder		
US 1	Yellow Line Options. Alternative routing from BWI to Arundel Mills via New Ridge Rd and Aviation Blvd with three additional stations along New Ridge Rd and Aviation Blvd in Anne Arundel County. Addition of an Elkridge spur & station only if demand warrants.	BWI Airport	College Park Metro Station	1	BWI Airport	Enhanced	On Shoulder	College Park/ Univ of MD, Laurel, Savage, BWI Airport	North Laurel P&R, Savage P&R  MARC, Metrobus, Metrorail Green Line, Purple Line, Shuttle UM, The Bus, RTA, MTA, Central Light Rail Line
				2	BWI Business Park	New w parking	On Shoulder Exclusive		
				3	Northrup Grumman	New/ w parking	Exclusive		
				4	Rental Car Facility	New	Exclusive Part in mixed flow		
				5	Arundel Mills	New/ w parking	Exclusive		
				6	Dorsey MARC	Enhanced	Exclusive		
				7	Jessup North	New/ w parking	Exclusive		
				8	Jessup South	New/ w parking	Exclusive		
				9	Savage	New/ w parking	Exclusive		
				10	North Laurel	New/ w parking	Exclusive		
				11	Laurel Marc	Enhanced	Exclusive		
				12	Downtown Laurel	New	Exclusive		
				13	South Laurel	New/ w parking	Exclusive		
				14	Konterra	New/ w parking	Exclusive		
				15	College Park North	New	Shared Lane		
				16	N. U of MD	New	Shared Lane		
				17	U of MD Route 1	New	Shared Lane		
				18	College Park Metro	Use Wmata Station	Shared Lane		
				19	Elkridge extension	New with Parking	Shared Lane		
Broken Land Parkway	Extend service along MD 31 east to MD 175 to Odenton Town Center/ MARC	Columbia Town Center	Savage MARC Station	1	Columbia Town Center	New w remote parking	Exclusive	Columbia Town Center, Snowden River Commercial Corridor, Savage	MTA, MARC, RTA, Broken Land P&R, Savage P&R
				2	Stevens Forest	New w parking	Exclusive		
				3	Snowden River Parkway	New w parking	Exclusive		
				4	Columbia Gateway	New	Exclusive		
				5	Jessup South	New w parking	Exclusive		
				6	Savage	New w parking	Exclusive		
				7	Savage MARC	Enhanced	On Shoulder		
				8	Fort Meade	New	On Shoulder		
				9	Odenton Town Center/ MARC	Enhanced	On Shoulder		

Figure 2 Proposed BRT System by Type of ROW Treatment



### **2.1.1 US 29 Corridor**

The US 29 Corridor extends from Mount Hebron to the North to the Silver Spring Metro Station to the South. The initial option is similar to the recommended service from the Phase I study. Within Howard County an exclusive right of way premium BRT service will be assumed for the BRT analysis with stations at Mount Hebron, Long Gate, Columbia Town Center, and Maple Lawn. Unconstrained parking capacity will be assumed for all of the stations within Howard County in the initial exploratory travel forecasts. Due to access issues and lack of land at MD 32 BRT service will start at the Broken Land and Clarksville Park and Ride Lots, run on the shoulders or in mixed traffic along MD 32 and enter the US 29 BRT at the MD 32 interchange. Figure 3 shows the US 29 Corridor and station locations.

Within Montgomery County the alignment and station locations consistent with the Montgomery County US 29 BRT study and the Montgomery County Transit Functional Master Plan will be assumed. However, as shown in Figure 3 the initial option the Howard County BRT will only make limited stops at the BRT stations serving major activity centers or transfer points. These include Burtonsville, Fairland, US 29 and Tech Road, White Oak Transit Center, Four Corners, and the Silver Spring Transit Center. Within Montgomery County, ROW treatments consistent with the Montgomery County US 29 BRT study will be assumed as they are determined.

Note: Briggs Chaney is not on the BRT right of way and neither option will provide service to/from the Briggs Chaney station due to the additional time it would take to make the diversion.

### **2.1.2 US 1 Corridor**

The US 1 Corridor extends from BWI and Arundel Mills in the North to the College Park Transit Center in the South. Figure 4 shows the initial alignment and stations for the US 1 alignment from BWI to the College Park Transit Center. An exclusive guideway is assumed along US 1 from the BWI to the I-495 Beltway in Prince George's County. Stations include: BWI, BWI Business Park, Northrup Grumman, the Consolidated Rental Car facility, Arundel Mills, The Dorsey MARC Station, Jessup North, Jessup South, Savage, North Laurel, Downtown Laurel, South Laurel, Konterra, College Park North (IKEA), North University of Maryland, University of Maryland US 1 and College Park Transit Center. The additional stations south of South Laurel have been added to serve the activity centers and land use concentrations along the route.

For North US 1 there is considerable interest from both Howard and Anne Arundel Counties to explore an alternative alignment that connects Arundel Mills and BWI along New Ridge Road. This has therefore become the chosen alignment to the North. It is based upon the 2005 BWI to Dorsey Corridor Preservation Study which examined extending the Yellow Line LRT from BWI to Arundel Mills, to the Dorsey MARC Station. Using aerial views in Google Earth and site visits it was determined that the original preferred alignment from that study is no longer feasible, especially as it enters and exits Arundel Mills. Consequently a feasible option was developed using New Ridge Road. Stations from the Anne Arundel study included in this option are the BWI Business Park and Northrup Grumman. The Consolidated Rental Car facility is also included as a station.

An additional extension from Jessup North to Elkridge will also be included in this option.

### **2.1.3 Broken Land Parkway Corridor**

The alignment and stations for the Broken Land Parkway Corridor are shown in Figure 5 and Figure 6. This corridor provides critical connectivity between the US 29 BRT service, and the US 1 Corridor allowing riders from both to reach both BWI, the University of Maryland, and the Silver Spring Transit Center. It runs from the Columbia Town Center to the North to the Savage MARC station to the South,



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and provides transfers to the US 1 BRT at Jessup South and the US 1 Savage stations. It also would be an exclusive guideway service.

Figure 6 shows the Broken Land Parkway service South of the Savage MARC Station. This is assumed to be in mixed traffic to serve both Fort Meade at its existing gate (with transfers to the Fort Meade shuttles), and then on to the Odenton MARC station. This option has been reviewed for feasibility and may require additional bypass lanes (queue jumpers) or bus on shoulder operations to maintain acceptable travel speeds. Whether these are needed will be part of the analysis of the initial run.

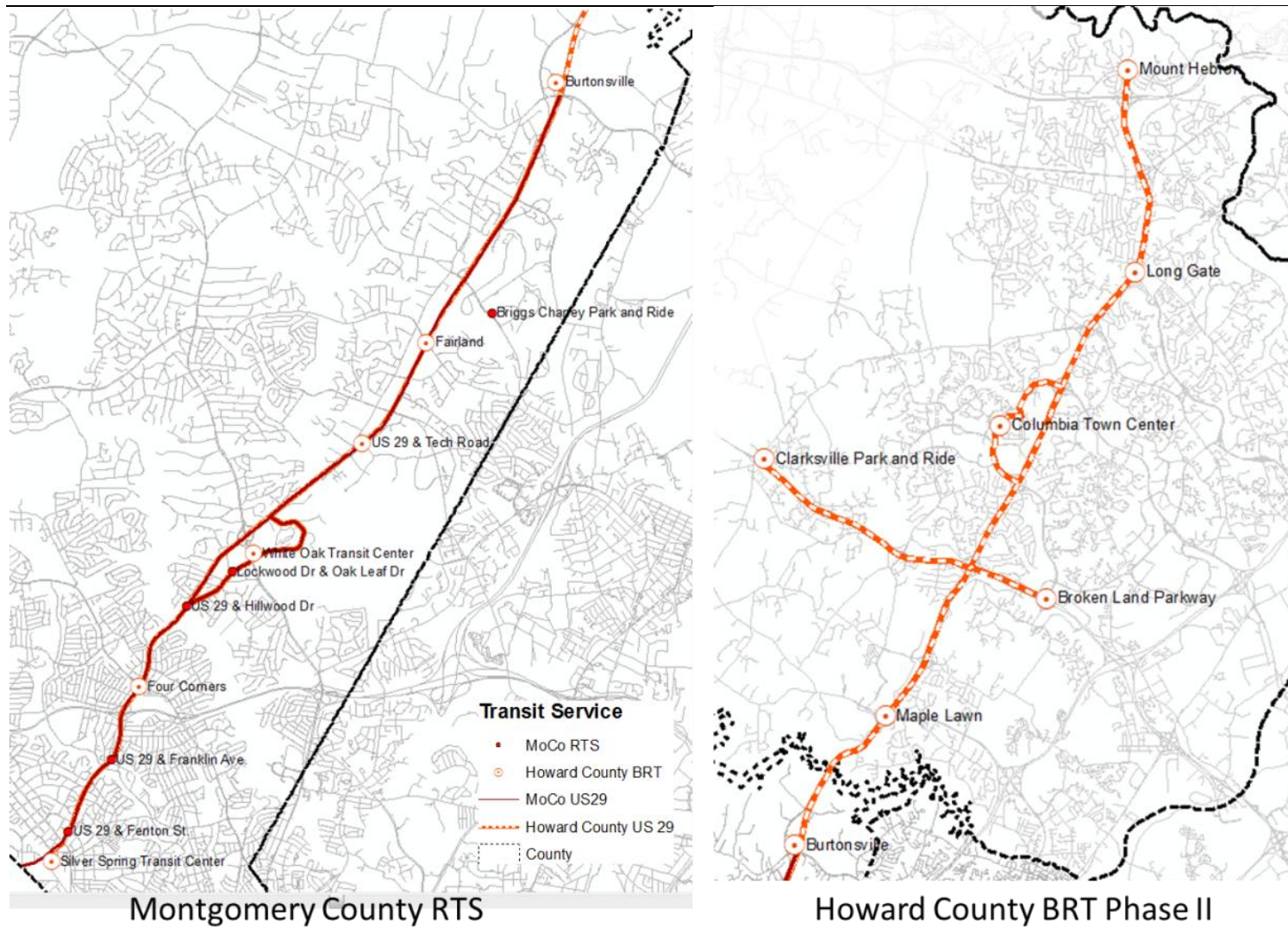
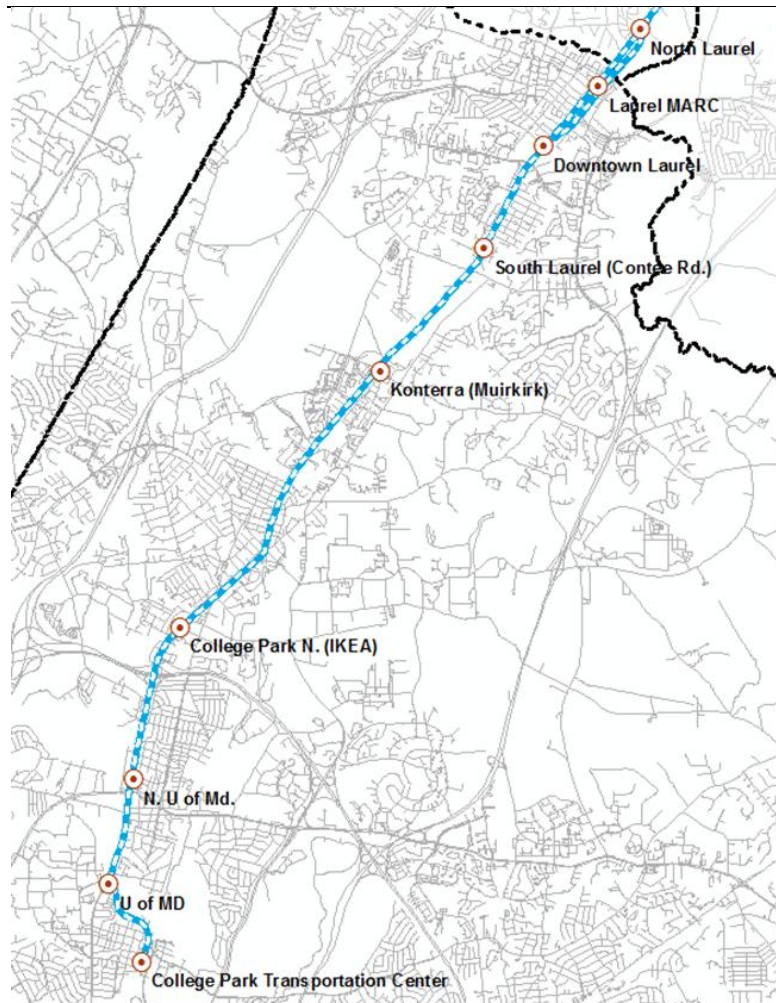
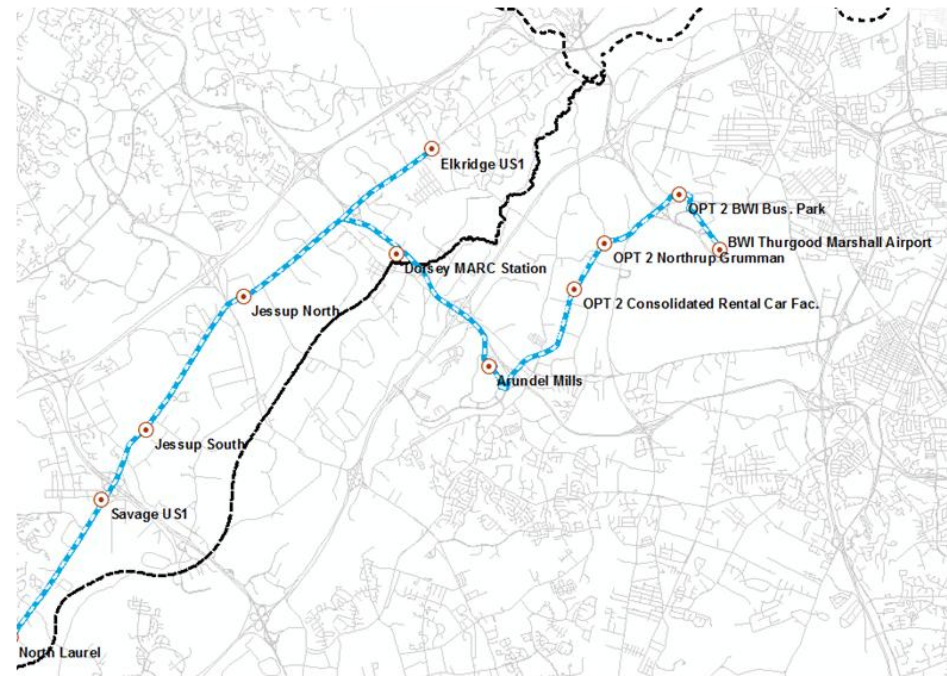


Figure 3 US 29 Corridor Potential Alignment and Stations



South (Prince George's Co.)



North (Howard and Anne Arundel Co.)

**Transit Service**

- US 1 Stations
- US 1
- - - County

Figure 4 US1 Alignment and Stations



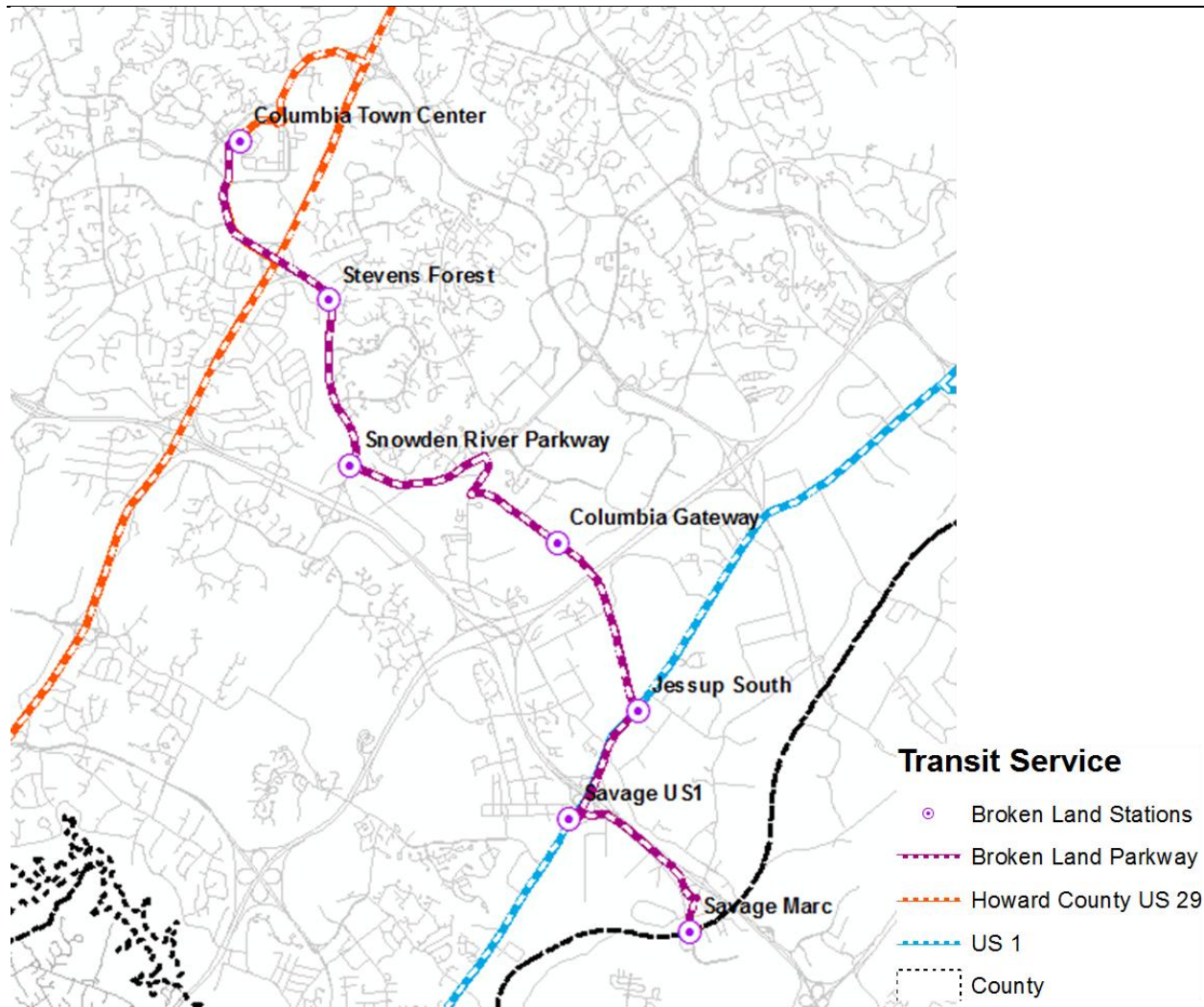
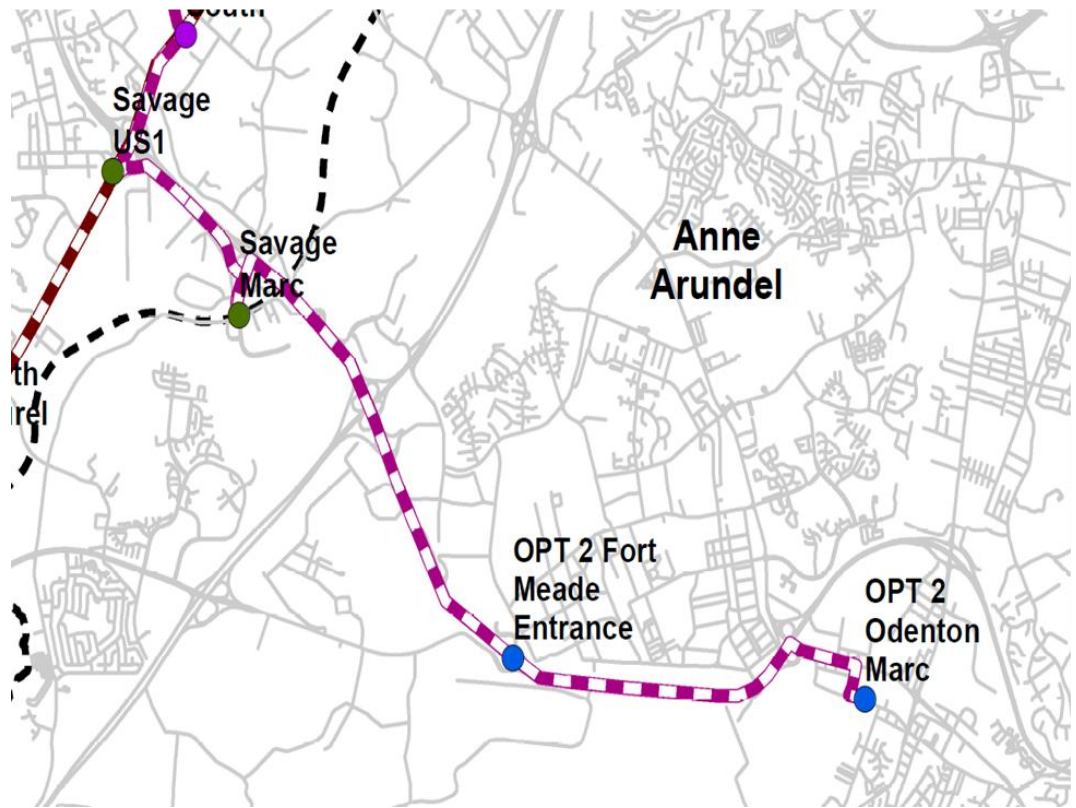


Figure 5 Broken Land Parkway Corridor Potential Alignment and Stations





- Extend service (20 minutes) from Savage Marc Station to Odenton Marc Station
- In mixed use along US 32
- Additional Stations
  - Fort Meade Entrance
  - Odenton Marc

Figure 6 Broken Land Parkway Corridor Extension

## 2.2 Station Area Planning

To support the modeling process, an overview was prepared of each of the 16 proposed BRT stations within Howard County. Each station area has been evaluated by Sabra, Wang and Associates (SWA) based upon the role that the station would play within the overall BRT system and the development pattern in the vicinity of each station with a particular emphasis on walkability. For each station, the key connections that should be the focus of future station access planning efforts have been identified.

This is described in detail in *SWAI Memorandum, Howard County BRT Phase II Station Area Planning Overview, June 12, 2015* (updated to account for Clarksville and Broken Land Parkway Park and Ride Lot Stations, February 23, 2016) which is attached as an Appendix.

That memorandum describes each station location, surrounding area characteristics and development patterns, parking, pedestrian and bicycle accessibility/walksheds, and key connections to the road network. For planning purposes, the stations are described to have one of the following roles: collector, distributor, mixed-use activity center, minor activity center or transfer point. This is shown in Table 2

**Table 2: Station Roles**

Station Roles	Description	Ridership Pattern	Importance of Access Facilities for:		
			Park & Ride/ Kiss & Ride	Connecting Bus Routes	Pedestrian/ Bike
Collector	<ul style="list-style-type: none"> <li>Focused on providing peak-period access to the transit system for commuters.</li> <li>Access emphasis is on parking facilities and transfers from feeder bus to BRT.</li> </ul>	<ul style="list-style-type: none"> <li>High boardings in AM peak</li> <li>High alightings in PM peak</li> <li>Little ridership outside of peak periods</li> </ul>	●	●	○
Distributor	<ul style="list-style-type: none"> <li>Similar to Collector, but at the employer end of commute trips.</li> <li>Focus is on providing transfers to last-mile feeder bus service to major employment centers.</li> </ul>	<ul style="list-style-type: none"> <li>High alightings in AM peak</li> <li>High boardings in PM peak</li> <li>Little ridership outside of peak periods</li> </ul>		●	○
Mixed-Use Activity Center	<ul style="list-style-type: none"> <li>Stations in densely developed areas with a mix of uses including employment, retail, and possibly entertainment.</li> <li>Destinations are within walking distance of the station.</li> </ul>	Ridership more distributed throughout the day, with less pronounced peak periods		○	●
Minor Activity Center	Similar to mixed-use activity center on a smaller scale, with less complete mix of uses.	Ridership more distributed throughout the day, with less pronounced peak periods		○	●
Transfer Point	Location with opportunities to transfer to other major regional transit service, such as subway, light rail or commuter rail.	Dependent on the service pattern of the connecting transit service	○	●	●

● = primary importance; ○ = secondary importance

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A summary of the Howard County stations and their status is provided in Table 3. More details are provided in the Appendix. Note, that it was decided that there is little opportunity to promote focused development around the planned stations, that is not already planned, or will occur naturally. Therefore, a separate transit oriented land use scenario was not investigated further as part of this effort.

**Table 3 Station Area Analysis Summary**

Corridor	Howard County Station	Status	Station Role	Parking	Walk/Bike	Development Potential	Needs
US 29	Mount Hebron	New	Collector	Parking	Limited	Low	Pedestrian connections shuttle/feeder
	US 40	Dropped due to access issues					
	Long Gate	New	Collector, Minor Activity Center	Parking	Limited	Medium Townhouse walk	Pedestrian connections shuttle/feeder
	Columbia Town Center	New	Mixed-Use Activity Center	Peripheral Parking	Good	High Part of Master Plan	Pedestrian, shuttle, Transfer Facility
	MD 32	Dropped due to land and access issues					
	Maple Lawn	New	Mixed-Use Activity Center	Parking	Good		Pedestrian connections shuttle/feeder
	MD 32 Clarksville P&R	Enhanced	Collector	Parking	Limited	Low	Pedestrian connections shuttle/feeder
	MD 32 Broken Land Pkwy P&R	Enhanced	Collector	Parking	Limited	Medium	Shuttle Feeder
US 1	Dorsey MARC	Enhanced	Collector, Transfer Point	Parking	Limited	N/A	Pedestrian connections shuttle/feeder
	Jessup North	New	Collector	Parking	Limited	Medium	Pedestrian connections shuttle/feeder
	Jessup South	New	Collector, Transfer Point	Parking	Limited	N/A	Pedestrian connections
	Savage	New	Collector, Transfer Point	Parking	Limited	N/A	Pedestrian connections
	North Laurel	New	Mixed-Use Activity Center	Parking	Moderate	High Mixed Use Dev. Planned	Pedestrian connections shuttle/feeder
	Elkridge extension	New	Collector	Parking	Moderate	N/A	Pedestrian connections shuttle/feeder
Broken Land Parkway	Columbia Town Center	New	Mixed-Use Activity Center	Peripheral Parking	Good	High Part of Master Plan	Pedestrian, shuttle, Transfer Facility
	Stevens Forest	New	Collector, Minor Activity Center	Parking	Limited	N/A	Pedestrian connections shuttle/feeder
	Snowden River Parkway	New	Collector, Distributor	Parking	Poor	N/A	Shuttle
	Columbia Gateway	New	Distributor		Poor	N/A	Pedestrian connections shuttle/feeder
	Jessup South	New	Collector, Transfer Point	Parking	Limited	N/A	Pedestrian connections
	Savage	New	Collector, Transfer Point	Parking	Limited	N/A	Pedestrian connections
	Savage MARC	Enhanced	Transfer Point, Distributor	Parking	Poor	N/A	Marc Access Pedestrian connections Shuttle

### 2.3 MTA, Local and Feeder Service

Additional changes were made to the MTA, local and feeder transit service in order to support the BRT's ability to provide a complete transit alternative and people's ability to leave their cars at home and provide a cost effective system avoiding duplicative service. These changes were built upon a review of the current and planned service for 2035 and how it connected with the planned BRT station needs, provided additional transit access to the areas surrounding each station, or duplicated the new BRT service.

First, among the supporting service changes was a review and modification of the MTA Commuter Service to Downtown Silver Spring and Washington DC. Recommended changes to the MTA service include:

- MTA Commuter Route 929: As shown in Figure 7, the MTA 929 route was converted to a circulating shuttle the connecting Broken Land Parkway, Maple Lawn, and Columbia Town Center stations to their surrounding areas. It was also moved to the Regional Transit Authority of Central Maryland local service utilizing small 30 foot standard buses.

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- MTA Commuter Route 995 A, B, C: As shown in Figure 8 The MTA route 995 route Branch C to Clarksville Park and Ride was removed since it duplicates the US 29 BRT Clarkesville Branch. The 995 A and B branches were combined and the peak service was reduced to 1 trip per hour. This allows those that still want to take a 1 seat direct route to Downtown Washington DC to do so. Service was also extended to operate in both directions throughout the day.

No Build 2035

MC 929 A, B\_SB, B\_NB

BRT 1 2035

MC 929 A, B

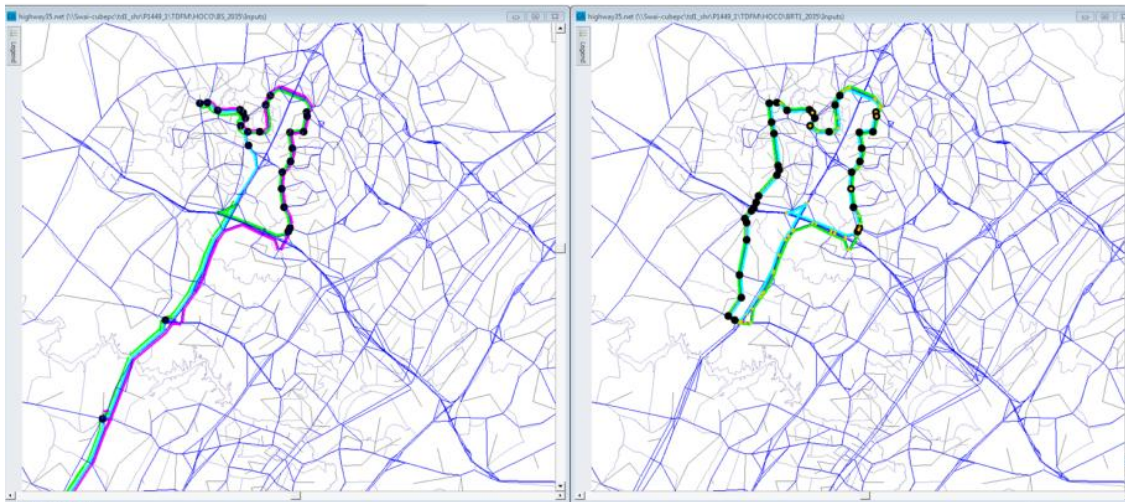


Figure 7 MTA 929 Route Changes

No Build 2035

MC 995 A, B, C

BRT 1 2035

MC 995 A, B (C dropped)

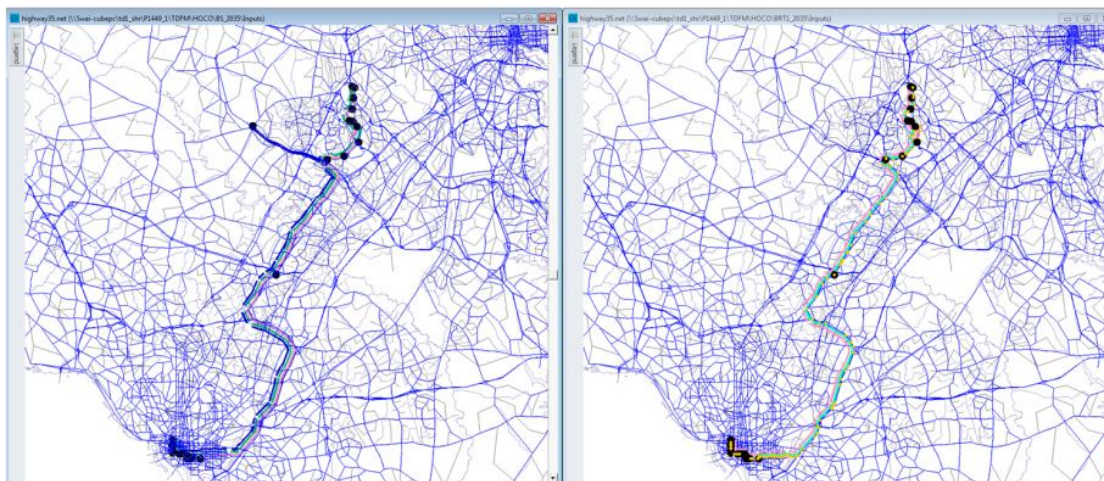
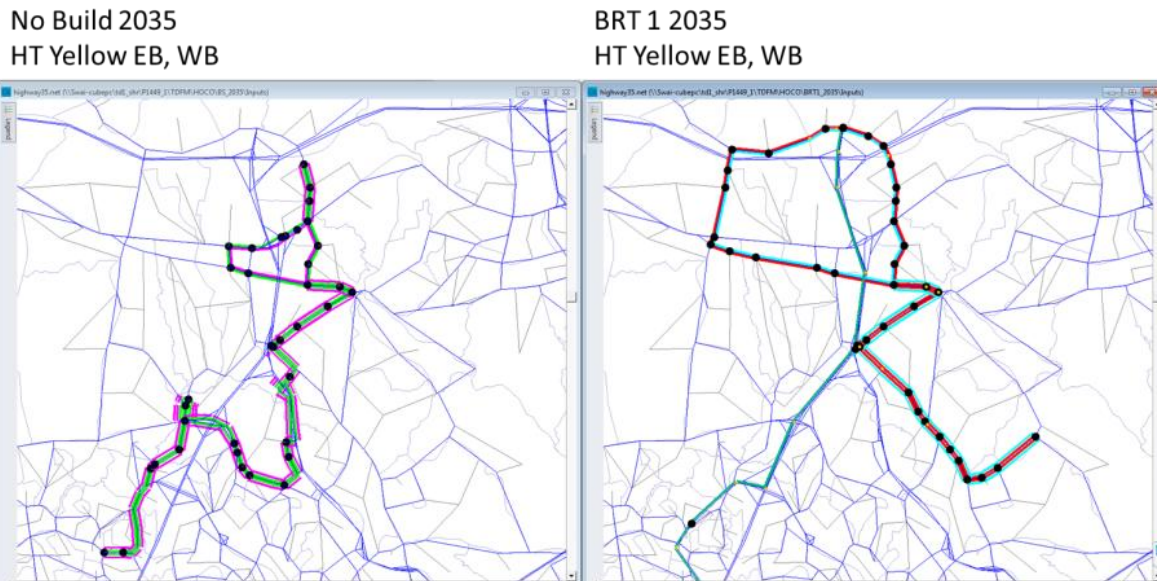


Figure 8 MTA 995 Route Changes

As shown in Service changes were also made to the Regional Transit Authority of Central Maryland's Howard Transit Yellow Line in order to provide additional first mile/last mile transit access to the Mount Hebron and Long Gate BRT Stations. Service was extended to the South West along MD 103 and Ilchester Rd and modified to provide circulating loop to the Mount Hebron Station. The portion South of Long Gate to Columbia Town Center was dropped since access to the Town Center will be provided by other circulators.

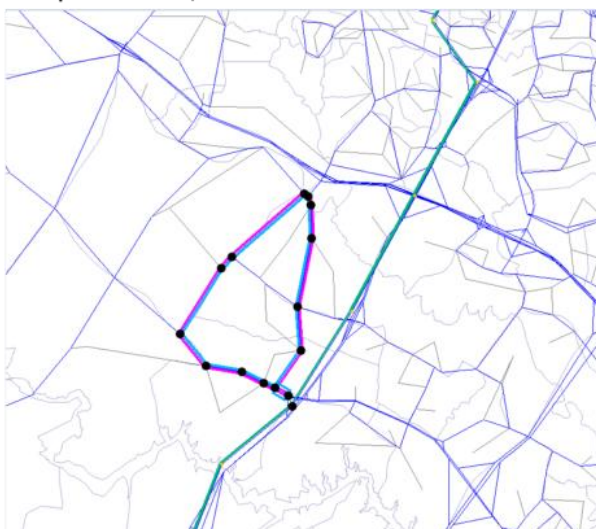




**Figure 9 Howard Transit Yellow Line Feeder Changes**

As recommended by stakeholders additional circulator service was also implemented to connect the Johns Hopkins Applied Physics Laboratory campus and surrounding development to the Maple Lawn station. This is shown in Figure 10.

**BRT 1 2035  
Maple Lawn A, B**



**Figure 10 Maple Lawn New Circulator**

Other changes incorporated into the BRT feeder service include:

- Reversed RTA of Central Maryland service coverage reductions (HT Purple, CTCJ, CTCKB)
- Added internal circulator for Fort Meade and Columbia Gateway (reflected in increased % walk)
- Routed all existing routes to BRT stations

### 3 Travel Forecasting

The process undertaken to develop and validate the Phase II travel forecasting model is described in the Technical Memorandum, "Howard County BRT Phase II Travel Forecasting Model Enhancements and Validation", January 17, 2015 which is provided as an Appendix. The most recently adopted BMC regional travel forecasting model (BMC model 4.3 utilizing the BMC Round 8 Regional Cooperative Land Use Forecasts) was used as a base model. Among the many efforts carried out by SWAI in regard to the model development and validation effort were:

- Addition of zone and network detail along each of the US 29, Broken Land Parkway, and US 1 corridors to better access to transit (walk, drive and feeder bus) to the BRT stations.
- Additional data development and GIS/database updates to account for the service changes caused by the formation of the RTA of Central Maryland in July, 2014, and updates to the Prince George's County, The Bus.
- Coordination and collaboration with the Montgomery County US 29 Rapid Transit System Project Corridor analysis, assumptions and forecasts which was examining BRT service within Montgomery County along US 29.
- Incorporation of the approved White Oak Science Gateway approved Master Plan land use for TAZs within the White Oak Master Plan in the 2035 nobuild and build scenarios. This land use data was shared by the Montgomery County US 29 BRT modeling team under contract with the Maryland SHA.

2035 was chosen for the horizon year for the travel forecasts since it was the horizon year for the BMC 4.3 model and Round 8 land use forecasts.

#### 3.1 Model Run Scenarios

This section provides the proposed travel forecasting analysis runs to examine the alignment options described in Section 2. The model runs carried out are shown in Table 1.

In addition to the 2010 base year, the original scope of work called for forecasting and analysis of three 2035 BRT System/Landuse Scenarios:

- 1) Base Case (No Build):
  - a. Currently assumed future land use (BMC Round 8a, Plan Howard 2030 data) (Task 2)
  - b. Base 2035 highway networks (Task 2)
  - c. Base 2035 transit networks and service levels (Task 2)
- 2) BRT System, Base Land use:
  - a. Currently assumed future land use (BMC Round 8a, Plan Howard 2030 data) (Task 2)
  - b. Base 2035 highway networks (Task 2)
  - c. Three-line Howard County BRT network/service with supporting access (feeder and local transit, park/kiss-n-ride, pedestrian/bicycle networks (Tasks 3, 4, and 5)

Two full forecasts are assumed for the case 2 forecasts. The outputs of the initial run were analyzed and used to revise the final run inputs. The results were then used for the Task 8 system performance and cost analyses. Note, that in order to gauge the full potential of premium BRT service from and to Howard County, premium fixed 2 way exclusive BRT ROW was presumed whenever it was deemed feasible. The BMC transit mode 4 representing this premium BRT service (equivalent to LRT) was also used to code the BRT alternatives.

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**Table 4 Travel Forecast Model Run Scenarios**

Forecast	Year	Regional Highway Network	Regional Transit Network	Demographic/Landuse	BRT Corridors			
					US 29	US 1	Broken Land Parkway	
Initial	1	2010	2010 BMC 4.3 + Corridor detail & TAZ splits	2010 BMC 4.3 + Corridor Detail & TAZ splits	BMC Round 8 + Corridor Detail & TAZ splits	Current (2010) Service	Current (2010) Service	Current (2010) Service
Validated	2	2010	2010 BMC 4.3 + Corridor detail & TAZ splits	2010 BMC 4.3 + Corridor Detail & TAZ splits	BMC Round 8 + Corridor Detail & TAZ splits	Current (2010) Service	Current (2010) Service	Current (2010) Service
Base (No Build)	3	2035	2035 BMC 4.3 + Corridor detail & TAZ splits	2035 BMC 4.3 + Corridor Detail & TAZ splits	BMC Round 8 + Corridor Detail & TAZ splits with White Oak Science Gateway from US 29 Mo. Co. study	2035 BMC 4.3 + Corridor Detail & TAZ splits	2035 BMC 4.3 + Corridor Detail & TAZ splits	2035 BMC 4.3 + Corridor Detail & TAZ splits
BRT System Initial	4	2035	2035 BMC 4.3 + Corridor detail & TAZ splits	2035 BMC 4.3 + Corridor Detail & TAZ splits	BMC Round 8 + Corridor Detail & TAZ splits with White Oak Science Gateway from US 29 Mo. Co. study	As described in Memo North: Mount Hebron South: Silver Spring TC Branches to Clarksville and Broken Land Parkway PNR	As described in Memo North: BWI to Arundel Mills on Yellow Line Alignment South: College Park TC	As described in Memo West: Columbia Town Center East: Extend service beyond Savage in Mixed flow to Odenton MARC station
Refine based upon Initial Run								
Adjust station locations, feeder bus, and balance demand to service								
Recommended BRT Alignment/Stations Base Land Use	5	2035	2035 BMC 4.3 + Corridor detail & TAZ splits	2035 BMC 4.3 + Corridor Detail & TAZ splits	BMC Round 8 + Corridor Detail & TAZ splits with White Oak Science Gateway from US 29 Mo. Co. study	As described in Memo North: Mount Hebron South: Silver Spring TC Branches to Clarksville and Broken Land Parkway PNR	As described in Memo North: BWI to Arundel Mills on Yellow Line Alignment South: College Park TC	As described in Memo North: BWI to Arundel Mills on Yellow Line Alignment South: College Park TC

### 3.2 Land Use/Demographics

As stated, the BMC Round 8.0 Cooperative Landuse Forecasts were used as a foundation for the BRT Phase II ridership forecasts. The Round 8.0 Cooperative Landuse Forecasts (adopted on August 27, 2013) incorporated information from the 2010 US Census. The BMC cooperative forecasting process utilizes information from each of the jurisdictions within the BMC region along with data from the MWCOG for the four jurisdictions within the MWCOG region (Montgomery County, Prince George's County, Frederick County, and Washington DC). Again, traffic analysis zones (TAZs) along each of the corridors were split divided to provide additional detail for capturing transit access. A summary of the land use and 2010 to 2035 percent growth is shown in Table 5. As shown, Howard County is forecast to have a 33.62 % growth in households but only a 21.30% growth in population. This indicates smaller families and an increase in single and two person households. Employment is growing faster than either at 38.77% indicating that commuting to Howard County may increase and/or some workers may remain within Howard County for their jobs. However, Montgomery County's Employment is increasing at a faster rate (44.35%) due in large part to the additional White Oak development. Montgomery County's households and population is also growing at a slower rate. This should indicate an increased demand for commuting from Howard County to Montgomery County, a prime travel market for the US 29 BRT.

**Table 5 Landuse Summary (2010 - 2035)**

Jurisdiction	2010			2035			Percent Growth (2010 to 2035)		
	Households	Population	Employment	Households	Population	Employment	Households	Population	Employment
Baltimore City	249,889	620,922	381,772	273,402	676,464	440,154	9.41%	8.95%	15.29%
Anne Arundel Co.	199,375	537,638	323,148	234,685	622,037	404,987	17.71%	15.70%	25.33%
Baltimore County	316,715	804,995	446,250	341,827	867,894	506,867	7.93%	7.81%	13.58%
Carroll County	62,406	167,134	70,890	71,305	186,180	83,003	14.26%	11.40%	17.09%
Harford County	90,218	244,826	104,670	113,578	291,853	157,191	25.89%	19.21%	50.18%
Howard County	104,751	287,083	181,381	139,965	348,243	251,709	33.62%	21.30%	38.77%
Baltimore Region	1,023,354	2,662,598	1,508,111	1,174,762	2,992,671	1,843,911	14.80%	12.40%	22.27%
Washington DC	266,707	601,723	783,460	326,410	741,181	955,757	22.39%	23.18%	21.99%
Montgomery County	359,041	964,722	508,615	453,180	1,188,833	734,108	26.22%	23.23%	44.33%
Prince George's	306,029	870,311	344,110	372,285	980,158	458,913	21.65%	12.62%	33.36%
Frederick County	84,800	233,385	98,695	113,895	311,705	112,302	34.31%	33.56%	13.79%
Washington Region	1,016,577	2,670,141	1,734,880	1,265,770	3,221,877	2,261,080	24.51%	20.66%	30.33%
Model Region	2,039,931	5,332,739	3,242,991	2,440,532	6,214,548	4,104,991	19.64%	16.54%	26.58%

Note, that the Round 8 land use control totals for each jurisdiction and original TAZ were maintained for the 2010 and 2035 horizon year with one exception. For 2035 the land use from the adopted White Oak Science Gateway was incorporated into the White Oak Master Plan TAZs. This added an additional 10,558 in population, 3,875 households, and 21,311 in employment in the White Oak area over the BMC Round 8 2035 land use. This additional growth in White Oak increased commuting to/from the White Oak area and Howard County and caused other shifts in travel patterns.

The concentration and density of households, population, and employment along a potential transit corridor are important for its successfully attracting high ridership. Consequently, Figure 11 shows the population, households, and employment within 5 miles of the Phase II BRT system. Of note is the concentration of development and density along the complete US 1 corridor indicating that it has high potential. Likewise, the employment concentrations in White Oak, Columbia Town Center and Gateway, Mort Meade, Arundel Mills, and of course Silver Spring, and College Park stand out as attractors.

Percent Growth is also an indicator of emerging markets for future transit use. Figure 12 highlights the forecast growth in households and employment between 2010 and 2035. White Oak along US 29 and Kontera and the MD 100 to BWI corridor along US 1 stand out. In Howard County, there is high growth in Maple Lawn, around the Columbia Town Center, and along I-70 to the West of Mount Hebron.



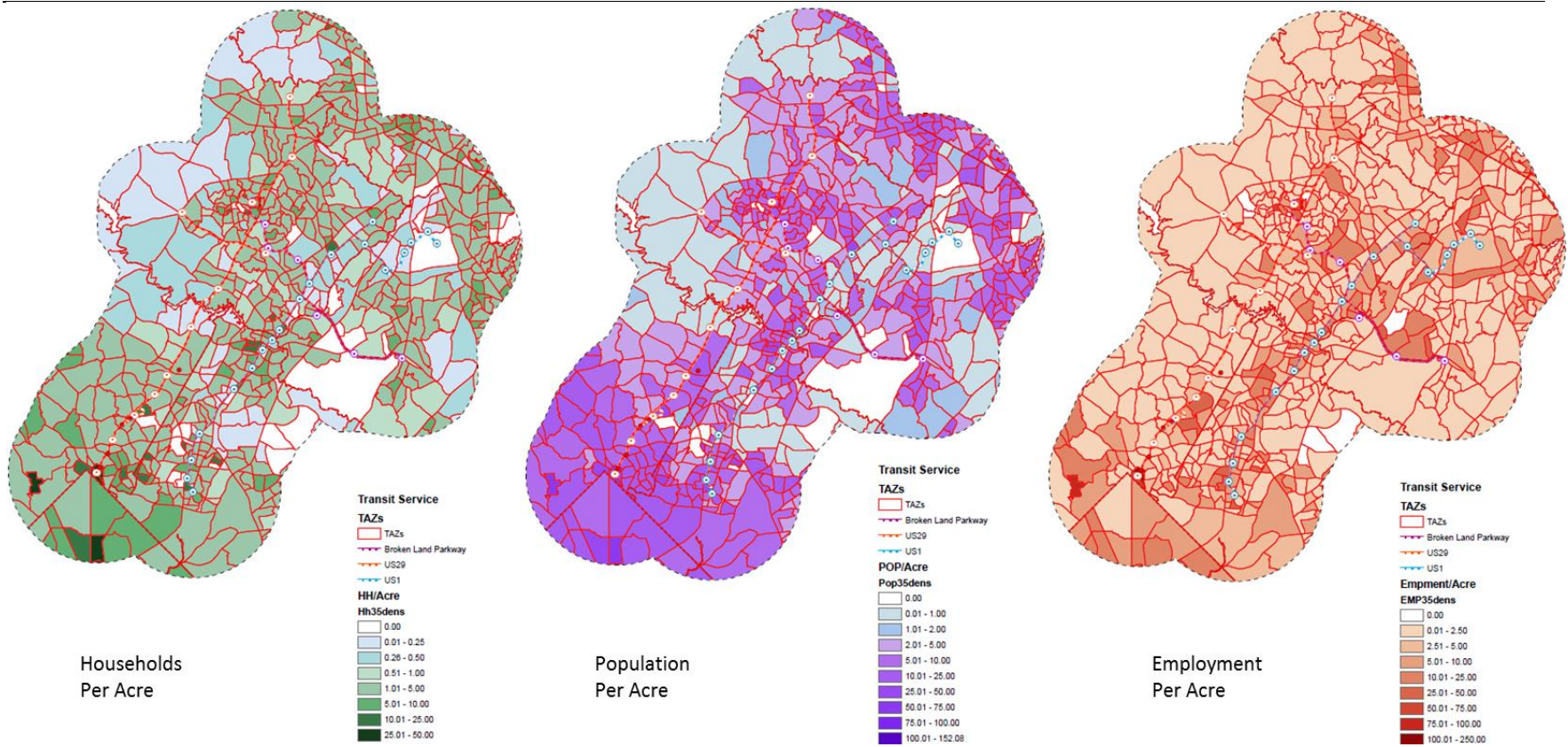


Figure 11 2035 Land Use Densities

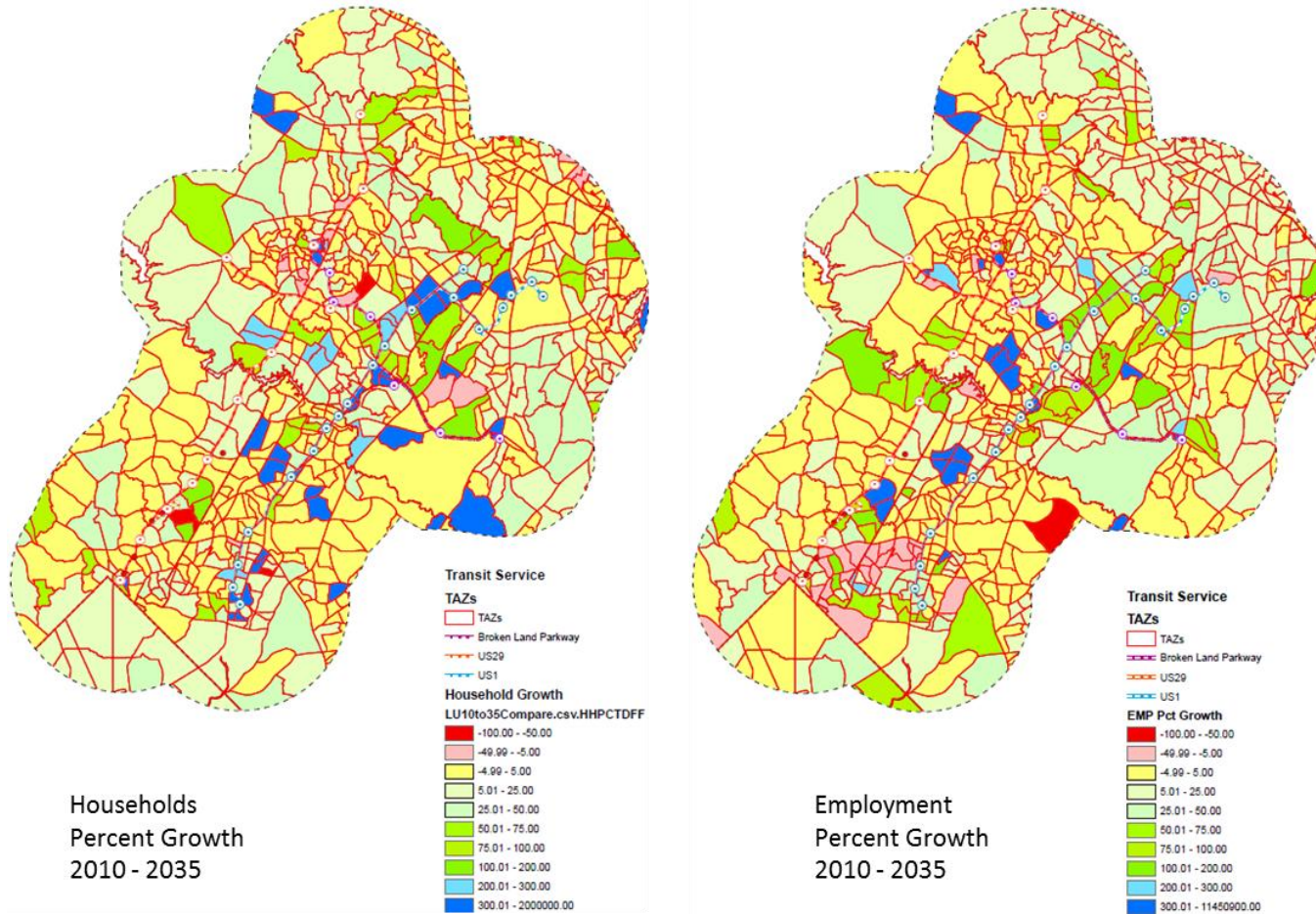


Figure 12 Percent Growth in Households and Employment (2010 - 2035)

### 3.3 Transit Service Policies

Service Policies deal with those factors that are most readily apparent to potential riders, and are therefore, in addition to destinations served, significant to attracting a pool of riders for the service. Simply put, the service policies determine the level of service that will be provided (service design, vehicles, speeds), how much service will be provided (headways), when will it be provided (span of service) and costs (fares). They provide the system inputs used for coding the transit network into the forecasting model. They also provide inputs required for developing the Operating and Maintenance (O&M) and other costs. The service policy assumptions were made initially based upon a review of the current operations in the corridor and recent BRT and LRT projects in Maryland and Virginia (Corridor Cities Transit Way, the Southern Maryland Rapid Transit System Study, the Purple Line, the Crystal City Potomac Yards BRT project, etc.). The initial and final service policy assumptions are shown in Table 6.

**Table 6 Howard County BRT 2035 Service Policies**

Policy Assumptions	Initial	Final
Vehicle	60 foot Articulated BRT Vehicle Capacity = 90 passengers Cross platform, multiple door access	Adjusted to demand within each corridor
Span of Service	Weekdays & Sunday: 5 am to 12 midnight Friday & Saturday: 5 am to 2 am	Weekdays & Sunday: 5 am to midnight Friday & Saturday: 6 am to 6 PM
Feeder Bus Speeds	From BMC model process: Congested speed + dwell time Dwell = 0.65 minutes for local service: Dwell = 1.4 minutes for Express (non BRT station)	Adjusted to final model run
Howard County BRT speed	Maximum: 55 mph for exclusive ROW Maximum: Free flow of Parallel facility for Bus on Shoulder Plus: acceleration, deceleration, dwell, and turn restrictions for stations Dwell: 20 seconds at BRT stations	Adjusted to final model run
Park and Ride Access	Within Howard County: Park and Ride at all Stations to estimate potential Other: As provided by Jurisdiction	Adjusted to demand within each corridor
Kiss and Ride Access	At all stations	No adjustment
Pedestrian and Bicycle Access	Expanded amenities and access at all stations	No adjustment
Fares	BRT = MTA Commuter Zone Fare Local Feeder = Free transfer	No adjustment
Transit Signal Priority	At all at grade crossings	No adjustment
Fare Collection	Off Board Fare Collection	No adjustment
Traveler Information	Next Bus Displays at all stations Internet Next Bus website and app On vehicle annunciation and display	No adjustment
Branding:	Unique Vehicle and Branding/Marketing	No adjustment
Headways:		
US 29 Corridor	Peak: 7.5 minutes Off Peak: 15 minutes Late Night & Weekend: 30 minutes	Peak: 7.5 minutes on US29 & Broken Land Pkwy 30 minutes on Clarksville Off Peak: 15 minutes & 60 minutes Late Night & Weekend: 60 minutes
US 1 Corridor	Peak: 7.5 minutes mainline (15 on each branch) Off Peak: 15 minutes mainline (30 on each branch) Late Night & Weekend: 30 minutes with turnback at Jessup North	Peak: 10 minutes BWI, 20 minutes Elkridge Off Peak: 20 minutes BWI, 30 minutes Elkridge Late Night & Weekend: 60 minutes
Broken Land Parkway	Peak: 7.5 minutes Off Peak: 15 minutes Late Night & Weekend: 30 minutes	Peak: 7.5 minutes Off Peak: 15 minutes Late Night & Weekend: 60 minutes Turnback at South Jessup

Highlights of the recommended service policies are:

- A 60 foot articulated special BRT vehicle for the BRT service and standard small 30 foot standard bus for new local/circulator service.



- Service Design
  - Exclusive guideway when considered feasible (see Section 2) in order to test the potential for high quality BRT to/from and within Howard County. The other jurisdictions (Montgomery County, Anne Arundel County and Prince George’s County) will ultimately determine the type of right of way treatment within their borders.
  - All Stop service along each corridor.
  - Bi-Directional service throughout the day.
- Service Frequency (Headways)
  - 7.5 min. Peak, 15 min. off peak, 30 min. night and weekends
  - Final Headways balanced to forecast ridership
- Span of Service
  - 5 am to midnight on weekdays
  - 6 am to 6 pm on weekends and holidays.

### 3.4 Ridership Forecasts for the Base and BRT system.

Ridership forecasts were carried out for the 2035 Nobuild and BRT alternatives.

One key indicator of the potential of a new transit alternative is the change in transit ridership. There are two basic ways to report ridership: Linked Trips where people choose transit as they travel from their origin to their destination (transfers are not counted), and unlinked trips where every time a person boards a transit vehicle their boarding is counted as a trip. Unlinked trips include transfers so one linked trip with 2 transfers would provide 3 unlinked trips (the initial boarding plus the 2 transfers). Both measures are useful. The following sections address new transit trips based upon linked trips and the boardings/alighting/onboard trips shown for each line.

#### Ridership Forecasting Terms

- Linked Trips = Transit trip from start to end
- Unlinked Trips = Each leg of a linked trip (Boardings on each line)
- Boarding = Getting on a transit vehicle
- Alighting = Getting off a transit vehicle
- Production = The home or starting location of a trip
- Attraction = The destination or ending location of a trip



#### 3.4.1 New transit trips

New linked transit trips reflect the ability of a transit alternative to attract transit riders from other modes. They are typically reported from where a traveler starts at the beginning of the day (home end) as productions and where a traveler works or shops (work/shop end) as attractions. These align with home/housing land uses for productions and commercial, office, retail, etc. land uses for the attractions.

Table 7 provides the changes in linked trips (productions and attractions to and from the four jurisdictions that are served by proposed Howard County BRT System. As shown there is a very significant potential market for this premium system with an increase of 9,080 transit trips produced from Howard County and 21,164 from the four counties in total. Likewise, the addition of reverse commute service in the peaks and throughout the day opens up new markets with an increase of 12,579 trips attracted to Howard County and 30,487 trips in total. Note, that these increases represent trips that would not be made by private automobiles and lead to reductions in automobile vehicle miles and vehicle hours travelled.



Table 7 New 2035 Linked Transit Trips

Jurisdiction	From (productions)			To (Attractions)		
	2035 Base	2035 BRT 1	Difference	2035 Base	2035 BRT 1	Difference
Howard County	12,896	21,976	9,080	9,554	22,133	12,579
Anne Arundel County	24,851	30,691	5,840	15,265	22,481	7,216
Prince George's County	1,642	4,631	2,989	973	4,018	3,045
Montgomery County	559	3,814	3,255	154	7,801	7,647
			21,164			30,487

**3.4.2 Unlinked Trips and Line Characteristics.**

Unlinked trips represented by boardings and alightings and onboard passengers between stations are also important in that they provide more detailed information on the operations of each line in the system. Along with providing information on how well each line attracts riders, they are used later to estimate peak loading points, vehicles, and operating costs.

Table 8 provides the unlinked trips (boardings) and other operating statistics for each of the BRT corridors that are part of the overall Phase II BRT system. The US 29 BRT attracts 18,222 boardings per average weekday, which is comparable to the forecasts made for the Baltimore Red Line before it was cancelled. It also has the longest average trip length of 12.2 miles and 14.9 minutes. This reflects the commuting nature of the travel in the US 29 corridor. On the other hand the US 1 BRT has the most boardings at 20,266 but the trips are shorter in nature. People are boarding and alighting for shorter trips along the whole corridor. The Broken Land Parkway BRT has close to the same number of boardings as the US 29 but much shorter trips. Note, that as discussed next many of the boardings for the Broken Land Parkway are likely due to transfers to/from US 29 or US 1.

Table 8 BRT Line Statistics Summary (2035)

	US 29	US1	Broken Land Parkway	Total
Average Weekday	US 29	US1	Broken Land Parkway	Total
Boardings	18222	20266	18213	56701
Passenger Miles	221404	186401	122466	530271
Passenger Hours	4510	4004	3357	11871
Average Trip Length (miles)	12.2	9.2	6.7	9.4
Average Trip Length (minutes)	14.9	11.9	11.1	12.6

For comparison: Baltimore Redline BRT Boardings =18,915

Line profiles capture the boardings and alightings and passengers on board along the BRT route by direction. The line profiles for each corridor are shown in the following figures and tables. Note, that only trips to/from the BMC region are included in these figures and tables (riders getting on and off within Montgomery or Prince George’s County are not shown).

Figure 13 and Table 9 provide the line profile and summary table for the US 29 BRT. The highest daily boardings Southbound are at the Mount Hebron Station reflecting the new market along I-70. The high boardings at the Long Gate station also are the result of this new market. Interestingly there are also noticeable boardings at the Snowden River Parkway station that are the result of transfers from the Broken Land Parkway BRT. Not surprisingly, the most significant alightings occur at the Columbia Town Center, the Tech Road (White Oak), and the Silver Spring Transit Center. The North bound line profile and data reflect these same travelers returning home. The peak passenger loading occurs just south of

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the US 32 branch point and high loading continues until passengers board/alight at Tech Road (White Oak).

Figure 14 and Table 10 provide the line profile and summary table for the Broken Land Parkway BRT. The highest boarding and alighting locations in both directions occur at the stations where there are transfers to the US 29 BRT, the US 1 BRT, or the MARC trains. This reflects the very important system connectivity provided by this line, that was not part of the Phase I Howard County BRT study. Fort Meade also has noticeable boardings and alightings. Peak passenger loading occurs in both directions around the Columbia Gateway Station.

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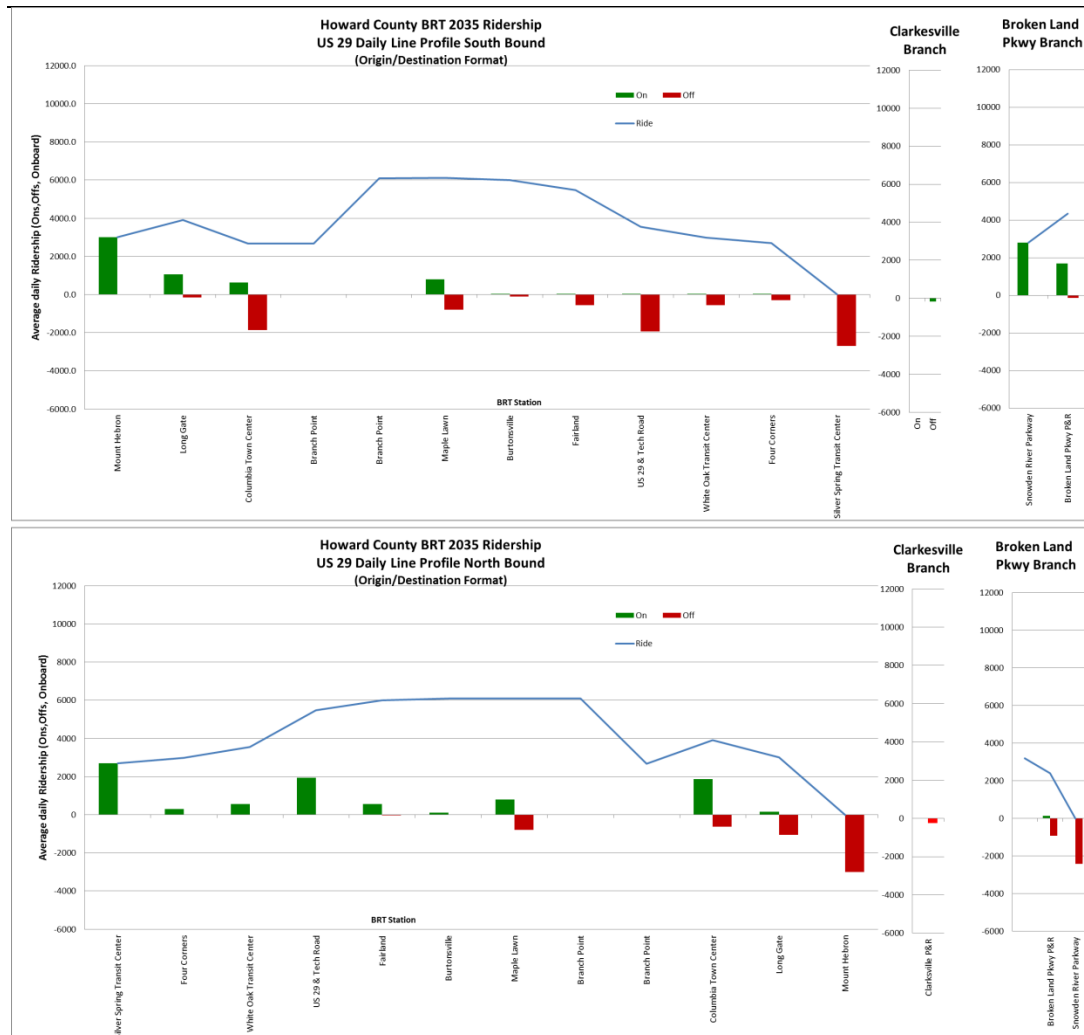


Figure 13 US 29 BRT Line Profile (2035)

Table 9 US 29 BRT Daily Ons, Offs, and Onboard (2035)

South Bound	-----Daily-----			North Bound	-----Daily-----		
Stop	On	Off	Ride	Stop	On	Off	Ride
Mount Hebron	3006.0	0.0	3006.0	Silver Spring Transit Center	2690	0	2690
Long Gate	1060.5	-152.5	3914.0	Four Corners	298	-11	2978
Columbia Town Center	627.5	-1872.0	2669.5	White Oak Transit Center	568	-2	3544
Branch Point	0.0	0.0	2669.5	US 29 & Tech Road	1926	-6	5464
Branch Point	0.0	0.0	6100.5	Fairland	553	-27	5989
Maple Lawn	798.0	-794.5	6104.0	Burtonsville	115	-3	6101
Burtonsville	3.0	-115.0	5992.0	Maple Lawn	795	-798	6098
Fairland	27.0	-553	5466.5	Branch Point	0	0	6098
US 29 & Tech Road	6.0	-1926.0	3546.5	Branch Point	0	0	2667
White Oak Transit Center	1.5	-567.5	2980.5	Columbia Town Center	1872	-628	3911
Four Corners	10.5	-298.0	2693.0	Long Gate	153	-1061	3003
Silver Spring Transit Center	0.0	-2690.0	3.0	Mount Hebron	0	-3006	-3
Stop	On	Off	Ride	Stop	On	Off	Ride
Clarksville P&R	235	0	235	Line Merge			235
Line Merge	0	0	235	Clarksville P&R	0	-235	0
Stop	On	Off	Ride	Stop	On	Off	Ride
Snowden River Parkway	2411	0	2411				3196
Broken Land Pkwy P&R	926	-141	3196	Broken Land Pkwy P&R	141	-926	2411
Branch Point	0	0	3196	Snowden River Parkway	0	-2411	0

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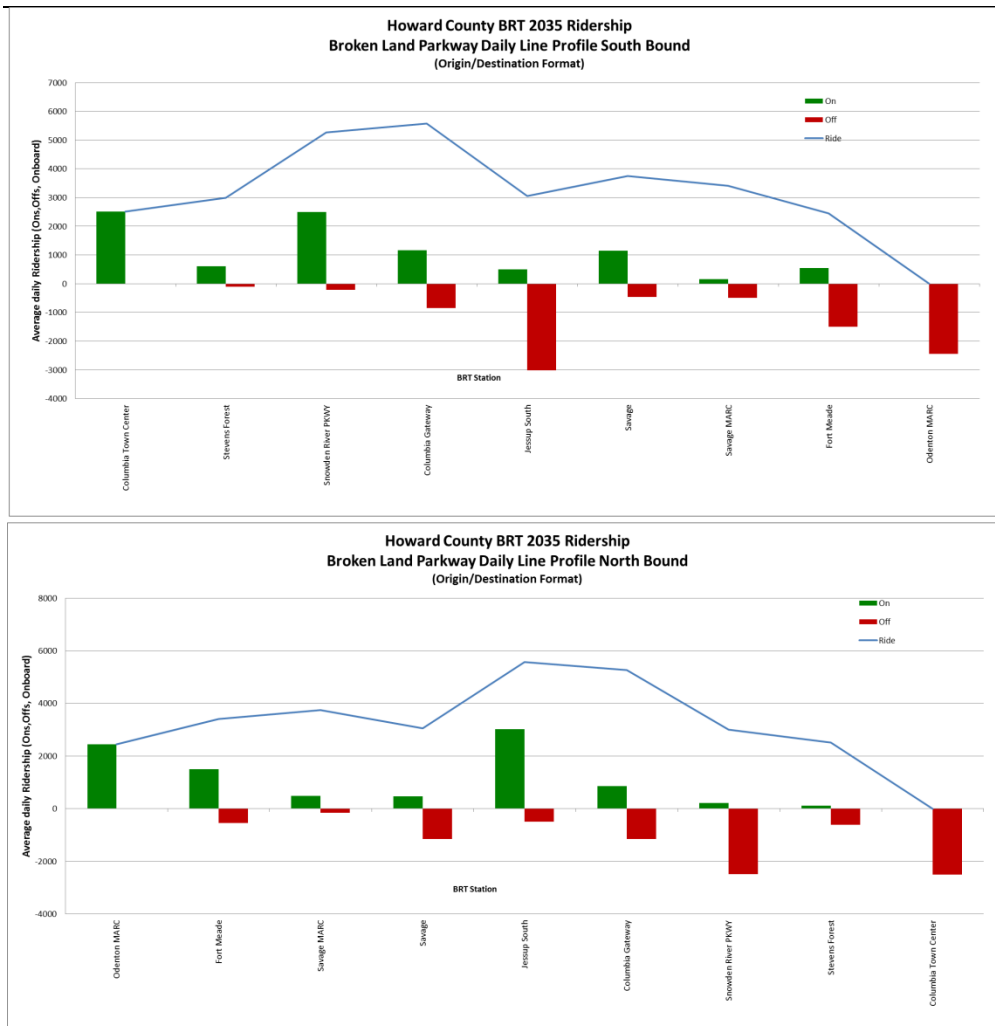


Figure 14 Broken Land Parkway BRT Line Profile (2035)

Table 10 Broken Land Parkway BRT Daily Ons, Offs, and Onboard (2035)

Southbound Stop	-----Daily-----			Northbound Stop	-----Daily-----		
	On	Off	Ride		On	Off	Ride
Columbia Town Center	2504	0	2504	Odenton MARC	2451	0	2451
Stevens Forest	605	-112	2997	Fort Meade	1506	-548	3409
Snowden River PKWY	2490	-219	5269	Savage MARC	490	-151	3748
Columbia Gateway	1159.5	-852	5577	Savage	462	-1153	3056
Jessup South	496	-3017	3056	Jessup South	3017	-496	5577
Savage	1153	-462	3748	Columbia Gateway	852	-1160	5269
Savage MARC	151	-490	3409	Snowden River PKWY	219	-2490	2997
Fort Meade	548	-1506	2451	Stevens Forest	112	-605	2504
Odenton MARC	0	-2451	0	Columbia Town Center	0	-2504	0

Figure 15 and Table 11 provide the line profile and summary table for the US 1 BRT. The US 1 BRT has very high boardings at BWI reflecting the new markets that its connectivity opens up. The boardings at Jessup North and Jessup South also reflect transfers to/From the Broken Land Parkway BRT for travelers to and from BWI. Boardings and alightings are also significant at Arundel Mills. What is interesting is the steady boardings and alightings at all of the stations to the south reflecting the many small activity centers along the corridor. The highest passenger loadings occur between Jessup North and South in both directions.



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Figure 15 US 1 BRT Line Profile (2035)

Table 11 US 1 BRT Daily Ons, Offs, and Onboard (2035)

Southbound	-----Daily-----			Northbound	-----Daily-----		
Stop	On	Off	Ride	Stop	On	Off	Ride
BWI Airport	3303	0	3303	College Park Metro	609	0	609
BWI Business Park	554	-7	3850	U of MD Route 1	403	0	1011
Northrup Grumman	220	-97	3973	N. U of MD	455	0	1466
Rental Car Facility	193	-151	4016	College Park North	888	-20	2334
Arundel Mills	980	-622	4374	Konterra	734	-7	3060
Dorsey MARC	178.5	-223	4330	South Laurel	392	-4	3448
Branch Point	0	0	4330	Downtown Laurel	732	-142	4038
Branch Point	0	0	5105	Laurel Marc	385	-30	4392
Jessup North	1535	-632	6008	North Laurel	759	-362	4789
Jessup South	764	-2585	4187	Savage	463	-1064	4188
Savage	1064	-463	4789	Jessup South	2585	-764	6008
North Laurel	362	-759	4392	Jessup North	632	-1535	5105
Laurel Marc	30	-385	4037	Branch Point	0	0	5105
Downtown Laurel	142	-732	3447	Branch Point	0	0	4330
South Laurel	4	-392	3060	Dorsey MARC	223	-178.5	4374
Konterra	7	-734	2333	Arundel Mills	622	-980	4016
College Park North	20	-888	1466	Rental Car Facility	151	-193	3973
N. U of MD	0	-455	1011	Northrup Grumman	97	-220	3850
U of MD Route 1	0	-403	608	BWI Business Park	7	-554	3303
College Park Metro	0	-609	-1	BWI Airport	0	-3303	0

South Bound	-----Daily-----			North Bound	-----Daily-----		
Stop	On	Off	Ride	Stop	On	Off	Ride
ElkRidge	775	0	775	ElkRidge	0	-775	775
Branch Point			775				

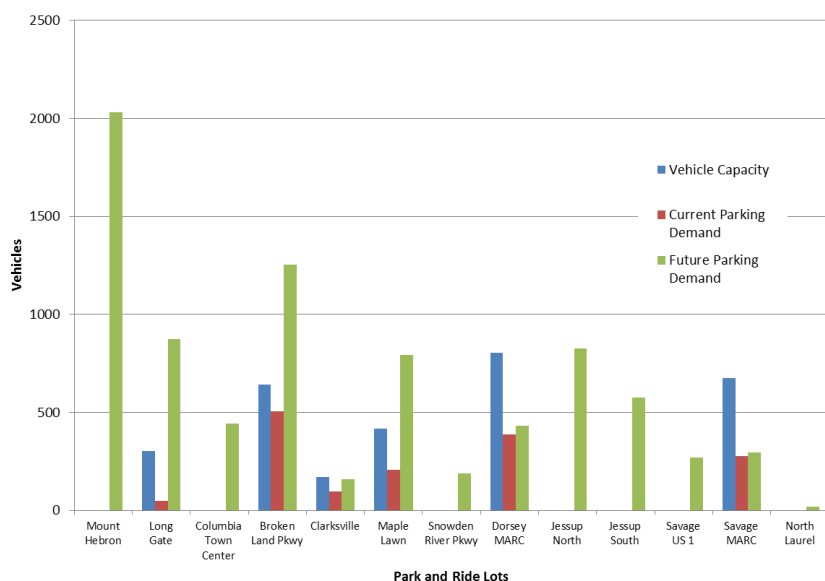
**3.4.3 Parking demand**

Parking demand is derived from the Drive Access trips to each park and ride lot, the likely turnover based upon the type of trip, and the coverage area overlap of the lots (for some park and ride lots near each other that draw on the same coverage areas demand is often balanced to reflect that travelers may go to one or the other depending on any particular day). The current and future (2035) park and ride demand and utilization is provided in Table 12 and Figure 16. These show the very high parking demand and needs in the Northern part of the US 29 BRT (Mount Hebron and Long Gate) as well as demand exceeding current supply at the existing Maple Lawn and Broken Land Parkway stations. Jessup North and Jessup South both also have demand for parking of greater than 500 spaces, and Columbia Town Center has demand just under 500 at 441 spaces.

Consequently, if the Howard County BRT is to successfully fulfill its potential then significant park and ride capacity will need to be planned for at both the existing facilities and also at the new stations with parking.

**Table 12 Park and Ride Demand and Utilization (2035)**

Park & Ride Name	Vehicle Capacity	Current Parking Demand	Percentage of Average Monthly Usage	Additional Parking Demand	Future Parking Demand	Forecasted Utilization
Mount Hebron	0	0	n/a	2032	2032	n/a
Long Gate	302	48.8	16.2%	824	872.8	289.0%
Columbia Town Center	0	0	n/a	441	441	n/a
Broken Land Pkwy	643	505.4	78.6%	749	1254.4	195.1%
Clarksville	170	95	55.9%	63	158	92.9%
Maple Lawn	416	205.6	49.4%	588	793.6	190.8%
Snowden River Pkwy	0	0	n/a	188	188	n/a
Dorsey MARC	802	386.8	48.2%	44	430.8	53.7%
Jessup North	0	0	n/a	826	826	n/a
Jessup South	0	0	n/a	574	574	n/a
Savage US 1	0	0	n/a	270	270	n/a
Savage MARC	676	276	40.8%	18	294	43.5%
North Laurel	0	0	n/a	19	19	n/a



**Figure 16 Forecast Parking Demand**

### 3.5 Performance Measures

The additional performance measures of transit travel time and the impacts of the BRT system on auto travel and congestion are discussed in this section.

#### 3.5.1 Transit Travel Time

The change in 2035 transit travel times from the base transit scenario to the BRT transit scenarios from select origin and destinations are shown in Table 13 and Figure 17. The origin and destination pairs were selected to highlight travel from and to the Phase II BRT system corridors and major destinations where people are likely to want to travel. Where an location was not connected in the base 2035 system a No Connection symbol is shown. Significant travel time savings of 10 to 15 minutes are provided from within the study corridor to Downtown Silver Spring, along with savings of over an hour to College Park Metro. Even more significant is the new travel markets opened up by providing bi-directional transit service and connectivity to places like to BWI, College Park, and White Oak Science Gateway. Note, that there are a few origin destination pairs where service was slightly realigned with essentially the same or slightly higher travel times (no more than 5 minutes greater). An example would be the College Park Metro to Clarksville.

**Table 13 2035 Origin to Destination Transit Travel Times (minutes)**

From:	To:	BASE 2035	BRT 2035	Difference
		Base Transit	BRT Transit	
BWI	Mount Hebron	0.00	32.10	No Access
BWI	Columbia Town Center	68.97	53.73	-15.24
BWI	Broken Land Parkway P&R	44.87	44.63	-0.24
BWI	Clarksville	40.91	41.51	0.60
BWI	Fort Meade	64.90	47.16	-17.74
BWI	Downtown Silver Spring	59.33	49.20	-10.13
BWI	College Park Metro	108.49	51.85	-56.64
BWI	White Oak Science Gateway	0.00	42.51	No Access
Mount Hebron	BWI	46.16	43.69	-2.47
Mount Hebron	Columbia Town Center	68.31	42.23	-26.08
Mount Hebron	Broken Land Parkway P&R	44.77	45.60	0.83
Mount Hebron	Clarksville	40.81	42.48	1.67
Mount Hebron	Fort Meade	0.00	58.24	No Access
Mount Hebron	Downtown Silver Spring	61.00	44.22	-16.78
Mount Hebron	College Park Metro	0.00	51.42	No Access
Mount Hebron	White Oak Science Gateway	0.00	37.54	No Access
Columbia Town Center	BWI	52.86	50.39	-2.47
Columbia Town Center	Mount Hebron	0.00	21.72	No Access
Columbia Town Center	Broken Land Parkway P&R	36.67	35.13	-1.54
Columbia Town Center	Clarksville	32.71	32.01	-0.70
Columbia Town Center	Fort Meade	112.15	72.68	-39.47
Columbia Town Center	Downtown Silver Spring	53.10	37.17	-15.93
Columbia Town Center	College Park Metro	135.02	47.18	-87.84
Columbia Town Center	White Oak Science Gateway	0.00	30.49	No Access
Downtown Silver Spring	BWI	111.77	72.56	-39.21
Downtown Silver Spring	Mount Hebron	0.00	42.82	No Access
Downtown Silver Spring	Columbia Town Center	81.27	56.28	-24.99
Downtown Silver Spring	Broken Land Parkway P&R	53.57	52.04	-1.53
Downtown Silver Spring	Clarksville	49.61	48.92	-0.69
Downtown Silver Spring	Fort Meade	126.95	73.03	-53.92
Downtown Silver Spring	White Oak Science Gateway	0.00	19.18	No Access
College Park Metro	BWI	93.24	66.90	-26.34
College Park Metro	Mount Hebron	0.00	49.23	No Access
College Park Metro	Columbia Town Center	79.97	64.73	-15.24
College Park Metro	Broken Land Parkway P&R	52.27	56.15	3.88
College Park Metro	Clarksville	48.31	53.03	4.72
College Park Metro	Fort Meade	104.08	67.37	-36.71
College Park Metro	White Oak Science Gateway	0.00	25.59	No Access

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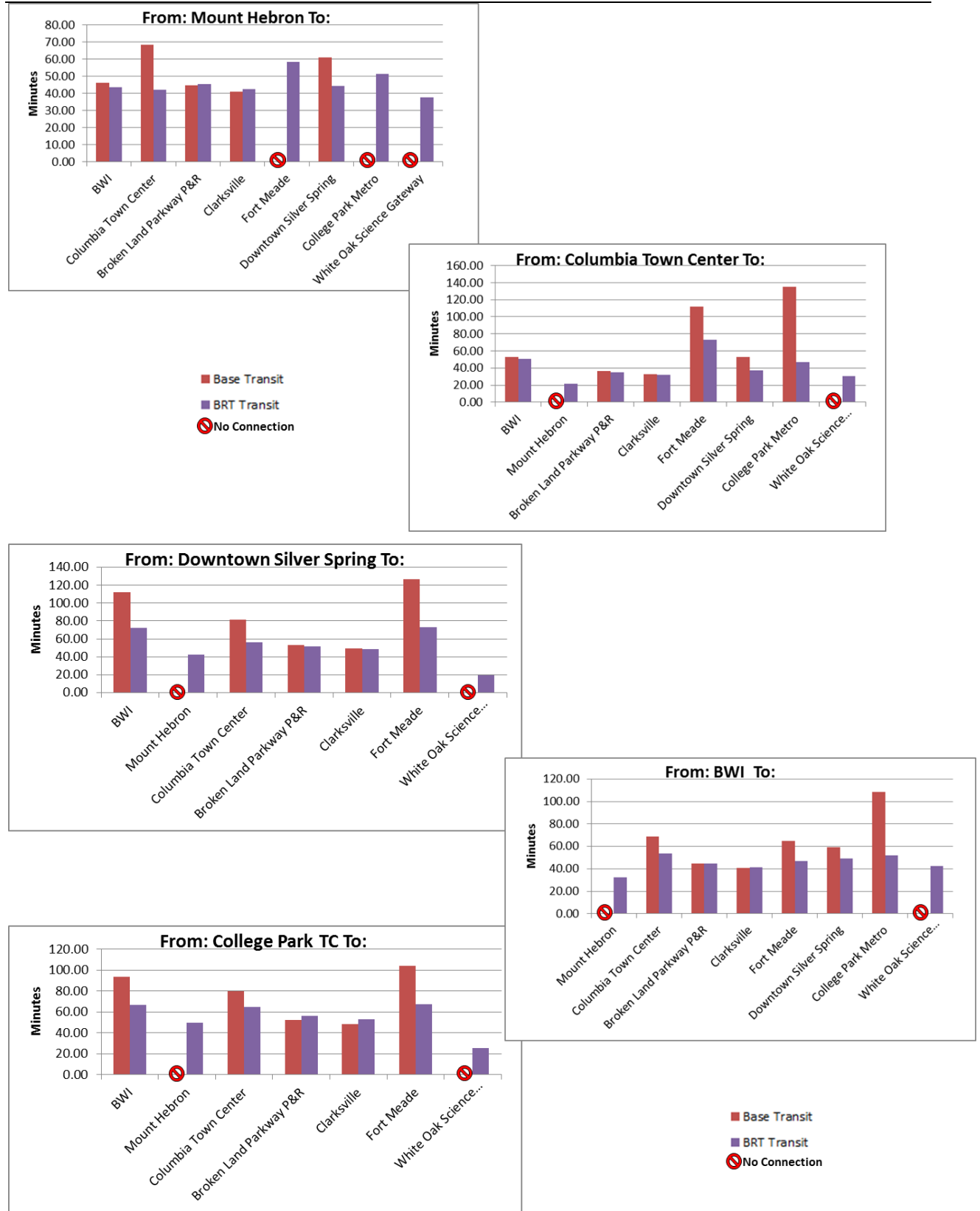


Figure 17 Select Origin Destination Transit 2034 Travel Times (minutes)



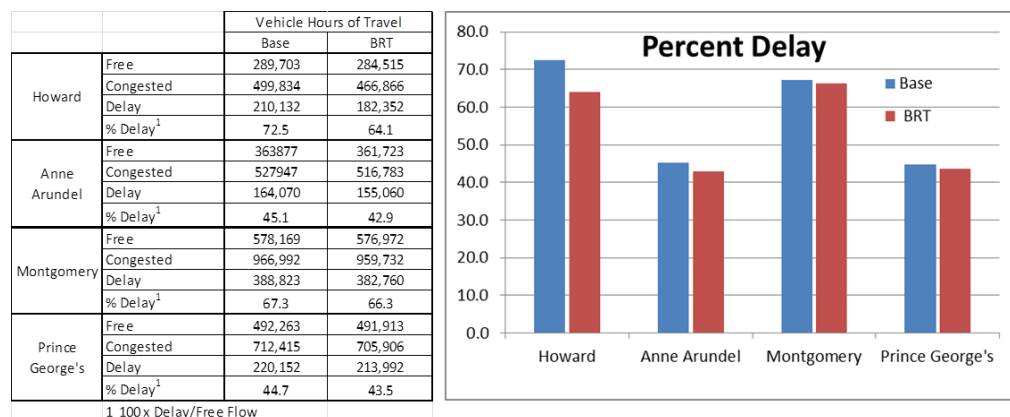
### 3.5.2 Network Auto Travel Congestion

It is desirable that a transit alternative will also produce noticeable changes in the travel on the area’s road networks. Given the significant increase in linked transit trips discussed earlier, this result is expected when comparing the No-Build and Build BRT year 2035 network vehicle mile and vehicle hours of travel. Table 14 shows the changes between the 2035 base and BRT system travel forecasts in vehicle miles traveled (VMT) and vehicle hours of travel (VHT) for the four jurisdictions that the BRT System is within. As expected, Howard County shows the most significant improvements with a drop of 1.71% in VMT and 6.60% in VHT (higher due to congestion). All of the other counties also show slight improvements (the BRT system impacts as smaller percentage of their regions and road networks).

**Table 14 Changes in Vehicle Miles and Vehicle Hours of Travel (2035)**

Vehicle Miles of Travel					Vehicle Hours of Travel				
County	Base	BRT	Diff	% Diff	County	Base	BRT	Diff	% Diff
Howard	13,597,305	13,364,447	-232,858	-1.71%	Howard	499,834	466,866	-32,968	-6.60%
Anne Arundel	16,625,971	16,580,762	-45,209	-0.27%	Anne Arundel	527,947	516,783	-11,164	-2.11%
Montgomery	24,052,667	24,005,163	-47,504	-0.20%	Montgomery	966,992	959,732	-7,260	-0.75%
Prince George's	22,483,952	22,470,401	-13,551	-0.06%	Prince George's	712,415	705,906	-6,509	-0.91%

Figure 18 highlights the VHT changes and impact of congestion. For each county the “Free” VHT is the hours of travel assuming free flow speeds, and the congested time is the time that actually occurred based upon the travel in the network. The Delay is the free time minus congested time, and the percent delay is the delay divided by the free flow time. For Howard County the percent delay improves from 72.5 % to 64.1 %. A significant improvement.



**Figure 18 Vehicle Hours of Travel and Percent Delay**

Figure 19 highlights the VMT changes by severity of congestion. In general if the Volume to Capacity Ratio (V/C) is greater than 0.79 the road segment is considered to have severe congestion (0.48 for 2 lane roads), and if the V/C is between 0.79 and 0.42 it is considered to have some congestion (0.17 for 2 lane roads). Here the change is still an improvement but less noticeable. VMT under severe congestion changes from 40.8 % to 39.9 % within Howard County. For the other counties it varies slightly but is virtually the same.

		Vehicle Miles of Travel		% Vehicle Miles of Travel	
		Base	BRT	Base	BRT
Howard	Free	2,407,366	2,428,180	17.7	18.2
	Some	5,647,729	5,606,902	41.5	42.0
	Severe	5,542,210	5,329,365	40.8	39.9
	Total	13,597,305	13,364,447	100.0	100.0
Anne Arundel	Free	4,110,376	4,094,747	24.7	24.7
	Some	6,184,398	6,205,370	37.2	37.4
	Severe	6,331,198	6,280,645	38.1	37.9
	Total	16,625,971	16,580,762	100.0	100.0
Montgomery	Free	4,073,038	4,062,091	16.9	16.9
	Some	8,042,668	7,959,601	33.4	33.2
	Severe	11,936,960	11,983,471	49.6	49.9
	Total	24,052,667	24,005,163	100.0	100.0
Prince George's	Free	5,308,998	5,350,391	23.6	23.8
	Some	8,584,900	8,571,301	38.2	38.1
	Severe	8,590,053	8,548,709	38.2	38.0
	Total	22,483,952	22,470,401	100.0	100.0

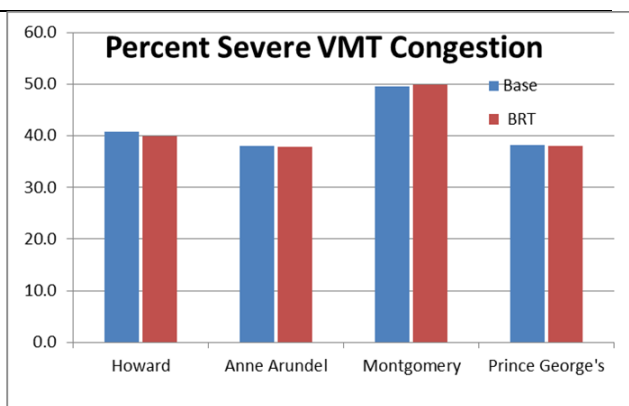


Figure 19 Vehicle Miles of Travel and Percent Severe Congestion

## 4 Costs (Vehicles and Operating and Maintenance)

The Phase II Scope of Work calls for the estimation of: Life cycle capital costs for Vehicles and Equipment (including implementation); the system annual operating costs for the BRT service; and changes to the operating costs of the proposed supporting feeder and local transit service. The scope specifically excludes the costing of stations/ stop structures/ amenities, fare collection systems, guideway and administrative and maintenance facilities/ functions. These capital costs will be addressed in the preliminary engineering analysis following this effort. The vehicle and operations and maintenance cost analyses are summarized in the sections that follow.

### 4.1 Rolling stock

The number of vehicles and their costs depend on the size and type of vehicle assumed for the new service provision. The costs, and can vary greatly depending upon the propulsion type, technology and branding, and loading policies for each type of service provided within the overall system. Table 15 provides a summary of the types of vehicles that are used within the corridor, or have been assumed for Maryland Transportation Administration recent studies (CCT, Purple Line, Red Line, Southern Maryland Rapid Transit), the 2014 APTA Vehicle Database, WMATA, Montgomery County Ride On, and the Regional Transit Authority of Central Maryland. Note, that Montgomery County Maryland is assuming 60 foot articulated branded BRT vehicle (\$1.0 Million/Vehicle) for their BRT service, and the RTA uses standard small 30 foot transit buses. The MTA completed a new purchase of clean diesel vehicles for \$556,800 in March 2016.

Table 15 Vehicle Types, Capacities, and Costs

Type	Length (Ft)	Capacity*			Propulsion Type	Capital Cost (2015 \$)
		Seats	Standees	Total		
Local: Small transit bus	30	30	6	36	Gasoline	\$ 443,000
Local: Standard transit vehicle	40	38	8	46	Clean Diesel	\$ 556,800
Local/Express: Articulated	60	61	12	73	Diesel	\$ 850,000
Commuter: Over the Road Coach	45	55	0 (policy)	55	Diesel	\$ 540,000
Type	Length (Ft)	Capacity			Propulsion Type	Capital Cost (\$)
Bus Rapid Transit (Articulated)	60	60	30	90	Hybrid	\$ 850,000
Specialty BRT (Articulated) <sup>3</sup>	60	27-37	37-90	104-117	Hybrid	\$ 1,146,600
Specialty BRT (2x Articulated) <sup>3</sup>	80	40-70	60-70	110-130	Hybrid	\$ 1,600,000

\* Based upon WMATA loading policy

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The 60 foot articulated branded specialty BRT vehicle (\$1 Million/vehicle) consistent with Montgomery County BRT assumptions was assumed for all BRT service as part of this analysis. New local and circulator service was assumed to be provided by the RTA using its 30 foot standard small bus (\$350,000/vehicle). MTA commuter service was assumed to be provided by a 45 foot over the road coach (\$540,000/vehicle).

The number of required vehicles is determined first by the assumed capacity for each vehicle and the peak hour ridership forecast in the peak direction at the maximum load point. Headways were adjusted until the vehicles could carry the peak load in the peak direction. Second the number of vehicles required to provide that headway are estimated based upon the estimated cycle time for each route (vehicles = [cycle time + assumed layover of 10 minutes]/headway).

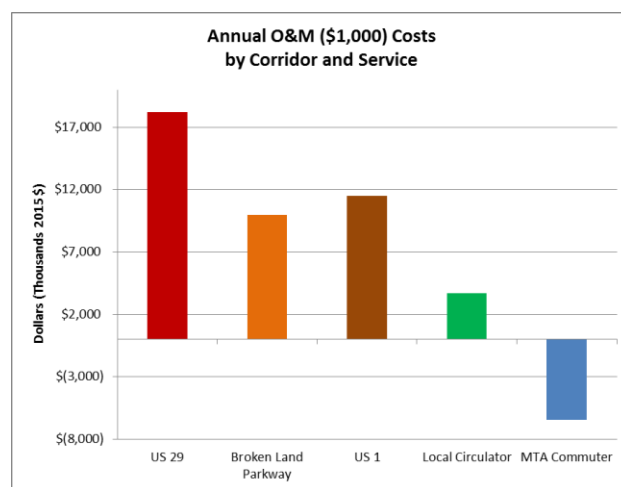
Table 16 summarizes the number of vehicles, and costs for the BRT by corridor, the local feeder service, and MTA commuter service that result. The US 29 BRT due to its length and three branches requires the most vehicles at 20. The Broken Land Parkway BRT service (with a turnback at the Savage Marc Station) requires 7 vehicles, and the US 1 BRT requires 12 vehicles. This results in a total of 39 vehicles with a costs of \$39 million (in 2015\$). The local feeder and shuttle/circulator service changes result in an additional 12 small transit buses at a cost of \$4.1 million. The reduction in MTA service to downtown DC results in a reduction of 22 vehicles and \$11.9 million in savings. The net vehicle costs for implementing the assumed BRT system is therefore \$31.32 million. Note, that these cost estimates do not address which agency finances the costs shown, or reaps any savings.

**Table 16 Howard County Phase II BRT 2035 Vehicle Costs (2015\$)**

Vehicles	Number	Cost/vehicle	Total
New BRT Vehicles			
US 29	20	\$ 1,000,000	\$ 20,000,000
Broken Land Parkway	7	\$ 1,000,000	\$ 7,000,000
US 1	12	\$ 1,000,000	\$ 12,000,000
Sub Total	39	\$ 1,000,000	\$ 39,000,000
Local Service (30 foot bus)*	12	\$ 350,000	\$ 4,200,000
MTA Commuter Bus	-22	\$ 540,000	\$ (11,880,000)
* RTA of Central Maryland (K Donodeo, 3/17/16)		<b>Net Cost</b>	<b>\$ 31,320,000</b>

### 4.2 Operations and Maintenance (O&M)

The Operating and Maintenance costs by BRT corridor and type of service are summarized in Figure 20



**Figure 20 Annual O&M Costs (\$1,000) by Corridor and Service**

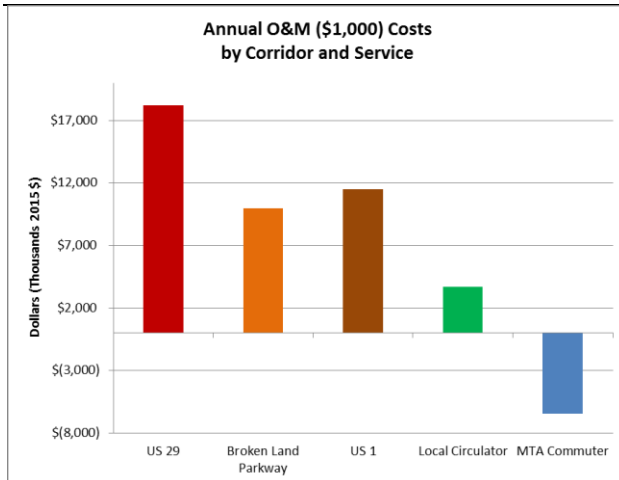


Figure 20.

There are several ways to estimate operating and maintenance costs for transit service including detailed bottom up analysis, simple costs per revenue hour or mile, or fully allocated costing models calibrated to local system characteristics. The FTA recommends that a “fully allocated cost model is the appropriate approach for O&M costing” because it is sensitive to different costs by mode and service type, reflections historic operating experience, and is sensitive to future changes in cost factors (Draft Procedures and Technical methods for Project Planning (FTA, April 2008)). A fully allocated cost model assigns each cost element to an operating characteristic and then calibrates the cost coefficients based upon agency data. This can be represented by the following formula:

$$\text{Annual O\&M Cost} = (A \times \text{Revenue Hours}) + (B \times \text{Revenue Miles}) + (C \times \text{Peak Vehicles})$$

Where: A,B, & C coefficients estimated from local system and NTD data

The fully allocated operations and maintenance cost model developed for the Corridor Cities Transitway and Purple Line as documented in the “I-27 Multi-Modal Corridor Study Corridor Cities Transitway Operating and Maintenance Cost Estimate Report” (MTA, March 2008) and “Purple Line Operating and Maintenance Cost Estimate Technical Report” (MTA, September 2008). Both studies used the same costing model which was validated to three years of agency and National Transit Database statistics. For this study the model was adjusted from 2007\$ to 2015\$ using the Bureau of Labor Statistics Consumer Price Index. Note, that the CCT and Purple Line model uses a cost per mile of guideway for station and guideway costs. This requires that the station spacing, parking lot sizing, and type of guideway be similar to the systems used to estimate the cost factor. This did not seem to be reasonable for the Howard County BRT. Therefore, separate cost factors for the station, guideway, and parking lot costs were determined from additional data obtained from the Crystal City Potomac Yard BRT Transit Operations Plan (January 2012) and the Montgomery County Department of Transportation Countywide Transit Corridors Functional Master Plan - Long Range Planning Cost Estimate (September 2013).

Table 17 provides the cost calculations based upon the revised model for the Howard County BRT system. As shown, the US 29 BRT has an annual O&M cost of \$18.18 million, the Broken Land Parkway O&M cost is \$9.98 million, and the US 1 BRT O&M cost is 11.50 million. This results in a total BRT system O&M cost of \$39.66 million.



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**Table 17 Howard County BRT System O&M Costs (2015\$)**

Howard County BRT								
Components	Peak Vehicles	Revenue Mile	Revenue Hours	ROW Lane miles	New Stations	Enhanced Stations	Parking Lots	
US 29	20	2163104	52261	32.28	4	2	4	
Broken Land Parkway	7	1163957	35256	15.98	4	2	2	
US 1	12	1315896	31094	38.78	14	3	9	
Total	39	4642958	118612	87.04	22	7	15	
Unit Costs (2015\$)	\$/peak vehicles	\$/Rev Mile	\$/Rev Hours	\$/ROW Miles	\$/New Station	\$/Enhanced Station	\$/w Parking	
	\$ 77,412	\$ 5.84	\$ 66.89	\$ 11,190	\$ 12,200	\$ 6,100	\$ 20,000	
Annual O&M Costs								Total
US 29	\$ 1,548,244	\$ 12,634,148	\$ 3,495,677	\$ 361,225	\$ 48,800	\$ 12,200	\$ 80,000	\$ 18,180,295
Broken Land Parkway	\$ 541,886	\$ 6,798,382	\$ 2,358,243	\$ 178,822	\$ 48,800	\$ 12,200	\$ 40,000	\$ 9,978,333
US 1	\$ 928,947	\$ 7,685,821	\$ 2,079,844	\$ 433,962	\$ 170,800	\$ 18,300	\$ 180,000	\$ 11,497,674
Total	\$ 3,019,076	\$ 27,118,351	\$ 7,933,765	\$ 974,009	\$ 268,400	\$ 42,700	\$ 300,000	\$ 39,656,302

In addition, Table 18 provides the changes in O&M costs to provide the additional local feeder and shuttle/circulator service (\$3.67 million), and cost savings due to the reduction in MTA commuter service (\$6.44 million). This results in the net total O&M costs shown in Table 19 for the complete system of \$36.89 million.

**Table 18 Local/Circulator/Commuter Bus Service O&M Costs**

Local/Circulator/Commuter Bus Service				
Components	Peak Vehicles	Revenue Mile	Revenue Hours	
Local/Circulator	12	339242.8	22478.9275	
MTA Commuter	-22	-666300	-35345	
Unit Costs (2015\$)	\$/peak vehicles	\$/Rev Mile	\$/Rev Hours	
Local/Circulator	\$96,599	\$2.33	\$76.45	
MTA Commuter	\$77,412	\$3.55	\$66.89	
Annual O&M Costs				Total
Local/Circulator	\$1,159,184	\$791,022	\$1,718,602	\$3,668,808
MTA Commuter	(\$1,703,069)	(\$2,368,524)	(\$2,364,177)	(\$6,435,770)
Total	(\$543,885)	(\$1,577,503)	(\$645,575)	(\$2,766,962)

**Table 19 Howard County BRT O&M Cost Summary**

Service Type	Annual O&M Costs
Howard County BRT	\$39,656,302
Local Circulator	\$3,668,808
MTA Commuter	(\$6,435,770)
Total	\$36,889,340

## 5 Summary of Findings and Next Steps

### 5.1 Key Findings

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This Technical Report documents the Howard County Bus Rapid Transit (BRT) Phase II Study effort, analysis, and results. The Phase II study is an extension of the previous conceptual Phase I effort performed to evaluate a Bus Rapid Transit network for the County, including linkages to other activity centers and transit systems in the Baltimore/Washington Region. Based upon the recommended BRT system for US 29, Broken Land Parkway and US 1, and related local/ feeder bus service, the study clearly documents a significant travel market and demand for high quality BRT From/To and within Howard County for each of the three corridors. New daily transit trips (linked) in 2035 from Howard County (production) over the Nobuild are 9,080, and to Howard County (attractions) are 12,579. Forecast daily BRT boardings for trips to and from the BMC region in 2035 are 18,222 for US 29, 20,266 for US 1, and 18, 213 for Broken Land Parkway. Other findings are:

- There is significant demand from the Northern most stations (Mount Hebron and Long Gate) due to their proximity to I-70, and the new travel markets that this opens up.
- The network connections and the “system” connectivity offered by tying the 3 corridors together to major activity centers and regional fixed-rail transit networks expand connectivity and open up new travel markets (Arundel Mills, University of Maryland, BWI, etc.).
- Much of the demand is for the drive access/park and ride transit users which generates significant demand for park and ride lots.

### **5.2 Recommended Next Steps**

With the completion of the Phase II study the BRT system can move forward to the next stage of right-of-way design, environmental impact and preliminary engineering. Specific suggested next steps include:

- Coordination with local stakeholder on corridor planning and preliminary engineering Montgomery County (US 29), Prince George’s County (US 1), Anne Arundel County (US 1/ Broken Land/ 32)
- Incorporate into next County Transit Development Plan
- Initiate Preliminary Engineering for determining: Dedicated ROW where needed to provide reliable transit speeds/ quality of service; Access/Egress to guideway at key locations; and Station costs/ parking supply/ ROW preservation
- Consideration of interim commuter service enhancements (e.g. Bus on Shoulder)
- Identify and secure funding for preliminary engineering and construction

Appendices

**Intermodal Connections/ Schematic Route Maps**

**Model Validation**

**Alignments and Station Location Development**

**Station Area Planning**

**Travel Forecasting Results**

**Technical Meeting Presentations**

## Intermodal Connections/ Schematic Route Maps

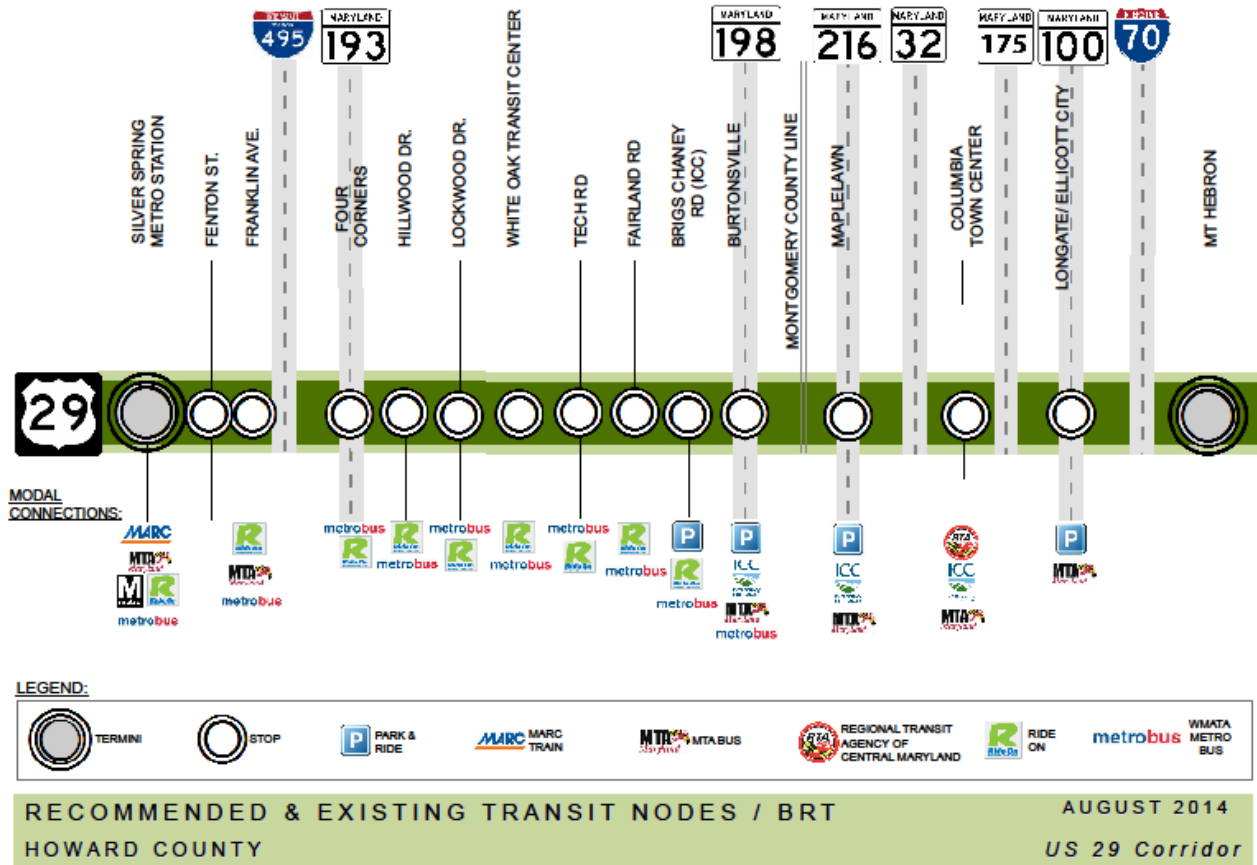


Figure 21 US 29 Corridor Modal Connections

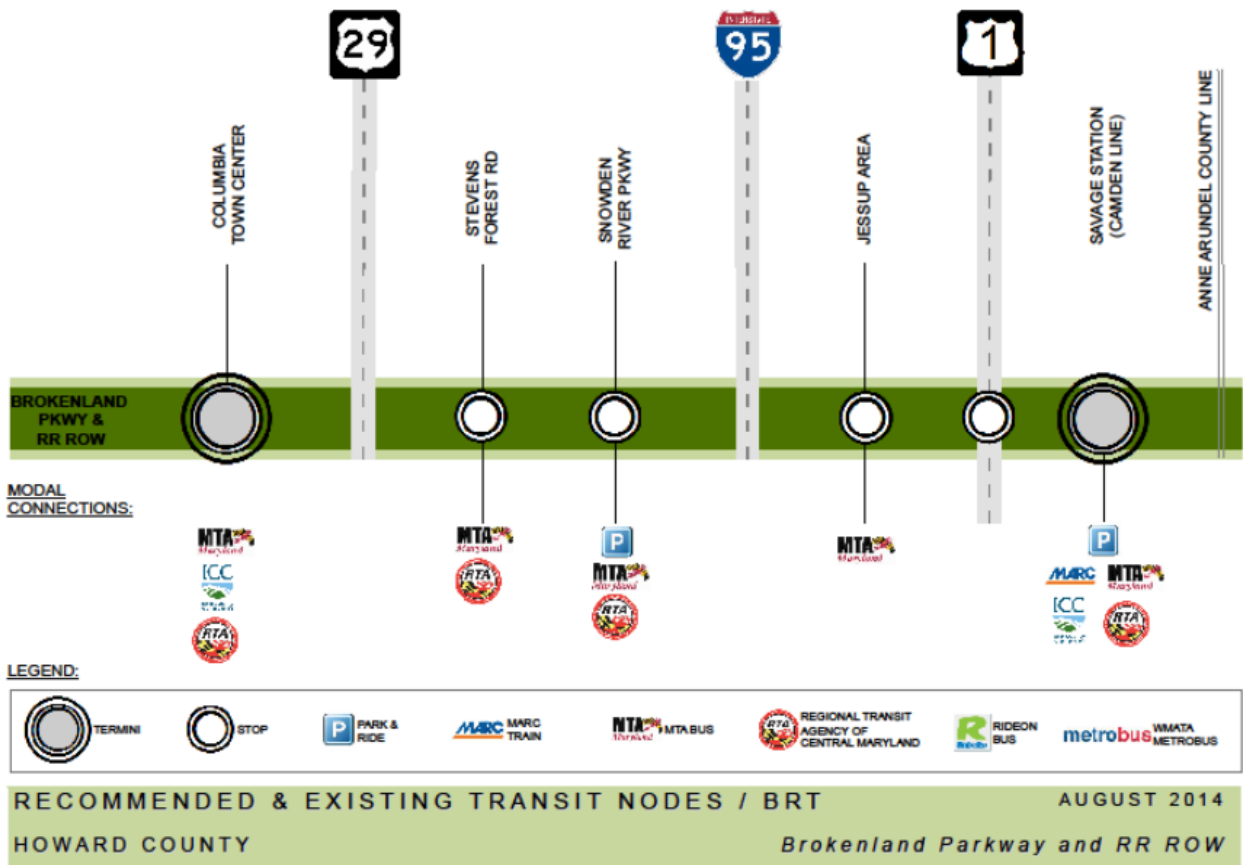


Figure 22 Broken Land Parkway Modal Connections



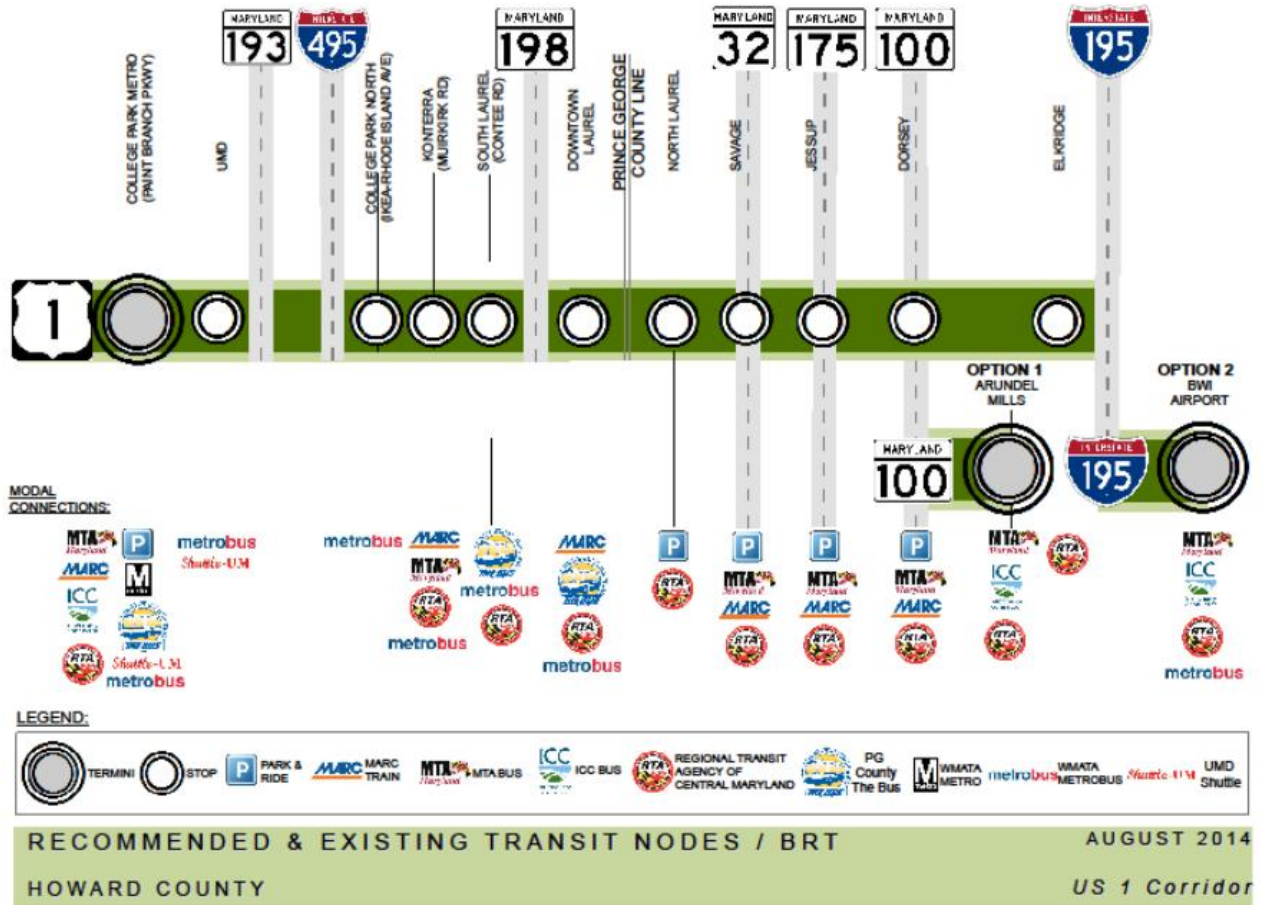
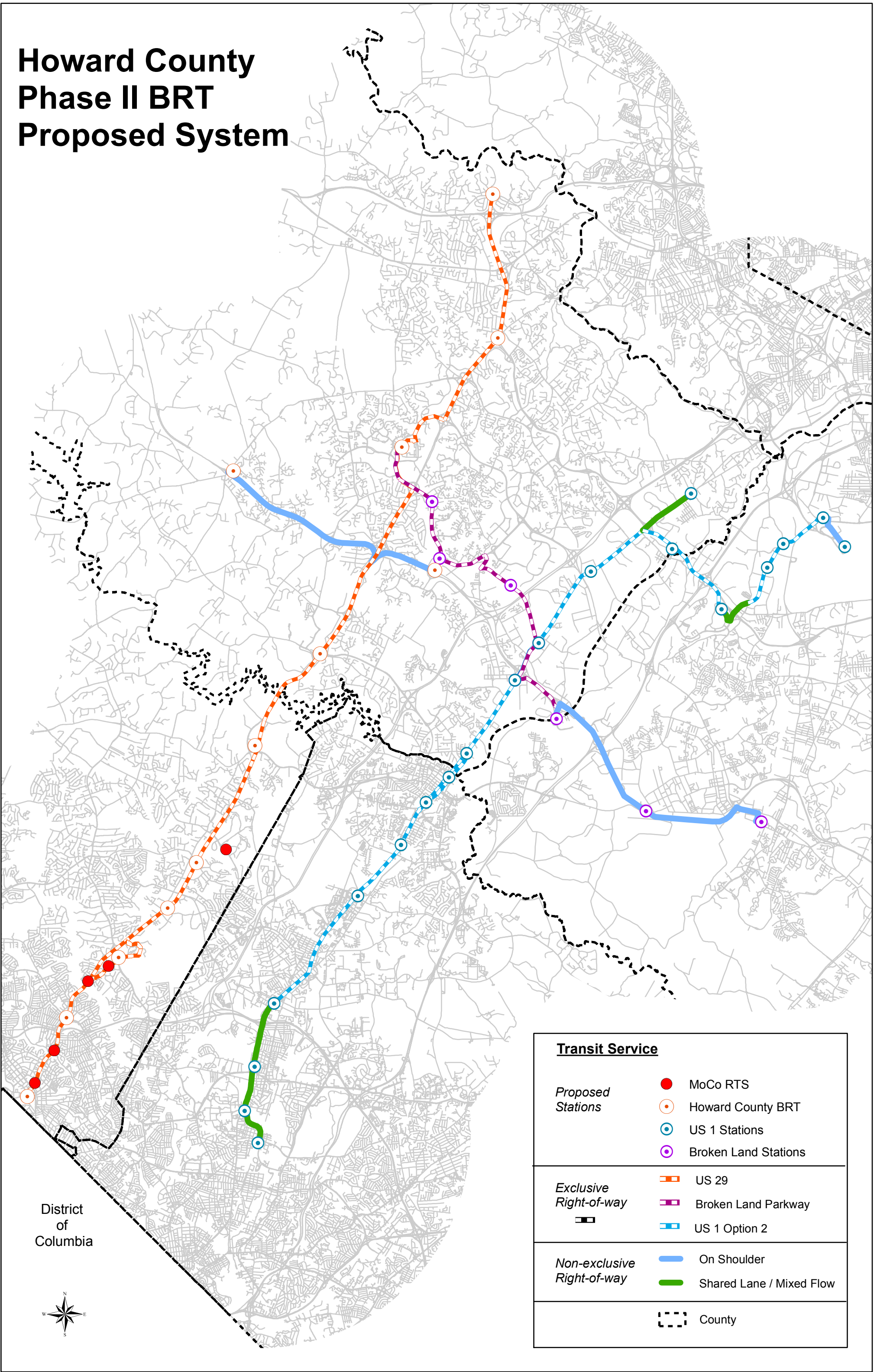


Figure 23 US 1 Corridor Modal Connections

# Howard County Phase II BRT Proposed System



<b>Transit Service</b>	
<i>Proposed Stations</i>	● MoCo RTS
	○ Howard County BRT
	⊙ US 1 Stations
	⊙ Broken Land Stations
<i>Exclusive Right-of-way</i>	▬ US 29
	▬ Broken Land Parkway
	▬ US 1 Option 2
<i>Non-exclusive Right-of-way</i>	▬ On Shoulder
	▬ Shared Lane / Mixed Flow
▬ County	

District of Columbia

